

Recommended Plant Lists for Best Management Practices

Appendix D2

RECOMMENDED PLANT LISTS FOR BEST MANAGEMENT PRACTICES

This appendix contains recommended native and non-native (when appropriate) plant species for the Best Management Practices detailed throughout the manual. The recommended list contains species that are considered suitable to conditions in Central Indiana, which is located in Ecoregion 55. Species have been recommended based on hardiness, aesthetics, functionality, and commercial availability. It is certain that species exist outside the confines of this list that will perform in a comparable way to those listed; however, commercial availability is often a limiting factor in obtaining material for native plantings. Over time, and in certain locales, additional species will become available to supplement those listed below.

An array of planting zones is provided based on normal water levels (**Figure 1**). Using these zones will provide the best chances for long-term success of native planting in the context of LID. While plants may

naturally occur outside of the given ranges, these ranges are intended to be guidelines for plant installation. Whenever possible and practical in standing water conditions, native plants should be installed in live plant form (rather than seed). Seed or a combination of seed and live plants may be used in upland situations.

Recommendations are given for height, bloom color, bloom time, sun requirements, and salt tolerance. Please note that these are recommendations based on a range of situations, and a specific plant or population may vary from site-to-site. For sun requirements, F = full sun required, P = partial sun tolerated, and S = shade tolerated. Salt tolerance is classified as Yes (Y) or No (N). This was determined through literature reviews and anecdotal evidence. If there is no information confirming tolerance, a “No” was listed.

	Zone A — 2”-4” Below Water Level	Zone B — 0”-2” Below Water Level	Zone C — 0”-2” Above Water Level	Zone D — 2”-4” Above Water Level	Zone E — 4”-18” Above Water Level	Zone F — 18”+ Above Water Level	Zone G — Planter Boxes	Zone H — Vegetated Roofs
Rain gardens/Bioretention	✿	✿	✿	✿	✿	✿		
Vegetated Filter Strips			✿	✿	✿	✿		
Vegetated Swales		✿	✿	✿				
Infiltration Basin		✿	✿					
Subsurface Infiltration Basins				✿	✿	✿		
Infiltration Trenches				✿	✿	✿		
Infiltration Berns	✿	✿	✿	✿	✿	✿		
Planter Boxes							✿	
Vegetated Roofs								✿
Constructed Wetlands	✿	✿	✿	✿				
Wet Ponds	✿	✿	✿					
Dry Extended Detention Basins			✿	✿	✿	✿		
Riparian Corridor Restoration			✿	✿				
Native Revegetation	✿	✿	✿	✿	✿	✿	✿	✿

Figure 1 Planting Zone/BMP Matrix

Plant Installation

Native Seeding

Seasonal consideration: October 1-June 15 (note: seeds should not be planted on frozen ground).

Native seeding is generally recommended for areas above the water line or 1-2" below the water line. Live plant material should be used to establish vegetation at deeper water levels.

Broadcast seeding

Broadcast seeding is preferred over drill seeding on graded, bare soil sites. Apply the seed uniformly over the surface using a combination seeder/cultipacker unit such as a Brillion or Truax Trillion seeder. The Trillion seeder is preferred as it is designed to handle native seeds.

A cone seeder or other similar broadcasting equipment may also be used if the seed mix does not contain fluffy seeds in amounts sufficient to prevent free flowing without plugging. Seed should then be pressed into the surface using a cultipacker or roller.

Drill seeding

A rangeland-type no-till drill designed to plant native grasses and forbs may be used in bare soils although this equipment is specifically designed to plant through existing vegetation which is killed with an herbicide. Cultipacking or rolling before seeding may be required to prevent seed placement depths exceeding 0.25 inch, but cultipacking or rolling after seeding is not required.

All seeding equipment, whether broadcast or drill, should be calibrated to deliver the seed at the rates and proportions specified in the plans. Equipment should be operated to ensure complete coverage of the entire area to be seeded, and seed must be placed no deeper than 0.25 inch in the soil. No fertilizers or soil conditioners will be required or allowed.

Native Planting

Seasonal considerations: May 1-July 1

Plant plugs should be installed in holes drilled with an auger the same diameter and depth as the plug within +0.75 inch/- 0.25 inch. In wetland plantings where soil is soft and moist enough, a dibble bar or trowel may also be used. The planting layout should consider the requirements of the individual species regarding soil type, moisture, slope, shading, and other factors for the particular plant species.

Planting densities vary according to budget and project goals and can range from three-to-five foot spacing for plug supplements of seeded areas to six inches to two foot spacing for high visibility landscaping projects with large budgets. Groups of five-to-seven plugs of the same species planted approximately one foot apart is usually preferable to planting all species intermixed randomly across the site at a uniform density.

In wetland or shoreline areas with potential for high wave action or wildlife predation that may dislodge newly planted plugs, plugs should be secured with 6-inch or 8-inch U-shaped wire erosion control blanket staples. Staple length is determined by the density of the planting substrate; softer substrates require longer length to hold plugs adequately.

In areas where potential for wildlife predation exists, such as retention basins or other planting areas adjacent to open water, waterfowl barriers should be installed around a minimum of 50 percent of the plugs. All plugs not protected by barriers should be stapled into the substrate as described above. Barriers may consist of plastic or wire mesh enclosures supported with wooden stakes, adequately constructed to inhibit access by waterfowl for one growing season. Enclosures should extend at least two feet above the plant tops. Methodology should be approved by the project designer with input from a restoration ecologist if necessary. Barriers may be removed after one growing season.

Tree and Shrub Planting

See "[Planting & Transplanting Landscape Trees & Shrubs](#)" from the Purdue University Cooperative Extension Service – Department of Horticulture, Publication HO-100-W.

Maintenance and Management

Maintaining vegetated BMPs is typically most important during the first few years following installation. Supplemental irrigation may be needed to help establish plants in drought conditions. Plants may need to be replaced due to predation or other unseen factors. Most commonly, management includes removing invasive species via mowing, hand-pulling, or spot herbicide applications. In larger areas, broadcast herbicide applications may be appropriate. Over time in upland areas, controlled burning may be used as a way to invigorate the plantings and control certain invasive species. If not feasible for social or cultural reasons, an annual or biennial mowing may be used instead of fire.

Long-term management may be necessary, but is typically significantly less intensive. The site should be periodically checked for invasive species infestations. Any prairie or open area may need occasional (every three to five years) burning or mowing to remove woody vegetation that may encroach.

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Zone A

Planting Zone = Two-to-four inches below water level

These species require continual inundation within the given water depths in order to thrive. Although slight, short-term variances may be tolerated (\pm five inches for a period of 48 hours or less), water levels must remain in this range for a majority of the growing season for maximum plant growth and survival.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
Woody Species:						
<i>Cephalanthus occidentalis</i>	Buttonbush	15'	White	Jun-Aug	F/P/S	N
Grasses/Sedges/Rushes:						
<i>Acorus calamus</i>	Sweet flag	1'-4'	Green	May-Jun	F/P	N
<i>Scirpus acutus</i>	Hard-stemmed bulrush	4'-6'	Brown	Apr-Aug	F	Y
<i>Scirpus validus</i>	Great bulrush	4'-8'	Brown	May-Aug	F	Y
<i>Sparganium americanum</i>	American bur reed	2'-5'	Green	Jun-Aug	F/P	N
<i>Sparganium eurycarpum</i>	Common bur reed	2'-6'	Green	May-Aug	F	N
Forbs:						
<i>Asclepias incarnata</i>	Swamp milkweed	3'-5'	Pink	Jun-Sep	F/P	N
<i>Decodon verticillatus</i>	Swamp loosestrife	2'-4'	Purple	Jul-Sep	F/P	N
<i>Iris virginica</i>	Blue flag iris	2'-3'	Purple	May-Jul	F/P/S	N
<i>Peltandra virginica</i>	Arrow arum	2'-5'	Green	Jun-Jul	F/P/S	N
<i>Pontedaria cordata</i>	Pickerelweed	1'-3'	Violet	Jun-Sep	F/P	N
<i>Sagittaria latifolia</i>	Arrowhead	1'-4'	White	Jun-Sep	F/P	N

Representative Zone A Species

Buttonbush



Arrowhead



Blue Flag Iris



Pickerel Weed



Swamp Milkweed

Source: JFNew

Zone B

Planting Zone = Zero-to-two inches below water level

These species tolerate fluctuating water levels within this range. Although slight, short-term variances may be tolerated (\pm five inches for a period of 48 hours or less), water levels must remain in this range for most of the growing season for maximum plant growth and survival.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
<i>Woody Species:</i>						
<i>Cephalanthus occidentalis</i>	Buttonbush	15'	White	Jun-Aug	F/P/S	N
<i>Grasses/Sedges/Rushes:</i>						
<i>Acorus calamus</i>	Sweet flag	1'-4'	Green	May-Jun	F/P	N
<i>Carex comosa</i>	Bristly sedge	2'-3'	Green	May-Jun	F	N
<i>Carex lacustris</i>	Lake sedge	2'-4'	Brown	May-Jun	F/P/S	N
<i>Carex stricta</i>	Tussock sedge	2'-3'	Brown	Apr-Jun	F/P	N
<i>Eleocharis acicularis</i>	Needle spike rush	6"	Green	May-Oct	F	N
<i>Eleocharis obtusa</i>	Blunt spike rush	1'-2'	Green	May-Sep	F/P	N
<i>Glyceria striata</i>	Fowl manna grass	1'-5'	Green	May-Jun	F/P/S	N
<i>Juncus effusus</i>	Soft rush	1'-4'	Brown	July	F/P	N
<i>Scirpus acutus</i>	Hard-stemmed bulrush	4'-6'	Brown	Apr-Aug	F	Y
<i>Scirpus cyperinus</i>	Wool grass	3'-5'	Tan	Jun-Sep	F	Y
<i>Scirpus pendulus</i>	Red bulrush	2'-4'	Brown	May-Jun	F	N
<i>Scirpus validus</i>	Great bulrush	4'-8'	Brown	May-Aug	F	Y
<i>Sparganium americanum</i>	American bur reed	2'-5'	Green	Jun-Aug	F/P	N
<i>Sparganium eurycarpum</i>	Common bur reed	2'-6'	Green	May-Aug	F	N
<i>Forbs:</i>						
<i>Alisma plantago-aquatica</i>	Water plantain	2'-4'	White	Jul-Sep	F	N
<i>Asclepias incarnata</i>	Swamp milkweed	3'-5'	Pink	Jun-Sep	F/P	N
<i>Decodon verticillatus</i>	Swamp loosestrife	2'-4'	Purple	Jul-Sep	F/P	N
<i>Iris virginica</i>	Blue flag iris	2'-3'	Purple	May-Jul	F/P/S	N
<i>Peltandra virginica</i>	Arrow arum	2'-5'	Green	Jun-Jul	F/P/S	N
<i>Pontedaria cordata</i>	Pickerelweed	1'-3'	Violet	Jun-Sep	F/P	N
<i>Sagittaria latifolia</i>	Arrowhead	1'-4'	White	Jun-Sep	F/P	N
<i>Saururus cernuus</i>	Lizard's tail	2'-4'	White	Jun-Aug	P/S	N

Representative Zone B Species

Blue Flag Iris



Arrowhead



Bristly Sedge



Pickerel Weed



Swamp Milkweed

Source: JFNew

Zone C

Planting Zone = Zero-to-two inches above water level

These plants are tolerant of fluctuating water levels within this range. They will also tolerate short periods of inundation, not to exceed 48 hours in most situations, making them appropriate for BMP settings.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
Woody Species:						
<i>Acer rubrum</i>	Red maple	90'	Green/ red	Mar-May	F/P/S	N
<i>Alnus rugosa</i>	Speckled alder	25'	Brown	Mar-May	F/P	N
<i>Amelanchier arborea</i>	Downy serviceberry	40'	White	April	F/P/S	N
<i>Aronia prunifolia</i>	Purple chokeberry	10'	White	Apr-Jul	F/P	N
<i>Betula alleghaniensis</i>	Yellow birch	100'	Purple/ Yellow	Apr-May	P/S	N
<i>Betula papyrifera</i>	Paper birch	70'	Brown	Apr-May	F/P	N
<i>Cephalanthus occidentalis</i>	Buttonbush	15'	White	Jun/Aug	F/P/S	N
<i>Cornus amomum</i>	Silky dogwood	10'	White	May-Jul	F/P	N
<i>Cornus sericea</i>	Red-osier dogwood	10'	White	May-Sep	F/P	N
<i>Ilex verticillata</i>	Winterberry	10'	White	June	F/P/S	Y
<i>Larix laricina</i>	American larch	75'	Brown	May	F/P	N
<i>Lindera benzoin</i>	Spicebush	15'	Yellow	Apr-May	P/S	N
<i>Morus rubra</i>	Red mulberry	50'	Green	May-Jun	F/P/S	N
<i>Nyssa sylvatica</i>	Black gum	100'	Green	May-Jul	F/P/S	Y
<i>Physocarpus opulifolius</i>	Ninebark	10'	White	May-Jun	F/P	N
<i>Picea mariana</i>	Black spruce	60'	Brown	May-Jun	F/P/S	N
<i>Quercus bicolor</i>	Swamp white oak	70'	Green/ yellow	May	F/P/S	Y
<i>Quercus palustris</i>	Pin oak	90'	Green/ yellow	Apr-May	F/P/S	Y
<i>Ribes americanum</i>	Wild black currant	5'	Yellow	Apr-Jun	F/P/S	N
<i>Rosa palustris</i>	Swamp rose	2'-7'	Pink	Jun-Aug	F/P/S	N
<i>Thuja occidentalis</i>	White cedar	50'	Brown	Apr-May	F/P/S	N
<i>Ulmus americana</i>	American elm	100'	Brown	Mar-Apr	F/P/S	N
<i>Ulmus rubra</i>	Slippery elm	80'	Green	Mar-Apr	F/P/S	N
<i>Viburnum lentago</i>	Nannyberry	20'	White	Apr-Jun	P/S	Y
Grasses/Sedges/Rushes:						
<i>Calamagrostis canadensis</i>	Blue joint grass	2'-4'	Brown	June	F/P	N
<i>Carex comosa</i>	Bristly sedge	2'-3'	Green	May-June	F/P	N
<i>Carex crinita</i>	Fringed sedge	2'-5'	Green	May	F/P/S	N
<i>Carex hystericina</i>	Porcupine sedge	2'-3'	Green	May-June	F/P/S	N
<i>Carex lupulina</i>	Common hop sedge	2'-3'	Green/ Brown	May-June	F/P/S	N
<i>Carex muskingumensis</i>	Palm sedge	1'-2'	Brown	May-June	S	N
<i>Carex stipata</i>	Common fox sedge	1'-3'	Brown	Apr-May	F/P/S	N
<i>Carex stricta</i>	Tussock sedge	2'-3'	Brown	Apr-Jun	F/P	N
<i>Carex vulpinoidea</i>	Brown fox sedge	2'-3'	Brown	May-Jun	F/P	N
<i>Cinna arundinacea</i>	Common wood reed	3'-4'	Green	Aug-Sep	P/S	N
<i>Eleocharis acicularis</i>	Needle spike rush	6"	Green	May-Oct	F	N
<i>Eleocharis obtusa</i>	Blunt spike rush	1'-2'	Green	May-Sep	F/P	N
<i>Glyceria striata</i>	Fowl manna grass	1'-5'	Green	May-Jun	F/P/S	N
<i>Juncus effusus</i>	Soft rush	1'-4'	Brown	July	F/P	N
<i>Juncus tenuis</i>	Path rush	6"-2'	Brown	June	F/P/S	N
<i>Juncus torreyi</i>	Torrey's rush	1'-2'	Brown	Jun-Sep	F	Y
<i>Scirpus acutus</i>	Hard-stemmed bulrush	4'-6'	Brown	Apr-Aug	F	Y
<i>Scirpus atrovirens</i>	Dark green rush	3'-5'	Brown	Jun-Aug	F	N
<i>Scirpus cyperinus</i>	Wool grass	3'-5'	Tan	Jun-Sep	F	Y
<i>Scirpus pendulus</i>	Red bulrush	2'-4'	Brown	May-Jun	F	N
<i>Scirpus validus</i>	Great bulrush	4'-8'	Brown	May-Aug	F	Y

