



Rain Gardens for RainScapes TECHNICAL DESIGN MANUAL



Table of Contents

- What is a rain garden? 1
- Site Assessment 2
 - Step One: Assess Yard & Identify Potential Rain Garden Sites & Designs2
 - Other Important Site Assessment Guidelines.....4
 - Step Two: Perform a Percolation Test (aka drawdown test)5
- Design 7
 - Inflow and Outflow Design7
 - Options for Sloped Yards9
 - Rain garden sizing 10
- Planting plans 13
 - Moisture and pollution zones 14
 - Design tips..... 14
 - Multi-level planting plan - Sun..... 15
 - Multi-level planting plan - Shade/Part Shade 19
 - Cottage planting plan - Sun 23
 - Cottage planting plan - Shade/Part Shade..... 27
 - Deer-Resistant planting plan - Sun 31
 - Deer-Resistant planting plan - Shade/Part Shade..... 35
 - Underdrained Planterbox planting plan - Sun 39
 - Underdrained Planterbox planting plan - Shade/Part Shade 43
- Details 47
- Construction 48
 - General construction guidelines 48
 - Clearing and excavation 49
 - Building a berm or a wall (choose the most appropriate one) 50
 - Overflow Weir..... 51
 - Overflow cobble (optional) 52
 - Underdrain (where applicable) 52
 - Inflow cobble and downspout extension..... 53
 - Planting media..... 54
 - Mulching and planting 55
 - Site stabilization 55
 - Step One:
 - Layout Garden and Mark-Up the Construction Elements 56
 - Step Two:
 - Excavate the Hole 57
 - Step Three:
 - Build a Berm; Cut and Shape the Ponding Perimeter 58
 - Step Four:
 - Fill Hole with Soil/Planting Media 59
 - Step Five:
 - Install Plants; Mulch and Water Garden 60
- Maintenance 61
- Trouble Shooting Guide 63
- Materials and equipment 64
- Montgomery County RainScapes 2014 Plant Palette 65
- References 66

Montgomery County RainScapes

Residential Rain Gardens

What is a rain garden?



A rain garden is an attractive, watershed-friendly way to capture and clean stormwater runoff, and is an important part of Montgomery County's RainScapes program. Residential rain gardens help to advance the goal of using innovative natural approaches to reduce water pollution, stream channel erosion, and drainage problems caused by stormwater runoff, while providing landscaping amenities for homeowners.

Rain gardens are designed to catch stormwater runoff that drains from impervious surfaces, such as roofs, driveways, and patios. A rain garden is a saucer-shaped garden that is placed slightly lower than the surrounding ground in order to collect water in a temporary ponding area. The captured water

is allowed to infiltrate into the ground, rather than flow off the property and enter a storm drain. The elements of a rain garden – enhanced soil filtration, deep-rooted native plants, and a mulch layer – provide some of the same ecological functions as a forest or meadow, just on a smaller scale.

The design standards in this guide are intended for use by qualified contractors in typical small-scale residential installations generally pursued through the RainScapes program. Non-typical applications, such as steep slopes, nearby trees, high water tables, and impermeable soils require consultation with a qualified designer/engineer.

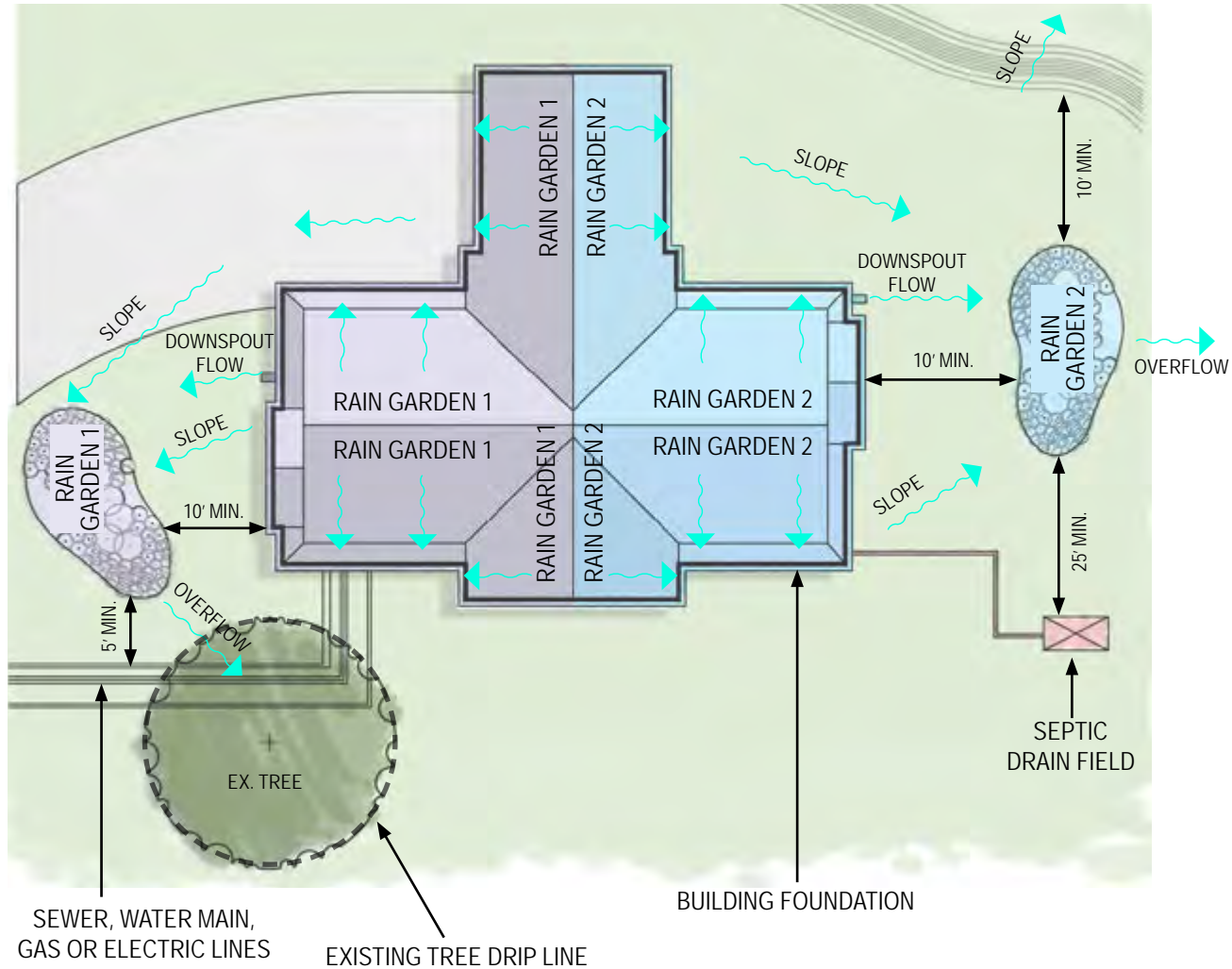
Rain Garden FAQs *This guide provides detail on these and other questions:*

- **How big can it be?** The area taken up by a residential rain garden is typically 10 to 20% of the drainage area from roofs and driveways. In residential settings, the total rain garden footprint typically ranges from 50 to 200 square feet.
- **What is the shape of a rain garden?** A rain garden is a bowl-shaped landscape feature. The surface shape of the rain garden is usually oval or curvilinear, based on site conditions and design aesthetics. Other shapes are also possible.
- **How deep to dig?** The digging depth depends on the area draining to the rain garden, the amount of rain being captured, and the planned footprint of the rain garden. During construction, the rain garden is excavated and then backfilled with planting media or existing soil that has been amended with compost. Leave a depth of six-inch from the top of the soil for temporary ponding. The total excavation depth typically ranges from one to three feet, depending on the design. In general, rain gardens should be designed to improve the soil performance using compost, rather than soil replacement. If necessary and advisable, then soils can be replaced with bioretention soil media.
- **Where can a rain garden be located?** Front yards are preferred because they often drain to a storm drain system, and the priority of the RainScapes Program is to reduce the amount of runoff that enters storm drains and ultimately local waterways. However, side and rear yards are also possible locations. All rain gardens should be at least 10 feet downslope from foundations, including neighbors' foundations.
- **How are rain gardens maintained?** Rain gardens can be maintained similarly to any other planted area. To ensure healthy plants and a properly-functioning rain garden, typical maintenance includes watering while the plants are becoming established, seasonal weeding, and periodic mulch replenishment.
- **What about mosquitoes?** Mosquitoes are not a concern because rain gardens are designed to have all standing water gone from the surface within 4 to 36 hours. Mosquito larvae need four days or longer to mature.
- Rain gardens are intended to infiltrate water. Soils must generally be 'A' or 'B' soils or will require an underdrain.

Site Assessment

Step One: Assess Yard & Identify Potential Rain Garden Sites & Designs

Design planting layout or use a Rain Garden Template that is sized for your site (10 feet, measured along the overflow path, between the rain garden overflow point and the nearest impervious surface).



Where does the garden go?

LOCATION

Every house and yard is different. The location of the rain garden will depend on available space, personal landscape preferences, and the guidelines listed below. **The rain garden inlet should be at least 10 feet downhill from any foundation.** After finding a suitable location, use flags or stakes to mark the area.

REQUIRED SETBACKS

When deciding on a rain garden location, follow the required setback distances listed in Table 1. If there is not enough space to accommodate the required setbacks, choose a different location or consult with RainScapes staff for other options.

Site Assessment



Garden with mix of four seasons interest plants. Berm is planted with plants tolerant of compaction.

Table 1. Required setbacks		
Setback	Distance	Reason
Foundation	Minimum of 10 feet downhill from foundation to closest edge of rain garden	Avoid possible water seepage into foundations
Property line	Generally 5 to 10 feet, measured along the overflow path, between the rain garden overflow point and the nearest downslope property line	Overflow from large storms needs enough space to spread out before leaving the property
Steep slopes	10 feet between any edge of the rain garden and an abrupt change from a gentle yard slope to a steep slope (approximately 15% or more)	Prevent possible slope instability
Trees	Generally, place the rain garden outside the dripline of large trees.	Reduce the likelihood of damage to tree root zones during excavation
Utilities	Five feet (horizontally offset) from sanitary sewer, gas or water mains (see illustration on page 2). Never place a rain garden over sewer or water mains. Locate all house connections prior to digging (dial 811). Consider future plant height in locations below overhead utilities.	Reduce the chance of infiltration into older pipes; prevent the rain garden from being dug up if utility work is needed
Sidewalks, driveways and other impervious surfaces	10 feet, measured along the overflow path, between the rain garden overflow point and the nearest impervious surface	Reduce the chance of winter icing on impervious surfaces

Site Assessment

Other Important Site Assessment Guidelines

Yard slope

Choose a gently sloping area if possible (2% - 5%). Very flat locations can be used, but may require more soil excavation and disposal to achieve the required ponding depth. If slopes exceed 6%, consider installing a short retaining wall on the upslope side (see Figure 5). Rain gardens are not recommended in areas where the existing slope is greater than 15%.

Structures

Rain gardens cannot be located upslope of a structure unless overflow can be directed away from the structure or it is at least 20 feet away from the structure.

Slow-draining spots

Placing rain gardens in areas known to be slow-draining may cause an excessively long drawdown time (greater than 36 hours). If the drawdown test shows that the rain garden will drain but will take longer than 36 hours, it may be possible to build the garden with a lower overflow elevation allowing for 2" of ponding. Then, after 3-5 years the deep-rooted native plants should have increased the soil porosity enough to install a higher overflow for 6" of ponding. If you anticipate being able to raise the ponding level, build the berm to your desired final elevation and insert a weir notch at the starting ponding elevation. Alternately, choose another location for the rain garden.

Ditches and swales

Avoid placing rain gardens along the path of any concentrated flow, such as a ditch or swale.

Eroded areas

Do not place rain gardens below areas with chronic erosion problems unless the eroded area can be permanently stabilized first.

Source control

Rain gardens ideally should be placed as close as possible to the point of discharge from downspouts or other contributing impervious area. As a result, water can be collected before concentrated flow paths develop.

Sun and shade

Rain garden plants generally do best in full or partial sun. This guide offers some suggestions for shade-tolerant plants if a shady spot is the best option, but mainly focuses on full to part sun vegetation. Plant lists for various light conditions are included in this guide. If space allows, the rain garden may be shifted to improve sun exposure.

Earthwork

If space allows, the rain garden location may be shifted to minimize earthwork and haul-off volume.



Miss Utility

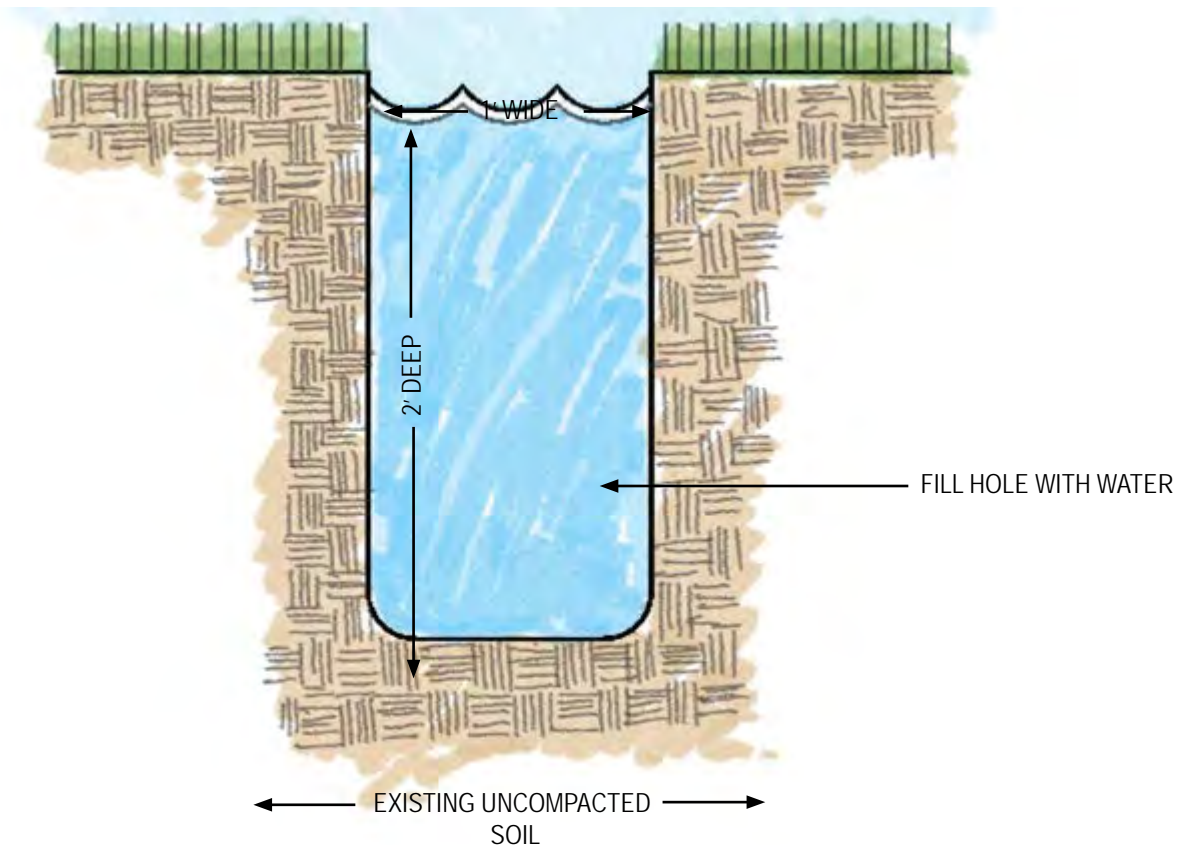
Always call Miss Utility (811) before digging. Calling before deciding on a rain garden location is recommended. Dig during the ticket timeframe, usually 10 days. It is advisable to have the ticket in hand while digging. Look for private house connections before digging. Verification of utility locations is the contractor's responsibility.

Site Assessment

Step Two:

Perform a Percolation Test (aka drawdown test)

For a rain garden to function properly, water must be able to infiltrate into the soil. Use a simple drawdown test to estimate the infiltration rate in the existing soil, following the directions below. Perform the test in the late spring or fall, when the water content of soils may be higher. Avoid testing when the ground is frozen, very wet, or very dry. In addition to this test, a simple penetrometer test can be used to verify soil characteristics if desired.



Directions:

- Dig a hole 2' deep, or to the design depth of the project, and approximately 1' wide.
- Fill hole with water and record how long it takes for water to drain completely.
- Within 12 hours of the first fill draining completely, fill the hole a second time and record how long it takes for it to drain completely.
- If the second drawdown takes **longer than 36 hours**, the site may not be suitable. In this case, select a different location or consult with the RainScapes staff.

Site Assessment

Testing the soil

For each 100 SF of rain garden, do a perk test.

If designing for a one-foot planting media depth, carefully examine the soil horizon in the test hole to check for a shallow clay layer at 1.5 feet below the surface. If a clay layer is present, the rain garden excavation must extend deeper than this layer, or you may be able to auger through it and install vertical stone sumps to facilitate garden drainage.

If the last drawdown test empties between 24 and 36 hours, then a soil exchange may be recommended, depending on the surrounding soils. If recommended, use 50% sand, 25% compost, 25% topsoil for the soil media. If it takes less than 24 hours, then the existing soil can be amended and re-used after excavation.



Depth to groundwater

In low-lying areas, the seasonal high water table may be close to the surface. The bottom of the excavation must be two feet above the seasonal high water table to ensure sufficient protection for groundwater.

If a high water table is suspected, use a more specialized soil test, or request a soil map from the Natural Resources Conservation Service or the Maryland-National Capital Park and Planning Commission.

For more information visit:

The Maryland Natural Resources Conservation Service
www.md.nrcs.usda.gov

The Maryland-National Capital Park and Planning Commission
www.montgomeryplanning.org

The Natural Resources Conservation Service Web Soil Survey
<http://websoilsurvey.nrcs.usda.gov>

Design

Inflow and Outflow Design

Flow into and out of the rain garden is a key aspect of design and long-term operation. Inflow can come from more than one area, including downspouts, patios, and driveways. Observing flow patterns on a rainy day can help to identify good rain garden locations, as well as spots to avoid. In general, construct the rain garden in a spot where the soils drain well and standing water does not linger after rain. Some guidelines are offered below.

Downspouts

Residential rain gardens are commonly used to collect roof runoff from downspouts. Downspout extensions that lead away from the house must direct the flow toward the rain garden (see pages 2 and 3). A few factors will affect the use of downspouts with a rain garden.

Directly connected – Some downspouts drain directly to a pipe in the ground that leads to the storm drain. By cutting the downspout and adding an elbow and extension, roof runoff can be directed to a rain garden.

Disconnected – If downspouts already drain to the yard or driveway, a rain garden can be placed to collect that flow. Adding a downspout extension or changing the direction of an extension will give more flexibility in placement.

Relocation – To direct flow to a suitable location for rain garden placement, it may be possible to re-pitch the gutter to change the direction of gutter flow, or to change the position of the downspout.

Directing flow into the rain garden

There are several ways to direct runoff into a rain garden (Figure 1). Flow paths must always slope away from the house to ensure good drainage. To disperse flows and prevent erosion, you may need to add cobble at the point where water enters the rain garden. In all cases, the rain garden ponding edge must be offset at least 10 feet from the foundation.

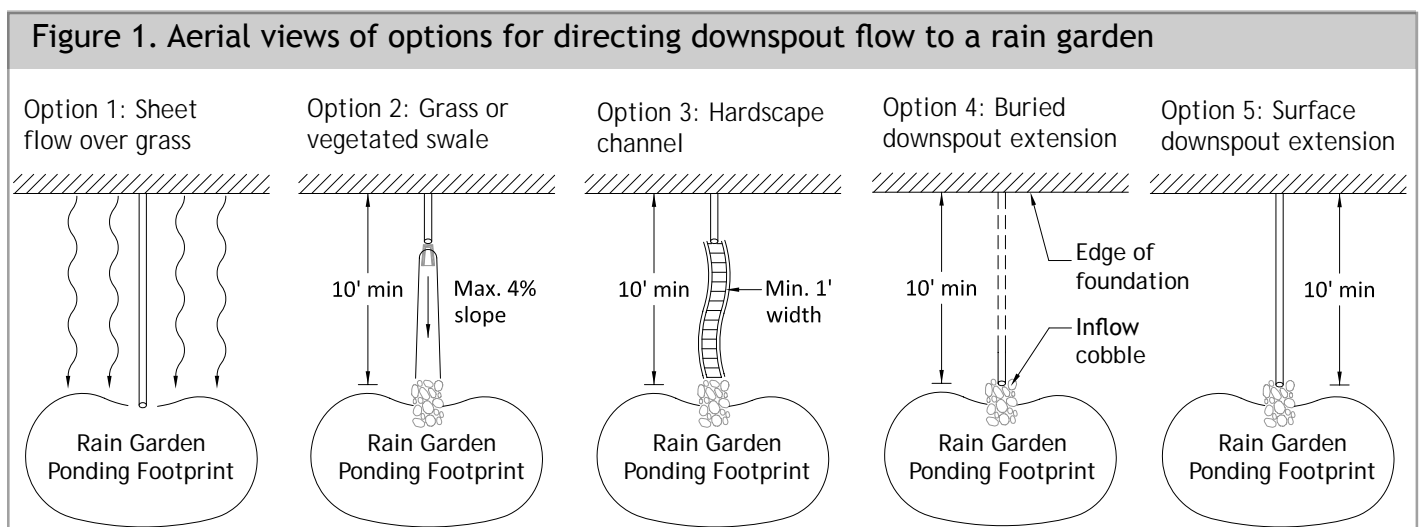
Option 1 – Sheet flow over grass to the uphill long edge of the rain garden.

Option 2 – Grass or vegetated swale (max. slope 4%) leading to rain garden. An existing swale can be used. If a downspout drains to the swale, use cobble or a splash block to disperse flows before entering the swale.

Option 3 – Decorative channel made of stone, bricks, or paver blocks. The bottom of the channel should be at least one foot wide.

Option 4 – Shallow buried downspout extension that daylights with the bottom of the pipe above the ponding level.

Option 5 – Ordinary downspout extension along the ground surface.