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
Forbs:						
<i>Alisma plantago-aquatica</i>	Water plantain	2'-4'	White	Jul-Sep	F	N
<i>Anemone canadensis</i>	Canada anemone	1'-2'	White	May-Sep	F/P	N
<i>Angelica atropurpurea</i>	Great angelica	6'-9'	White	May-Jun	F/P	N
<i>Asclepias incarnata</i>	Swamp milkweed	3'-5'	Pink	Jun-Sep	F/P	N
<i>Aster novae-angliae</i>	New England aster	3'-6'	Violet	Jul-Oct	F/P	N
<i>Aster puniceus</i>	Swamp aster	3'-6'	Lav/ White	Aug-Oct	F	Y
<i>Aster umbellatus</i>	Flat-topped aster	1'-4'	White	Jul-Oct	F/P	N
<i>Cassia hebecarpa</i>	Wild senna	3'-5'	Yellow	Jul-Aug	F/P	N
<i>Chelone glabra</i>	Turtlehead	2'-4'	Cream	Aug-Sep	F/P/S	N
<i>Eupatorium maculatum</i>	Spotted Joe-pye weed	4'-7'	Pink	Jun-Oct	F/P	N
<i>Eupatorium perfoliatum</i>	Boneset	3'-5'	White	Jul-Oct	F/P	Y
<i>Euthamia graminifolia</i>	Grass-leaved goldenrod	1'-4'	Yellow	Jul-Sep	F/P	N
<i>Gentiana andrewsii</i>	Bottle gentian	1'-3'	Blue	Aug-Oct	F/P	N
<i>Helenium autumnale</i>	Sneezeweed	3'-5'	Yellow	Jul-Nov	F/P	Y
<i>Helianthus giganteus</i>	Tall sunflower	5'-12'	Yellow	Jul-Sep	F/P	N
<i>Iris virginica</i>	Blue flag iris	2'-3'	Purple	May-Jul	F/P/S	N
<i>Liatris spicata</i>	Marsh blazing star	3'-5'	Pink	Jul-Sep	F/P	N
<i>Lilium michiganense</i>	Michigan lily	3'-8'	Orange	Jul-Aug	P/S	N
<i>Lobelia cardinalis</i>	Cardinal flower	2'-5'	Red	Jul-Oct	F/P/S	N
<i>Lobelia siphilitica</i>	Great blue lobelia	1'-4'	Blue	Jul-Oct	F/P/S	N
<i>Lobelia spicata</i>	Pale spiked lobelia	1'-3'	Lavender	May-Aug	F/P	N
<i>Mimulus ringens</i>	Monkeyflower	2'-4'	Lavender	Jun-Sep	F/P	N
<i>Physostegia virginiana</i>	Obedient plant	2'-5'	Pink	Aug-Oct	F	Y
<i>Pycnanthemum virginianum</i>	Mountain mint	1'-3'	White	Jun-Oct	F/P	N
<i>Rudbeckia laciniata</i>	Cutleaf coneflower	3'-10'	Yellow	Jul-Nov	F/P/S	N
<i>Sagittaria latifolia</i>	Arrowhead	1'-4'	White	Jun-Sep	F/P	N
<i>Saururus cernuus</i>	Lizard's tail	2'-4'	White	Jun-Aug	P/S	N
<i>Sisyrinchium angustifolium</i>	Stout blue-eyed grass	1'	Blue	May-Aug	F/P	N
<i>Solidago ohioensis</i>	Ohio goldenrod	2'-3'	Yellow	Jul-Oct	F/P	N
<i>Solidago patula</i>	Swamp goldenrod	3'-6'	Yellow	Aug-Oct	F/P/S	N
<i>Solidago riddellii</i>	Riddell's goldenrod	2'-5'	Yellow	Sep-Nov	F	N
<i>Spiraea alba</i>	Meadowsweet	3'-6'	White	June-Sep	F/P	Y
<i>Spiraea tomentosa</i>	Steeplebush	2'-5'	Pink	Jul-Sep	F/P	Y
<i>Thalictrum dasycarpum</i>	Purple meadow-rue	3'-6'	Cream	May-Jul	F/P	N
<i>Verbena hastata</i>	Blue vervain	3'-6'	Violet	Jun-Sep	F	N
<i>Vernonia missurica</i>	Missouri ironweed	3'-5'	Purple	Jul-Sep	F	N
<i>Zizia aurea</i>	Golden Alexanders	1'-3'	Yellow	Apr-Jun	F/P/S	Y

Representative Zone C Species



Cardinal Flower



Swamp Milkweed



Blue-Eyed Grass



Path Rush



Joe-Pye Weed



Obedient Plant



Red-Osier Dogwood



Monkey Flower

Source: JFNew

Zone D

Planting Zone = Two-to-four inches above water level

These plants tolerate fluctuating water levels within this range. They will also tolerate short periods of inundation, not to exceed 48 hours in most situations, making them appropriate for BMP settings.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
Woody Species:						
<i>Acer rubrum</i>	Red maple	90'	Green/ red	Mar-May	F/P/S	N
<i>Acer saccharinum</i>	Silver Maple	100'	Yellow	Mar-Apr	F/P	N
<i>Amelanchier arborea</i>	Downy serviceberry	40'	White	April	F/P/S	N
<i>Aronia prunifolia</i>	Purple chokeberry	10'	White	Apr-Jul	F/P	N
<i>Betula alleghaniensis</i>	Yellow birch	100'	Purple/ Yellow	Apr-May	P/S	N
<i>Betula papyrifera</i>	Paper birch	70'	Brown	Apr-May	F/P	N
<i>Celtis occidentalis</i>	Hackberry	60'	Green	May	F/P/S	N
<i>Cercis canadensis</i>	Redbud	25'	Red	Apr-May	F/P/S	N
<i>Cornus amomum</i>	Silky dogwood	10'	White	May-Jul	F/P	N
<i>Cornus sericea</i>	Red-osier dogwood	10'	White	May-Sep	F/P	N
<i>Corylus americana</i>	American hazelnut	10'	Yellow	Apr-May	F/P	N
<i>Ilex verticillata</i>	Winterberry	10'	White	June	F/P/S	Y
<i>Juglans nigra</i>	Black walnut	90'	Green	May	F/P	N
<i>Juniperus virginiana</i>	Red-cedar	50'	Brown	Apr-May	F/P	N
<i>Larix laricina</i>	American larch	75'	Brown	May	F/P	N
<i>Lindera benzoin</i>	Spicebush	15'	Yellow	Apr-May	P/S	N
<i>Liriodendron tulipifera</i>	Tulip tree	110'	Green	May-Jun	F/P	N
<i>Morus rubra</i>	Red mulberry	50'	Green	May-Jun	F/P/S	N
<i>Nyssa sylvatica</i>	Black gum	100'	Green	May-Jul	F/P/S	Y
<i>Physocarpus opulifolius</i>	Ninebark	10'	White	May-Jun	F/P	N
<i>Picea mariana</i>	Black spruce	60'	Brown	May-Jun	F/P/S	N
<i>Platanus occidentalis</i>	Sycamore	100'	Green	May	F/P	N
<i>Quercus bicolor</i>	Swamp white oak	70'	Green/ yellow	May	F/P/S	N
<i>Quercus macrocarpa</i>	Bur oak	85'	Yellow	May-Jun	F/P/S	N
<i>Quercus palustris</i>	Pin oak	90'	Green/ yellow	Apr-May	F/P/S	Y
<i>Ribes americanum</i>	Wild black currant	5'	Yellow	Apr-Jun	F/P/S	N
<i>Rosa carolina</i>	Pasture rose	3'	Pink	Jun-Sep	F/P	N
<i>Rosa palustris</i>	Swamp rose	2'-7'	Pink	Jun-Aug	F/P/S	N
<i>Thuja occidentalis</i>	White cedar	50'	Brown	Apr-May	F/P/S	N
<i>Tilia americana</i>	Basswood	100'	White	Jun-Jul	F/P/S	N
<i>Tsuga canadensis</i>	Hemlock	100'	Brown	Apr-May	F/P/S	N
<i>Ulmus americana</i>	American elm	100'	Brown	Mar-Apr	F/P/S	N
<i>Ulmus rubra</i>	Slippery elm	80'	Green	Mar-Apr	F/P/S	N
<i>Viburnum dentatum</i>	Arrowwood	10'	White	May-Jun	F/P/S	N
<i>Viburnum lentago</i>	Nannyberry	20'	White	Apr-Jun	P/S	Y
<i>Viburnum prunifolium</i>	Black haw	10'	White	Apr-May	F/P	N
<i>Viburnum trilobum</i>	Cranberry Viburnum	10'	White	Apr-May	F/P/S	N
Grasses/Sedges/Rushes:						
<i>Andropogon gerardii</i>	Big bluestem	4'-8'	Purple	Jul-Sep	F	N
<i>Calamagrostis canadensis</i>	Blue joint grass	2'-4'	Brown	June	F/P	N
<i>Carex comosa</i>	Bristly sedge	2'-3'	Green	May-June	F/P	N
<i>Carex crinita</i>	Fringed sedge	2'-5'	Green	May	F/P/S	N
<i>Carex hystericina</i>	Porcupine sedge	2'-3'	Green	May-June	F/P/S	N
<i>Carex lupulina</i>	Common hop sedge	2'-3'	Green/ Brown	May-June	F/P/S	N
<i>Carex muskingumensis</i>	Palm sedge	1'-2'	Brown	May-June	S	N
<i>Carex stipata</i>	Common fox sedge	1'-3'	Brown	Apr-May	F/P/S	N
<i>Carex stricta</i>	Tussock sedge	2'-3'	Brown	Apr-Jun	F/P	N
<i>Carex vulpinoidea</i>	Brown fox sedge	2'-3'	Brown	May-Jun	F/P	N
<i>Cinna arundinacea</i>	Common wood reed	3'-4'	Green	Aug-Sep	P/S	N
<i>Elymus canadensis</i>	Canada wild rye	3'-6'	Green	Jun-Sep	F/P	N

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
<i>Glyceria striata</i>	Fowl manna grass	1'-5'	Green	May-Jun	F/P/S	N
<i>Juncus tenuis</i>	Path rush	6"-2'	Brown	June	F/P/S	N
<i>Juncus torreyi</i>	Torrey's rush	1'-2'	Brown	Jun-Sep	F	Y
<i>Panicum virgatum</i>	Switch grass	3'-5'	Green/ Purple	Jun-Oct	F/P	Y
<i>Scirpus atrovirens</i>	Dark green rush	3'-5'	Brown	Jun-Aug	F	N
<i>Scirpus cyperinus</i>	Wool grass	3'-5'	Tan	Jun-Sep	F	Y
<i>Scirpus pendulus</i>	Red bulrush	2'-4'	Brown	May-Jun	F	N
<i>Spartina pectinata</i>	Prairie cordgrass	6'-7'	Green	Jul-Aug	F	Y
Forbs:						
<i>Anemone canadensis</i>	Canada anemone	1'-2'	White	May-Sep	F/P	N
<i>Angelica atropurpurea</i>	Great angelica	6'-9'	White	May-Jun	F/P	N
<i>Asclepias incarnata</i>	Swamp milkweed	3'-5'	Pink	Jun-Sep	F/P	N
<i>Aster novae-angliae</i>	New England aster	3'-6'	Violet	Jul-Oct	F/P	N
<i>Aster puniceus</i>	Swamp aster	3'-6'	Lav/ White	Aug-Oct	F	Y
<i>Aster umbellatus</i>	Flat-topped aster	1'-4'	White	Jul-Oct	F/P	N
<i>Cacalia atriplicifolia</i>	Pale Indian plantain	3'-8'	White	Jun-Oct	F/P/S	N
<i>Cassia hebecarpa</i>	Wild senna	3'-5'	Yellow	Jul-Aug	F/P	N
<i>Chelone glabra</i>	Turtlehead	2'-4'	Cream	Aug-Sep	F/P/S	N
<i>Coreopsis tripteris</i>	Tall coreopsis	4'-8'	Yellow	Aug-Sep	F/P	N
<i>Desmodium canadense</i>	Showy tick-trefoil	2'-5'	Purple	Jun-Sep	F/P	N
<i>Eryngium yuccifolium</i>	Rattlesnake master	3'-5'	White	Jul-Sep	F	N
<i>Eupatorium maculatum</i>	Spotted Joe-pye weed	4'-7'	Pink	Jun-Oct	F/P	N
<i>Eupatorium perfoliatum</i>	Boneset	3'-5'	White	Jul-Oct	F/P	Y
<i>Euthamia graminifolia</i>	Grass-leaved goldenrod	1'-4'	Yellow	Jul-Sep	F/P	N
<i>Gentiana andrewsii</i>	Bottle gentian	1'-3'	Blue	Aug-Oct	F/P	N
<i>Helenium autumnale</i>	Sneezeweed	3'-5'	Yellow	Jul-Nov	F/P	Y
<i>Helianthus giganteus</i>	Tall sunflower	5'-12'	Yellow	Jul-Sep	F/P	N
<i>Heliopsis helianthoides</i>	False sunflower	4'-6'	Yellow	Jun-Oct	F/P	N
<i>Iris virginica</i>	Blue flag iris	2'-3'	Purple	May-Jul	F/P/S	N
<i>Liatris spicata</i>	Marsh blazing star	3'-5'	Pink	Jul-Sep	F/P	N
<i>Lilium michiganense</i>	Michigan lily	3'-8'	Orange	Jul-Aug	P/S	N
<i>Lobelia cardinalis</i>	Cardinal flower	2'-5'	Red	Jul-Oct	F/P/S	N
<i>Lobelia siphilitica</i>	Great blue lobelia	1'-4'	Blue	Jul-Oct	F/P/S	N
<i>Lobelia spicata</i>	Pale spiked lobelia	1'-3'	Lavender	May-Aug	F/P	N
<i>Mimulus ringens</i>	Monkeyflower	2'-4'	Lavender	Jun-Sep	F/P	N
<i>Monarda fistulosa</i>	Wild bergamot	2'-5'	Lavender	Jul-Sep	F/P	N
<i>Physostegia virginiana</i>	Obedient plant	2'-5'	Pink	Aug-Oct	F	Y
<i>Polygonatum biflorum</i>	Solomon seal	1'-4'	Green/ White	May/Jul	P/S	N
<i>Pycnanthemum virginianum</i>	Mountain mint	1'-3'	White	Jun-Oct	F/P	N
<i>Rudbeckia laciniata</i>	Cutleaf coneflower	3'-10'	Yellow	Jul-Nov	F/P/S	N
<i>Rudbeckia triloba</i>	Three-lobed coneflower	2'-5'	Yellow	Aug-Oct	F/P	N
<i>Solidago caesia</i>	Bluestem goldenrod	1'-2'	Yellow	Sep-Oct	P/S	N
<i>Solidago flexicaulis</i>	Zigzag goldenrod	1'-3'	Yellow	Aug/Oct	P/S	N
<i>Solidago ohioensis</i>	Ohio goldenrod	2'-3'	Yellow	Jul-Oct	F/P	N
<i>Solidago patula</i>	Swamp goldenrod	3'-6'	Yellow	Aug-Oct	F/P/S	N
<i>Solidago riddellii</i>	Riddell's goldenrod	2'-5'	Yellow	Sep-Nov	F	N
<i>Spiraea alba</i>	Meadowsweet	3'-6'	White	June-Sep	F/P	Y
<i>Spiraea tomentosa</i>	Steeplebush	2'-5'	Pink	Jul-Sep	F/P	Y
<i>Thalictrum dasycarpum</i>	Purple meadow-rue	3'-6'	Cream	May-Jul	F/P	N
<i>Verbena hastata</i>	Blue vervain	3'-6'	Violet	Jun-Sep	F	N
<i>Vernonia missurica</i>	Missouri ironweed	3'-5'	Purple	Jul-Sep	F	N
<i>Veronicastrum virginicum</i>	Culver's root	3'-6'	White	Jun-Aug	F/P	N
<i>Zizia aurea</i>	Golden Alexanders	1'-3'	Yellow	Apr-Jun	F/P/S	Y