Design

Overflow

All rain gardens will overflow during periods of high rainfall depth or intensity. Overflow must be directed to a suitable location.

Unless designed otherwise, overflow will follow any natural flow paths below the rain garden. Even flat yards may have a preferred flow path – watch for it on rainy days.

An unpaved surface, such as a lawn or vegetated area, is usually the best location for overflow because it may allow water to soak into the ground. Other options include existing drainage channels, area drains, or a dry well. There is a risk of winter icing if overflow is directed to a paved surface.

- An overflow weir notch allows overflow to be directed in the desired direction. A weir is often recommended for rain garden designs that use a berm. A weir is optional for designs that use a wall with an underdrain. (See Figures 3, 4 and 5 on page 12 and “Overflow Weir” on page 51.)
- If constructing a berm without a weir notch, it is important to use a laser or line level to ensure uniformity of height in the finished elevation of the berm. This allows the overflow water to sheet flow over the entire berm when exiting the garden. This type of berm needs to be planted with sod to prevent erosion.
- To reduce the chance of creating problems with erosion or lot-to-lot drainage, overflow should generally be directed to an existing flow path, rather than an area that does not currently receive stormwater flow.
- In some instances, it may be desirable to establish a new drainage pattern to solve an existing problem, but this should be done with extreme care.



Notch Overflow



Level Berm Overflow

Design

Options for Sloped Yards

The preferred rain garden design depends in part on the yard slope. All but the most gently-sloped yards will require either a berm (Figure 4) or a wall (Figure 5) to create a level ponding area. Table 2 lists recommended rain garden designs based on yard slope. Moderately sloped yards may use either a berm or a wall, as indicated in Table 2. A wall design takes up less space but also requires a deeper excavation. If either design is feasible, a berm will typically be less expensive to construct.

Yard Slope and Design Type	0-2% No berm	2-6% Berm	2-6% Upslope wall	6-15% Upslope wall	6-15% 2-cell design
Cobble at inflow, when runoff enters via pipe or swale	Yes	Yes	Yes	Yes	Yes
Outflow design	Shallow graded path	Overflow weir in berm, or level berm overflow	Shallow graded path	Shallow graded path, or level berm overflow	Shallow graded path
Comment	Small slope avoids need for berm, but may increase amount of excavation	An overflow weir is easier to install but re-concentrates the water, whereas a level berm overflow does not.	Likely to be more costly than a berm for this range of yard slope	Berm would occupy too much space in steep yards	A terraced design may be suitable for steep yards

Measuring yard slope

To measure the slope of the yard, drive two stakes at least 10 feet apart on the upslope and downslope ends of the rain garden location.

Tie a string to the upslope stake so that the end of the string just touches the ground.

Attach the other end of the string to the downslope stake.

Using a line level, adjust the string on the downslope stake so that the string is level.

The slope equals:

$$100 \times \frac{\text{height of string (ft) above ground at downslope stake}}{\text{horizontal distance along string (ft)}}$$

Design

Rain garden sizing

Rain garden sizing depends on the drainage area, media footprint, and excavation depth. Tables 3-5 show sizing for different media depths. **The recommended media depth is two feet.** Depth to groundwater (and the ability to dispose of soil, if doing a soil exchange) should be considered when choosing a media depth.

Figure 2 shows the media footprint used for sizing. Allow an additional five to ten feet of width and length to account for the ponding footprint (Table 6) and other common features such as a berm or wall. The available width must be approximately twice the available length.

Residential rain gardens should be sized for 1.0 to 2.5 inches of rain. The minimum rain capture goal for a RainScapes Reward Rebate is 1.0 inch. Overflow will occur less frequently if a rainfall depth greater than 1.0 inch can be captured.

Using the sizing tables

1. Use the rain garden location guidelines to estimate the available media footprint. The media footprint is shown in Figures 2 & 3.
2. Measure the impervious area (e.g., roof and driveway) that can be directed to the rain garden. The roof drainage area to each downspout can be found by dividing the house footprint by the number of downspouts.
3. Table 4 is the recommended starting point. Across the top of the table, find the number closest to the impervious drainage area.
4. Look down the column. Find the number closest to the desired rainfall storage (at least 1.0 inch).
5. Look to the left side of the table to find the corresponding media footprint.
6. If the required area is larger than the available space, choose a smaller rainfall depth or repeat the process with three feet of media (Table 5).
7. Make a note of the final planting media depth and media footprint.

Sizing example

Use Table 4 for a design with two feet of planting media. This table shows that a rain garden with a 30 sq. ft. media footprint and a 400 sq. ft. drainage area can capture 1.2 inches of rainfall.

Note: This rainfall capture calculation is conservative because it does not include drawdown into the underlying soil.

Table 3. Sizing table for 1 ft planting media

Inches of rain stored	Drainage area (square feet)					
	100	200	300	400	500	600
5	1.1	0.6	0.4	0.3	0.2	0.2
15	2.2	1.1	0.7	0.6	0.4	0.4
30	3.8	1.9	1.3	1.0	0.8	0.6
50	6.0	3.0	2.0	1.5	1.2	1.0
60	7.1	3.6	2.4	1.8	1.4	1.2
75	8.8	4.4	2.9	2.2	1.8	1.5
100	11	5.7	3.8	2.9	2.3	1.9
125	14	7.1	4.7	3.6	2.8	2.4

Table 4. Sizing table for 2 ft planting media

Inches of rain stored	Drainage area (square feet)					
	100	200	300	400	500	600
5	1.3	0.7	0.4	0.3	0.3	0.2
15	2.8	1.4	0.9	0.7	0.6	0.5
30	5.0	2.5	1.7	1.2	1.0	0.8
50	7.9	4.0	2.6	2.0	1.6	1.3
60	9.4	4.7	3.1	2.3	1.9	1.6
75	12	5.8	3.9	2.9	2.3	1.9
100	15	7.6	5.1	3.8	3.1	2.5
125	19	9.5	6.3	4.7	3.8	3.2

Table 5. Sizing table for 3 ft planting media

Inches of rain stored	Drainage area (square feet)					
	100	200	300	400	500	600
5	1.5	0.7	0.5	0.4	0.3	0.2
15	3.3	1.7	1.1	0.8	0.7	0.6
30	6.1	3.1	2.0	1.5	1.2	1.0
50	9.8	4.9	3.3	2.5	2.0	1.6
60	12	5.8	3.9	2.9	2.3	1.9
75	14	7.2	4.8	3.6	2.9	2.4
100	19	9.5	6.4	4.8	3.8	3.2
125	24	12	7.9	5.9	4.7	3.9

Design

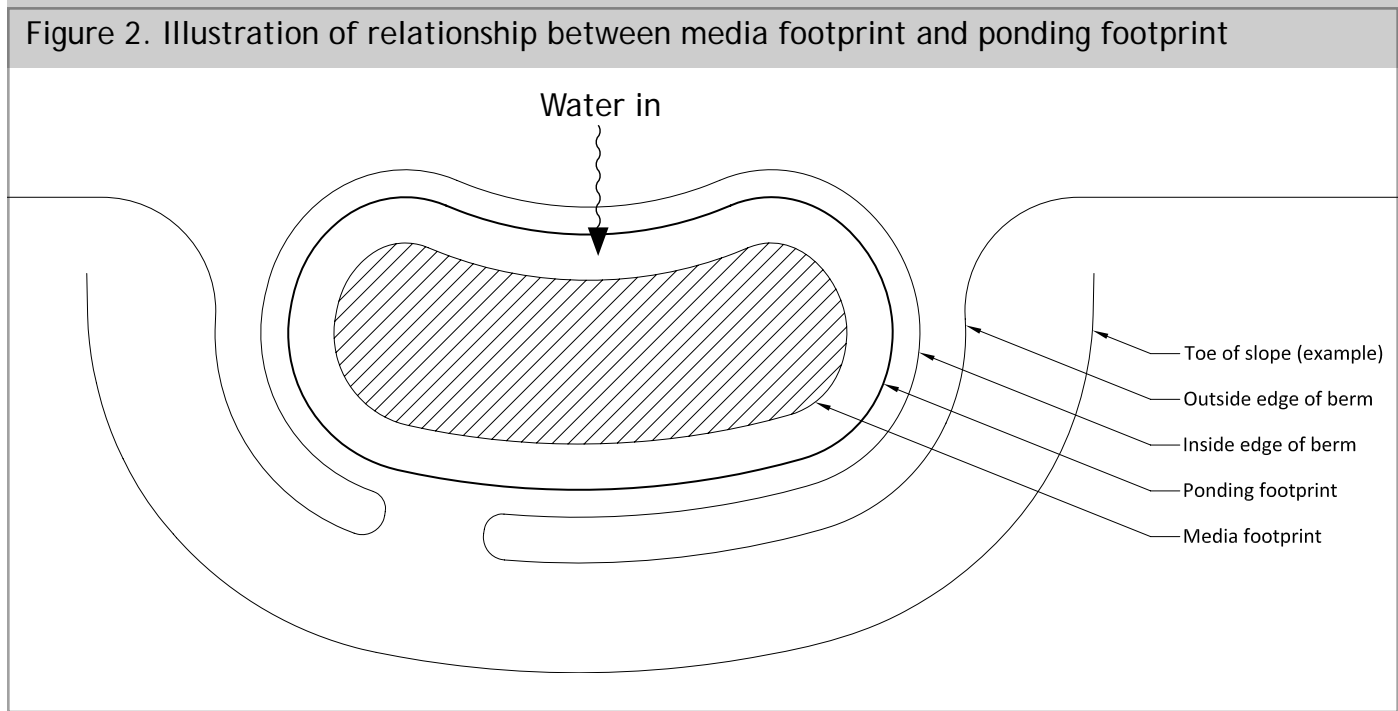
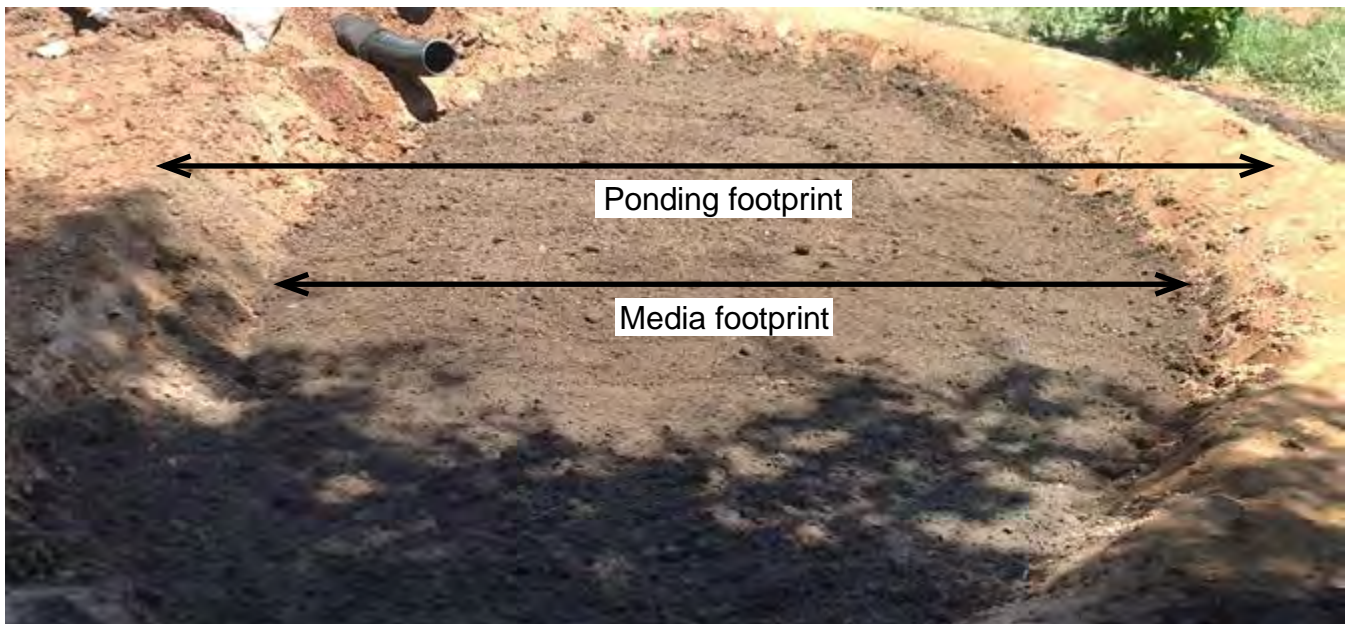


Table 6. Relationship between media footprint and ponding footprint in square feet

Media footprint	5	15	30	50	60	75	100	125
Ponding footprint	25	35	55	80	95	110	145	175

Example: A rain garden with a 100 square foot media footprint has a ponding footprint of 145 square feet. Additional space may be needed for rain gardens with walls or large berms.



Design

Figure 3. Plan view with berm and overflow weir

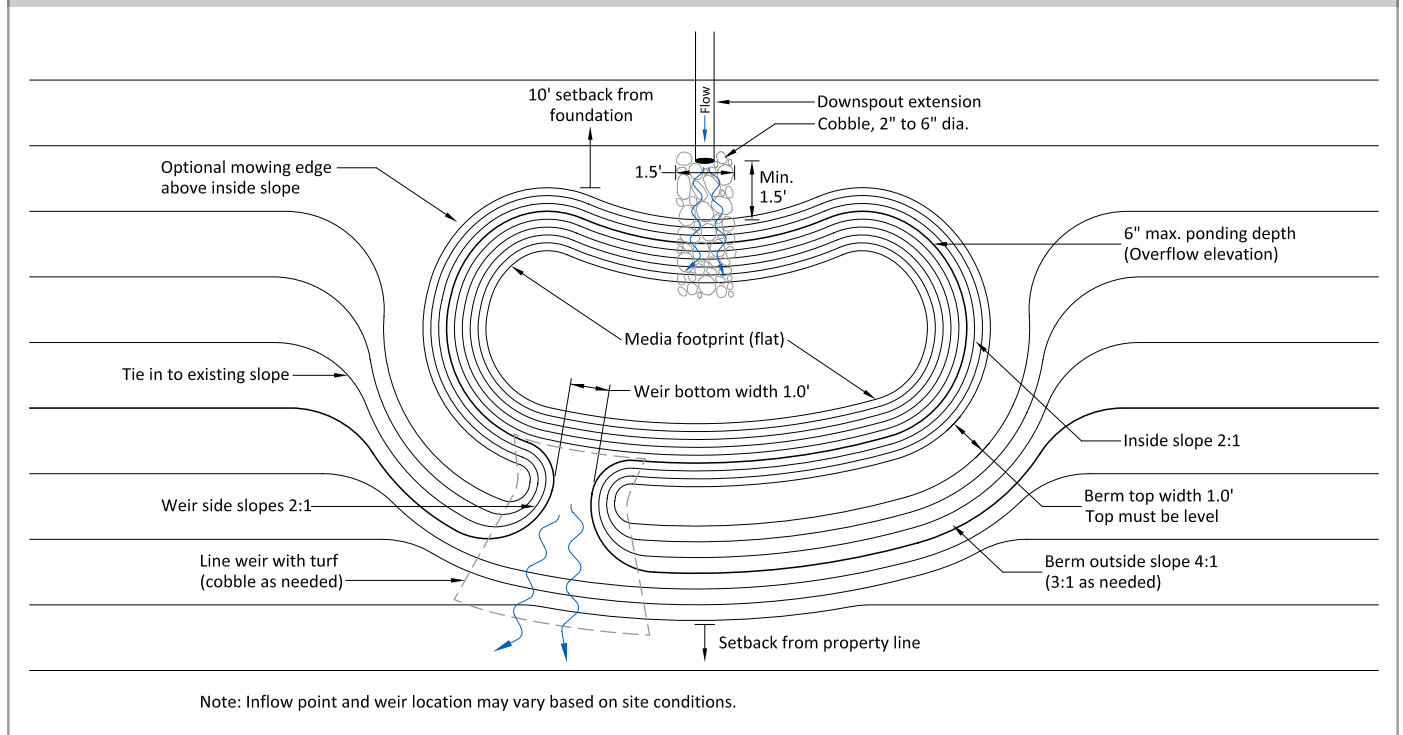


Figure 4. Profile view with berm and overflow weir. Overflow weir is required for berm designs.

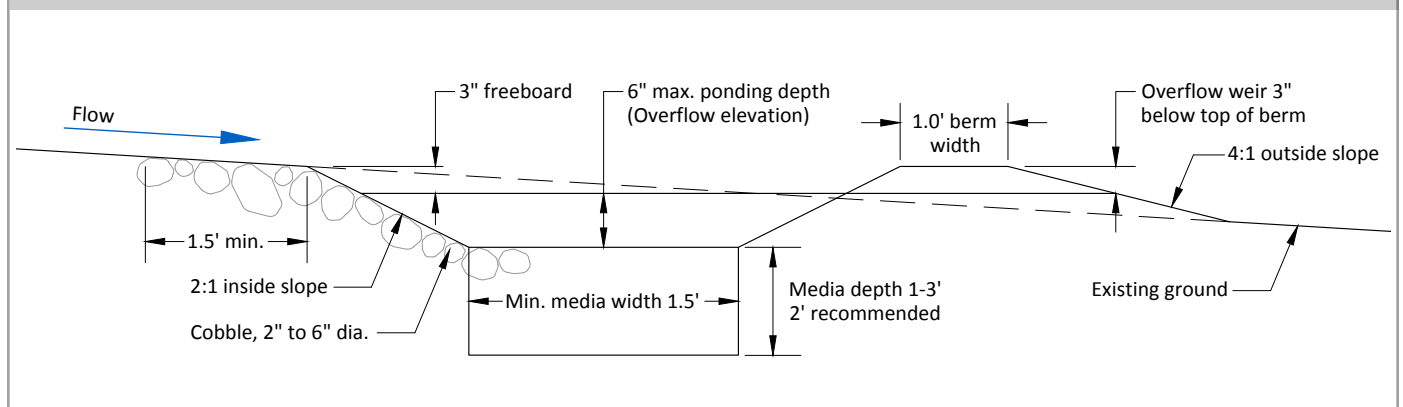
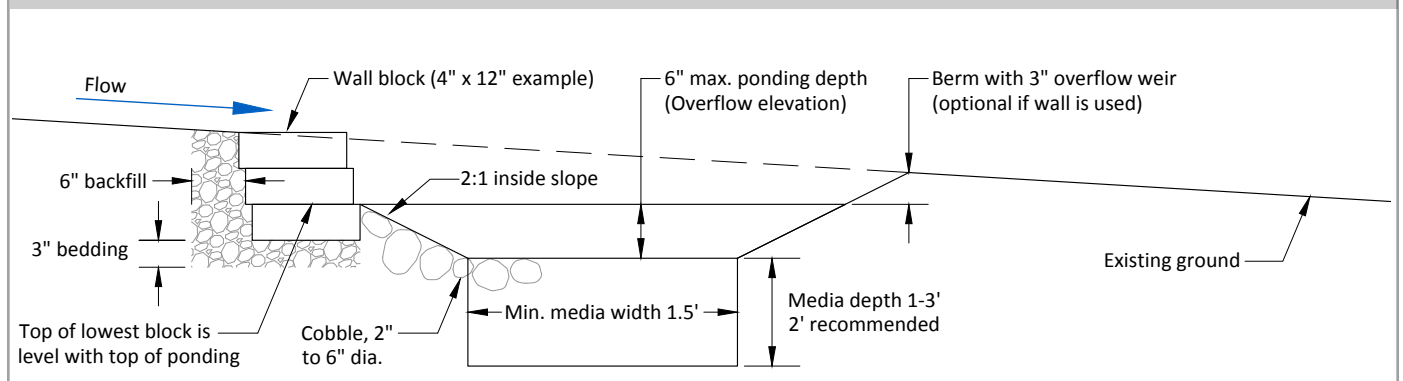


Figure 5. Profile view with wall. Overflow weir is also shown, which is optional for wall designs.



Planting Plans

Vegetation in rain gardens should be attractive, easy to maintain, provide ecological value, and suit the homeowner's design preference. Recommendations for basic planting zones are listed below and are illustrated in Figure 6.

- Media surface: Tolerant of both drought and periodic inundation. Woody vegetation (excluding large trees) can be included in this zone.
- Inside slopes: Tolerant of both drought and periodic inundation.
- Top and outside slopes of berm (if used): Shallow-rooted, drought-tolerant plants or sod.
- Aim for vegetated cover year round. This can be accomplished by selecting plants with basal rosette winter forms. Also, cut back plants in the spring rather than fall .

Consult the sample planting plans (Figures 7 through 14) for planting ideas, and use the references listed at the end of this guide for additional help in selecting plants and other planting templates.