Representative Zone D Species



Big Bluestem



Marsh Blazing Star



Wild Columbine



Great Blue Lobelia



Michigan Lily



Virginia Mountain Mint



Meadowsweet



Blue Vervain

Source: JFNew

Zone E

Planting Zone = Four-to-18 inches above water level

These plants tolerate fluctuating water levels within this range. They will also tolerate short periods of inundation, not to exceed 48 hours in most situations, making them appropriate for BMP settings.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
Woody Species:						
<i>Acer rubrum</i>	Red maple	90'	Green/red	Mar-May	F/P/S	N
<i>Acer saccharum</i>	Sugar maple	100'	Green	Apr-May	F/P/S	N
<i>Acer saccharinum</i>	Silver Maple	100'	Yellow	Mar-Apr	F/P	N
<i>Amelanchier arborea</i>	Downy serviceberry	40'	White	April	F/P/S	N
<i>Aronia prunifolia</i>	Purple chokeberry	10'	White	Apr-Jul	F/P	N
<i>Betula papyrifera</i>	Paper birch	70'	Brown	Apr-May	F/P	N
<i>Carya ovata</i>	Shagbark hickory	80'	Green	May-Jun	F/P/S	N
<i>Ceanothus americanus</i>	New Jersey tea	1'-3'	White	Jun-Oct	F/P	N
<i>Celtis occidentalis</i>	Hackberry	60'	Green	May	F/P/S	N
<i>Cercis canadensis</i>	Redbud	25'	Red	Apr-May	F/P/S	N
<i>Cornus amomum</i>	Silky dogwood	10'	White	May-Jul	F/P	N
<i>Cornus florida</i>	Flowering dogwood	30'	White	May-Jun	F/P/S	N
<i>Cornus sericea</i>	Red-osier dogwood	10'	White	May-Sep	F/P	N
<i>Corylus americana</i>	American hazelnut	10'	Yellow	Apr-May	F/P	N
<i>Gymnocladus dioica</i>	Kentucky coffee tree	85'	White	Jun	F/P	N
<i>Juglans nigra</i>	Black walnut	90'	Green	May	F/P	N
<i>Juniperus virginiana</i>	Red-cedar	50'	Brown	Apr-May	F/P	N
<i>Larix laricina</i>	American larch	75'	Brown	May	F/P	N
<i>Lindera benzoin</i>	Spicebush	15'	Yellow	Apr-May	P/S	N
<i>Liriodendron tulipifera</i>	Tulip tree	110'	Green	May-Jun	F/P	N
<i>Morus rubra</i>	Red mulberry	50'	Green	May-Jun	F/P/S	N
<i>Nyssa sylvatica</i>	Black gum	100'	Green	May-Jul	F/P/S	Y
<i>Physocarpus opulifolius</i>	Ninebark	10'	White	May-Jun	F/P	N
<i>Picea mariana</i>	Black spruce	60'	Brown	May-Jun	F/P/S	N
<i>Pinus banksiana</i>	Jack pine	60'	Brown	May-Jun	F/P	N
<i>Pinus resinosa</i>	Red pine	100'	Brown	Apr-May	F/P	N
<i>Pinus strobus</i>	White pine	100'	Brown	Jun	F/P/S	N
<i>Platanus occidentalis</i>	Sycamore	100'	Green	May	F/P	N
<i>Prunus americana</i>	American plum	30'	Red	Apr-May	F/P	N
<i>Prunus virginiana</i>	Choke cherry	30'	White	May-Jun	F/P/S	N
<i>Quercus bicolor</i>	Swamp white oak	70'	Green/yellow	May	F/P/S	N
<i>Quercus macrocarpa</i>	Bur oak	85'	Yellow	May-Jun	F/P/S	N
<i>Quercus palustris</i>	Pin oak	90'	Green/yellow	Apr-May	F/P/S	Y
<i>Quercus rubra</i>	Red Oak	90'	Green	May-Jun	F/P/S	N
<i>Ribes americanum</i>	Wild black currant	5'	Yellow	Apr-Jun	F/P/S	N
<i>Rosa carolina</i>	Pasture rose	3'	Pink	Jun-Sep	F/P	N
<i>Tilia americana</i>	Basswood	100'	White	Jun-Jul	F/P/S	N
<i>Thuja occidentalis</i>	White cedar	50'	Brown	Apr-May	F/P/S	N
<i>Tsuga canadensis</i>	Hemlock	100'	Brown	Apr-May	F/P/S	N
<i>Ulmus americana</i>	American elm	100'	Brown	Mar-Apr	F/P/S	N
<i>Ulmus rubra</i>	Slippery elm	80'	Green	Mar-Apr	F/P/S	N
<i>Viburnum acerifolium</i>	Maple-leaved Viburnum	7'	White	May-Aug	F/P	N
<i>Viburnum dentatum</i>	Arrowwood	10'	White	May-Jun	F/P/S	N
<i>Viburnum prunifolium</i>	Black haw	10'	White	Apr-May	F/P	N
Grasses/Sedges/Rushes:						
<i>Andropogon gerardii</i>	Big bluestem	4'-8'	Purple	Jul-Sep	F	N
<i>Carex bicknellii</i>	Copper-shouldered oval sedge	1'-2'	Brown	May-Jun	F	N
<i>Carex mühlenbergii</i>	Sand bracted sedge	1'-3'	Brown	May-Jun	F/P/S	N
<i>Elymus canadensis</i>	Canada wild rye	3'-6'	Green	Jun-Sep	F/P	N

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
<i>Elymus hystrix</i>	Bottlebrush Grass	3'-5'	Green	Jun-Jul	P/S	N
<i>Elymus virginicus</i>	Virginia wild rye	2'-4'	Green	Jun	F/P/S	N
<i>Eragrostis spectabilis</i>	Purple love grass	1'-2'	Purple	Aug-Oct	F	N
<i>Juncus tenuis</i>	Path rush	6"-2'	Brown	June	F/P/S	N
<i>Panicum virgatum</i>	Switch grass	3'-6'	Green/ Purple	Jun-Oct	F/P	Y
<i>Schizachyrium scoparium</i>	Little bluestem	2'-4'	Brown	Aug-Sep	F/P	Y
<i>Sorghastrum nutans</i>	Indian grass	4'-9'	Green	Aug-Sep	F	N
<i>Spartina pectinata</i>	Prairie cordgrass	6'-7'	Green	Jul-Aug	F	Y
<i>Stipa spartea</i>	Porcupine grass	2'-4'	Green	Aug-Sep	F	Y
Forbs:						
<i>Allium cernuum</i>	Nodding wild onion	1'-2'	Lavender	Jun-Oct	F/P	N
<i>Aquilegia canadensis</i>	Wild columbine	1'-3'	Red/ Yellow	Apr-Jun	F/P/S	Y
<i>Asclepias syriaca</i>	Common milkweed	2'-4'	Pink	Jun-Aug	F/P	N
<i>Asclepias tuberosa</i>	Butterflyweed	1'-3'	Orange	Jun-Sep	F/P	Y
<i>Asclepias verticillata</i>	Whorled milkweed	1'-2'	White	Jun-Sep	F/P	N
<i>Aster cordifolius</i>	Heart-leaved aster	2'-4'	Blue/ White	Sep-Oct	P/S	N
<i>Aster laevis</i>	Smooth aster	3'-5'	Blue	Aug-Oct	F	Y
<i>Aster lateriflorus</i>	Calico aster	1'-3'	White	Jul-Oct	F/P/S	N
<i>Aster macrophyllus</i>	Big-leaved aster	6"-2'	Lav/ White	Jul-Oct	P/S	N
<i>Aster novae-angliae</i>	New England aster	3'-6'	Violet	Jul-Oct	F/P	N
<i>Aster oolentangiensis</i>	Sky-blue aster	1'-4'	Blue	Jul-Nov	F/P	Y
<i>Aster shortii</i>	Short's aster	1'-4'	Blue	Aug-Oct	P/S	N
<i>Cacalia atriplicifolia</i>	Pale Indian plantain	3'-8'	White	Jun-Oct	F/P/S	N
<i>Campanula americana</i>	Tall bellflower	2'-6'	Blue	Jul-Nov	P/S	N
<i>Cassia hebecarpa</i>	Wild senna	3'-5'	Yellow	Jul-Aug	F/P	N
<i>Clematis virginiana</i>	Virgin's bower	9' long	White	Jul-Aug	F/P	N
<i>Coreopsis tripteris</i>	Tall coreopsis	4'-8'	Yellow	Aug-Sep	F/P	N
<i>Desmodium canadense</i>	Showy tick-trefoil	2'-5'	Purple	Jun-Sep	F/P	N
<i>Echinacea pallida</i>	Purple coneflower	2'-5'	Lavender	May-Aug	F	N
<i>Eryngium yuccifolium</i>	Rattlesnake master	3'-5'	White	Jul-Sep	F	N
<i>Eupatorium purpureum</i>	Purple Joe-pye weed	3'-6'	Pink	Jul-Sep	P	N
<i>Euphorbia corollata</i>	Flowering spurge	2'-4'	White	May-Oct	F/P	N
<i>Geranium maculatum</i>	Wild geranium	1'-2'	Pink	Apr-Jul	F/P/S	N
<i>Helianthus divaricatus</i>	Woodland sunflower	2'-6'	Yellow	Jun-Sep	P/S	N
<i>Helianthus giganteus</i>	Tall sunflower	5'-12'	Yellow	Jul-Sep	F/P	N
<i>Helianthus pauciflorus</i>	Prairie sunflower	3'-5'	Yellow	Jul-Oct	F	N
<i>Heliopsis helianthoides</i>	False sunflower	4'-6'	Yellow	Jun-Oct	F/P	N
<i>Lespedeza capitata</i>	Round-headed bush clover	2'-4'	Green	Jul-Sep	F/P	N
<i>Liatis aspera</i>	Rough blazing star	2'-3'	Violet	Jul-Nov	F/P	Y
<i>Liatis spicata</i>	Marsh blazing star	3'-5'	Pink	Jul-Sep	F/P/S	N
<i>Liatis scariosa</i>	Savanna blazing star	3'-5'	Violet	Aug-Oct	F/P	N
<i>Monarda fistulosa</i>	Wild bergamot	2'-5'	Lavender	Jul-Sep	F/P	N
<i>Penstemon digitalis</i>	Foxglove beardtongue	2'-4'	White	May-Jul	F/P	N
<i>Penstemon hirsutus</i>	Hairy beardtongue	1'-2'	Purple	May-Jul	F/P	N
<i>Phlox divaricata</i>	Wild blue phlox	1'-2'	Blue	Apr-Jun	P/S	N
<i>Phlox pilosa</i>	Sand prairie phlox	1'-2'	Pink	May-Aug	F/P	N
<i>Physostegia virginiana</i>	Obedient plant	2'-5'	Pink	Aug-Oct	F	Y
<i>Polygonatum biflorum</i>	Solomon seal	1'-4'	Green/ White	May/Jul	P/S	N
<i>Polygonatum pubescens</i>	Downy Solomon seal	1'-3'	White	May-Jul	P/S	N
<i>Pycnanthemum virginianum</i>	Mountain mint	1'-3'	White	Jun-Oct	F/P	N
<i>Ratibida pinnata</i>	Yellow coneflower	3'-6'	Yellow	Jul-Oct	F	N
<i>Rudbeckia hirta</i>	Black-eyed Susan	1'-3'	Yellow	May-Oct	F/P	Y
<i>Rudbeckia triloba</i>	Three-lobed coneflower	2'-5'	Yellow	Aug-Oct	F/P	N
<i>Silphium terebinthinaceum</i>	Prairie-dock	3'-8'	Yellow	Jun-Sep	F	N
<i>Smilacina racemosa</i>	Feathery false Solomon's seal	1'-3'	White	Apr-Jun	P/S	N
<i>Smilacina stellata</i>	Starry false Solomon's seal	1'-2'	White	Apr-Jun	F/P	N
<i>Solidago caesia</i>	Bluestem goldenrod	1'-2'	Yellow	Sep-Oct	P/S	N
<i>Solidago flexicaulis</i>	Zigzag goldenrod	1'-3'	Yellow	Aug/Oct	P/S	N