Features of a **multi-level planting plan** (Figures 7 and 8) include:

- Multiple garden cells on two levels
- Installed on slopes that are too steep to fit a large garden
- Berm provides an access path through the garden
- Plant selection and arrangement can be switched to create a cottage or deer-resistant garden

Features of a **cottage planting plan** (Figures 9 and 10) include:

- Meadow-like mixture of plant textures, heights and colors
- Taller shrubs on the upslope side act as a backdrop to the plantings
- Provides habitat for birds, butterflies and other pollinators

Features of a **deer-resistant planting plan** (Figures 11 and 12) include:

- Plants selected that deer do not prefer
- Fragrant plants which mask more deer attractive plants
- A hedge on the upslope side, which will require regular pruning to maintain its shape



Multi-level planting plan

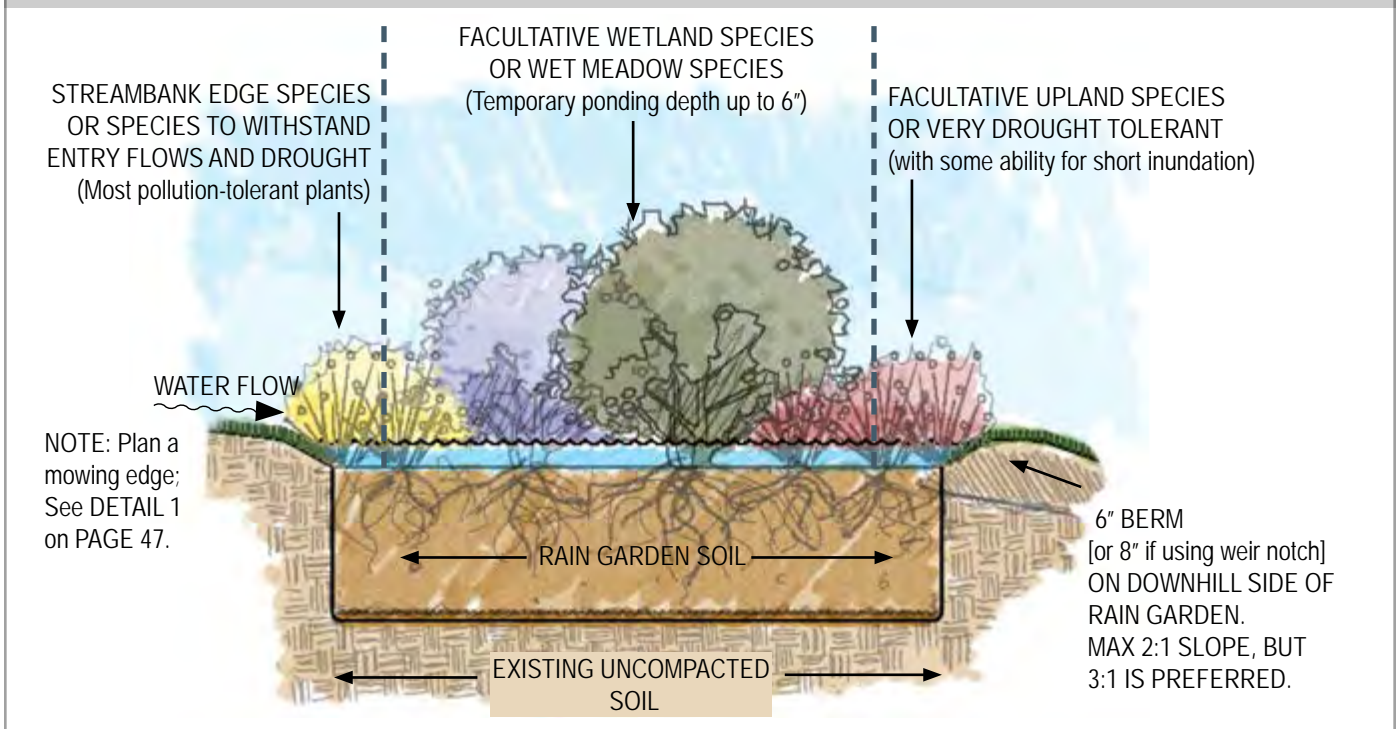


Cottage planting plan

Planting Plans

Moisture and pollution zones

Figure 6. Planting plan moisture and pollution zones



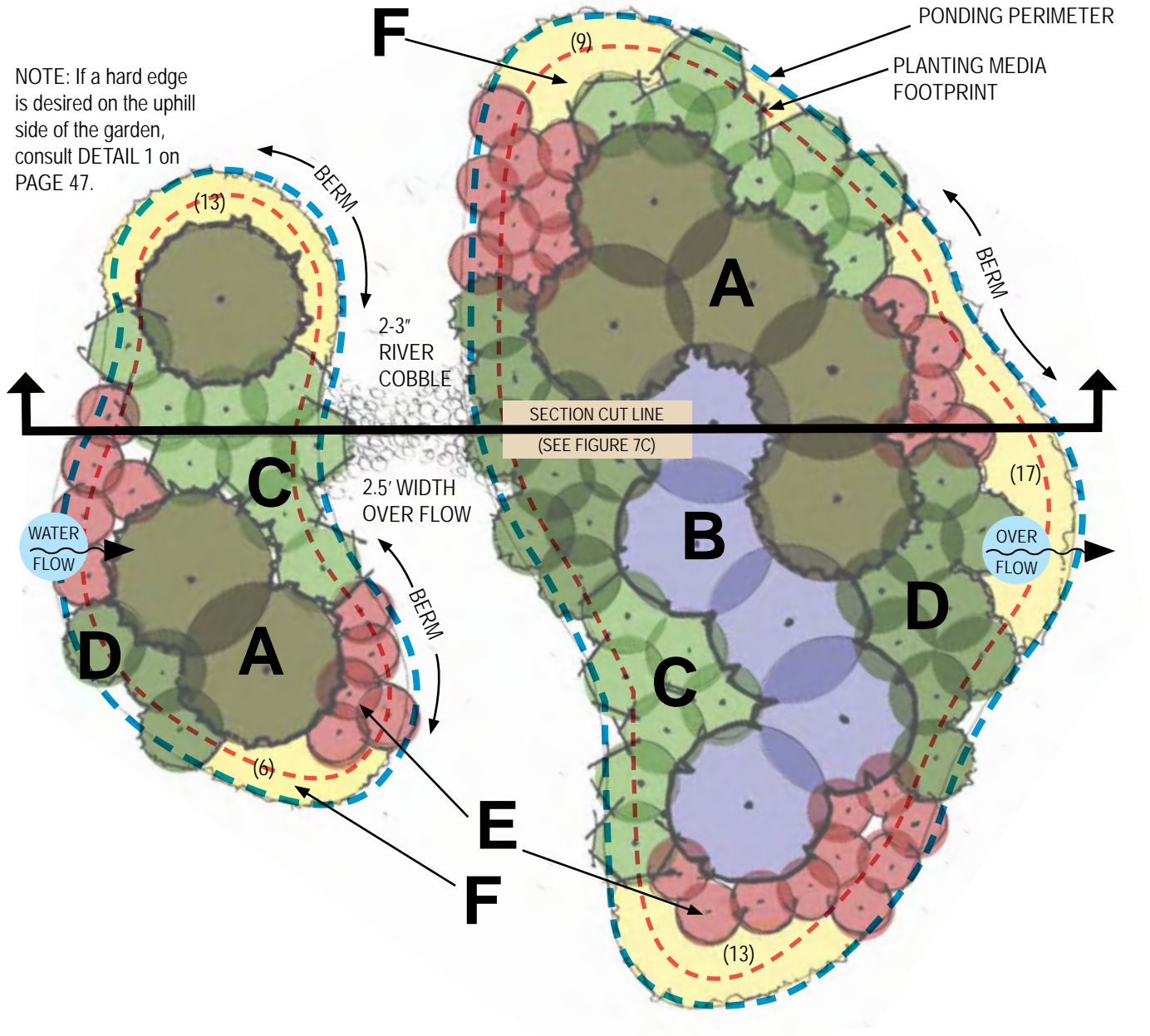
Design tips

- Plants native to the Mid-Atlantic Piedmont are recommended because they are well-adapted to the region and will provide high ecological value.
- Consider plant maintenance when designing and planting the rain garden. Allow room for a mulch path that allows access to all the plant groups.
- Plant shrubs and perennials in groups of three to five of the same species. Avoid complex planting plans – simpler plant palettes make plant identification for maintenance easier.
- If a tree is used, generally plant the tree at one edge of the garden. Use only small understory trees. Large canopy trees should be avoided within the garden because their roots will take up too much space.
- Space and plant perennials so that their canopies will grow together and cover the ground to minimize weeds. Plant spacing should be about 25% closer than typically recommended.
- Select perennials with winter basal rosette to maintain winter coverage.
- Consider how the rain garden will fit into the surrounding landscape and how it will look from different positions, including views from the house and neighboring properties.
- Consider the color selection, such as warm versus cool colors, and the relationship they have to existing plantings and the house.
- Consider seasonal changes to color and texture in the garden. Select plants to provide visual interest in each season.
- Consider complementary mixtures of textures: fine textures mixed with coarser foliage textures creates interest and contrast.
- Larger groups of each species can be labeled to allow desirable vegetation to be distinguished from weeds.

Planting Plans

Multi-level planting plan - Sun

Figure 7A. Multi-level planting plan - Sun



Plan -Multiple Levels- Sun (+/- 325 sf of Ponding Perimeter)

Scale: 1/4"=1'-0"



Planting Plans

Figure 7B. Multi-level planting plan: Plant list- Sun



A *Ilex verticillata* 'Cacapon'/ Winterberry*
 6-8' HT.- 42" o.c.
 • Medium height shrub providing year round interest with red berries



B *Baptisia australis*/ Blue False Indigo
 3-4' HT.- 42" o.c.
 • Upright perennial with many purple flowers atop flower spikes in Spring



C *Iris versicolor*/ Blue Flag Iris
 24-30" HT.- 12" o.c.
 • Swordlike leaves with large, violet-blue flowers in late Spring



D *Rudbeckia fulgida*/ Black Eyed Susan
 2' HT.- 24" o.c.
 • Native, yellow flowering perennial that blooms from June to October



E *Asclepias tuberosa* / Butterfly Milkweed
 1-2' HT.- 18" o.c.
 • Medium height perennial with orange flowers in early Summer



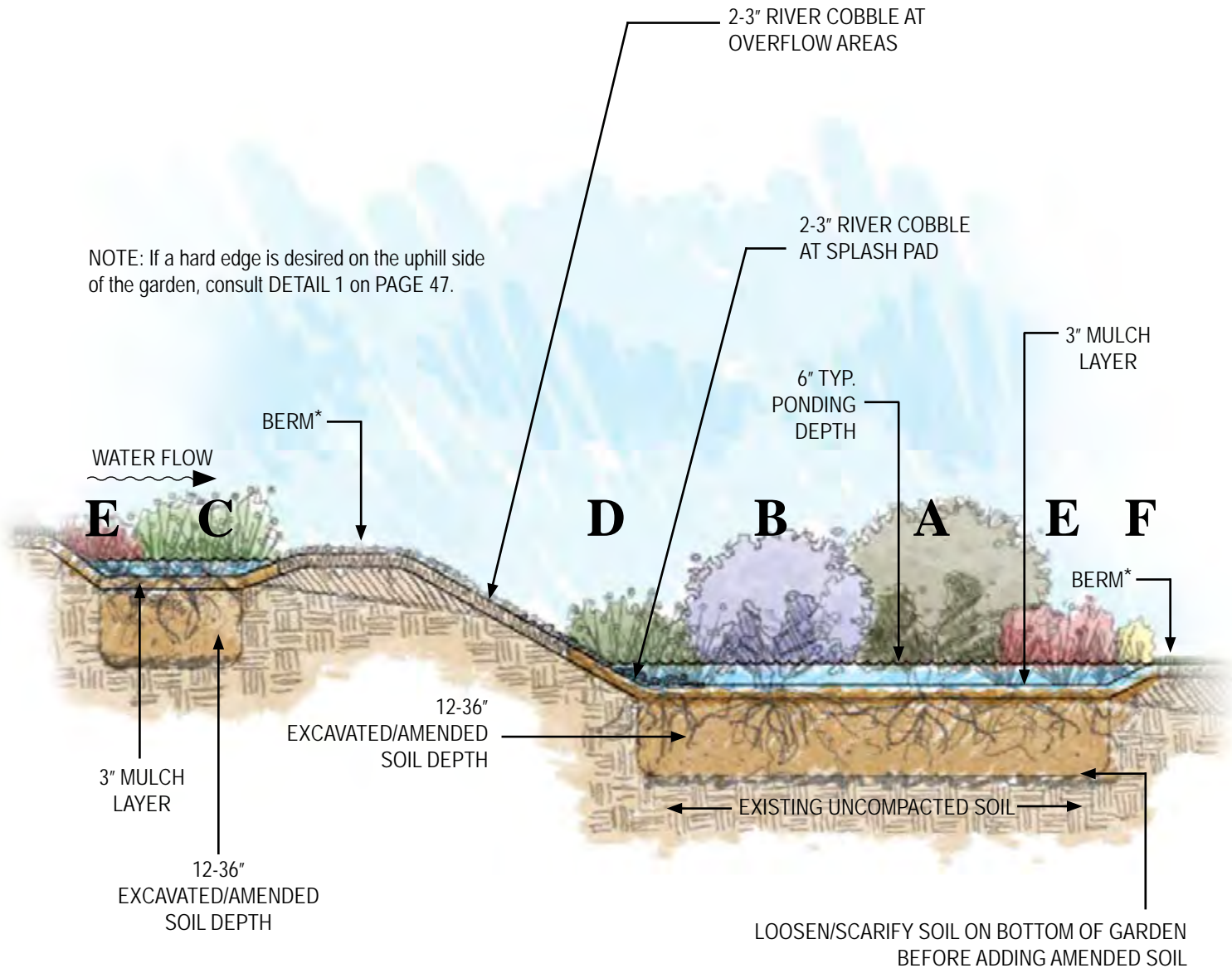
F *Phlox subulata*/ Moss Phlox
 4-6" HT.- 12" o.c.
 • Spring blooming fragrant perennial with lower growth habit

Note: o.c. = on center spacing

* Denotes Female Plant; Requires 1 male counterpart. For Winterberry, provide one 'Jim Dandy' (male) for each grouping of 'Cacapon' (female).

Planting Plans

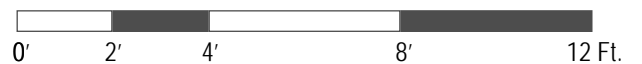
Figure 7C. Multi-level planting plan: Cross-section - Sun



*BERM NOTE: Maximum inside slope of berm from ponding perimeter to media footprint is 2:1 (but 3:1 is better). Maximum slope for exterior of berm is 3:1. See page 58 for more details.

Section- Multiple Levels- Sun

Scale: 1/4"=1'-0"



Planting Plans

Figure 7D. Multi-level planting plan: Alternate plant choices- Sun

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Ilex glabra</i> 'Shamrock'	Inkberry	3-4'	42" o.c.	Medium height shrub providing evergreen foliage.
	<i>Viburnum dentatum</i>	Arrowwood Viburnum	4-6'	42" o.c.	Medium height deciduous shrub which produces white flowers in late Spring.
B-	<i>Panicum virgatum</i> 'Shenandoah'	Switchgrass	3-4'	42" o.c.	Medium height grass with color interest Spring through Fall.
	<i>Eupatorium dubium</i> 'Little Joe'	Joe Pye Weed	3-4'	42" o.c.	Perennial with late summer blooms that will attract butterflies. Dwarf form of tall.
C-	<i>Aster novae angliae</i> 'Purple Dome'	New England Aster	1.5-2'	24" o.c.	Dwarf perennial that blooms through September with vibrant purple flowers.
	<i>Schizachyrium scoparium</i> 'The Blues'	Little Bluestem	2-3'	24" o.c.	Narrow, upright grass with light-blue foliage and year-round color interest.
D-	<i>Monarda didyma</i> 'Petite Delight'	Bee Balm	1.5 - 2.5'	24" o.c.	Perennial with pink blooms June through September attracting hummingbirds.
	<i>Eupatorium coelestinum</i>	Mist Flower	1.5 - 2.5'	24" o.c.	Perennial with light blue blooms July through October.
E-	<i>Penstemon digitalis</i> 'Huskers Red'	Beard Tongue	2-3'	18" o.c.	Clump forming perennial with tubular flowers in mid Spring early Summer.
	<i>Liatris spicata</i> 'Kobold'	Purple Gayfeather	2.5'	18" o.c.	Medium height perennial with protruding purple spikes in late Summer.
F-	<i>Sisyrinchium graminoides</i>	Blue-Eyed Grass	6-12"	12" o.c.	Small perennial with fine textured leaves and blue flowers.
	<i>Geranium maculatum</i>	Wild Geranium	1-2'	12" o.c.	A low clustering perennial with many pale pink flowers that bloom April to May.

Note: o.c. = On Center



Eupatroium dubium



Eupatroium coelestinum

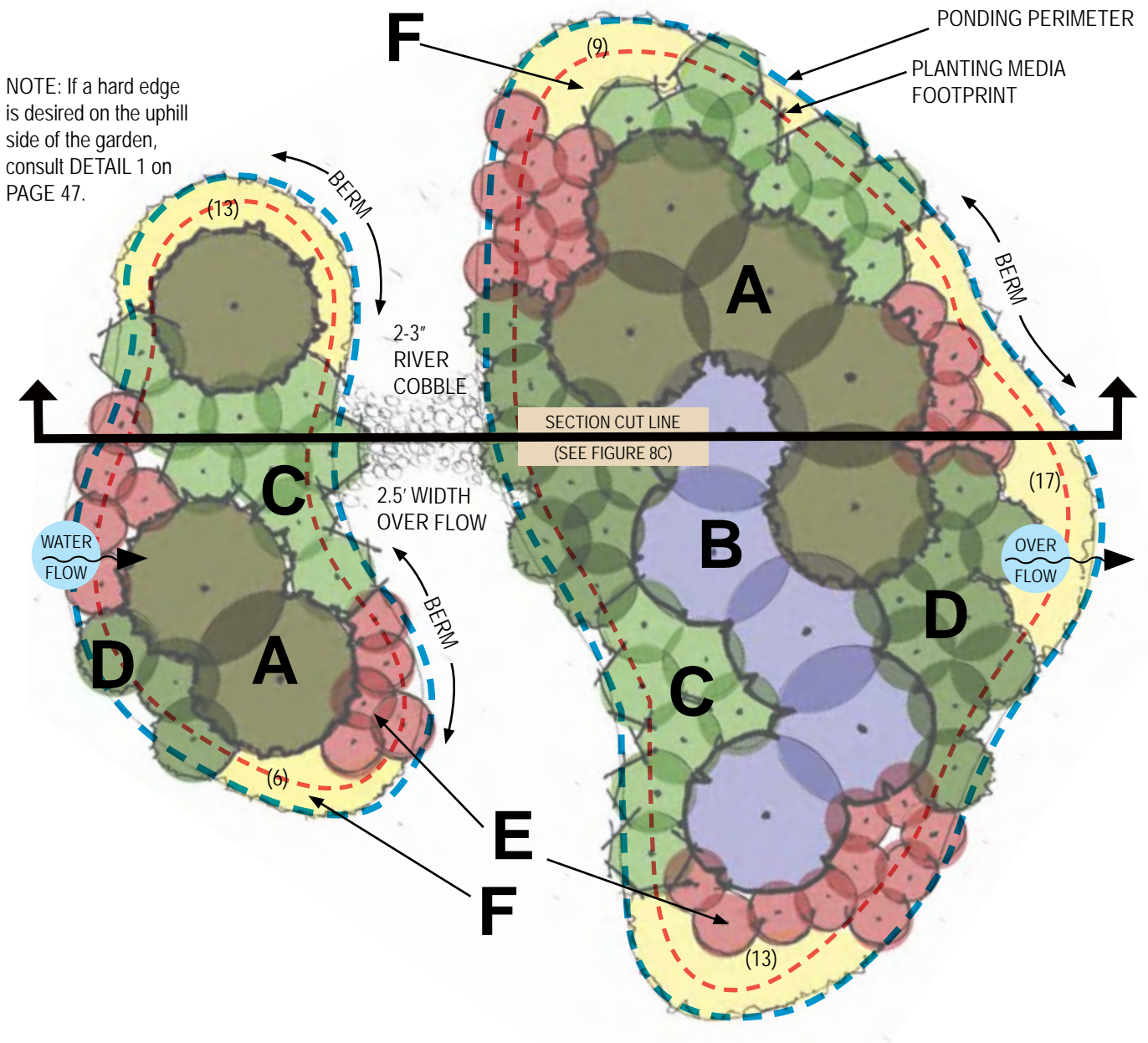


Liatris spicata

Planting Plans

Multi-level planting plan - Shade/Part Shade

Figure 8A. Multi-level planting plan - *Shade/Part Shade*



Plan -Multiple Levels- Shade/Part Shade (+/- 325 sf of Ponding Perimeter)

Scale: 1/4"=1'-0"



Planting Plans

Figure 8B. Multi-level planting plan: Plant list- *Shade/Part Shade*



A *Aronia arbutifolia* 'Brilliantissima'/Chokeberry
 6-8' HT.- 42" o.c.
 • Medium height shrub with glossy red berries and Fall foliage



D *Polystichum acrostichoides*/Christmas Fern
 1.5-3' HT.- 24" o.c.
 • Evergreen fern that grows in a fountain-like clump



B *Leucothoe fontanesiana* 'Scarletta'/Scarletta Fetterbush
 2-3' HT.- 42" o.c.
 • Low, dense shrub with red to deep purple foliage color



E *Carex stricta*/ Tussock Sedge
 2-3' HT.- 18" o.c.
 • Perennial sedge that forms a dense tussock of leafy culms



C *Aster divaricatus*/White Wood Aster
 1-2' Ht.- 24" o.c.
 • Shorter perennial with white daisy flowers appearing August to October

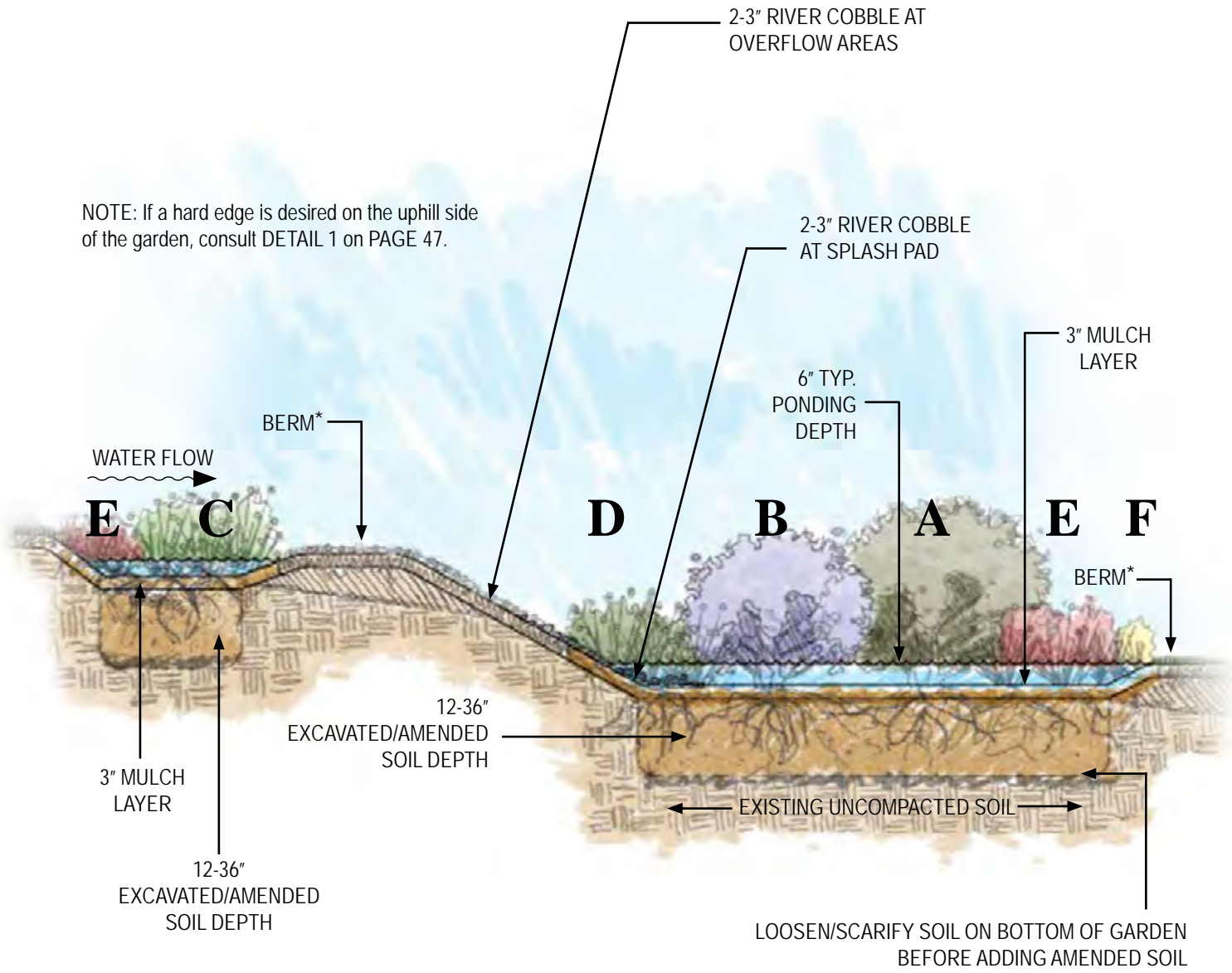


F *Phlox stolonifera* 'Blue Ridge'/Creeping Phlox
 8" HT.- 12" o.c.
 • Mat forming habit with masses of clear purple flowers

Note: o.c. = on center spacing

Planting Plans

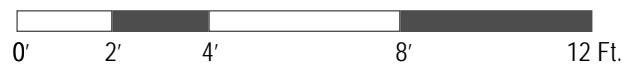
Figure 8C. Multi-level planting plan: Cross-section - *Shade/Part Shade*



*BERM NOTE: Maximum inside slope of berm from ponding perimeter to media footprint is 2:1 (but 3:1 is better). Maximum slope for exterior of berm is 3:1. See page 58 for more details.

Section- Multiple Levels- Shade/Part Shade

Scale: 1/4"=1'-0"



Planting Plans

Figure 8D. Multi-level planting plan: Alternate plant choices- *Shade/Part Shade*

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Myrica pensylvanica</i>	Bayberry	5-10'	42" o.c.	Larger shrub providing evergreen foliage.
	<i>Lindera benzoin</i>	Spicebush	6-8'	42" o.c.	Larger deciduous shrub providing many yellow flowers in Spring.
B-	<i>Clethra alnifolia 'Sixteen Candles'</i>	Summersweet	4-5'	42" o.c.	Medium height shrub with color interest Spring through Fall.
	<i>Hydrangea arborescens 'Annabelle'</i>	Smooth Hydrangea	4-5'	42" o.c.	Medium height shrub which produces large white flowers in late Spring.
C-	<i>Amsonia hubrechtii</i>	Willowleaf Bluestar	2-5'	24" o.c.	Fine textured perennial with blue star-like flowers appearing in early Summer.
	<i>Aruncus dioicus</i>	Goat's Beard	1.5-3'	24" o.c.	Perennial with fine textured feathery blooms in late Spring
D-	<i>Chasmanthium latifolium</i>	Northern Sea Oats	3-4'	24" o.c.	Clump-forming, ornamental grass with drooping seeds.
	<i>Dryopteris marginalis</i>	Evergreen Wood Fern	1-3'	24" o.c.	Woodland fern with excellent rich brown color in Autumn.
E-	<i>Chelone glabra</i>	Turtlehead	2-3'	18" o.c.	Shorter height perennial with white flowers appearing in late Summer early Fall.
	<i>Heuchera americana</i>	Coral Bell	1-2'	18" o.c.	Darker purple foliage perennial with white showy flowers in Spring.
F-	<i>Phlox divaricata</i>	Wild Blue Phlox	10-12"	12" o.c.	Spring blooming fragrant perennial with lower growth habit.
	<i>Tiarella cordifolia 'Brandywine'</i>	Foam Flower	6-8"	12" o.c.	Low growing, spreading perennial with white puffy flowers in Spring.

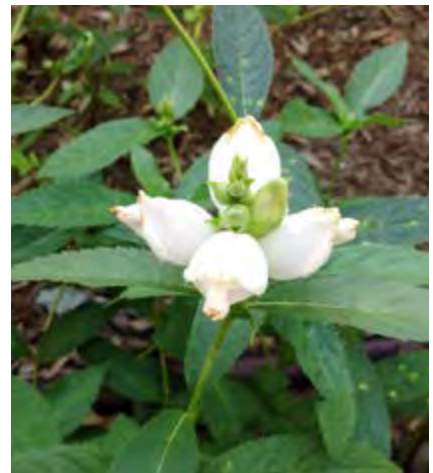
Note: o.c. = On Center



Dryopteris marginalis



Heuchera americana



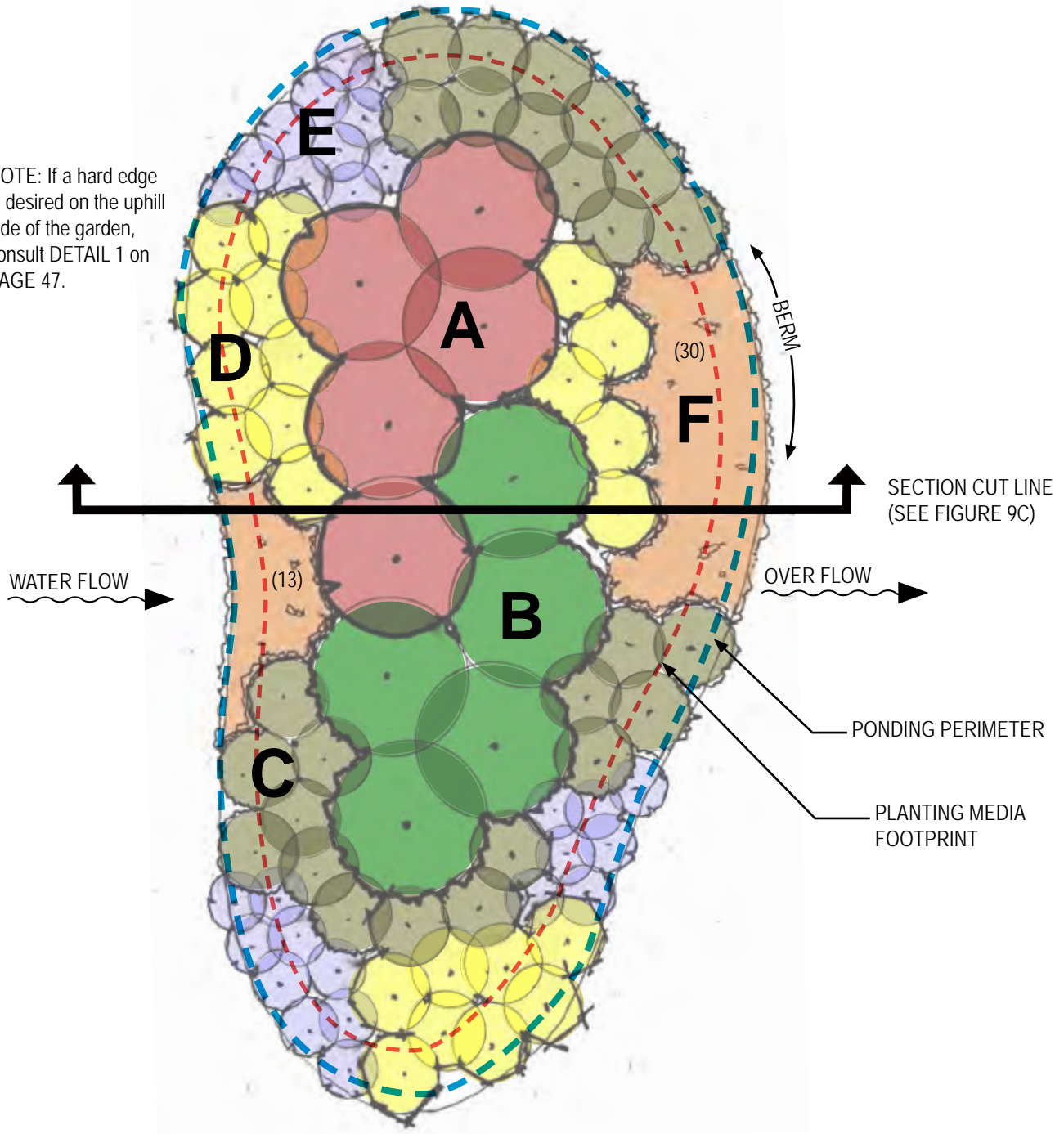
Chelone glabra

Planting Plans

Cottage planting plan - Sun

Figure 9A. Cottage planting plan - Sun

NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



Plan - Cottage- Sun (+/- 285 sf of Ponding Perimeter)

Scale: 1/4"=1'-0"



Planting Plans

Figure 9B. Cottage planting plan: Plant list- Sun



A *Ilex verticillata* 'Cacapon'/Winterberry*
 6-8' HT.- 42" o.c.
 • Medium height shrub providing year round interest with red berries



B *Baptisia australis*/ Blue False Indigo
 3-4' HT.- 42" o.c.
 • Upright perennial with many purple flowers atop flower spikes in Spring



C *Iris versicolor*/ Blue Flag Iris
 24-30" HT.- 12" o.c.
 • Swordlike leaves with large, violet-blue flowers in late Spring



D *Rudbeckia fulgida*/ Black Eyed Susan
 2' HT.- 24" o.c.
 • Native, yellow flowering perennial that blooms from June to October



E *Asclepias tuberosa* / Butterfly Milkweed
 1-2' HT.- 18" o.c.
 • Medium height perennial with orange flowers in early Summer



F *Phlox subulata*/ Moss Phlox
 4-6" HT.- 12" o.c.
 • Spring blooming fragrant perennial with lower growth habit

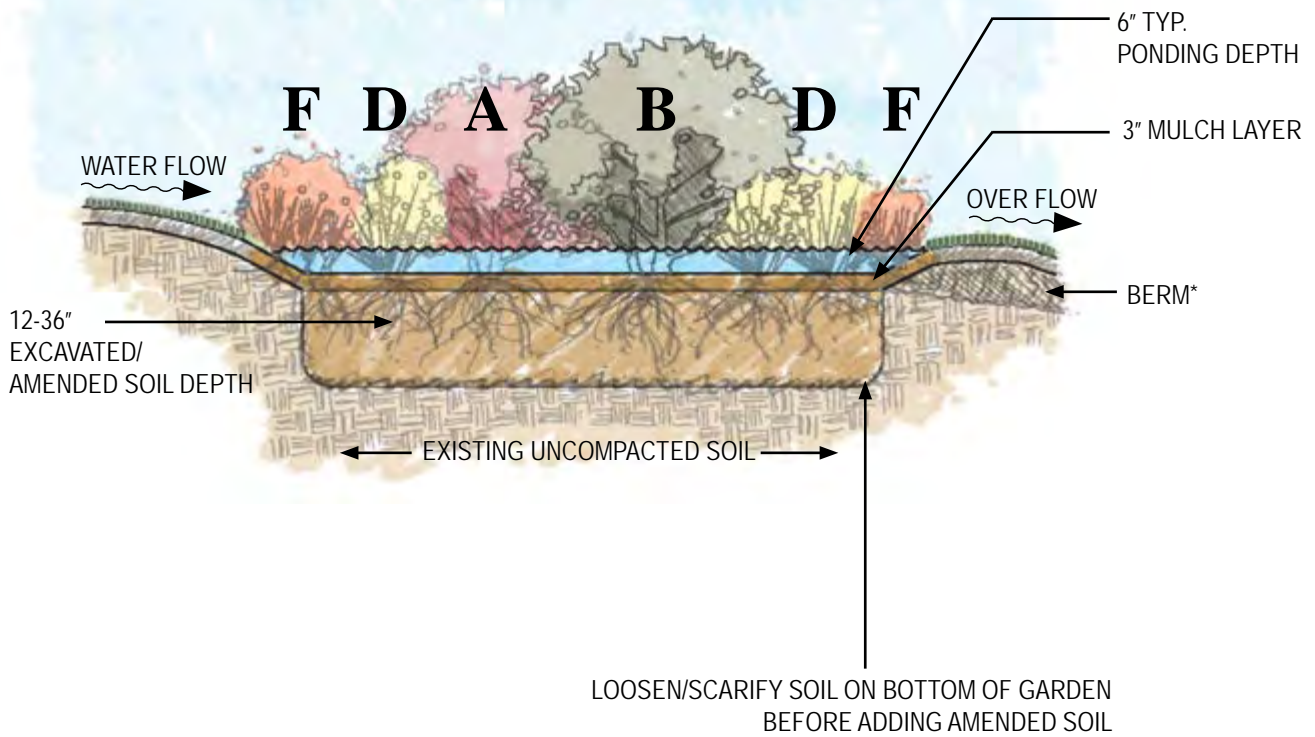
Note: o.c. = on center spacing

* Denotes Female Plant; Requires 1 male counterpart. For Winterberry, provide one 'Jim Dandy' (male) for each grouping of 'Cacapon' (female).

Planting Plans

Figure 9C. Cottage planting plan: Cross-section - Sun

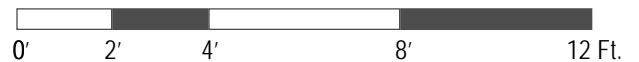
NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



*BERM NOTE: Maximum inside slope of berm from ponding perimeter to media footprint is 2:1 (but 3:1 is better). Maximum slope for exterior of berm is 3:1. See page 58 for more details.

Section- Cottage- Sun

Scale: 1/4"=1'-0"



Planting Plans

Figure 9D. Cottage planting plan: Alternate plant choices- Sun

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Ilex glabra</i> 'Shamrock'	Inkberry	3-4'	42" o.c.	Medium height shrub providing evergreen foliage.
	<i>Viburnum dentatum</i>	Arrowwood Viburnum	4-6'	42" o.c.	Medium height deciduous shrub which produces white flowers in late Spring.
B-	<i>Panicum virgatum</i> 'Shenandoah'	Switchgrass	3-4'	42" o.c.	Medium height grass with color interest Spring through Fall.
	<i>Eupatorium dubium</i> 'Little Joe'	Joe Pye Weed	3-4'	42" o.c.	Perennial with late summer blooms that will attract butterflies. Dwarf form of tall.
C-	<i>Aster novae angliae</i> 'Purple Dome'	New England Aster	1.5-2'	24" o.c.	Dwarf perennial that blooms through September with vibrant purple flowers.
	<i>Schizachyrium scoparium</i> 'The Blues'	Little Bluestem	2-3'	24" o.c.	Narrow, upright grass with light-blue foliage and year-round color interest.
D-	<i>Monarda didyma</i> 'Petite Delight'	Bee Balm	1.5 - 2.5'	24" o.c.	Perennial with pink blooms June through September attracting hummingbirds.
	<i>Eupatorium coelestinum</i>	Mist Flower	1.5 - 2.5'	24" o.c.	Perennial with light blue blooms July though October.
E-	<i>Penstemon digitalis</i> 'Huskers Red'	Beard Tongue	2-3'	18" o.c.	Clump forming perennial with tubular flowers in mid Spring early Summer.
	<i>Liatrix spicata</i> 'Kobold'	Purple Gayfeather	2.5'	18" o.c.	Medium height perennial with protruding purple spikes in late Summer.
F-	<i>Sisyrinchium graminoides</i>	Blue-Eyed Grass	6-12"	12" o.c.	Small perennial with fine textured leaves and blue flowers.
	<i>Geranium maculatum</i>	Wild Geranium	1-2'	12" o.c.	A low clustering perennial with many pale pink flowers that bloom April to May.

Note: o.c. = On Center



Aster nova-angliae



Panicum virgatum



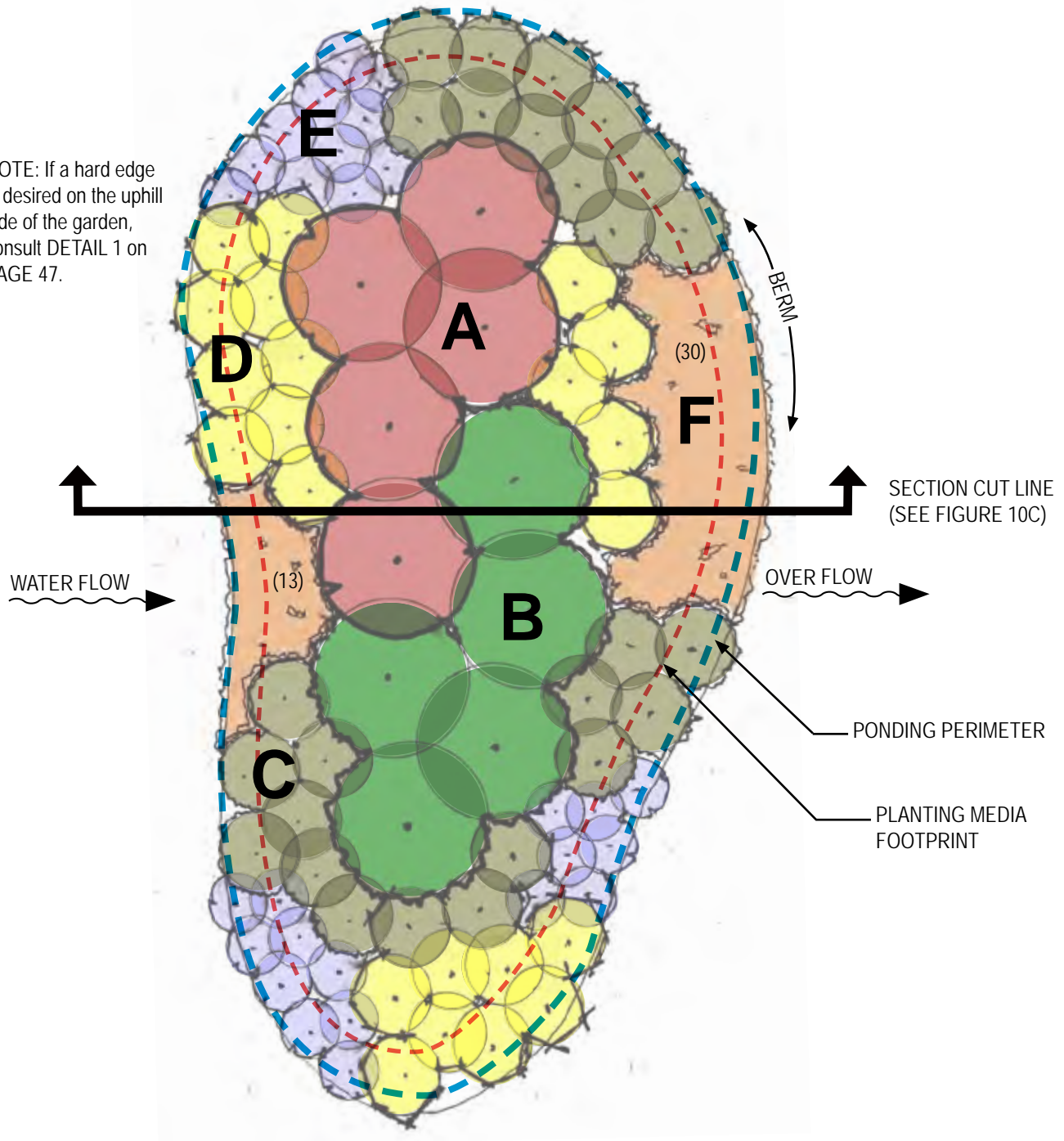
Schizachyrium scoparium

Planting Plans

Cottage planting plan - Shade/Part Shade

Figure 10A. Cottage planting plan - *Shade/Part Shade*

NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



Plan - Cottage- Shade/Part Shade (+/- 285 sf of Ponding Perimeter)

Scale: 1/4"=1'-0"



Planting Plans

Figure 10B. Cottage planting plan: Plant list- *Shade/Part Shade*



A *Aronia arbutifolia* 'Brilliantissima'/Chokeberry
 6-8' HT.- 42" o.c.
 • Medium height shrub with glossy red berries and Fall foliage



D *Polystichum acrostichoides*/Christmas Fern
 1.5-3' HT.- 24" o.c.
 • Evergreen fern that grows in a fountain-like clump



B *Leucothoe fontanesiana* 'Scarletta'/Scarletta Fetterbush
 2-3' HT.- 42" o.c.
 • Low, dense shrub with red to deep purple foliage color



E *Carex stricta*/ Tussock Sedge
 2-3' HT.- 18" o.c.
 • Perennial sedge that forms a dense tussock of leafy culms



C *Aster divaricatus*/White Wood Aster
 1-2' Ht.- 24" o.c.
 • Shorter perennial with white daisy flowers appearing August to October



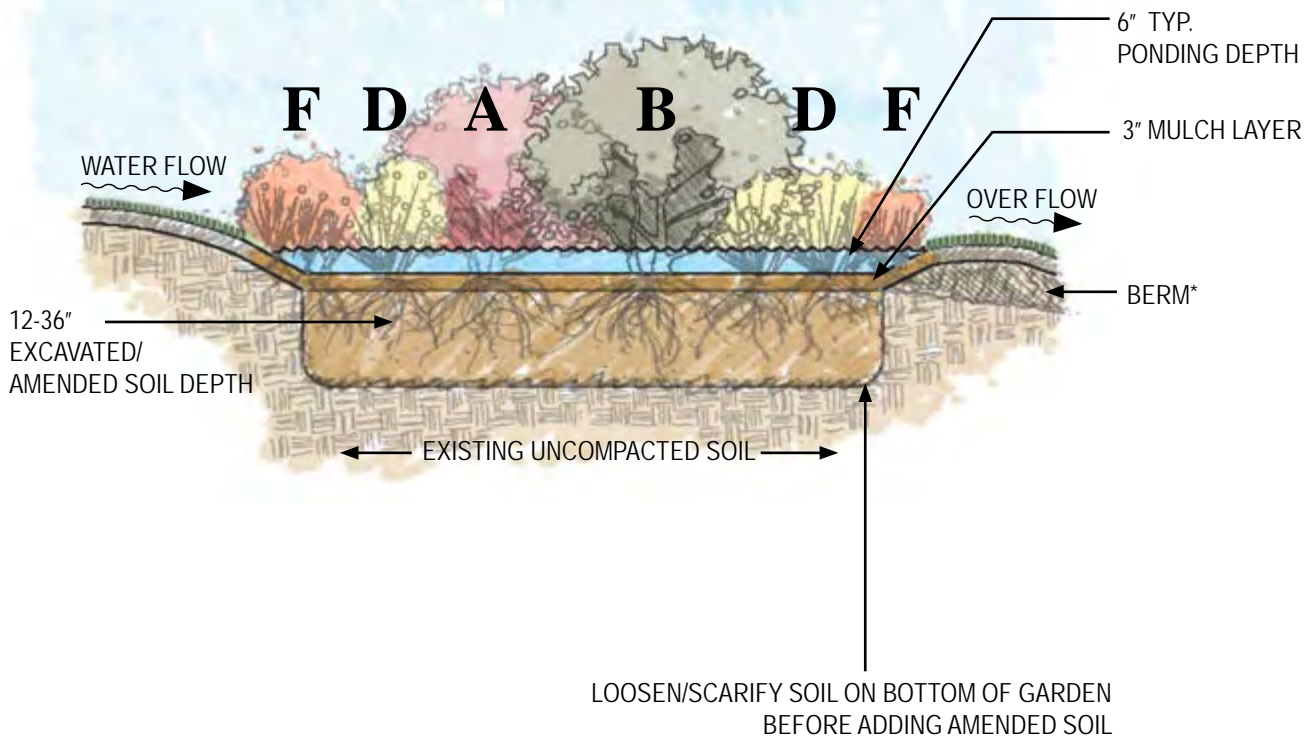
F *Phlox stolonifera* 'Blue Ridge'/Creeping Phlox
 8" HT.- 12" o.c.
 • Mat forming habit with masses of clear purple flowers

Note: o.c. = on center spacing

Planting Plans

Figure 10C. Cottage planting plan: Cross-section - *Shade/Part Shade*

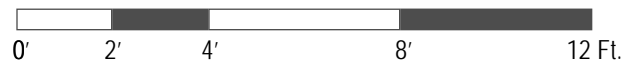
NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



*BERM NOTE: Maximum inside slope of berm from ponding perimeter to media footprint is 2:1 (but 3:1 is better). Maximum slope for exterior of berm is 3:1. See page 58 for more details.