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
<i>Solidago juncea</i>	Early goldenrod	2'-4'	Yellow	Jul-Sep	F/P	N
<i>Solidago speciosa</i>	Showy goldenrod	1'-3'	Yellow	Jul-Oct	F/P	Y
<i>Thalictrum dioicum</i>	Early meadow-rue	1'-3'	Green	Apr-May	P/S	N
<i>Tradescantia ohiensis</i>	Spiderwort	2'-4'	Blue	May-Oct	F/P	N
<i>Vernonia missurica</i>	Missouri ironweed	3'-5'	Purple	Jul-Sep	F	N

Representative Zone E Species



New England Aster



Wild Bergamot



Showy Goldenrod



Tall Bellflower



Wild Geranium



Tall Coreopsis



Redbud



Indian Grass

Source: JFNew

Zone F

Planting Zone = 18 inches or more above water level

These plants tolerate fluctuating water levels within this range, although they are generally less tolerant than most wetter species. They may tolerate short periods of inundation, not to exceed 48 hours in most situations, making them appropriate for upland BMP settings.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
Woody Species:						
<i>Acer rubrum</i>	Red maple	90'	Green/red	Mar-May	F/P/S	N
<i>Acer saccharum</i>	Sugar maple	100'	Green	Apr-May	F/P/S	N
<i>Acer saccharinum</i>	Silver Maple	100'	Yellow	Mar-Apr	F/P	N
<i>Betula papyrifera</i>	Paper birch	70'	Brown	Apr-May	F/P	N
<i>Carya ovata</i>	Shagbark hickory	80'	Green	May-Jun	F/P/S	N
<i>Ceanothus americanus</i>	New Jersey tea	1'-3'	White	Jun-Oct	F/P	N
<i>Celtis occidentalis</i>	Hackberry	60'	Green	May	F/P/S	N
<i>Cercis canadensis</i>	Redbud	25'	Red	Apr-May	F/P/S	N
<i>Cornus florida</i>	Flowering dogwood	30'	White	May-Jun	F/P/S	N
<i>Corylus americana</i>	American hazelnut	10'	Yellow	Apr-May	F/P	N
<i>Gymnocladus dioicus</i>	Kentucky coffee tree	85'	White	Jun	F/P	N
<i>Hamamelis virginiana</i>	Witch hazel	30'	Yellow	Oct-Nov	F/P/S	N
<i>Juglans nigra</i>	Black walnut	90'	Green	May	F/P	N
<i>Juniperus virginiana</i>	Red-cedar	50'	Brown	Apr-May	F/P	N
<i>Liriodendron tulipifera</i>	Tulip tree	110'	Green	May-Jun	F/P	N
<i>Morus rubra</i>	Red mulberry	50'	Green	May-Jun	F/P/S	N
<i>Nyssa sylvatica</i>	Black gum	100'	Green	May-Jul	F/P/S	Y
<i>Pinus banksiana</i>	Jack pine	60'	Brown	May-Jun	F/P	N
<i>Pinus resinosa</i>	Red pine	100'	Brown	Apr-May	F/P	N
<i>Pinus strobus</i>	White pine	100'	Brown	Jun	F/P/S	N
<i>Prunus americana</i>	American plum	30'	Red	Apr-May	F/P	N
<i>Prunus virginiana</i>	Choke cherry	30'	White	May-Jun	F/P/S	N
<i>Quercus macrocarpa</i>	Bur oak	85'	Yellow	May-Jun	F/P/S	N
<i>Quercus palustris</i>	Pin oak	90'	Green/yellow	Apr-May	F/P/S	Y
<i>Quercus rubra</i>	Red Oak	90'	Green	May-Jun	F/P/S	N
<i>Rosa carolina</i>	Pasture rose	3'	Pink	Jun-Sep	F/P	N
<i>Tilia americana</i>	Basswood	100'	Yellow	Jun-Jul	F/P/S	N
<i>Tsuga canadensis</i>	Hemlock	100'	Brown	Apr-May	F/P/S	N
<i>Viburnum acerifolium</i>	Maple-leaved Viburnum	7'	White	May-Aug	F/P	N
<i>Viburnum dentatum</i>	Arrowwood	10'	White	May-Jun	F/P/S	N
Grasses/Sedges/Rushes:						
<i>Andropogon gerardii</i>	Big bluestem	4'-8'	Purple	Jul-Sep	F	N
<i>Carex bicknellii</i>	Copper-shouldered oval sedge	1'-2'	Brown	May-Jun	F	N
<i>Carex muhlenbergii</i>	Sand bracted sedge	1'-3'	Brown	May-Jun	F/P/S	N
<i>Elymus canadensis</i>	Canada wild rye	3'-6'	Green	Jun-Sep	F/P	N
<i>Elymus hystrix</i>	Bottlebrush Grass	3'-5'	Green	Jun-Jul	P/S	N
<i>Eragrostis spectabilis</i>	Purple love grass	1'-2'	Purple	Aug-Oct	F	N
<i>Koeleria macrantha</i>	June grass	1'-2'	White	May-Jul	F/P	N
<i>Panicum virgatum</i>	Switch grass	3'-6'	Green/Purple	Jun-Oct	F/P	Y
<i>Schizachyrium scoparium</i>	Little bluestem	2'-4'	Brown	Aug-Sep	F/P	Y
<i>Sorghastrum nutans</i>	Indian Grass	4'-9'	Green	Aug-Sep	F	N
<i>Spartina pectinata</i>	Prairie Cordgrass	6'-7'	Green	Jul-Aug	F	Y

Botanical Name	Common Name	Height	Color	Bloom Time	Sun	Salt Tolerant
<i>Stipa spartea</i>	Porcupine grass	2'-4'	Green	Aug-Sep	F	Y
Forbs:						
<i>Allium cernuum</i>	Nodding wild onion	1'-2'	Lavender	Jun-Oct	F/P	N
<i>Asclepias syriaca</i>	Common milkweed	2'-4'	Pink	Jun-Aug	F/P	N
<i>Asclepias tuberosa</i>	Butterflyweed	1'-3'	Orange	Jun-Sep	F/P	Y
<i>Asclepias verticillata</i>	Whorled milkweed	1'-2'	White	Jun-Sep	F/P	N
<i>Aster cordifolius</i>	Heart-leaved aster	2'-4'	Blue/White	Sep-Oct	P/S	N
<i>Aster laevis</i>	Smooth aster	3'-5'	Blue	Aug-Oct	F	Y
<i>Aster oolentangiensis</i>	Sky-blue aster	1'-4'	Blue	Jul-Nov	F/P	Y
<i>Aster shortii</i>	Short's aster	1'-4'	Blue	Aug-Oct	P/S	N
<i>Cacalia atriplicifolia</i>	Pale Indian plantain	3'-8'	White	Jun-Oct	F/P/S	N
<i>Campanula americana</i>	Tall bellflower	2'-6'	Blue	Jul-Nov	P/S	N
<i>Clematis virginiana</i>	Virgin's bower	9' long	White	Jul-Aug	F/P	N
<i>Coreopsis lanceolata</i>	Sand coreopsis	1'-2'	Yellow	May-Aug	F/P	N
<i>Coreopsis palmata</i>	Prairie coreopsis	1'-2'	Yellow	Jun-Aug	F/P	N
<i>Coreopsis tripteris</i>	Tall coreopsis	4'-8'	Yellow	Aug-Sep	F/P	N
<i>Echinacea pallida</i>	Purple coneflower	2'-5'	Lavender	May-Aug	F	N
<i>Eryngium yuccifolium</i>	Rattlesnake master	3'-5'	White	Jul-Sep	F	N
<i>Eupatorium purpureum</i>	Purple Joe-pye weed	3'-6'	Pink	Jul-Sep	P	N
<i>Euphorbia corollata</i>	Flowering spurge	2'-4'	White	May-Oct	F/P	N
<i>Geranium maculatum</i>	Wild geranium	1'-2'	Pink	Apr-Jul	F/P/S	N
<i>Helianthus divaricatus</i>	Woodland sunflower	2'-6'	Yellow	Jun-Sep	P/S	N
<i>Helianthus occidentalis</i>	Western sunflower	2'-4'	Yellow	Aug-Sep	F/P	N
<i>Helianthus pauciflorus</i>	Prairie sunflower	3'-5'	Yellow	Jul-Oct	F	N
<i>Heliopsis helianthoides</i>	False sunflower	4'-6'	Yellow	Jun-Oct	F/P	N
<i>Lespedeza capitata</i>	Round-headed bush clover	2'-4'	Green	Jul-Sep	F/P	N
<i>Liatris aspera</i>	Rough blazing star	2'-3'	Violet	Jul-Nov	F/P	Y
<i>Liatris cylindracea</i>	Cylindrical blazing star	1'-2'	Violet	Jul-Oct	F/P	N
<i>Liatris scariosa</i>	Savanna blazing star	3'-5'	Violet	Aug-Oct	F/P	N
<i>Lupinus perennis</i>	Wild lupine	1'-2'	Purple	Apr-Jun	F/P	N
<i>Monarda fistulosa</i>	Wild bergamot	2'-5'	Lavender	Jul-Sep	F/P	N
<i>Penstemon digitalis</i>	Foxglove beardtongue	2'-4'	White	May-Jul	F/P	N
<i>Phlox pilosa</i>	Sand prairie phlox	1'-2'	Pink	May-Aug	F/P	N
<i>Polygonatum biflorum</i>	Solomon seal	1'-4'	Green/ White	May/Jul	P/S	N
<i>Polygonatum pubescens</i>	Downy Solomon seal	1'-3'	White	May-Jul	P/S	N
<i>Ratibida pinnata</i>	Yellow coneflower	3'-6'	Yellow	Jul-Oct	F	N
<i>Rudbeckia hirta</i>	Black-eyed Susan	1'-3'	Yellow	May-Oct	F/P	Y
<i>Silphium terebinthinaceum</i>	Prairie-dock	3'-8'	Yellow	Jun-Sep	F	N
<i>Smilacina racemosa</i>	Feathery false Solomon's seal	1'-3'	White	Apr-Jun	P/S	N
<i>Smilacina stellata</i>	Starry false Solomon's seal	1'-2'	White	Apr-Jun	F/P	N
<i>Solidago caesia</i>	Bluestem goldenrod	1'-2'	Yellow	Sep-Oct	P/S	N
<i>Solidago juncea</i>	Early goldenrod	2'-4'	Yellow	Jul-Sep	F/P	N
<i>Solidago speciosa</i>	Showy goldenrod	1'-3'	Yellow	Jul-Oct	F/P	Y
<i>Tradescantia ohiensis</i>	Spiderwort	2'-4'	Blue	May-Oct	F/P	N
<i>Veronicastrum virginicum</i>	Culver's root	3'-6'	White	June-Aug	F/P	N

Representative Zone F Species



Spiderwort



Butterfly Weed



Yellow Coneflower



Little Bluestem



Foxglove Beardtongue



Wild Lupine



Pale Purple Coneflower



Rattlesnake Master



Sand Coreopsis

Source: JFNew

Zone G

Planter Box Plantings

Although this manual typically recommends using native plants wherever possible, certain situations call for nonnative plants due to particular site conditions. Because planter boxes traditionally have a short soil column and are exposed to drier conditions, non-native plants should be considered as long as they are considered non-invasive. Therefore, the list below contains both native and non-native species. Many planter boxes have traditionally used annual flowers. However, we recommend using perennial plants for establishing root systems and lowering maintenance in the long term. Many more species are available for planter boxes than are listed.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun
<i>Ajuga reptans</i> 'Bronze Beauty'	Bronze Beauty Ajuga	6"	Blue	May-Jun	F
<i>Allium maximowiczii</i> 'Alba'	White Flowered Ornamental Chive	6"-1'	White	May-Jun	F
<i>Allium schoenoprasum</i> 'Glaucum'	Blue Flowered Ornamental Chive	6"-1'	Blue	Jun-Jul	F
<i>Allium senescens montanum</i>	Mountain Garlic	6"-1'	Pink/Purple	Jun-Aug	F
<i>Allium senescens glaucum</i>	Curly Onion	6"-1'	Pink	Jul-Sep	F
<i>Allium tanguticum</i> 'Summer Beauty'	Summer Beauty Ornamental Chive	6"-1'	Pink	Jul-Aug	F
<i>Aster</i> 'Wood's Light Blue'	Wood's Light Blue Aster	1'-3'	Blue	Aug-Sep	F
<i>Athyrium filix-femina</i>	Lady Fern	1'-3'	Green	NA	F/P/S
<i>Blechnum spicant</i>	Deer Fern	1'-2'	Green	NA	F/P/S
<i>Dryopteris erythrosora</i>	Autumn Fern	1'-2'	Green	NA	F/P/S
<i>Euphorbia myrsinites</i>	Myrtle Spurge	6"-1'	Yellow	May-Jun	F
<i>Dryopteris intermedia</i>	Fancy Fern	1'-3'	Green	NA	F/P/S
<i>Dryopteris marginalis</i>	Leatherleaf Fern	1'-2'	Green	NA	F/P/S
<i>Geranium x</i> 'Rozanne'	Rozanne Geranium	1'-2'	Violet	Jun-Sep	F/P
<i>Hemerocallis</i> 'Barbara Mitchell'	Barbara Mitchell Daylily	2'-3'	Pink	Jun-Aug	F/P
<i>Hemerocallis</i> 'Bill Norris'	Bill Norris Daylily	2'-3'	Yellow	Jun-Aug	F/P
<i>Hemerocallis</i> 'Chicago Apache'	Chicago Apache Daylily	2'-3'	Red	Jul-Sep	F/P
<i>Hosta</i> 'Francee'	Francee Hosta	1'-2'	Lavender	Jul-Aug	F/P/S
<i>Hosta</i> 'Guacamole'	Guacamole Hosta	1'-2'	Pink	Aug-Sep	F/P/S
<i>Hosta</i> 'Summer Fragrance'	Summer Fragrance Hosta	1'-2'	Lavender	Aug-Sep	F/P/S
<i>Hosta sieboldiana</i> 'Elegans'	Elegans Hosta	1'-2'	White	Jul-Aug	F/P/S
<i>Sedum</i> 'Autumn Charm'	Autumn Charm Sedum	6"-1'	Pink	Jun-Jul	F
<i>Sedum</i> 'Joyce Henderson'	Joyce Henderson Sedum	6"-1'	Pink	May-Jun	F
<i>Sedum</i> 'Mini Me'	Mini Me Sedum	6"-1'	Green	NA	F
<i>Sedum acre</i> 'Oktoberfest'	Oktoberfest Sedum	6"-1'	Yellow	Jul-Sep	F
<i>Sedum album</i> 'Athoum'	Jelly Bean Sedum	6"-1'	Pink	Aug-Sep	F
<i>Sedum album</i> 'Coral Carpet'	Coral Carpet Sedum	6"-1'	White	Jun-Aug	F
<i>Sedum album</i> 'Faro Island'	Faro Island Sedum	6"-1'	White	Jun-Aug	F
<i>Sedum album</i> 'Green Ice'	Green Ice Sedum	6"-1'	White	Jun-Jul	F
<i>Sedum album</i> 'Murale'	Wall Sedum	6"-1'	White	Jun-Jul	F
<i>Sedum cauticola</i> 'Sunset Cloud'	Sunset Cloud Sedum	6"-1'	Pink	Jul-Aug	F
<i>Sedum divergens</i>	Cascade Sedum	6"-1'	Yellow	Jun-Jul	F
<i>Sedum ellacombianum</i>	Ellacombe's Sedum	6"-1'	Yellow	May-Jun	F
<i>Sedum ellacombianum</i> 'Variegatum'	Variegated Ellacombe's Sedum	6"-1'	Yellow	May-Jun	F
<i>Sedum floriferum</i> 'Weihenstephaner Gold'	Weihenstephaner Gold Sedum	6"-1'	Yellow	Jun-Jul	F
<i>Sedum grisebachii</i>	Griseback Sedum	6"-1'	Yellow	Jul-Aug	F
<i>Sedum hybridum</i> 'Tekaridake'	Tekaridake Kamtschatka Sedum	6"-1'	Yellow	Jun	F
<i>Sedum kamtschaticum</i> 'Variegatum'	Variegated Kamtschatka Sedum	6"-1'	Orange	Jul-Aug	F
<i>Sedum middendorffianum</i> var. <i>diffusum</i>	Diffuse Middendorf's Sedum	6"-1'	Yellow	May-Jun	F