Section- Cottage- Shade/Part Shade

Scale: 1/4"=1'-0"



Planting Plans

Figure 10D. Cottage planting plan: Alternate plant choices- *Shade/Part Shade*

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Myrica pensylvanica</i>	Bayberry	5-10'	42" o.c.	Larger shrub providing evergreen foliage.
	<i>Lindera benzoin</i>	Spicebush	6-8'	42" o.c.	Larger deciduous shrub providing many yellow flowers in Spring.
B-	<i>Clethra alnifolia</i> 'Sixteen Candles'	Summersweet	4-5'	42" o.c.	Medium height shrub with color interest Spring through Fall.
	<i>Hydrangea arborescens</i> 'Annabelle'	Smooth Hydrangea	4-5'	42" o.c.	Medium height shrub which produces large white flowers in late Spring.
C-	<i>Amsonia hubrechtii</i>	Willowleaf Bluestar	2-5'	24" o.c.	Fine textured perennial with blue star-like flowers appearing in early Summer.
	<i>Aruncus dioicus</i>	Goat's Beard	1.5-3'	24" o.c.	Perennial with fine textured feathery blooms in late Spring
D-	<i>Chasmanthium latifolium</i>	Northern Sea Oats	3-4'	24" o.c.	Clump-forming, ornamental grass with drooping seeds.
	<i>Dryopteris marginalis</i>	Evergreen Wood Fern	1-3'	24" o.c.	Woodland fern with excellent rich brown color in Autumn.
E-	<i>Chelone glabra</i>	Turtlehead	2-3'	18" o.c.	Shorter height perennial with white flowers appearing in late Summer early Fall.
	<i>Heuchera americana</i>	Coral Bell	1-2'	18" o.c.	Darker purple foliage perennial with white showy flowers in Spring.
F-	<i>Phlox divaricata</i>	Wild Blue Phlox	10-12"	12" o.c.	Spring blooming fragrant perennial with lower growth habit.
	<i>Tiarella cordifolia</i> 'Brandywine'	Foam Flower	6-8"	12" o.c.	Low growing, spreading perennial with white puffy flowers in Spring.

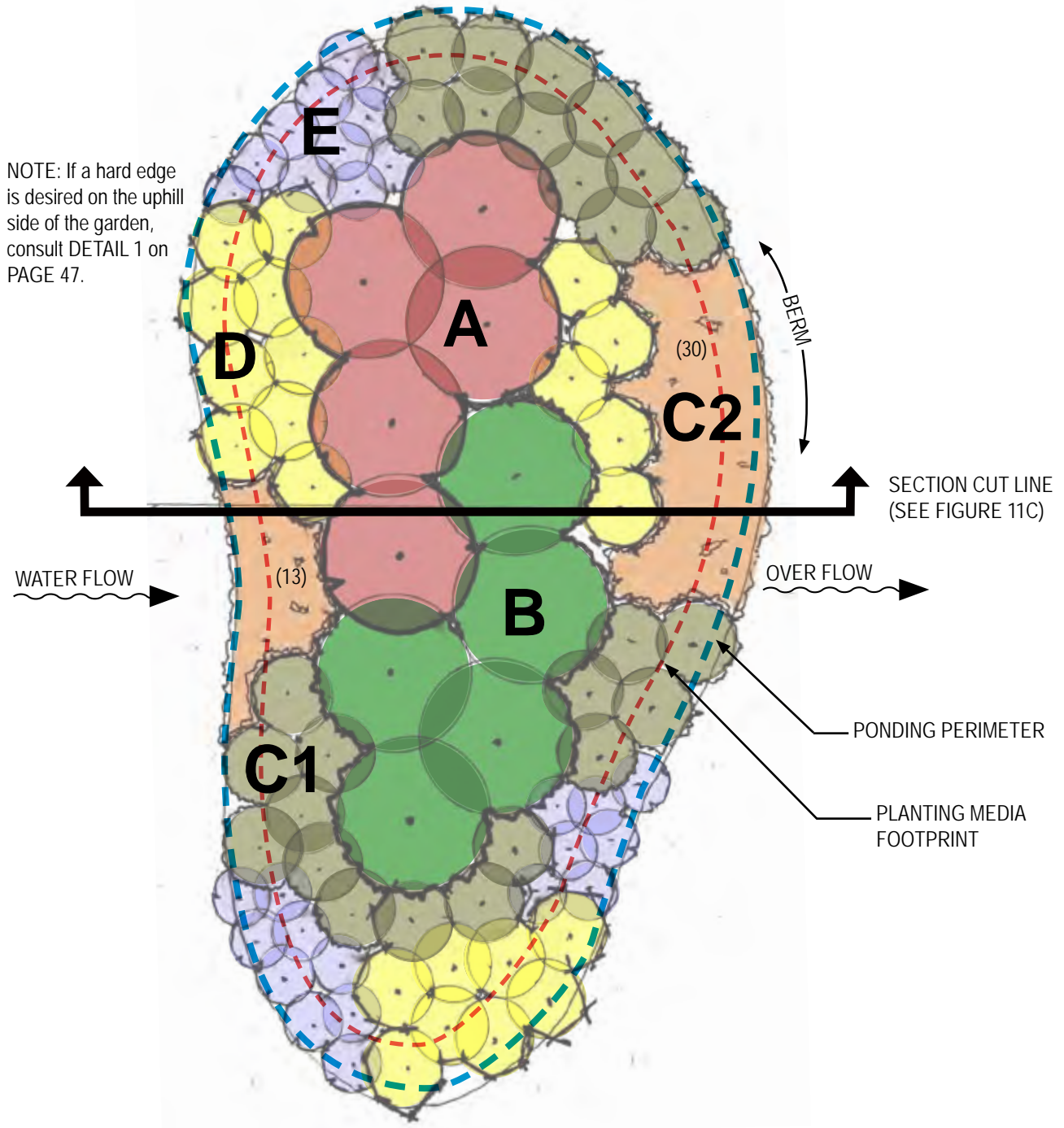
Note: o.c. = On Center



Planting Plans

Deer-Resistant planting plan - Sun

Figure 11A. Deer-Resistant planting plan - Sun



Plan - Deer-Resistant- Sun (+/- 285 sf of Ponding Perimeter)

Scale: 1/4"=1'-0"



Planting Plans

Figure 11B. Deer-Resistant planting plan: Plant list- Sun



A *Viburnum dentatum*/Arrowwood Viburnum
 4-6' HT.- 42" o.c.
 • Medium height deciduous shrub which produces white flowers in late Spring



B *Panicum virgatum 'Shenandoah'*/Red Switchgrass; 3-4' HT.- 42" o.c.
 • Medium height grass with color interest Spring through Fall



C1 *Aster novae-angliae 'Purple Dome'*/New England Aster; 1.5-3' HT.- 24" o.c.
 • Dwarf perennial that blooms through September with vibrant purple flowers



C2 *Iris versicolor*/Blue Flag Iris
 24-30" HT.- 12" o.c.
 • Swordlike leaves with large, violet-blue flowers in late Spring



D *Rudbeckia fulgida*/Black Eyed Susan
 2' HT.- 24" o.c.
 • Native, yellow flowering perennial that blooms from June to October



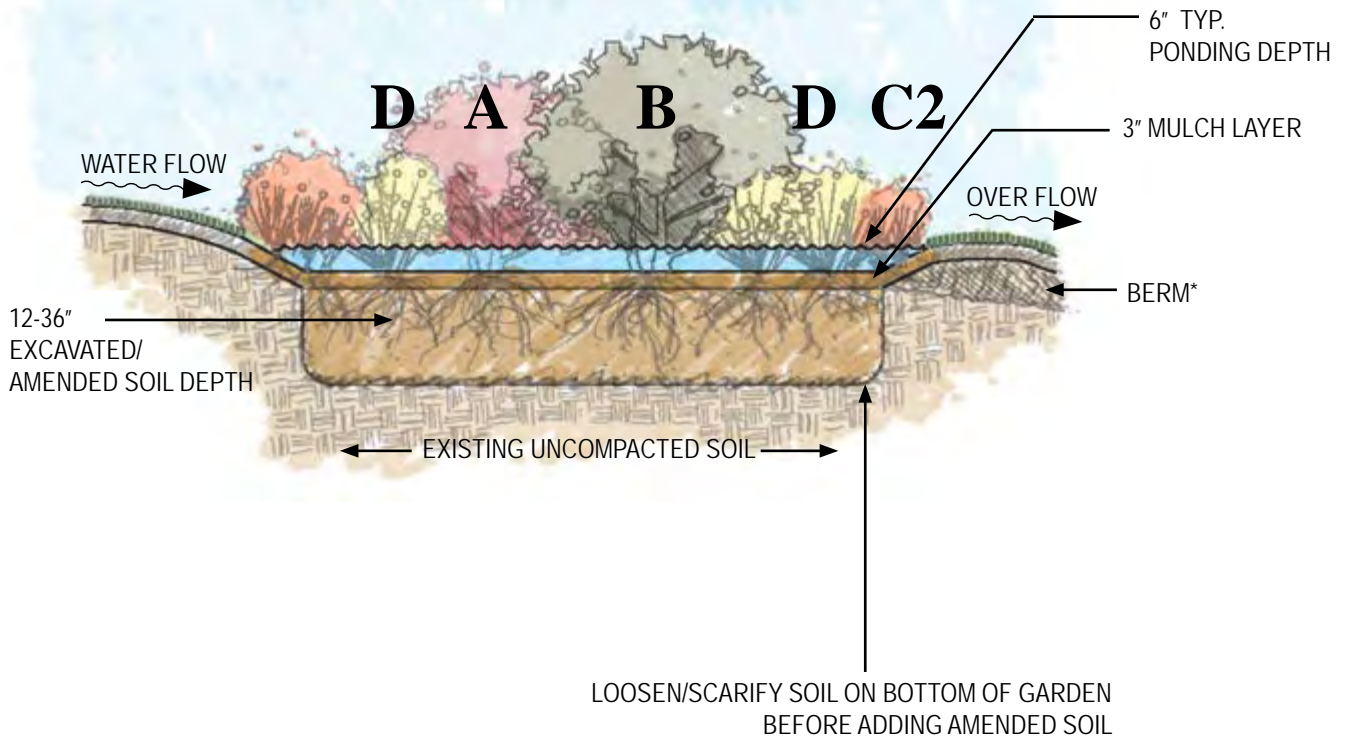
E *Asclepias tuberosa*/Butterfly Milkweed
 1-2' HT.- 18" o.c.
 • Medium height perennial with orange flowers in early Summer

Note: o.c. = on center spacing

Planting Plans

Figure 11C. Deer-Resistant planting plan: Cross-section - Sun

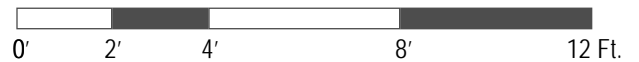
NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



*BERM NOTE: Maximum inside slope of berm from ponding perimeter to media footprint is 2:1 (but 3:1 is better). Maximum slope for exterior of berm is 3:1. See page 58 for more details.

Section- Deer-Resistant- Sun

Scale: 1/4"=1'-0"



Planting Plans

Figure 11D. Deer-Resistant planting plan: Alternate plant choices- Sun

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Ilex glabra</i> 'Shamrock'	Inkberry	3-4'	42" o.c.	Medium height shrub providing evergreen foliage.
	<i>Ilex verticillata</i> 'Cacapon'	Winterberry	6-8'	42" o.c.	Medium height shrub providing year round interest with red berries
B-	<i>Eupatorium dubium</i> 'Little Joe'	Joe Pye Weed	3-4'	42" o.c.	Perennial with late summer blooms that will attract butterflies. Dwarf form of tall.
	<i>Baptisia australis</i>	Blue False Indigo	3-4'	42" o.c.	Upright perennial with many purple flowers atop flower spikes in Spring.
C-	<i>Schizachyrium scoparium</i> 'The Blues'	Little Bluestem	2-3'	24" o.c.	Narrow, upright grass with light-blue foliage and year-round color interest.
D-	<i>Monarda didyma</i> 'Petite Delight'	Bee Balm	1.5 - 2.5'	24" o.c.	Perennial with pink blooms June through September attracting hummingbirds.
	<i>Eupatorium coelestinum</i>	Mist Flower	1.5 - 2.5'	24" o.c.	Perennial with light blue blooms July though October.
E-	<i>Penstemon digitalis</i> 'Huskers Red'	Beard Tongue	2-3'	18" o.c.	Clump forming perennial with tubular flowers in mid Spring early Summer.
	<i>Liatis spicata</i> 'Kobold'	Purple Gayfeather	2.5'	18" o.c.	Medium height perennial with protruding purple spikes in late Summer.

Note: o.c. = On Center



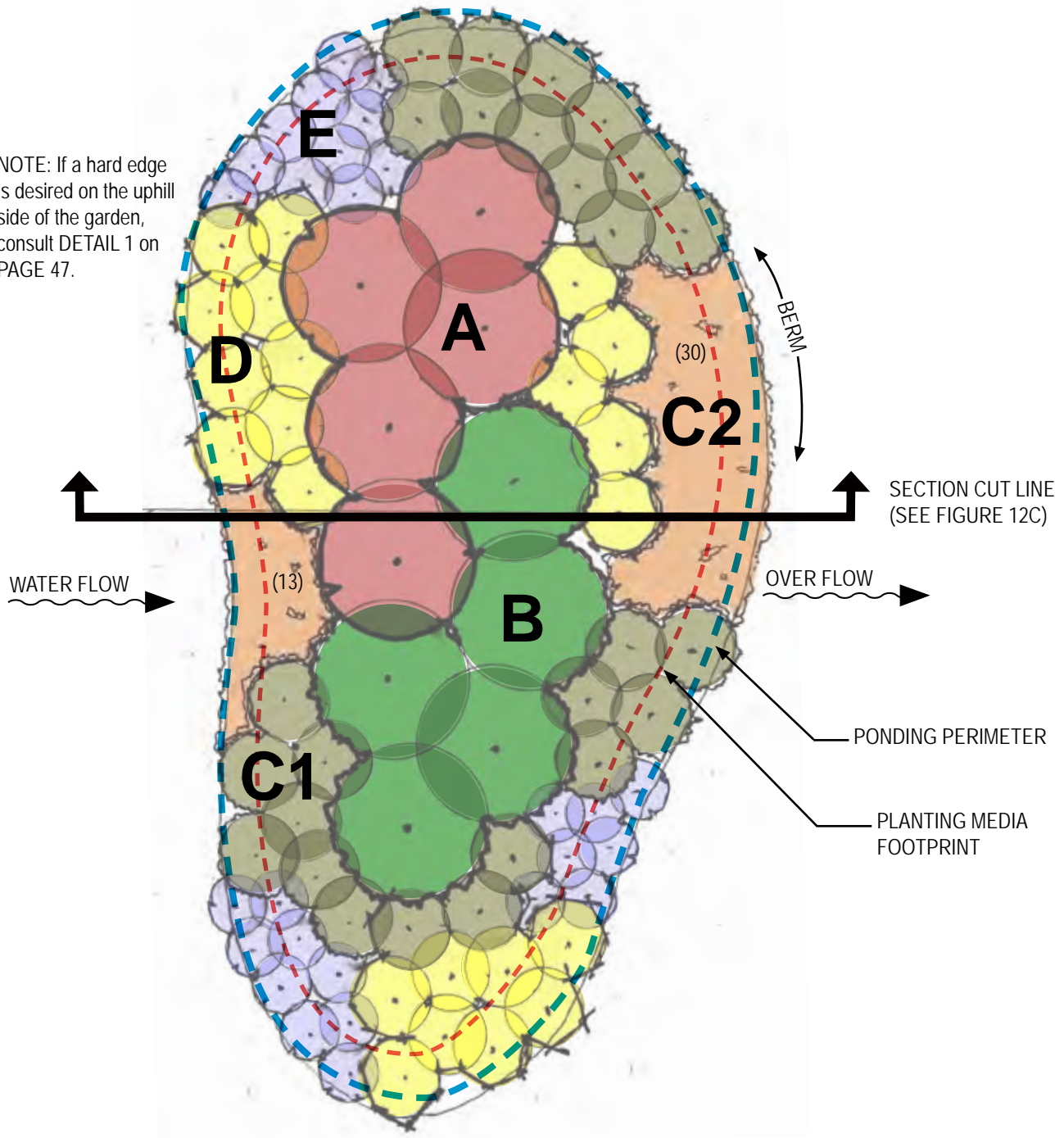
Scarify the bottom of the planting area using a shovel or tiller.

Planting Plans

Deer-Resistant planting plan - Shade/Part Shade

Figure 12A. Deer-Resistant planting plan - *Shade/Part Shade*

NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



Plan - Deer-Resistant- Shade/Part Shade (+/- 285 sf of Ponding Perimeter)

Scale: 1/4"=1'-0"



Planting Plans

Figure 12B. Deer-Resistant planting plan: Plant list- *Shade/Part Shade*



A *Lindera benzoin*/Spicebush
 6-8' HT.- 42" o.c.
 • Larger deciduous shrub providing many yellow flowers in Spring



C2 *Aster divaricatus*/White Wood Aster
 1-2' Ht.- 24" o.c.
 • Shorter perennial with white daisy flowers appearing August to October



B *Hydrangea aborescens* 'Annabelle'/Smooth Hydrangea
 3-4' HT.- 42" o.c.
 • Deciduous shrub with large white clusters of flowers in Summer



D *Chasmanthium latifolium*/Northern Sea Oats
 3' HT.- 24" o.c.
 • Clump-forming, ornamental grass with drooping seeds



C1 *Aruncus dioicus*/Goat's Beard
 1.5-3' HT.- 24" o.c.
 • Perennial with fine textured feathery blooms in late Spring



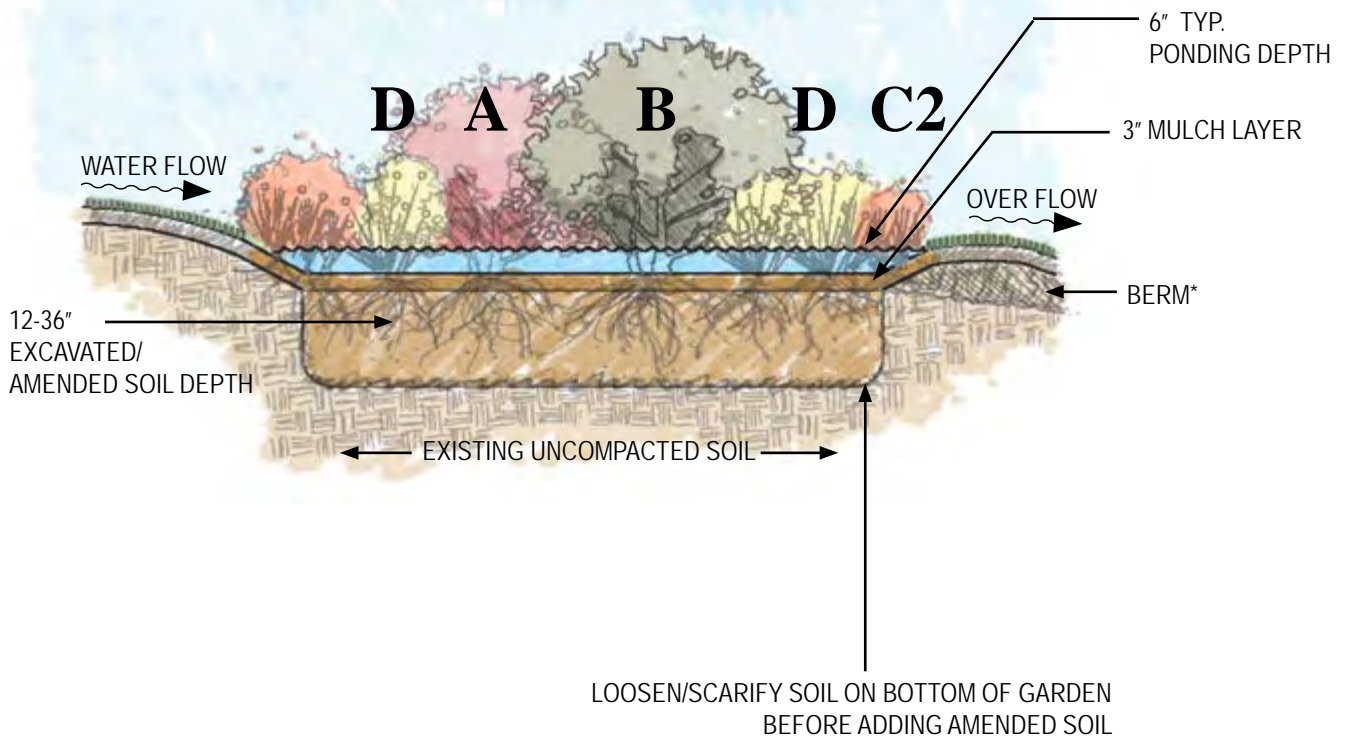
E *Carex stricta*/ Tussock Sedge
 2-3' HT.- 18" o.c.
 • Perennial sedge that forms a dense tussock of leafy culms

Note: o.c. = on center spacing

Planting Plans

Figure 12C. Deer-Resistant planting plan: Cross-section - *Shade/Part Shade*

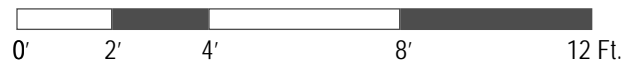
NOTE: If a hard edge is desired on the uphill side of the garden, consult DETAIL 1 on PAGE 47.