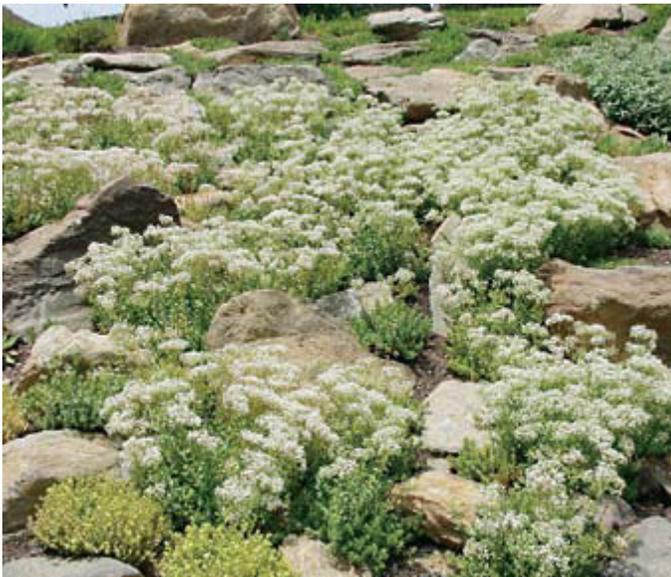
Representative Zone G Species



Guacamole Hosta



Mountain Garlic



Wall Sedum



Lady Fern

Source: JFNew

Zone H

Vegetated Roof Plantings

Research to-date shows that native plants do not typically thrive in vegetated roofs. Therefore, the list below reflects species that are known to thrive in green roof situations. All species listed below will generally grow to a height of 6-to-18 inches.

Botanical Name	Common Name	Height	Color	Bloom Time	Sun
<i>Ajuga reptans</i> 'Bronze Beauty'	Bronze Beauty Ajuga	6"	Blue	May-Jun	F
<i>Allium maximowiczii</i> 'Alba'	White Flowered Ornamental Chive	6"-1'	White	May-Jun	F
<i>Allium schoenoprasum</i> 'Glaucum'	Blue Flowered Ornamental Chive	6"-1'	Blue	Jun-Jul	F
<i>Allium senescens montanum</i>	Mountain Garlic	6"-1'	Pink/Purple	Jun-Aug	F
<i>Allium senescens glaucum</i>	Curly Onion	6"-1'	Pink	Jul-Sep	F
<i>Allium tanguticum</i> 'Summer Beauty'	Summer Beauty Ornamental Chive	6"-1'	Pink	Jul-Aug	F
<i>Aster</i> 'Wood's Light Blue'	Wood's Light Blue Aster	1'-3'	Blue	Aug-Sep	F
<i>Athyrium filix-femina</i>	Lady Fern	1'-3'	Green	NA	F/P/S
<i>Blechnum spicant</i>	Deer Fern	1'-2'	Green	NA	F/P/S
<i>Dryopteris erythrosora</i>	Autumn Fern	1'-2'	Green	NA	F/P/S
<i>Euphorbia myrsinites</i>	Mytle Spurge	6"-1'	Yellow	May-Jun	F
<i>Dryopteris intermedia</i>	Fancy Fern	1'-3'	Green	NA	F/P/S
<i>Dryopteris marginalis</i>	Leatherleaf Fern	1'-2'	Green	NA	F/P/S
<i>Geranium x</i> 'Rozanne'	Rozanne Geranium	1'-2'	Violet	Jun-Sep	F/P
<i>Hemerocallis</i> 'Barbara Mitchell'	Barbara Mitchell Daylily	2'-3'	Pink	Jun-Aug	F/P
<i>Hemerocallis</i> 'Bill Norris'	Bill Norris Daylily	2'-3'	Yellow	Jun-Aug	F/P
<i>Hemerocallis</i> 'Chicago Apache'	Chicago Apache Daylily	2'-3'	Red	Jul-Sep	F/P
<i>Hosta</i> 'Francee'	Francee Hosta	1'-2'	Lavender	Jul-Aug	F/P/S
<i>Hosta</i> 'Guacamole'	Guacamole Hosta	1'-2'	Pink	Aug-Sep	F/P/S
<i>Hosta</i> 'Summer Fragrance'	Summer Fragrance Hosta	1'-2'	Lavender	Aug-Sep	F/P/S
<i>Hosta sieboldiana</i> 'Elegans'	Elegans Hosta	1'-2'	White	Jul-Aug	F/P/S
<i>Sedum</i> 'Autumn Charm'	Autumn Charm Sedum	6"-1'	Pink	Jun-Jul	F
<i>Sedum</i> 'Joyce Henderson'	Joyce Henderson Sedum	6"-1'	Pink	May-Jun	F
<i>Sedum</i> 'Mini Me'	Mini Me Sedum	6"-1'	Green	NA	F
<i>Sedum acre</i> 'Oktoberfest'	Oktoberfest Sedum	6"-1'	Yellow	Jul-Sep	F
<i>Sedum album</i> 'Athoum'	Jelly Bean Sedum	6"-1'	Pink	Aug-Sep	F
<i>Sedum album</i> 'Coral Carpet'	Coral Carpet Sedum	6"-1'	White	Jun-Aug	F
<i>Sedum album</i> 'Faro Island'	Faro Island Sedum	6"-1'	White	Jun-Aug	F
<i>Sedum album</i> 'Green Ice'	Green Ice Sedum	6"-1'	White	Jun-Jul	F
<i>Sedum album</i> 'Murale'	Wall Sedum	6"-1'	White	Jun-Jul	F
<i>Sedum cauticola</i> 'Sunset Cloud'	Sunset Cloud Sedum	6"-1'	Pink	Jul-Aug	F
<i>Sedum divergens</i>	Cascade Sedum	6"-1'	Yellow	Jun-Jul	F
<i>Sedum ellacombianum</i>	Ellacombe's Sedum	6"-1'	Yellow	May-Jun	F
<i>Sedum ellacombianum</i> 'Variegatum'	Variegated Ellacombe's Sedum	6"-1'	Yellow	May-Jun	F
<i>Sedum floriferum</i> 'Weihenstephaner Gold'	Weihenstephaner Gold Sedum	6"-1'	Yellow	Jun-Jul	F
<i>Sedum grisebachii</i>	Griseback Sedum	6"-1'	Yellow	Jul-Aug	F
<i>Sedum hybridum</i> 'Tekaridake'	Tekaridake Kamtschatka Sedum	6"-1'	Yellow	Jun	F
<i>Sedum kamtschaticum</i> 'Variegatum'	Variegated Kamtschatka Sedum	6"-1'	Orange	Jul-Aug	F
<i>Sedum middendorffianum</i> var. <i>diffusum</i>	Diffuse Middendorf's Sedum	6"-1'	Yellow	May-Jun	F

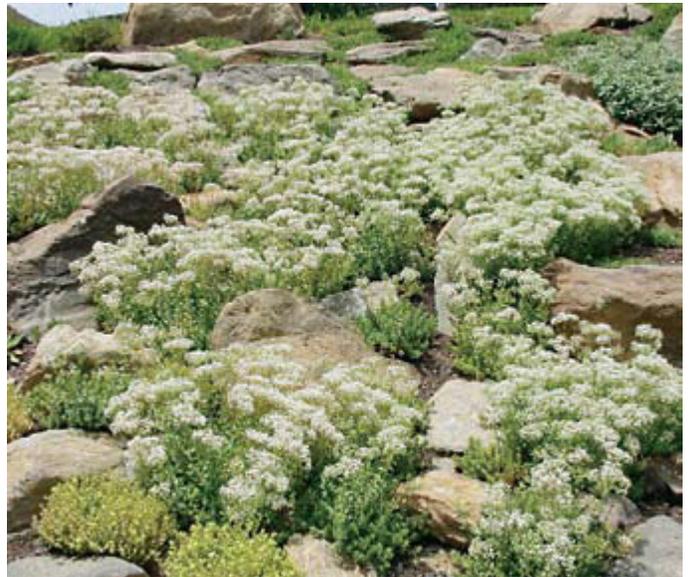
Representative Zone H Species



Mountain Garlic



Cascade Sedum



Wall Sedum



Ellacombe's Sedum

Source: JFNew

Credits and Acknowledgments

This Appendix has been developed by Christopher B. Burke Engineering, LLC, and is primarily based upon similar segments contained in “Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers” published in 2009 by the Southeast Michigan Council of Governments (SEMCOG). A selection of material contained in the noted SEMCOG publication has been modified to reflect conditions in Indiana and used, with permission, for development of this Appendix. The valuable contribution of SEMCOG through sharing of this material for use in this Appendix is hereby acknowledged.

Recommended Materials

Appendix D3

Recommended Materials

Numerous BMPs in this manual have similar material needs. These BMPs are listed in the table below. Detailed information on each material requirement follows. In addition, Porous Pavement and Vegetated Roofs have significant material requirements that are listed according to their individual needs.

	Constructed Filters	Dry Well	Infiltration Trench	Planter Boxes	Porous Pavement	Subsurface Infiltration	Vegetated Filter Strip	Vegetated Swale
Check dams							X	X
Non-Woven Geotextile	X	X	X	X	X	X	X	
Pea Gravel							X	
Peat	X			X				
Pervious Berms							X	
Pipe – 8”	X	X	X	X	X	X	X	
Sand	X			X				X
Stone/Gravel	X			X				
Stone – 30%							X	
Stone – 40%			X		X			

Check dams (Vegetated Filter Strip, Vegetated Swale)

An earthen check dam shall be constructed of sand, gravel, and sandy loam to encourage grass cover. (Sand: ASTM C-33 fine aggregate concrete sand 0.02 in to 0.04 in, Gravel: AASHTO M-43 0.5 in to 1.0 in). A stone check dam shall be constructed of R-4 rip rap, or equivalent.

Non-Woven Geotextile (Constructed Filter, Dry Well, Infiltration Trench, Planter Boxes, Vegetated Filter Strip)

Should consist of needled nonwoven polypropylene fibers and meet the following properties:

- | | |
|---|-------------------------------------|
| a. Grab Tensile Strength (ASTM-D4632) | 120 lbs minimum |
| b. Mullen Burst Strength (ASTM-D3786) | 225 psi minimum |
| c. Flow Rate (ASTM-D4491) | 110 gal/min/ft ² minimum |
| d. UV Resistance after 500 hrs (ASTM-D4355) | 70% minimum |
| e. Puncture strength (ASTM D-4833-00) | 90 lbs minimum |
| f. Apparent opening size (ASTM D-4751-99A) | 60-70 US Sieve |

Heat-set or heat-calendared fabrics are not permitted. Acceptable types include Mirafi 140N, Amoco 4547, Geotex 451, or approved others.

Pea Gravel (Vegetated Filter Strip)

Clean bank-run gravel may also be used and should meet ASTM D 448 and be sized as per No.6 or 1/8” to 3/8”.

Peat (Constructed Filter, Planter Boxes)

Should have ash content <15%, pH range 3.3-5.2, loose bulk density range 0.12-0.14 g/cc.

Pervious Berms (Vegetated Filter Strip)

The berm shall have a height of 6-12 inches and be constructed of sand, gravel, and sandy loam to encourage grass cover. (Sand: ASTM C-33 fine aggregate concrete sand 0.02”-0.04”, Gravel: AASHTO M-43, ½” to 1”)

Pipe - (Dry Well, Porous Pavement, Subsurface Infiltration, Constructed Filter, Infiltration Trench, Planter Boxes, Vegetated Filter Strip)

Should be continuously perforated, double-wall, smooth interior (smooth bore), with a minimum inside diameter as required. High-density polyethylene (HDPE) pipe shall meet AASHTO M252, Type S or M294, Type S (12-gauge aluminum or pipe may also be used in seepage pits).

Sand (Constructed Filter, Planter Boxes, Vegetated Swale)

Should be ASTM-C-33 (or AASHTO M-6) size (0.02” – 0.04”), concrete sand, clean, medium to fine sand.

Soil Testing (all BMPs)

Should be completed in accordance to the Purdue University Cooperative Extension Service Department of Horticulture “Collecting Soil Samples for Testing” HO-71-W” <http://www.hort.purdue.edu/ext/HO-71.pdf>

Stone/Gravel (Constructed Filter, Planter Boxes):

Should be uniformly graded coarse aggregate, 1-inch to ½-inch with a wash loss of no more than 0.5%, AASHTO size number 5 per AASHTO Specifications, Part I, 19th Ed., 1998, or later and have voids of 40% as measured by ASTM-C29.

Stone – 40% voids (Infiltration Trench, Porous Pavement, Subsurface Infiltration Bed,)

Infiltration trenches should have stone 2-inch to 1-inch uniformly graded coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size number 3 per AASHTO Specifications, Part I, 19th Ed., 1998, or later and shall have voids 40% as measured by ASTM-C29.

Porous Pavement

General

Choker base course aggregate for beds shall be 3/8 inch to 3/4 inch clean, uniformly-graded, coarse, crushed aggregate AASHTO size number 57 per Table 4, AASHTO Specifications, Part I, 19th Ed., 1998 (p. 47).

Porous Asphalt

Bituminous surface course for porous paving shall be 2.5 to 3 inches thick with a bituminous mix of 5.75% to 6.75% by total weight as determined by testing below. Use neat asphalt binder modified with an elastomeric polymer to produce a binder meeting the requirements of PG 76-22P as specified in AASHTO MP-1. The composite materials shall be thoroughly blended at the asphalt refinery or terminal prior to being loaded into the transport vehicle. The polymer modified asphalt binder shall be heat and storage stable.

Determination of optimal asphalt content should be determined according the following tests:

- Draindown Test (ASTM Method D6390)
- Moisture Susceptibility Test using the Modified Lottman Method (AASHTO T283) with the following:
 - Compact using 50 gyrations of Superpave gyratory compactor
 - Apply partial vacuum of 26 inches of Hg for 10 minutes to whatever saturation is achieved.
 - Keep specimens submerged in water during freeze cycle.
 - Required retained tensile strength (TSR) ≥ 80%

- Air Voids Test (AASHTO T269/ASTM D3203)

Hydrated lime, if required, shall meet the requirements of AASHTO M 303 Type 1 and shall be blended with the damp aggregate at a rate of 1.0% by weight of the total dry aggregate. The additive must be able to prevent the separation of the asphalt binder from the aggregate and achieve a required tensile strength ratio (TSR) of at least 80% on the asphalt mix.

Fibers, if used, shall consist of either cellulose fibers or mineral fibers which are to be treated with a cationic sizing agent to enhance dispersment of the fiber as well as increase cohesion of the fiber to the bitumen. Fiber is to be added at a dosage rate between 0.2% and 0.4% by weight of total mix.

- Mineral fibers shall be from virgin, basalt, diabase, or slag with a maximum average fiber length of 6.35 mm and a maximum average fiber thickness of 0.005 mm.
- Cellulose fiber – Fiber length shall be 6.4 mm (max), Ash Content 18% non-volatiles ($\pm 5\%$), pH 7.5 (± 1), Oil absorption (times fiber weight) 5.0 (± 1), Moisture Content 5.0 (max).

Porous Concrete

The use of Installers or Craftsmen who have been certified by the NRMCA's Pervious Concrete Contractor Certification Program is strongly recommended. Contractor shall furnish a proposed mix design with all applicable information to the Engineer prior to commencement of work. Critical mix characteristics typically include the following:

- Cement Content: 550 to 650 lb/yd³
- Fine aggregate, if used: maximum 3 cubic feet per cubic yard
- Admixtures: use in accordance with the manufacturer's instructions and recommendations
- An aggregate/cement (A/C) ratio: 4:1 to 4.5:1
- Water/cement (W/C) ratio: 0.27 to 0.34
- Curing: shall begin within 15 minutes after placement and continue for 7 days

The data shall include unit weights determined in accordance with ASTM C29 paragraph 11, jigging procedure.

Cement: Portland Cement Type II or V conforming to ASTM C150 or Portland Cement Type IP or IS conforming to ASTM C595. The total cementitious material shall be between 550 and 650 lb/yd³.

Aggregate: Use No 8 coarse aggregate (3/8 to No. 16) per ASTM C33 or No. 89 coarse aggregate (3/8 to No. 50) per ASTM D 448. If other gradation of aggregate is to be used, submit data on proposed material to owner for approval. The volume of aggregate per cubic yard shall be equal to 27 cubic feet when calculated as a function of the unit weight determined in accordance with ASTM C29 jigging procedure. Fine aggregate, if used, should not exceed 3 cubic feet and shall be included in the total aggregate volume.

Air Entraining Agent: Shall comply with ASTM C 260 and shall be used to improve workability and resistance to freeze/thaw cycles.

Admixtures: The following admixtures shall be used:

- Type D Water Reducing/Retarding – ASTM C 494.
- A hydration stabilizer that also meets the requirements of ASTM C 494 Type B Retarding or Type D Water Reducing/Retarding admixtures may be used. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set.

Water: Potable shall be used and shall comply with ASTM C1602. Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration).

- Insufficient water results in inconsistency in the mix and poor bond strength.
- High water content results in the paste sealing the void system primarily at the bottom and poor surface bond.

An aggregate/cement (A/C) ratio range of 4:1 to 4.5:1 and a water/cement (W/C) ratio range of 0.27 to 0.34 should produce pervious pavement of satisfactory properties in regard to permeability, load carrying capacity, and durability characteristics.

Vegetated roofs

Some key components and associated performance-related properties are as follows:

Root-barriers should be thermoplastic membranes with a thickness of at least 30 mils. Thermoplastic sheets can be bonded using hot-air fusion methods, rendering the seams safe from root penetration. Membranes that have been certified for use as root-barriers are recommended. At present only FLL offers a recognized test for root-barriers. Several FLL-certified materials are available in the United States. Interested American manufactures can submit products for testing to FLL-certified labs.

Granular drainage media should be a non-carbonate mineral aggregate conforming to the following specifications:

- Saturated Hydraulic Conductivity ≥ 25 in/min
- Total Organic Matter, by Wet Combustion (MSA) $\leq 1\%$
- Abrasion Resistance (ASTM-C131-96) $\leq 25\%$ loss
- Soundness (ASTM-C88 or T103 or T103-91) $\leq 5\%$ loss
- Porosity (ASTM-C29) $\geq 25\%$
- Alkalinity, CaCO₃ equivalents (MSA) $\leq 1\%$
- Grain-Size Distribution (ASTM-C136)
 - Percentage Passing US#18 sieve $\leq 1\%$
 - Percentage Passing ¼-inch sieve $\leq 30\%$
 - Percentage Passing 3/8-inch sieve $\leq 80\%$

Growth media should be a soil-like mixture containing not more than 15% organic content (wet combustion or loss on ignition methods). The appropriate grain-size distribution is essential for achieving the proper moisture content, permeability, nutrient management, and non-capillary porosity, and ‘soil’ structure. The grain-size guidelines vary

- Non-capillary Pore Space at Field Capacity, 0.333 bar (TMECC 03.01, A) $\geq 15\%$ (vol)
- Moisture Content at Field Capacity (TMECC 03.01, A) $\geq 12\%$ (vol)
- Maximum Media Water Retention (FLL) $\geq 30\%$ (vol)
- Alkalinity, Ca CO₃ equivalents (MSA) $\leq 2.5\%$
- Total Organic Matter by Wet Combustion (MSA) 3-15% (dry wt.)
- pH (RCSTP) 6.5 - 8.0
- Soluble Salts (DTPA saturated media extraction) (RCSTP) ≤ 6 mmhos/cm
- Cation exchange capacity (MSA) ≥ 10 meq/100g

- Saturated Hydraulic Conductivity for Single Media Assemblies (FLL) ≥ 0.05 in/min
- Saturated Hydraulic Conductivity for Dual Media Assemblies (FLL) ≥ 0.30 in/min

Grain-size Distribution of the Mineral Fraction (ASTM-D422)

- Single Media Assemblies:
 - Clay fraction (2 micron) 0
 - Pct. Passing US#200 sieve (i.e., silt fraction) $\leq 5\%$
 - Pct. Passing US#60 sieve $\leq 10\%$
 - Pct. Passing US#18 sieve 5 - 50%
 - Pct. Passing 1/8-inch sieve 0 - 70%
 - Pct. Passing 3/8-inch sieve 75 -100%
- Dual Media Assemblies:
 - Clay fraction (2 micron) 0
 - Pct. Passing US#200 sieve (i.e., silt fraction) 5 - 15%
 - Pct. Passing US#60 sieve 10 - 25%
 - Pct. Passing US#18 sieve 20 - 50%
 - Pct. Passing 1/8-inch sieve 55 - 95%
 - Pct. Passing 3/8-inch sieve 90 - 100%

Macro- and micro-nutrients shall be incorporated in the formulation in initial proportions suitable for support the specified planting.

Separation fabric should be readily penetrated by roots, but provide a durable separation between the drainage and growth media layers (Only lightweight nonwoven geotextiles are recommended for this function.

- Unit Weight (ASTM-D3776) ≤ 4.25 oz/yd²
- Grab tensile (ASTM-D4632) ≤ 90 lb
- Mullen Burst Strength (ASTM-D4632) ≥ 135 lb/in
- Permittivity (ASTM-D4491) ≥ 2 per second

Credits and Acknowledgments

This Appendix has been developed by Christopher B. Burke Engineering, LLC, and is primarily based upon similar segments contained in “Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers” published in 2009 by the Southeast Michigan Council of Governments (SEMCOG). A selection of material contained in the noted SEMCOG publication has been modified to reflect conditions in Indiana and used, with permission, for development of this Appendix. The valuable contribution of SEMCOG through sharing of this material for use in this Appendix is hereby acknowledged.

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Soil Infiltration Testing Protocol

Appendix D4

Soil Infiltration Testing Protocol

Purpose of this Protocol

The soil infiltration testing protocol describes evaluation and field testing procedures to determine if infiltration BMPs are suitable at a site, as well as to obtain the required data for infiltration BMP design.

When to Conduct Testing

It is recommended that soil evaluation and investigation be conducted following development of a concept plan or early in the development of a preliminary plan.

Who Should Conduct Testing

Soil evaluation and investigation may be conducted by soil scientists, design engineers, professional geologists, and other qualified professionals and technicians. The stormwater designer is *strongly* encouraged to directly observe the testing process to obtain a first-hand understanding of site conditions.

Importance of Stormwater BMP Areas

Sites are often defined as unsuitable for infiltration BMPs and soil-based BMPs due to proposed grade changes (excessive cut or fill) or lack of suitable areas. Many sites will be constrained and unsuitable for infiltration BMPs. However, if suitable areas exist, these areas should be identified early in the design process and should not be subject to a building program that precludes infiltration BMPs. When pursuing the LID Approach, full build-out of site areas otherwise deemed to be suitable for infiltration should not provide an exemption or waiver for adequate storm-water volume control or groundwater recharge.

Safety

As with all field work and testing, attention to all applicable Occupational Safety and Health Administration (OSHA) regulations and local guidelines related to earthwork and excavation is required. Digging and excavation should never be conducted without adequate notification through the Indiana Underground Plant Protection Service (IUPPS) at www.IUPSS.org. Excavations should never be left

unsecured and unmarked, and all applicable authorities should be notified prior to any work.

Infiltration Testing: A Multi-Step Process

Infiltration testing is a four-step process to obtain the necessary data for the design of the stormwater management plan. The four steps include:

- 1. Background evaluation**
 - Based on available published and site specific data
 - Includes consideration of proposed development plan
 - Used to identify potential BMP locations and testing locations
 - Prior to field work (desktop)
- 2. Test pit (deep hole) observations**
 - Includes multiple testing locations
 - Provides an understanding of sub-surface conditions
 - Identifies limiting conditions
- 3. Infiltration testing**
 - Must be conducted onsite
 - Different testing methods available
- 4. Design considerations**
 - Determine suitable infiltration rate for design calculations
 - Consider BMP drawdown
 - Consider peak rate attenuation

Step 1. Background evaluation

Prior to performing testing and developing a detailed site plan, existing conditions at the site should be inventoried and mapped including, but not limited to:

- Existing mapped soils and USDA Hydrologic Soil Group classifications.
- Existing geology, including depth to bedrock, karst conditions, or other features of note.
- Existing streams (perennial and intermittent, including intermittent swales), water bodies, wetlands, hydric soils, floodplains, alluvial soils, stream classifications, headwaters, and first order streams.
- Existing topography, slope, drainage patterns, and watershed boundaries.
- Existing land use conditions.

- Other natural or man-made features or conditions that may impact design, such as past uses of site, existing nearby structures (buildings, walls), abandoned wells, etc.
- A concept plan or preliminary layout plan for development should be evaluated, including:
 - Preliminary grading plan and areas of cut and fill,
 - Location of all existing and proposed water supply sources and wells,
 - Location of all former, existing, and proposed onsite wastewater systems,
 - Location of other features of note such as utility rights-of-way, water and sewer lines, etc.,
 - Existing data such as structural borings, and
 - Proposed location of development features (buildings, roads, utilities, walls, etc.).

In Step 1, the designer should determine the potential location of infiltration BMPs. The approximate location of these BMPs should be on the proposed development plan and serve as the basis for the location and number of tests to be performed onsite.

Important: If the proposed development is located on areas that may otherwise be a suitable BMP location, or if the proposed grading plan is such that potential BMP locations are eliminated, the designer is *strongly* encouraged to revisit the proposed layout and grading plan and adjust the development plan as necessary. Full build-out of areas suitable for infiltration BMPs should *not* preclude the use of BMPs for runoff volume reduction and groundwater recharge.

Step 2. Test pits (deep holes)

A test pit (deep hole) allows visual observation of the soil horizons and overall soil conditions both horizontally and vertically in that portion of the site. An extensive number of test pit observations can be made across a site at a relatively low cost and in a short time period. The use of soil borings as a substitute for test pits is strongly discouraged, as visual observation is narrowly limited in a soil boring and the soil horizons cannot be observed in-situ, but must be observed from the extracted borings.

A test pit (deep hole) consists of a backhoe-excavated trench, 2½-3 feet wide, to a depth of 6-7½ feet, or until bedrock or fully saturated conditions are encountered.

The trench should be benched at a depth of 2-3 feet for access and/or infiltration testing.

At each test pit, the following conditions are to be noted and described. Depth measurements should be described as depth below the ground surface:

- Soil horizons (upper and lower boundary),
- Soil texture, structure, and color for each horizon,
- Color patterns (mottling) and observed depth,
- Depth to water table,
- Depth to bedrock,
- Observance of pores or roots (size, depth),
- Estimated type and percent coarse fragments,
- Hardpan or limiting layers,
- Strike and dip of horizons (especially lateral direction of flow at limiting layers), and
- Additional comments or observations.

The Sample Soil Log Form at the end of this protocol may be used for documenting each test pit.

At the designer's discretion, soil samples may be collected at various horizons for additional analysis. Following testing, the test pits should be refilled with the original soil and the topsoil replaced. A test pit should *never* be accessed if soil conditions are unsuitable or unstable for safe entry, or if site constraints preclude entry. OSHA regulations should always be observed.

It is important that the test pit provide information related to conditions at the bottom of the proposed infiltration BMP. If the BMP depth will be greater than 90 inches below existing grade, deeper excavation of the test pit will be required. The designer is cautioned regarding the proposal of systems that are significantly deeper than the existing topography, as the suitability for infiltration is likely to decrease. The design engineer is encouraged to consider reducing grading and earthwork as needed to reduce site disturbance and provide greater opportunity for stormwater management.