*BERM NOTE: Maximum inside slope of berm from ponding perimeter to media footprint is 2:1 (but 3:1 is better). Maximum slope for exterior of berm is 3:1. See page 58 for more details.

Section- Deer-Resistant- Shade/Part Shade

Scale: 1/4"=1'-0"



Planting Plans

Figure 12D. Deer-Resistant planting plan: Alternate plant choices- *Shade/Part Shade*

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Myrica pensylvanica</i>	Bayberry	5-10'	42" o.c.	Larger shrub providing evergreen foliage.
	<i>Aronia arbutifolia</i>	Chokeberry	6-8'	42" o.c.	Medium height shrub with glossy red berries and Fall foliage.
B-	<i>Clethra alnifolia 'Sixteen Candles'</i>	Summersweet	4-5'	42" o.c.	Medium height shrub with color interest Spring through Fall.
	<i>Hydrangea arborescens 'Annabelle'</i>	Smooth Hydrangea	4-5'	42" o.c.	Medium height shrub which produces large white flowers in late Spring.
C-	<i>Amsonia hubrechtii</i>	Willowleaf Bluestar	2-5'	24" o.c.	Fine textured perennial with blue star-like flowers appearing in early Summer.
D-	<i>Polystichum acrostichoides</i>	Christmas Fern	1.5-3'	24" o.c.	Evergreen fern that grows in a fountain-like clump.
	<i>Dryopteris marginalis</i>	Evergreen Wood Fern	1-3'	24" o.c.	Woodland fern with excellent rich brown color in Autumn.
E-	<i>Chelone glabra</i>	Turtlehead	2-3'	18" o.c.	Shorter height perennial with white flowers appearing in late Summer early Fall.
	<i>Heuchera americana</i>	Coral Bell	1-2'	18" o.c.	Darker purple foliage perennial with white showy flowers in Spring.

Note: o.c. = On Center

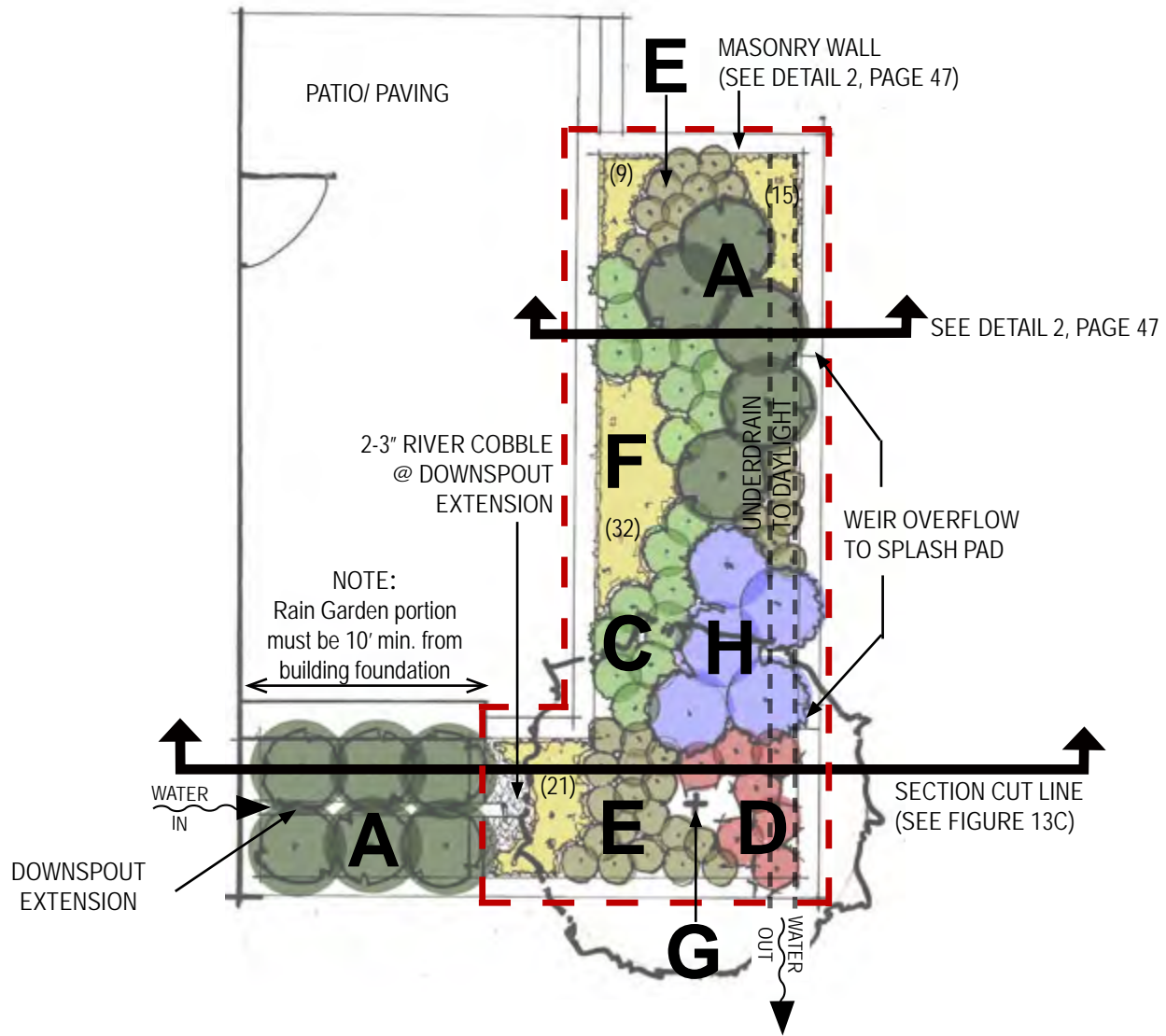


Selecting plants the deer don't prefer will help to reduce the effort needed to use repellent spray or fence the garden.

Planting Plans

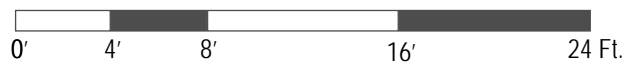
Underdrained Planterbox planting plan - Sun

Figure 13A. Underdrained Planterbox planting plan - Sun



Plan- Underdrained Planterbox Rain Garden - Sun (+/- 300 sf Garden FP)

Scale: 1/8"=1'-0"



Note: FP = Footprint

Planting Plans

Figure 13B. Underdrained Planterbox planting plan: Plant list- Sun



A *Ilex verticillata* 'Cacapon' / Winterberry*; 6-8' HT.- 42" o.c.
 • Medium height shrub providing year round interest with red berries



C *Iris versicolor* / Blue Flag Iris
 24-30" HT.- 12" o.c.
 • Swordlike leaves with large, violet-blue flowers in late Spring



D *Rudbeckia fulgida* / Black Eyed Susan
 2' HT.- 24" o.c.
 • Native, yellow flowering perennial that blooms from June to October



E *Asclepias tuberosa* / Butterfly Milkweed
 1-2' HT.- 18" o.c.
 • Medium height perennial with orange flowers in early Summer



F *Phlox subulata* / Moss Phlox
 4-6" HT.- 12" o.c.
 • Spring blooming fragrant perennial with lower growth habit



G *Cercis canadensis* / Eastern Redbud
 20-30' HT.
 • Tallest structural element with a burst of pink pea-like flowers in Spring

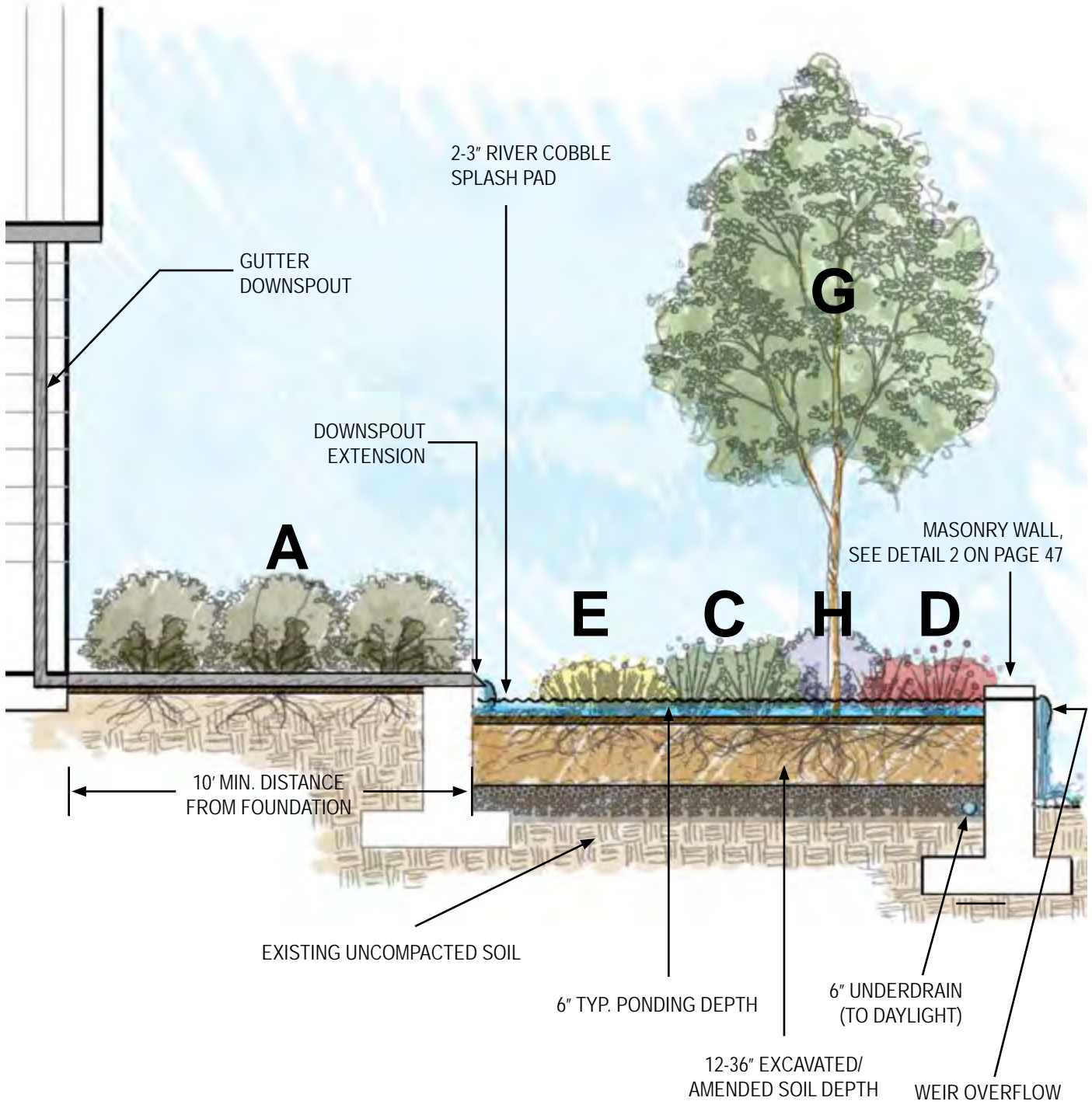


H *Clethra alnifolia* 'Hummingbird' / Hummingbird Summersweet; 2-4' HT.- 42" o.c.
 • Medium height shrub with fragrant white flower spikes attracting butterflies

Note: o.c. = On Center
 * Denotes Female Plant; Requires 1 male counterpart. For Winterberry, provide one 'Jim Dandy' (male) for each grouping of 'Cacapon' (female).

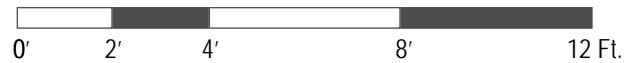
Planting Plans

Figure 13C. Underdrained Planterbox planting plan: Cross-section - Sun



Section- Underdrained Planterbox - Sun

Scale: 1/4"=1'-0"



Planting Plans

Figure 13D. Underdrained Planterbox planting plan: Alternate plant choices- Sun

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Ilex glabra</i> 'Shamrock'	Inkberry	3-4'	42" o.c.	Medium height shrub providing evergreen foliage
	<i>Viburnum dentatum</i>	Arrowwood Viburnum	4-6'	42" o.c.	Medium height deciduous shrub which produces white flowers in late Spring.
C-	<i>Aster novae angliae</i> 'Purple Dome'	New England Aster	1.5-2'	24" o.c.	Dwarf perennial that blooms through September with vibrant purple flowers.
	<i>Schizachyrium scoparium</i> 'The Blues'	Little Bluestem	2-3'	24" o.c.	Narrow, upright grass with light-blue foliage and year-round color interest.
D-	<i>Monarda didyma</i> 'Petite Delight'	Bee Balm	1.5 - 2.5'	24" o.c.	Perennial with pink blooms June through September attracting hummingbirds.
	<i>Eupatorium coelestinum</i>	Mist Flower	1.5 - 2.5'	24" o.c.	Perennial with light blue blooms July though October.
E-	<i>Penstemon digitalis</i> 'Huskers Red'	Beard Tongue	2-3'	18" o.c.	Clump forming perennial with tubular flowers in mid Spring early Summer.
	<i>Liatriis spicata</i> 'Kobold'	Purple Gayfeather	2.5'	18" o.c.	Medium height perennial with protruding purple spikes in late Summer.
F-	<i>Sisyrinchium graminoides</i>	Blue-Eyed Grass	6-12"	12" o.c.	Small perennial with fine textured leaves and blue flowers.
	<i>Geranium maculatum</i>	Wild Geranium	1-2'	12" o.c.	A low clustering perennial with many pale pink flowers that bloom April to May.
G-	<i>Betula nigra</i> 'Heritage'	River Birch	50-80'	N/A	Tallest structural element providing shade and vertical interest.
	<i>Crataegus virdis</i> 'Winter King'	Green Hawthorn	25-35'	N/A	Tallest structural element providing year round interest.
H-	<i>Hypericum densiflorum</i>	St. John's Wart	4-6'	42" o.c.	Taller, dense, perennial with bright yellow flowers.
	<i>Baptisia australis</i>	Blue False Indigo	3-4'	42" o.c.	Taller perennial with intense blue blooms.

Note: o.c. = On Center

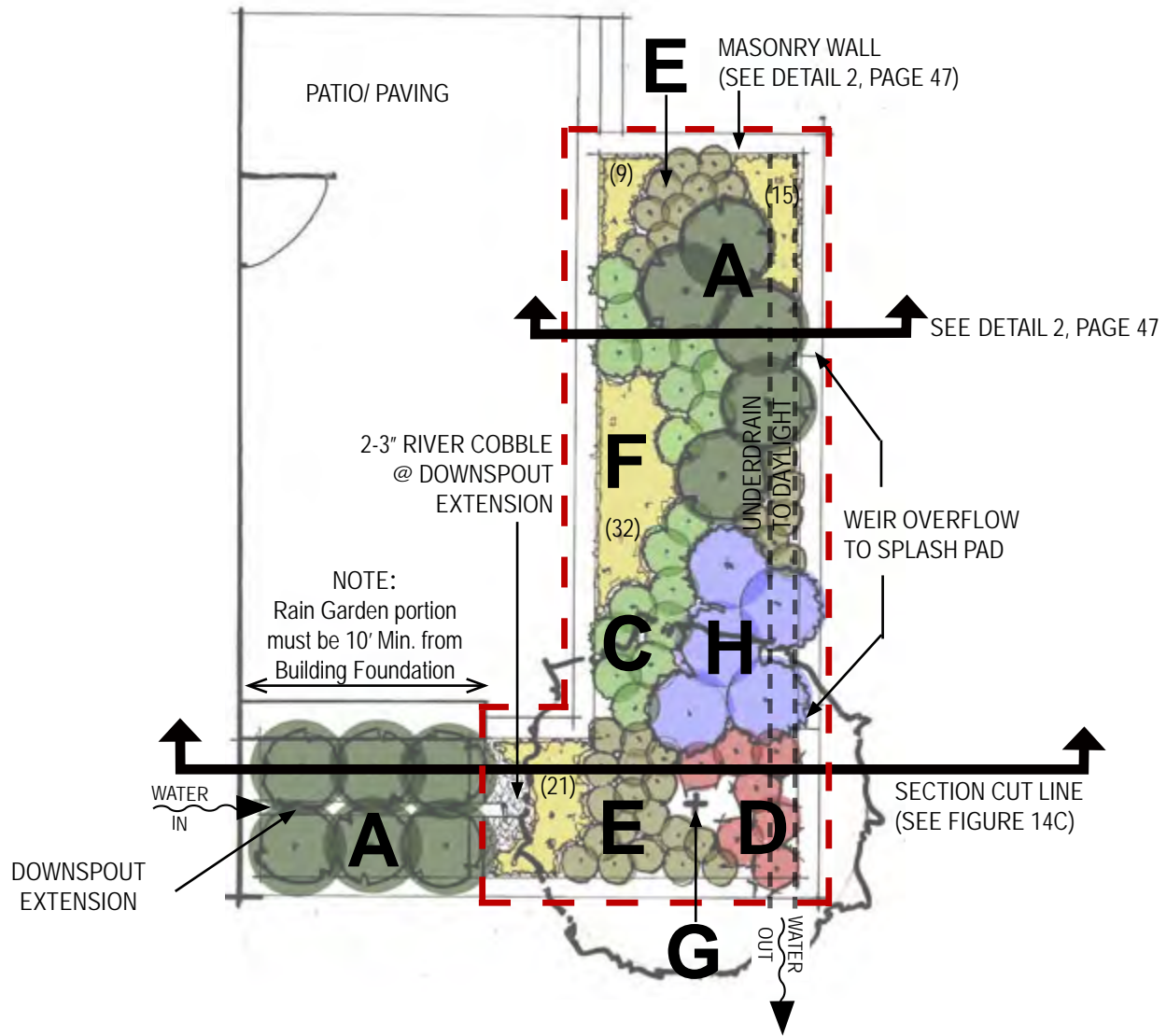
Planter boxes can allow a raingarden to be fit into a very narrow space. Usually, they require an underdrain.