The number of test pits varies depending on site conditions and the proposed development plan. General guidelines are as follows:

- For single-family residential subdivisions with on-lot infiltration BMPs, one test pit per lot is recommended, preferably within 100 feet of the proposed BMP area.

- For multi-family and high-density residential developments, one test pit per BMP area or acre is recommended.
- For large infiltration areas (basins, commercial, institutional, industrial, and other proposed land uses), multiple test pits should be evenly distributed at the rate of four to six pits per acre of BMP area.

The recommendations above are guidelines. Additional tests should be conducted if local conditions indicate significant variability in soil types, geology, water table levels, depth and type of bedrock, topography, etc. Similarly, uniform site conditions may indicate that fewer test pits are required. Excessive testing and disturbance of the site prior to construction is not recommended.

Step 3. Infiltration tests

A variety of field tests exists for determining the infiltration capacity of a soil. Laboratory tests are not recommended, as a homogeneous laboratory sample does not represent field conditions. Infiltration tests should be conducted in the field. Infiltration tests should not be conducted in the rain, within 24 hours of significant rainfall events (> 0.5 inches), or when the temperature is below freezing.

At least one test should be conducted at the proposed bottom elevation of an infiltration BMP, and a minimum of two tests per test pit are recommended. Based on observed field conditions, the designer may elect to modify the proposed bottom elevation of a BMP. Personnel conducting infiltration tests should be prepared to adjust test locations and depths depending on observed conditions.

Methodologies discussed in this protocol include:

- Double-ring infiltrometer tests.
- Percolation tests (such as for onsite wastewater systems).

There are differences between the two methods. A double-ring infiltrometer test estimates the vertical movement of water through the bottom of the test area. The outer ring helps to reduce the lateral movement of water in the soil from the inner ring. A percolation test allows water movement through both the bottom and sides of the test area. For this reason, the measured rate of water level drop in a percolation test must be adjusted

to represent the discharge that is occurring on both the bottom and sides of the percolation test hole.

Other testing methodologies and standards that are available but not discussed in detail in this protocol include (but are not limited to):

- Constant head double-ring infiltrometer.
- Testing as described in the *Maryland Stormwater Manual*, Appendix D.1, using five-inch diameter casing.
- ASTM 2003 Volume 4.08, Soil and Rock (I): Designation D 3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using a Double-Ring Infiltrometer.
- ASTM 2002 Volume 4.09, Soil and Rock (II): Designation D 5093-90, Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring.
- Guelph permeameter.
- Constant head permeameter (Amoozometer).

Methodology for double-ring infiltrometer field test

A double-ring infiltrometer consists of two concentric metal rings. The rings are driven into the ground and filled with water. The outer ring helps to prevent divergent flow. The drop-in water level or volume in the inner ring is used to calculate an infiltration rate. The infiltration rate is the amount of water per surface area and time unit which penetrates the soils. The diameter of the inner ring should be approximately 50-70 percent of the diameter of the outer ring, with a minimum inner ring size of four inches. Double-ring infiltrometer testing equipment designed specifically for that purpose may be purchased. However, field testing for storm-water BMP design may also be conducted with readily available materials.

Equipment for double-ring infiltrometer test:

Two concentric cylinder rings six inches or greater in height. Inner ring diameter equal to 50-70 percent of outer ring diameter (i.e., an 8-inch ring and a 12-inch ring). Material typically available at a hardware store may be acceptable.

- Water supply,
- Stopwatch or timer,
- Ruler or metal measuring tape,
- Flat wooden board for driving cylinders uniformly into soil,

- Rubber mallet, and
- Log sheets for recording data.

Procedure for double-ring infiltrometer test

- Prepare level testing area.
- Place outer ring in place; place flat board on ring and drive ring into soil to a minimum depth of two inches.
- Place inner ring in center of outer ring; place flat board on ring and drive ring into soil a minimum of two inches. The bottom rim of both rings should be at the same level.
- The test area should be presoaked immediately prior to testing. Fill both rings with water to water level indicator mark or rim at 30-minute intervals for one hour. The minimum water depth should be four inches. The drop in the water level during the last 30 minutes of the presoaking period should be applied to the following standard to determine the time interval between readings:
 - If water level drop is two inches or more, use 10-minute measurement intervals.
 - If water level drop is less than two inches, use 30-minute measurement intervals.
- Obtain a reading of the drop in water level in the center ring at appropriate time intervals. After each reading, refill both rings to water level indicator mark or rim. Measurement to the water level in the center ring should be made from a fixed reference point and should continue at the interval determined until a minimum of eight readings are completed or until a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of ¼-inch or less of drop between the highest and lowest readings of four consecutive readings.
- The drop that occurs in the center ring during the final period or the average stabilized rate, expressed as inches per hour, should represent the infiltration rate for that test location.

Methodology for percolation test

Equipment for percolation test

- Post hole digger or auger,
- Water supply,
- Stopwatch or timer,
- Ruler or metal measuring tape,
- Log sheets for recording data,

- Knife blade or sharp-pointed instrument (for soil scarification),
- Course sand or fine gravel, and
- Object for fixed-reference point during measurement (nail, toothpick, etc.).

Procedure for percolation test

This percolation test methodology is based largely on the criteria for onsite sewage investigation of soils. A 24-hour pre-soak is generally not required as infiltration systems, unlike wastewater systems, will not be continuously saturated.

- Prepare level testing area.
- Prepare hole having a uniform diameter of 6-10 inches and a depth of 8-12 inches. The bottom and sides of the hole should be scarified with a knife blade or sharp-pointed instrument to completely remove any smeared soil surfaces and to provide a natural soil interface into which water may percolate. Loose material should be removed from the hole.
- (Optional) Two inches of coarse sand or fine gravel may be placed in the bottom of the hole to protect the soil from scouring and clogging of the pores.
- Test holes should be presoaked immediately prior to testing. Water should be placed in the hole to a minimum depth of six inches over the bottom and readjusted every 30 minutes for one hour.
- The drop in the water level during the last 30 minutes of the final presoaking period should be applied to the following standard to determine the time interval between readings for each percolation hole:
 - If water remains in the hole, the interval for readings during the percolation test should be 30 minutes.
 - If no water remains in the hole, the interval for readings during the percolation test may be reduced to 10 minutes.
- After the final presoaking period, water in the hole should again be adjusted to a minimum depth of six inches and readjusted when necessary after each reading. A nail or marker should be placed at a fixed reference point to indicate the water refill level. The water level depth and hole diameter should be recorded.
- Measurement to the water level in the individual percolation holes should be made from a fixed reference point and should continue at the interval determined from the previous step for each

individual percolation hole until a minimum of eight readings are completed or until a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of ¼ inch or less of drop between the highest and lowest readings of four consecutive readings.

- The drop that occurs in the percolation hole during the final period, expressed as inches per hour, should represent the percolation rate for that test location.
- The average measured rate must be adjusted to account for the discharge of water from both the sides and bottom of the hole and to develop a representative infiltration rate. The average/final percolation rate should be adjusted for each percolation test according to the following formula:

Infiltration Rate = (Percolation Rate)/ (Reduction Factor)

Where the Reduction Factor is given by[#]:

$$R_f = \frac{2d_i - \Delta d}{DIA} + 1$$

With:

d_i = Initial Water Depth (in.)

Δd = Average/Final Water Level Drop (in.)

DIA = Diameter of the Percolation Hole (in.)

The percolation rate is simply divided by the reduction factor as calculated above or shown in Table 1 below to yield the representative infiltration rate. In most cases, the reduction factor varies from about two to four depending on the percolation hole dimensions and water level drop – wider and shallower tests have lower reduction factors because proportionately less water exfiltrates through the sides.

The area reduction factor accounts for the exfiltration occurring through the sides of percolation hole. It assumes that the percolation rate is affected by the depth of water in the hole and that the percolating surface of the hole is in uniform soil. If there are significant problems with either of these assumptions then other adjustments may be necessary.

Step 4. Use design considerations provided in the infiltration BMP.

Perc. Hole Diameter, DIA (in.)	Initial Water Depth, d_i (in.)	Ave./Final Water Level Drop, Δd (in.)	Reduction Factor, R_f
6	6	0.1	3.0
		0.5	2.9
		2.5	2.6
	8	0.1	3.7
		0.5	3.6
		2.5	3.3
	10	0.1	4.3
		0.5	4.3
		2.5	3.9
8	6	0.1	2.5
		0.5	2.4
		2.5	2.2
	8	0.1	3.0
		0.5	2.9
		2.5	2.7
	10	0.1	3.5
		0.5	3.4
		2.5	3.2
10	6	0.1	2.2
		0.5	2.2
		2.5	2.0
	8	0.1	2.6
		0.5	2.6
		2.5	2.4
	10	0.1	3.0
		0.5	3.0
		2.5	2.8

Table 1 Sample Percolation Rate Adjustments

Additional Potential Testing – Bulk Density

Bulk density tests measure the level of compaction of a soil, which is an indicator of a soil’s ability to absorb rainfall. Developed and urbanized sites often have very high bulk densities and, therefore, possess limited ability to absorb rainfall (and have high rates of stormwater runoff). Vegetative and soil improvement programs can lower the soil bulk density and improve the site’s ability to absorb rainfall and reduce runoff.

Macropores occur primarily in the upper soil horizons and are formed by plant roots (both living and decaying), soil fauna such as insects, the weathering processes caused by movement of water, the freeze-thaw cycle, soil shrinkage due to desiccation of clays, chemical processes, and other mechanisms. These macropores provide an important mechanism for infiltration prior to development, extending vertically and horizontally for considerable distances. It is the intent of good engineering and design practice to maintain these macropores when installing infiltration BMPs as much as possible. Bulk density tests can help determine the relative compaction of soils before and after site disturbance and/or restoration and should be used at the discretion of the designer/reviewer.

Soil Test Pit Log Sheet

Project: _____
 Name: _____
 Location: _____
 Test Pit #: _____

Date: _____
 Soil Series: _____
 Other: _____

Horizon	Depth (in.)	Color	Redox Features	Texture	Notes (if applicable)	Boundary

Notes:

REDOX FEATURES

Abundance
Few..... < 2%
Common... 2-20%
Many..... >20%

Contrast
faint
 hue and chroma of matrix and redox are closely related
distinct
 matrix & redox features vary 1-2 units of hue and several units of chroma & value
prominent
 Matrix & redox features vary several units in hue, value & chroma

COARSE FRAGMENTS (% of profile)

15-35%	35-65%	>65%
gravelly	very gravelly	extremely gravelly
channery	very channery	extremely channery
cobbly	very cobbly	extremely cobbly
flaggy	very flaggy	extremely flaggy
stony	very stony	extremely stony

BOUNDARY

Distinctness
abrupt... < 1" (thick) *gradual*... 2.5" – 5"
clear.... 1" – 2.5" *diffuse*... > 5"

HORIZONS

O – organic layers of decaying plant and animal tissue (must be greater than 12-18% organic carbon, excluding live roots)
A (topsoil) – mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material
E – mineral horizon which the main feature is loss of silicate clay, iron, aluminum. Must be underlain by B (alluvial) horizon.

B (subsoil) – mineral horizon with evidence of pedogenesis or illuviation (movement into the horizon)
C (substratum) – the un-weathered geologic material the soil formed in. Shows little or no sign of soil formation

Credits and Acknowledgments

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Maintenance Inspection Checklists

Appendix D5

MAINTENANCE INSPECTION CHECKLISTS

This appendix contains nine checklists available as guides for maintenance inspections of specific BMPs. The checklists are designed to help identify key components of BMPs that require ongoing maintenance as well as a basic schedule of when the maintenance should occur.

It is suggested that the inspection be undertaken by a licensed PE and/or a person knowledgeable about the design and function of the BMP.

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BIORETENTION (RAIN GARDEN) & VEGETATED SWALE (BIOSWALE) MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Irrigate if plants appear wilted or unhealthy; replace dead plants <input type="checkbox"/> Check for erosion, cracking, embankment failure, burrowing animals, and sediment clogging the drain and other pipes <input type="checkbox"/> Repair erosion with additional plant material similar to original and/or small stones for stability <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants <input type="checkbox"/> Replace bark mulch on bare, exposed soil	
Monthly (during growing season)	<input type="checkbox"/> Irrigate 1" water/week during the first growing season <input type="checkbox"/> Check/clean inlets, outlets/overflows and curb cuts from debris <input type="checkbox"/> Check plants for pest damage or disease <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants	
Semi-Annually (spring & fall)	<input type="checkbox"/> Redefine lawn edge	
Annually	<input type="checkbox"/> Cut perennial plantings and divide grasses and perennials to prevent overcrowding (fall) <input type="checkbox"/> Mow bioswale (> 6") (fall) <input type="checkbox"/> Check overflow and subsurface drain; check infiltration and flow-through rates (0.5"/hr) <input type="checkbox"/> Check pH of infiltration/planting soil (<5.2 add limestone; >7.0 add iron sulfate plus sulfur) <input type="checkbox"/> Check/correct for uniformity in cross-section and longitudinal slope (bioswale) <input type="checkbox"/> Replace mulch. Minimum every 3 years <input type="checkbox"/> Remove accumulated sediment and replace with approved soil mix, bark mulch, and vegetation (> 25% ponding depth for bioretention; >50% checkdam height for bioswale). Minimum every 5 years	
Upon Failure	<input type="checkbox"/> Redesign and reconstruct	

CONSTRUCTED WETLAND MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Irrigate if plants appear wilted or unhealthy; replace dead plants <input type="checkbox"/> Check for erosion, cracking, embankment failure, burrowing animals, and sediment clogging the drain and other pipes <input type="checkbox"/> Repair erosion and bare soil with additional plant material similar to original and/or small stones for stability <input type="checkbox"/> Remove weeds and woody vegetation < 15' toe of embankment and < 25' from spillway <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants	
Monthly (during growing season)	<input type="checkbox"/> Irrigate 1" water/week during the first growing season; maintain low water levels to allow sufficient oxygen to the roots of establishing plants <input type="checkbox"/> Check/clean inlets, outlets/overflows and trash racks from debris <input type="checkbox"/> Check plants for pest damage or disease <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants	
Semi-Annually (spring & fall)	<input type="checkbox"/> Check/remove sediment build-up and plant debris (especially < 18" of outlet) <input type="checkbox"/> Check water levels with design specifications <input type="checkbox"/> Check/remove burrowing animals; repair holes in embankments <input type="checkbox"/> Mow side slopes and embankments, emergency spillways, and access road <input type="checkbox"/> Divide grasses and perennials (fall) to prevent overcrowding	
Annually	<input type="checkbox"/> Remove large colonies of cattails <input type="checkbox"/> Manage weeds through burning or trimming plant stalks when new growth is 4-6" tall <input type="checkbox"/> Replace mulch. Minimum every 3 years <input type="checkbox"/> Replace soil. Minimum every 20 years <input type="checkbox"/> Remove accumulated sediment (> 50% capacity forebay, > 25% capacity wetland). Minimum every 5 years. Wetland should be drained and dry prior to sediment removal and immediately stabilized and re-vegetated	
Upon Failure	<input type="checkbox"/> Redesign and reconstruct	