Planting Plans

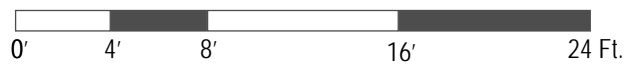
Underdrained Planterbox planting plan - Shade/Part Shade

Figure 14A. Underdrained Planterbox planting plan - *Shade/Part Shade*



Plan- Underdrained Planterbox Rain Garden - Shade/Part Shade (+/- 300 sf Garden FP)

Scale: 1/8"=1'-0"



Note: FP = Footprint

Planting Plans

Figure 14B. Underdrained Planterbox planting plan: Plant list- *Shade/Part Shade*



A *Hydrangea aborescens* 'Annabelle'/
Smooth Hydrangea
3-4' HT.- 42" o.c.
• Deciduous shrub with large white clusters of flowers in Summer



C *Aruncus dioicus*/Goat's Beard
1.5-3' HT.- 24" o.c.
• Perennial with fine textured feathery blooms in late Spring



D *Chasmanthium latifolium*/
Northern Sea Oats
3' HT.- 24" o.c.
• Clump-forming, ornamental grass with drooping seeds



E *Carex stricta*/ Tussock Sedge
2-3' HT.- 18" o.c.
• Perennial sedge that forms a dense tussock of leafy culms



F *Phlox stolonifera* 'Blue Ridge'/
Creeping Phlox; 8" HT.- 12" o.c.
• Mat forming habit with masses of clear purple flowers



G *Magnolia virginiana*/
Sweetbay Magnolia ;10-35' HT.
• Tallest structural element with fragrant white flowers in Spring

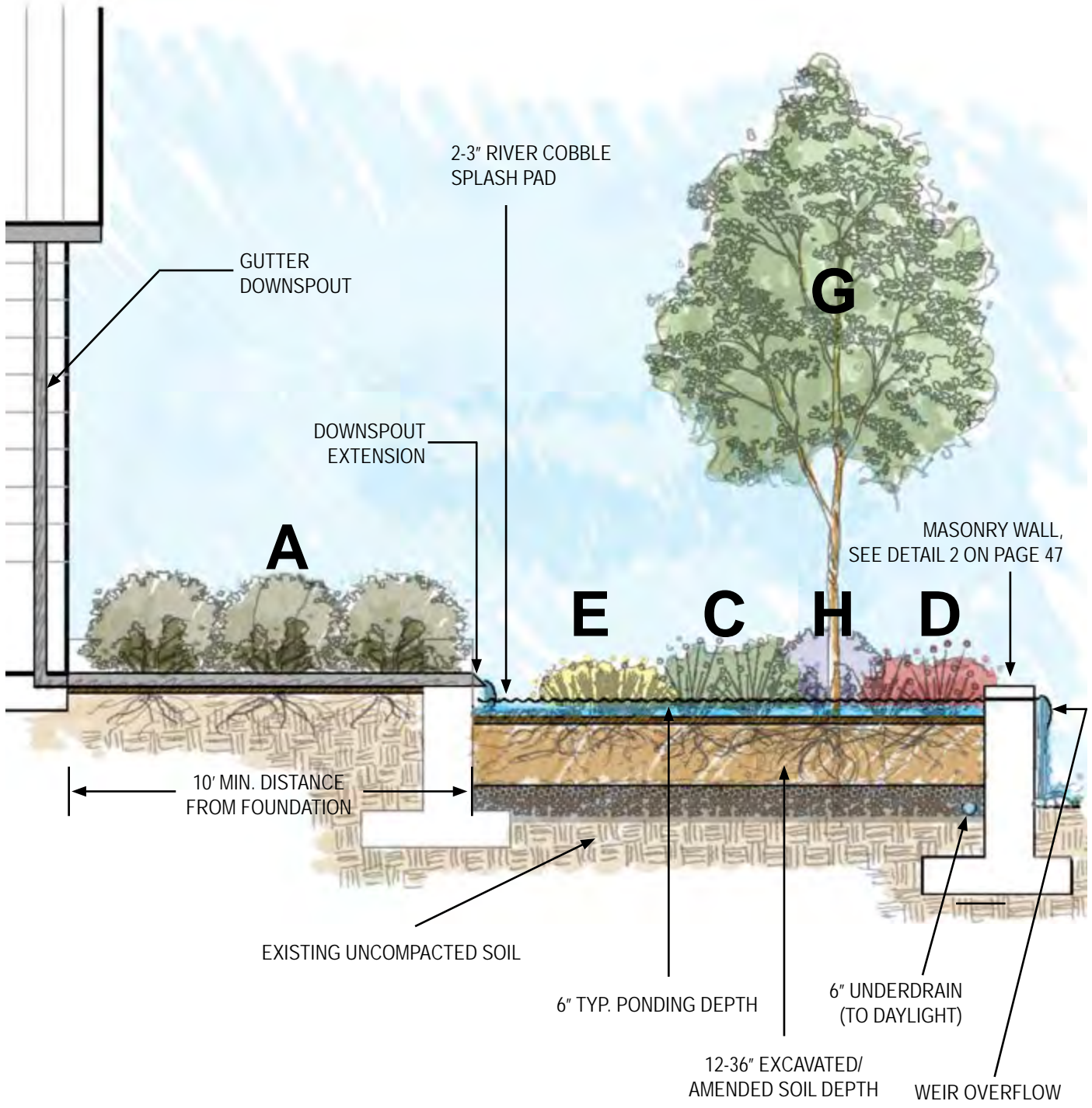


H *Itea virginica* 'Henry's Garnet'/
Sweetspire; 3-4' HT.- 42" o.c.
• Medium height shrub with natural growth habit providing year round interest

Note: o.c. = On Center

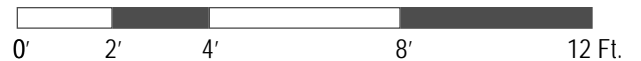
Planting Plans

Figure 14C. Underdrained Planterbox planting plan: Cross-section - *Shade/Part Shade*



Section- Underdrained Planterbox - Sun

Scale: 1/4"=1'-0"



Planting Plans

Figure 14D. Underdrained Planterbox plan: Alternate plant choices- *Shade/Part Shade*

	Latin Name	Common	Ht.	Spacing	Design Value
A-	<i>Leucothoe fontanesiana</i> 'Scarletta'	Scarletta Fetterbush	2-3'	42" o.c.	Low, dense shrub with red to deep purple foliage color.
	<i>Ilex glabra</i> 'Compacta'	Compacta Inkberry	4-6'	42" o.c.	Medium height shrub with fine textured evergreen foliage.
C-	<i>Amsonia hubrechtii</i>	Willowleaf Bluestar	2-5'	24" o.c.	Fine textured perennial with blue star-like flowers appearing in early Summer.
	<i>Aster divaricatus</i>	White Wood Aster	1-2'	24" o.c.	Shorter perennial with white daisy flowers appearing August to October.
D-	<i>Polystichum acrostichoides</i>	Christmas Fern	1.5-3'	24" o.c.	Evergreen fern that grows in a fountain-like clump.
	<i>Osmunda cinnamomea</i>	Cinnamon Fern	3-4'	24" o.c.	Woodland fern with excellent rich brown color in Autumn.
E-	<i>Chelone glabra</i>	Turtlehead	2-3'	18" o.c.	Shorter height perennial with white flowers appearing in late Summer early Fall.
	<i>Heuchera americana</i>	Coral Bell	1-2'	18" o.c.	Darker purple foliage perennial with white showy flowers in Spring.
F-	<i>Phlox divaricata</i>	Wild Blue Phlox	10-12"	12" o.c.	Spring blooming fragrant perennial with lower growth habit.
	<i>Chrysogonum virginianum</i>	Goldenstar	6-8"	12" o.c.	Low growing, spreading perennial with bright yellow flowers appearing in Spring.
G-	<i>Amelanchier canadensis</i>	Shadbush	12-20'	N/A	Tallest structural element as a deciduous, white flowering tree with fine texture.
	<i>Chionanthus virginicus</i>	White Fringetree	4-5'	N/A	Tallest structural element with creamy white flowers and good Fall color.
H-	<i>Rhododendron periclymenoides</i>	Pinxterbloom Azalea	3-8'	42" o.c.	Taller deciduous shrub with many showy blooms in Spring.
	<i>Viburnum trilobum</i> 'Compactum'	Viburnum	8-12'	42" o.c.	Taller round deciduous shrub with attractive Fall color and showy red fruit.

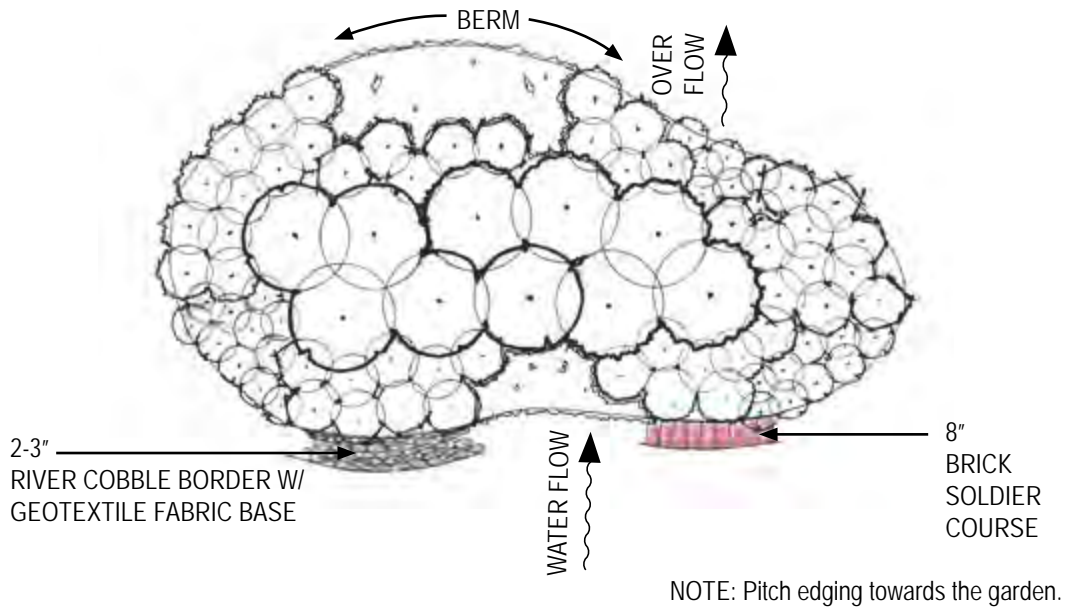
Note: o.c. = On Center



Whether it is full sun or shade, evaluate your site and determine if a planter box is the best solution

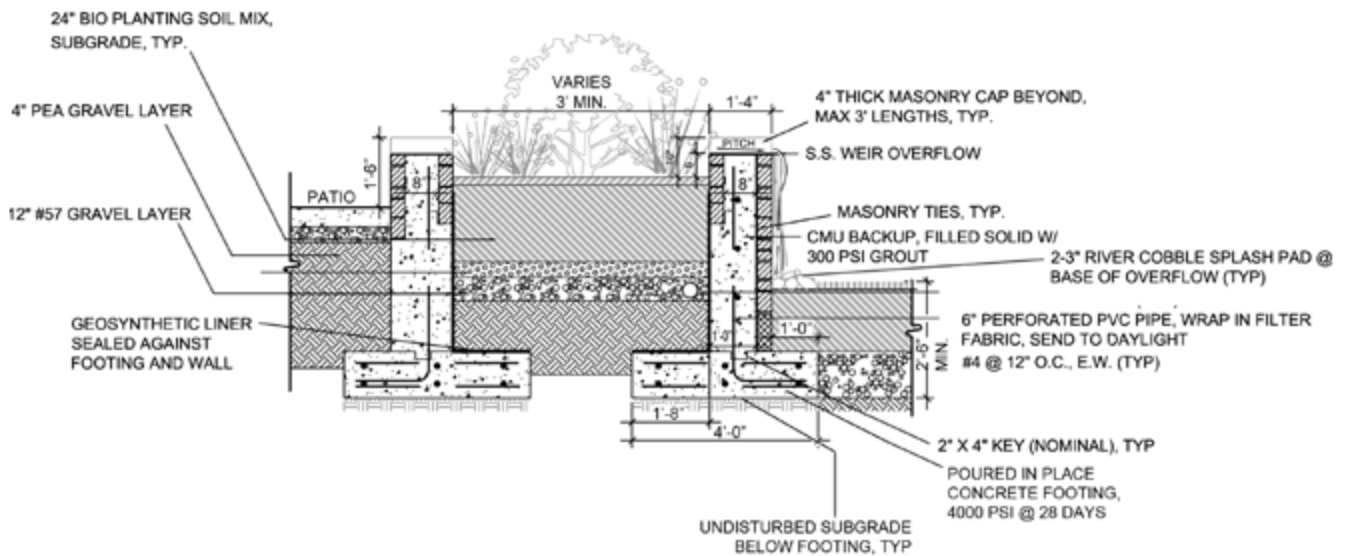
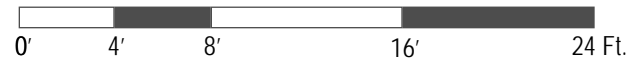
Planting Plans

Details



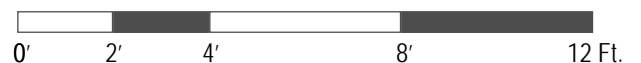
DETAIL 1: Garden Plan - Optional Edging- Brick or Beach Pebbles

Scale: 1/8"=1'-0"



DETAIL 2: Section- Masonry Wall for Underdrained Rain Garden Planter

Scale: 1/4"=1'-0"



Construction



Miss Utility

Always call Miss Utility (811) before starting construction.

GENERAL CONSTRUCTION GUIDELINES

To ensure long-term performance of rain gardens, it is critical to follow good construction practices that control sediment, divert runoff, and minimize soil compaction. Installation steps are illustrated on pages 54 – 58 of this section.

a) Sequencing

- Install rain gardens after any other site work has been completed. This will prevent accidental soil compaction and possible clogging from sediment.
- Do not install when the ground or stockpiled material is frozen or very wet. Spring or fall are best, when the ground has a moderate amount of moisture.

b) Soil protection

- All access for equipment, staging, and worker movement must have suitable ground protection. Acceptable methods include a mulch access path, wooden mats, and HDPE mats, following County standards.
- During construction, avoid disturbing or compacting the surrounding soil as much as possible, especially around healthy vegetation.
- Minimize the use of heavy equipment in the excavated area to avoid compacting the subsoil. Operate equipment at the sides of the excavation if feasible.
- As much as possible, avoid walking on disturbed areas until they have been stabilized with mulch or sod.

c) Controlling runoff

- Secure a waterproof covering over any working surface during breaks in construction over eight hours, or if rain is imminent.
- Do not direct downspout flow to the rain garden until it has been stabilized.
- To control any remaining sources of sediment-laden runoff after the above measures have been taken, install temporary erosion control measures such as silt fences, temporary swales, or berms as appropriate.

d) Stockpiling

- Stockpile mulch or amendments as close to the excavation as possible, or deposit directly into the excavated area.
- Keep stockpile away from standing water and from sources of sediment and debris. Stockpiled materials should be placed on pavement or geotextile and covered with a tarp to avoid sediment contamination.

Weed prevention

All imported materials must be free of weed plants and seeds. Bagged materials are ideal since they are weed seed free.

Construction

CLEARING AND EXCAVATION

- a) The cleared area must contain the total rain garden area, which includes the media footprint as well as earthwork, such as the berm. See “Rain garden sizing” and Figures 2-5.
- b) A recommended approach is to stake out the media footprint, offset around the media footprint to account for earthwork, and confirm that setbacks and other location guidelines are met.
- c) Any grass or vegetated swale used to direct flow to the rain garden should be excavated during this step.
- d) Remove sod. Set sod aside for stabilizing the berm, if a berm is used. Otherwise, reuse it elsewhere on the lawn, or compost it if possible.
- e) Excavate with construction equipment (toothed buckets only to avoid soil glazing.) Hand excavation may be feasible for small rain gardens. Set aside excavated material. **The excavation depth equals the sum of the following depths:**
 - 6 inches for ponding and earthwork
 - The selected planting media depth (one to three feet; see “Rain garden sizing”)
- f) Remove additional soil to create inside slopes as indicated in Figures 3-5.
- g) The bottom of the excavated area must be level.
- h) Use a hoe or heavy-duty rake to roughen the top six inches of the existing soil at the bottom of the excavated area.
- i) Take care to minimize root impacts during excavation. Prune roots one inch in diameter or less as needed. For larger roots, excavate around them with care so they can remain in place.



Sod removal



Excavation with toothed bucket

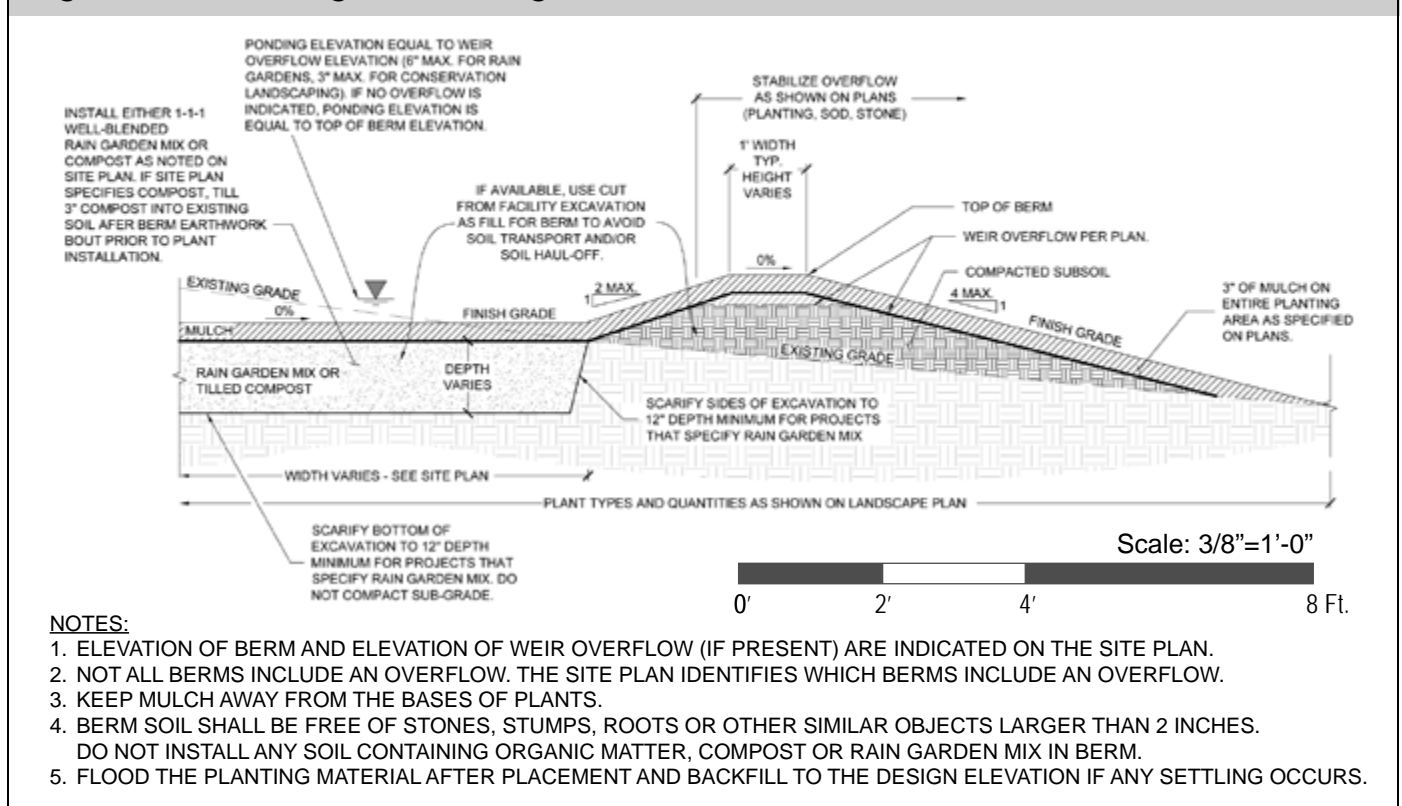
Construction

BUILDING A BERM OR A WALL *(choose the most appropriate one)*

Berms

- Berms are not recommended for yard slopes greater than 6% because of the amount of space needed. (See “Walls” on the following page.)
- Remove sod under berm footprint. Set sod aside, compost it, or use it elsewhere in the yard. Use a heavy-duty rake to roughen the exposed soil.
- Construct a berm with the excavated sub-soil, not topsoil, using dimensions indicated in Figures 3 and 4. Add soil in four-inch layers. Compact each layer with a soil tamper or by pressing with the back of an excavator bucket. The berm must be properly compacted to ensure stability. The berm is the only area of the garden that will be compacted.
- After media installation, use a string or laser level to compare the top of the berm elevation to the elevation of the planting media. This step is necessary to ensure proper berm height.
- When complete, if using a weir, the top of the berm must be nine inches above the top of the planting media to allow for a three-inch overflow weir (see “Overflow Weir” on the following page) and six inches of ponding depth above planting media.
- If using a level berm, the entire berm top must be 6” above the soil level. Otherwise, the garden will create weirs or erosion flow paths.
- When using a weir overflow, ensure that the rest of the berm is level across the top to discourage erosion. Fill in any low points on the top and side slopes of the berm and compact the fill material.

Figure 15. Berm Design and Grading



Construction

Photo documentation

Take photos to document all steps of the installation process to assist in rebate processing. Take photos of the basement before and after installation. Pay attention to any pre-existing water damage and/or foundation damage.

Walls

- a) As an alternative to a berm, a small retaining wall can be built on the upslope side of the rain garden. This wall is built into the existing ground and extends to the ground surface on the upslope side.
- b) Excavate on the upslope side of the rain garden to create a foundation for the wall. Level the soil and compact it with a soil tamper or by pressing with the back of an excavator bucket.
- c) Place, level, and compact three inches of #7 stone.
- d) After completing excavation and #7 stone placement, the top of the first block layer should be level with the top of ponding (Figure 5).
- e) Install the first block layer. Check for levelness and gently tap with a hammer to level the blocks if needed.
- f) Add additional layers of blocks as needed. Stagger the joints in each additional row by half a block width. Offset each row approximately 0.25 inches away from the rain garden to increase wall stability (Figure 5).
- g) When the wall is complete, backfill with a minimum six-inch width of #57 stone (Figure 5).
- h) Place and compact soil for the side slope at the base of the wall, as indicated in Figure 5.

OVERFLOW WEIR

- a) An overflow weir is used to direct water in a desired direction – for instance, away from a neighbor’s property. (See “Inflow and outflow design” on page 7.)
- b) Excavate a three-inch deep weir at the front of the rain garden (usually the berm) to direct overflow in the desired direction. The bottom of the weir must be level.
- c) Compact the bottom and side slopes of the weir with a soil tamper or by pressing with the back of an excavator bucket.
- d) The overflow weir must be reinforced to prevent erosion. Turf is recommended in most situations. Place sod in the overflow weir, including weir side slopes (Figure 3). The sod must extend down the outside slope of the rain garden. Pin sod securely at the top of the inside slope. Do not use grass seed.

Construction

OVERFLOW COBBLE *(optional)*

- a) A cobble-lined overflow weir may be preferred in certain situations, including rain gardens with large drainage areas, located on steep slopes, or located in the shade.
- b) Add cobble stones (two to six inch diameter) in the weir. Cover the same area indicated for turf in Figure 3.
- c) Embed cobbles in the soil to maintain the three-inch weir depth – do not obstruct the weir opening with cobbles.
- d) Do not use mortar to hold cobbles in place.
- e) Do not use geotextile under cobbles.