DRY POND & WET POND MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Irrigate if plants appear wilted or unhealthy; replace dead plants <input type="checkbox"/> Check/repair areas with erosion, cracking, embankment failure, burrowing animals, and sediment clogging the drain and other pipes <input type="checkbox"/> Repair erosion and bare soil <input type="checkbox"/> Remove woody vegetation < 15' toe of embankment and mow < 25' from spillway <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants	
Monthly (during growing season)	<input type="checkbox"/> Irrigate 1" water/week during the first growing season; maintain low water levels to allow sufficient oxygen to the roots of establishing plants (wet pond shelf) <input type="checkbox"/> Check/clean inlets, outlets/overflows and trash racks from debris <input type="checkbox"/> Check plants for pest damage or disease <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Mow side slopes and embankments, emergency spillways, and access road (dry pond – maintain bottom at 6-8"; wet pond – allow 5-10' of embankment to grow 24-30")	
Semi-Annually (spring & fall)	<input type="checkbox"/> Check/remove sediment build-up and plant debris (especially < 18" of outlet) <input type="checkbox"/> Check water levels with design specifications (wet pond) <input type="checkbox"/> Check/repair any settlement of berms <input type="checkbox"/> Check/remove burrowing animals; repair holes in embankments	
Annually	<input type="checkbox"/> Seed or sod to restore dead or dying grass/groundcover <input type="checkbox"/> Replace mulch every 3 years (min); replace topsoil every 10 years (min) <input type="checkbox"/> Remove accumulated sediment (> 50% capacity forebay, > 25% capacity pond). Minimum 2-10 years (dry pond), 5-10 years (wet pond)	
Upon Failure	<input type="checkbox"/> Redesign and reconstruct	

VEGETATED ROOF (GREEN ROOF) MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Irrigate if plants appear wilted or unhealthy; replace dead plants <input type="checkbox"/> Check for sediment clogging the drain and weirs <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants <input type="checkbox"/> Replace bark mulch on bare, exposed soil <input type="checkbox"/> Check mechanical equipment for leaks or spills	
Monthly (during growing season)	<input type="checkbox"/> Irrigate 1" water/week during the first growing season <input type="checkbox"/> Check/clean outlets/overflows and weirs from debris <input type="checkbox"/> Check plants for pest damage or disease <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants	
Semi-Annually (spring and fall)	<input type="checkbox"/> Check roof and building interior for leaks from mechanical equipment and structural deficiencies to waterproof membrane <input type="checkbox"/> Add bark mulch	
Annually	<input type="checkbox"/> Cut perennial plantings at end of growing season; divide grasses and perennials to prevent overcrowding (fall) <input type="checkbox"/> Check outlet/overflow drain; check infiltration and flow-through rates (0.5"/hr) <input type="checkbox"/> Check pH of infiltration/planting soil (<5.2 add limestone; >7.0 add iron sulfate plus sulfur) <input type="checkbox"/> Replace mulch. Minimum every 3 years <input type="checkbox"/> Remove accumulated sediment and replace with approved soil mix, bark mulch, and vegetation (> 25% ponding depth) <input type="checkbox"/> Remove trees/shrubs and replace with smaller specimens (10-25 years) (intensive green roof)	
Upon Failure	<input type="checkbox"/> Redesign and reconstruct	

INFILTRATION PRACTICE (TRENCH) MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Check infiltration rate (< 3"/hr) <input type="checkbox"/> Mow or trim grassed edge of trench; remove clippings to prevent clogging <input type="checkbox"/> Check observation well for clogging; clean subsurface drain	
Monthly (during growing season)	<input type="checkbox"/> Remove trash, debris, and sediment	
Semi-Annually (spring & fall)	<input type="checkbox"/> Check/clean gutters and downspouts <input type="checkbox"/> Check/clean pre-treatment BMPs or diversion structures for clogging, sediment/debris accumulation, or structural damage	
Annually	<input type="checkbox"/> Check/clean silt trap and intermediate sump pump (if applicable)	
Upon Failure	<input type="checkbox"/> Replace filter from roof drain <input type="checkbox"/> Remove and install clean, washed trench aggregate; trench walls should be excavated to expose clean soil; replace filter fabric and piping	

PERVIOUS PAVEMENT MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Repair potholes and patch cracks <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and unwanted grass including grass clippings and vegetation trimmings from adjacent landscaped areas <input type="checkbox"/> Sweep or vacuum more frequently depending on traffic, sediment, and debris <input type="checkbox"/> Monitor infiltration rate (20"/hr)	
Monthly (during growing season)	<input type="checkbox"/> Remove trash, debris, and sediment	
Semi-Annually (spring & fall)	<input type="checkbox"/> Monitor infiltration rate (20"/hr) <input type="checkbox"/> Sweep or vacuum; pressure wash (concrete pavement only) <input type="checkbox"/> Clean inlets draining to subsurface bed and subsurface drain <input type="checkbox"/> Check overflow outlet for clogging	
Annually	<input type="checkbox"/> Check and replenish lost aggregate between pavers <input type="checkbox"/> Check and reseed grassed pavers	
Upon Failure	<input type="checkbox"/> Remove existing pervious pavement and aggregate, wash and/or replace and reinstall per manufacture specifications	

PLANTER BOX / TREE BOX MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Irrigate if plants appear wilted or unhealthy; replace dead plants <input type="checkbox"/> Check for sediment clogging the drain and other pipes <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants <input type="checkbox"/> Replace bark mulch on bare, exposed soil	
Monthly (during growing season)	<input type="checkbox"/> Irrigate 1" water/week during the first growing season; stake/tie younger trees <input type="checkbox"/> Check/clean inlets and outlets/overflows and curb cuts from debris <input type="checkbox"/> Check plants for pest damage or disease; remove weeds and invasive plants <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Sweep surrounding area	
Semi-Annually (spring & fall)	<input type="checkbox"/> Check stakes and ties on trees; replace if worn or damaged <input type="checkbox"/> Prune/trim vegetation <input type="checkbox"/> Add bark mulch	
Annually	<input type="checkbox"/> Cut perennial planting; divide grasses and perennials to prevent overcrowding (fall) <input type="checkbox"/> Check infiltration and flow-through rates (0.5"/hr) <input type="checkbox"/> Check pH of infiltration/planting soil (<5.2 add limestone; >7.0 add iron sulfate plus sulfur) <input type="checkbox"/> Replace mulch every 3 years (min) <input type="checkbox"/> Remove accumulated sediment and replace with approved soil mix, bark mulch, and vegetation (> 25% ponding depth) <input type="checkbox"/> Replace trees and shrubs with smaller specimens (10-25 years)	
Upon Failure	<input type="checkbox"/> Redesign and reconstruct	

RAINWATER HARVESTING MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Check/ clean sediment or debris from within the tank <input type="checkbox"/> Check/clean diverts, cleanout plugs, screens, seals, covers, and overflow pipes; repair and replace damaged components <input type="checkbox"/> Empty tank when full (within 48 hrs) <input type="checkbox"/> Replace components and/or tank if leaking	
Monthly (during growing season)	<input type="checkbox"/> Remove trash, debris, and sediment from inlet, screen, and outlet	
Semi-Annually (spring & fall)	<input type="checkbox"/> Check and clean with brush; disinfect tank <input type="checkbox"/> Check pump	
Annually	<input type="checkbox"/> Pressure wash area draining to system <input type="checkbox"/> Flush and remove debris and sediment from tank <input type="checkbox"/> Replace pump on large systems (5 years)	
Upon Failure	<input type="checkbox"/> Contact manufacturer for corrective solution	

RIPARIAN RESTORATION & NATIVE REVEGETATION MAINTENANCE INSPECTION CHECKLIST

BMP Location:	Inspector's Remarks:
Overall Condition (circle one): <i>ACCEPTABLE</i> <i>UNACCEPTABLE</i>	
Inspection Date:	

FREQUENCY	MAINTENANCE ACTIVITY	COMMENTS
As Needed & Following > 1" Rainfall	<input type="checkbox"/> Irrigate if plants appear wilted or unhealthy; replace dead plants <input type="checkbox"/> Check for erosion and slope stability; repair with additional plant material similar to original and/or small stones for stability <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants <input type="checkbox"/> Replace bark mulch on bare, exposed soil	
Monthly (during growing season)	<input type="checkbox"/> Irrigate 1" water/week during the first growing season <input type="checkbox"/> Check plants for pest damage or disease <input type="checkbox"/> Remove trash, debris, and sediment <input type="checkbox"/> Remove weeds and invasive plants	
Semi-Annually (spring & fall)	<input type="checkbox"/> Check for erosion, embankment failure, and sediment accumulation <input type="checkbox"/> Prune/trim plants <input type="checkbox"/> Mow or spot apply herbicide (until canopy and/or vegetation established) <input type="checkbox"/> Redefine landward edge <input type="checkbox"/> Add bark mulch	
Annually	<input type="checkbox"/> Prescribed burn (prairie only) end of second year OR mow to very close to ground; remove plant debris from site to expose soil to sun; repeat on 2 to 5 year cycle	
Upon Failure	<input type="checkbox"/> Redesign and reconstruct	

Stormwater Management Practices Maintenance Agreement

Appendix D6

STORMWATER MANAGEMENT PRACTICES/BMPs MAINTENANCE AGREEMENT

THIS AGREEMENT is made this _____ day of _____, 20____, by _____ [Owner Name] of _____ [Company Name] with principal offices located _____ [Owner/Company Address], hereinafter “Owner”.

In accordance with _____ [Community Regulations], the Owner agrees to install and maintain stormwater management practice(s) (also known as BMPs) on the subject property, known as _____ [Property’s Common Name] located at _____ [Property’s Address], hereinafter “Property” in accordance with Exhibit A. The Owner further agrees to the terms stated in this document to ensure that the stormwater management practice(s) continues serving the intended function in perpetuity. This Agreement includes the following exhibit:

Exhibit A: BMP Operation and Maintenance Manual (“Manual”).

Note: This agreement and all Exhibits shall be recorded with the deed of property by the Owner at the [County Name] County Recorder’s Office and two (2) copies of the recorded document provided to [Community’s Name], hereinafter “Community”.

Through this Agreement, the Owner hereby subjects the Property to the following covenants, conditions, and restrictions:

1. The Owner shall be solely responsible for the installation, maintenance, and repair of the stormwater management practices, drainage easements, and associated landscaping identified in the Manual.
2. No alterations or changes to the stormwater management practice(s) identified in the Manual shall be permitted unless they are deemed to comply with this Agreement and are approved in writing by the Community.
3. The Owner shall retain the services of a qualified individual or company to operate and ensure the maintenance of the stormwater management practice(s) identified in the Manual.
4. The Owner shall annually, by December 30th, provide to the Community records of inspections, maintenance, and repair of the stormwater management practices in accordance with the Manual.
5. The Community or its designee is authorized to access the property as necessary to conduct inspections of the stormwater management practices or drainage easements to ascertain compliance with the intent of this Agreement and the activities prescribed in the Manual. Upon written notification by the Community or its designee of required maintenance or repairs, the Owner shall complete the specified maintenance or repairs within a reasonable time frame determined by the Community. The Owner(s) shall be liable for the failure to undertake any maintenance or repairs so that the public health, safety and welfare shall not be endangered nor the road improvement damaged.
6. If the Owner fails to properly maintain the stormwater management practice(s) in accordance with the Manual and this Agreement, the Community is authorized, but not required, to perform the specified inspections, maintenance, or repairs in order to preserve the intended functions of the practice(s) and prevent the practice(s) from becoming a threat to public health, safety, general welfare or the environment. In the case of an emergency, as determined by the Community, no notice shall be required prior to the Community performing emergency maintenance or repairs. The Community may levy the costs and expenses of such inspections, maintenance, or repairs plus a ten percent (10%) administrative fee against the Owner. The Community at the time of entering upon said stormwater management practice for the purpose of maintenance or repair may file a notice of lien in the office of the Register of Deeds of [County’s Name] County upon the property affected by the lien. If said

costs and expenses are not paid by the Owner, the Community may pursue the collection of same through appropriate court actions and in such a case, the Owner shall pay in addition to said costs and expenses all costs of litigation, including attorney fees.

7. The Owner hereby conveys to the Community an easement over, on, and in the Property or otherwise grants perpetual access rights for the purpose of access to the stormwater management practice for the inspection, maintenance, and repair thereof, should the Owner fail to properly inspect, maintain, and repair the practice(s).
8. The Owner agrees that this Agreement shall be recorded and that the Property shall be subject to the covenants and obligations contained herein, and this Agreement shall bind all current and future owners of the property.
9. The Owner agrees in the event that the Property is sold, transferred, or leased to provide information to the new owner, operator, or lessee regarding proper inspection, maintenance, and repair of the stormwater management practice(s). The information shall accompany the first deed transfer and include this Agreement and all Exhibits. The transfer of this information shall also be required with any subsequent sale, transfer, or lease of the Property.
10. The Owner agrees that the rights, obligations, and responsibilities hereunder shall commence upon execution of the Agreement.
11. The Owner whose signatures appear below hereby represent and warrant that they have the authority and capacity to sign this agreement and bind the respective parties hereto.
12. The Owner, its agents, representatives, successors, and assigns shall defend, indemnify and hold the Community harmless from and against any claims, demands, actions, damages, injuries, costs or expenses of any nature whatsoever, hereinafter "Claims", fixed or contingent, known or unknown, arising out of or in any way connected with the design, construction, use, maintenance, repair or operation (or omissions in such regard) of the stormwater management practice(s) referred to in Exhibit A which are the subject of this Agreement. This indemnity and hold harmless shall include any costs, expenses, and attorney fees incurred by the Community in connection with such Claims or the enforcement of this Agreement.

IN WITNESS WHEREOF, the Owner has executed this Agreement on the day and year first above written.

Owner Signature

Date

Printed Name

Company

Title

STATE OF INDIANA)
)
COUNTY OF [County Name])

SS:

BEFORE ME, the undersigned, a Notary Public in and for said County and State, personally appeared _____ Owner subscribed and sworn before this _____ day of _____, 20 ____.

Commission Expiration Date

County of Residence

Signature

Printed Name

WHEN RECORDED, RETURN FILE STAMPED COPY TO:

[Community's Name]
[Community's Address]
[City, IN, zip code]

.....
Accepted by [Community's name]:

Signature: _____

Date: _____

Printed Name: _____

Title: _____