UNDERDRAIN *(where applicable)*

- a) An underdrain should only be installed on lots with an existing pipe stub to the storm drain.
- b) The recommended underdrain orientation is along the long axis of the rain garden.
- c) The invert of the underdrain must be placed at the bottom of the media. If using a gravel layer sump, the pipe is placed on top of the gravel layer. In this case, the pipe is designed as an overdrain.
- d) Install one six-inch, schedule 40 PVC vertical cleanout pipe at the far end of the underdrain. The cleanout must extend six inches above the media surface and have a removable waterproof cap.
- e) Place at least three inches of #57 stone above and below the underdrain, and six to twelve inches on either side. Place an additional three inches of #7 stone above the top layer of #57 stone to prevent migration of fines.
- f) The underdrain must have 0% slope.
- g) Do not wrap geotextile around the underdrain. However, geotextile *may* be placed on top of underdrain.



Underdrain pipe is placed on an optional gravel sump.



Pipe is covered with 57 stone gravel, then a layer of geotextile before placing the planting media.



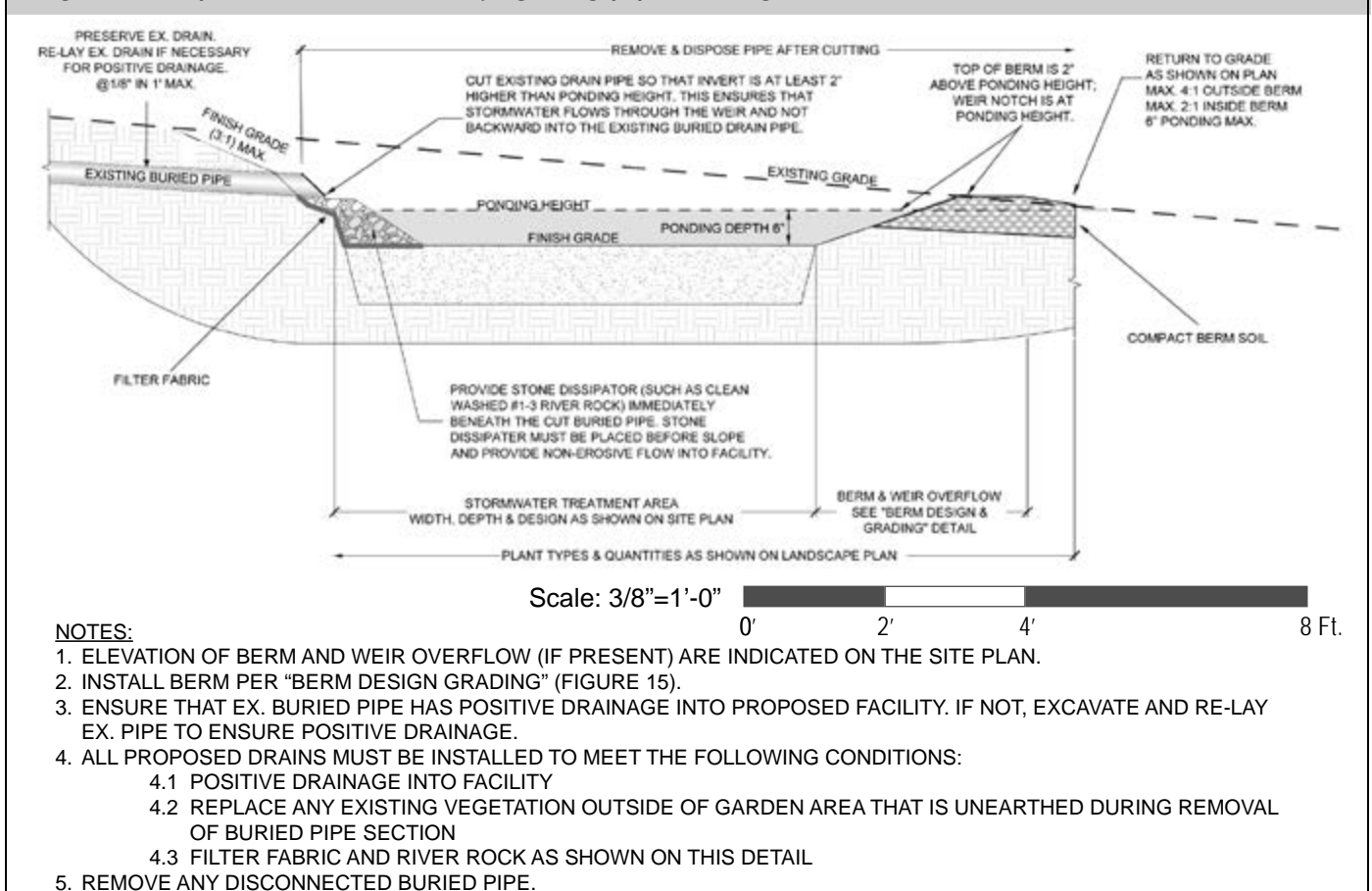
Planting media is installed. Final media elevation is 6" below berm top or weir notch elevation if using a weir.

Construction

INFLOW COBBLE AND DOWNSPOUT EXTENSION

- a) Any downspout extension or swale must end at or above the maximum ponding level.
- b) Use cobble stones (two to six inch diameter) to stabilize the flow path down to the media surface (Figure 3). If a wall is used, place cobble on the side slope at the base of the wall below the inflow point (Figure 5).
- c) If flow is coming from a downspout extension, the width of the cobble pad must be 18 inches. If flow is coming from a swale or channel, use the width of the inflow swale or channel plus nine inches on each side.
- d) The cobble must extend at least 18 inches from the end of the downspout or channel to the top of the side slope (Figure 3) and one foot across the media surface.
- e) Cobbles should be firmly placed in the soil. Embed larger cobbles in the soil. Approximately 1/2 of base layer of cobble should be buried.
- f) Do not use mortar to hold cobbles in place.
- g) Do not use geotextile under cobbles.
- h) A downspout leaf strainer and a flexible downspout section may be installed to assist with inspection and maintenance for downspout clogging, especially for buried downspout extensions.

Figure 16. Special condition: Daylighting pipes into garden with overflow notch



Construction

PLANTING MEDIA

- a) Backfill with the excavated soil or with rain garden planting media as specified in the Materials and Equipment section. Table 7 provides a guideline for media quantities.
- b) If using media, it should be mixed prior to placement in the excavated area.
- c) Add planting media or excavated soil, one foot at a time, up to the required planting media depth. (See “Rain garden sizing” on page 10.) Gently settle each layer after adding it, either by slowly flooding the rain garden to saturate the media, or by placing boards over the rain garden surface and walking across them. Do not use mechanical compactors. Alternatively, you can add an additional 2” of soil to compensate for settling. Do not use mulch to make up any shortfall in media depth. Measure final ponding depth from surface of planting media to the top of the overflow.
- d) After the final media depth has been reached, use a carpenter’s level or string level to check the levelness of the planting media. Add and settle additional media if needed, then check levelness again.
- e) As described below, install the mulch layer immediately after finishing the planting media installation to protect against erosion.

Table 7. Planting media quantities in cubic yards

Media footprint (square feet)	1 foot media + 10% extra		2 foot media + 10% extra		3 foot media + 10% extra	
5	0.2	0.2	0.4	0.4	0.6	0.6
15	0.6	0.6	1.1	1.2	1.7	1.8
30	1.1	1.2	2.2	2.4	3.3	3.7
50	1.9	2.0	3.7	4.1	5.6	6.1
60	2.2	2.4	4.4	4.9	6.7	7.3
75	2.8	3.1	5.6	6.1	8.3	9.2
100	3.7	4.1	7.4	8.1	11	12
125	4.6	5.1	9.3	10	14	15



Media installation

Construction

MULCHING AND PLANTING

- a) The recommended sequence is to add mulch before planting. Planting can occur before mulching if planting immediately follows installation of the media (Step 7), and care is taken not to damage plants during mulching.
- b) Place three inches of double-shredded hardwood mulch on the planting media surface and the inside slopes of the rain garden. Turf may be used for the inside slopes if desired. However, be aware that this may cause maintenance problems from grass clippings clogging the planting area. The inside slopes must be vegetated because unplanted mulch will erode. *Note: The templates in this guide have planted inside slopes.*
- c) For perennials, use container-grown quart or gallon size stock. Do not use plugs in the bottom areas. Plugs may be used on side slopes if doing a spring installation.
- d) For woody plants, use container-grown stock. Size #2 – 3 is best. Do not use bare-root stock.
- e) If planting through the mulch, set mulch aside at each plant location and replace after planting. Take care to plant in the media and not the mulch.
- f) Plants should be placed slightly high in the soil media, with $\frac{1}{8}$ to $\frac{1}{4}$ inch of root ball exposed. Add additional mulch after planting, if needed, to cover the root ball, but do not pile mulch against plant stems.

Importance of mulch

Mulch is an integral part of the rain garden. It helps to retain moisture, maintain media permeability, prevent erosion and weed growth, supply organic matter to the media, and improve water quality.

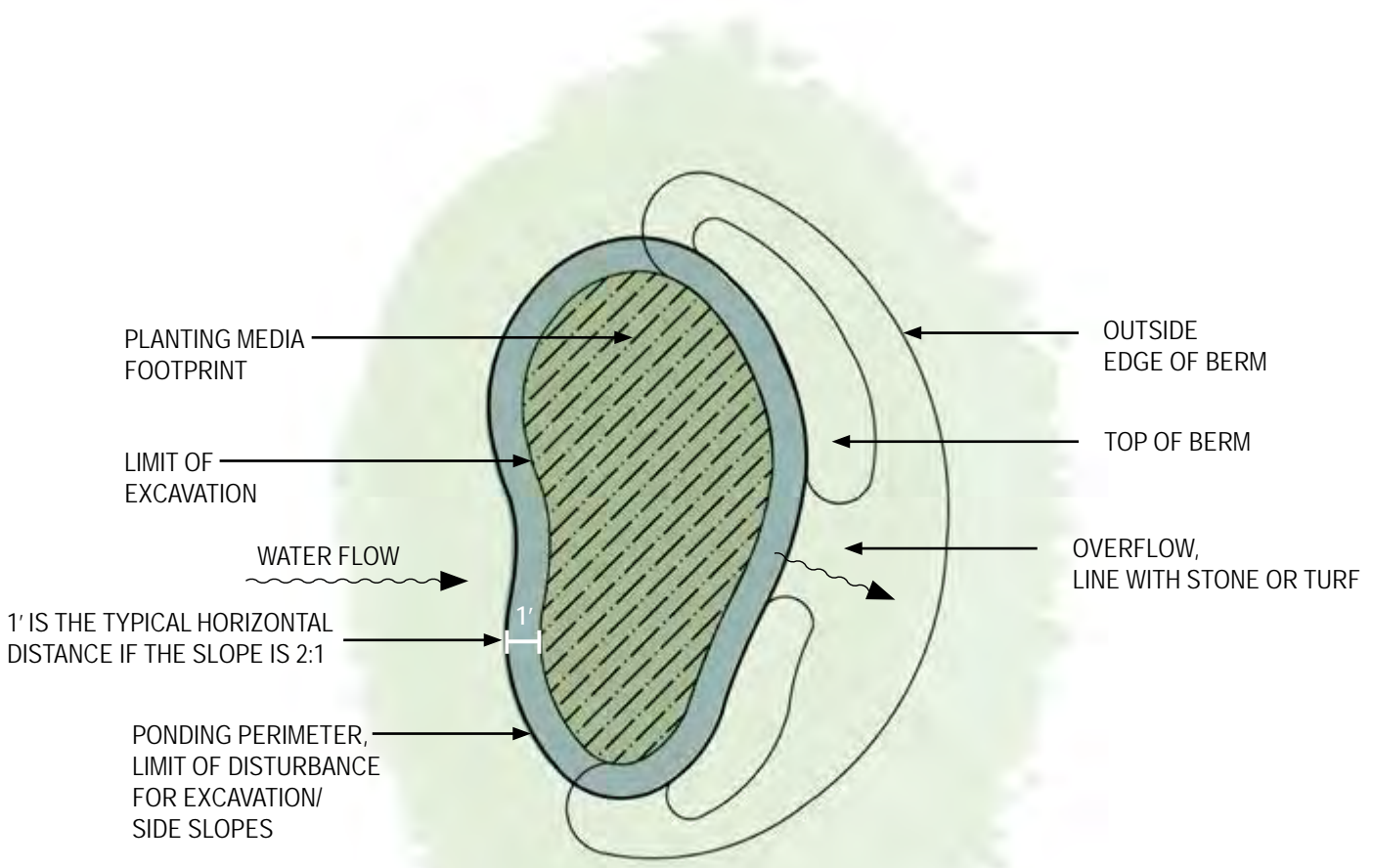
Only use undyed, double-shredded hardwood mulch. Do not use grass clippings for mulch. Bark nugget and leaf mulch must not be used because they are light and will tend to float.

SITE STABILIZATION

- a) Stabilize all exposed soil immediately after construction. A delay may lead to erosion and clogging of the planting media.
- b) If a berm is used, add mulch and fast-growing vegetation on the inside of the berm. Place sod on the top and outside slope of the berm, or mulch and plant with native groundcover that is tolerant of compacted soil.
- c) Do not use grass seed on the berm because of the establishment time required.
- d) Re-establish other disturbed turf areas surrounding the rain garden with sod or seed. Sod removed during initial excavation (Step 2) may be used.
- e) Use garden edging, mulch, turf, or stone to create a well-defined edge for the rain garden.

Construction

Step One: Layout Garden and Mark-Up the Construction Elements



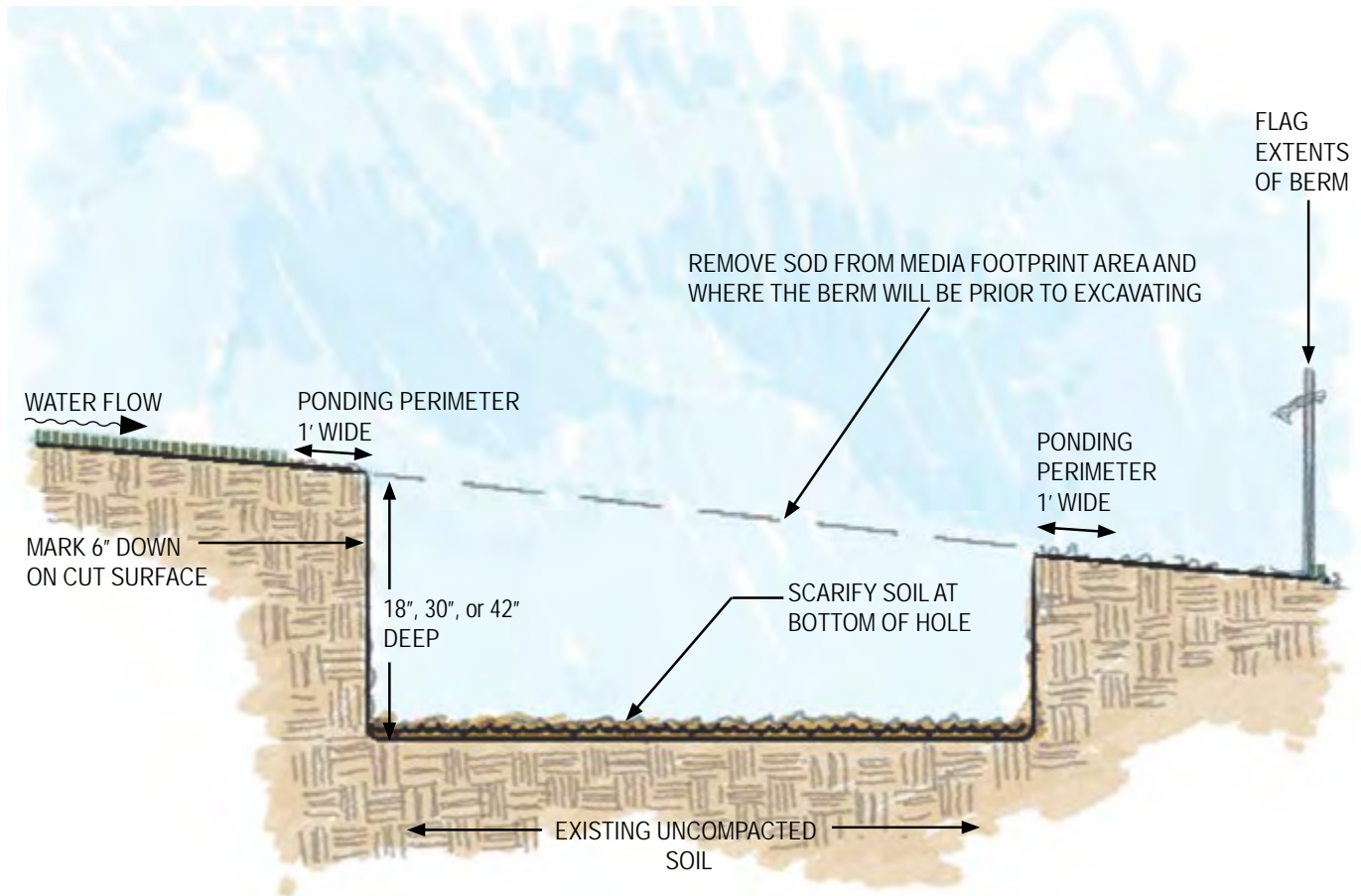
NOTE: Plan is not to scale

Directions:

- Spray paint the extents of the garden.
- Paint the ponding perimeter of the garden.
- Paint the media footprint / limit of excavation on the ground (1' inside the ponding perimeter).
- Paint the berm location
- Mark all lines with flagging.

Construction

Step Two: Excavate the Hole

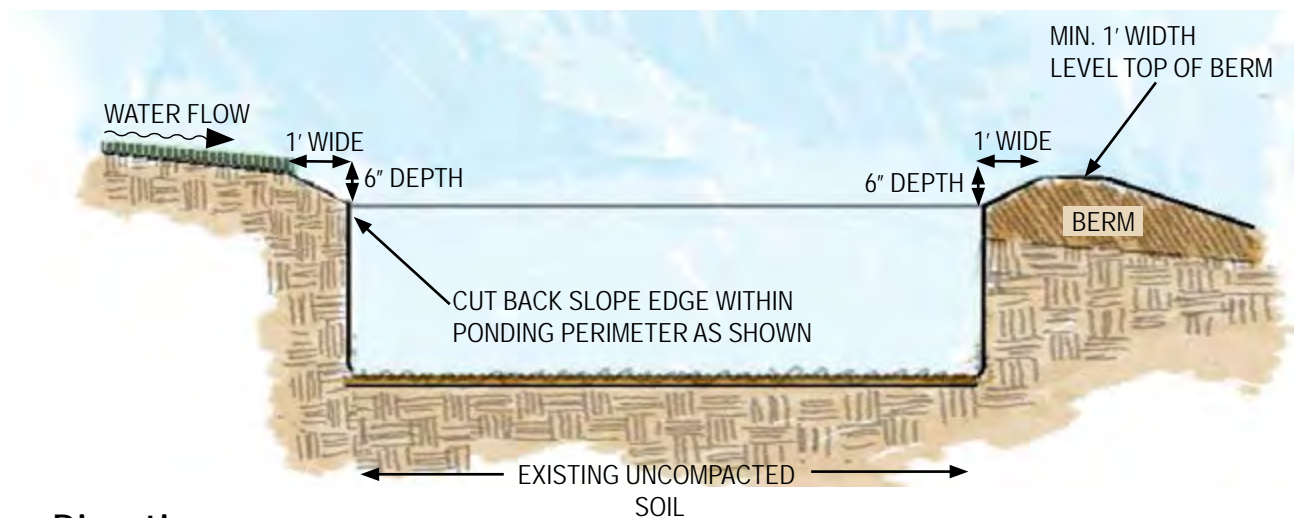
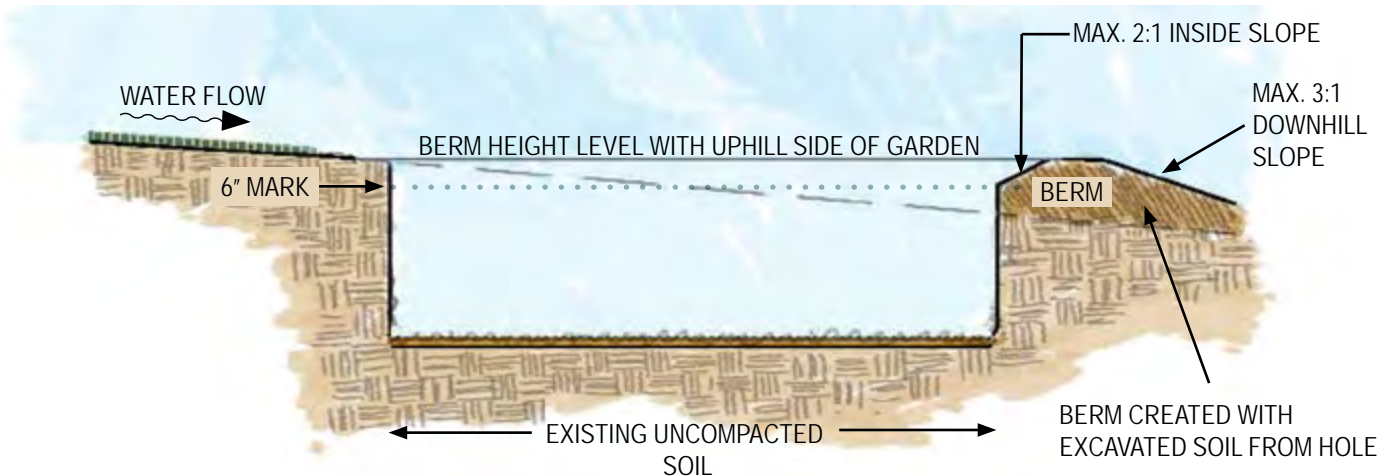


Directions:

- Leaving flagging in place, remove sod from rain garden area, including berm footprint. Remark the media/ flat area of the rain garden.
- Excavate 9"- 42" depth of soil depending on Rain Garden size and site slope.
- Be sure to remove only within the area for the rain garden planting media and not the ponding perimeter mark. (This edge will be cut back later.)
- Sides should be cut straight down. Be sure to scarify the sides of the hole, and NOT glaze them.
- Bottom of hole should be flat and soil decompacted/loosened.
- Do not run machinery in the hole — compaction of the bottom of the rain garden will result in poor drainage.

Construction

Step Three: Build a Berm; Cut and Shape the Ponding-Perimeter

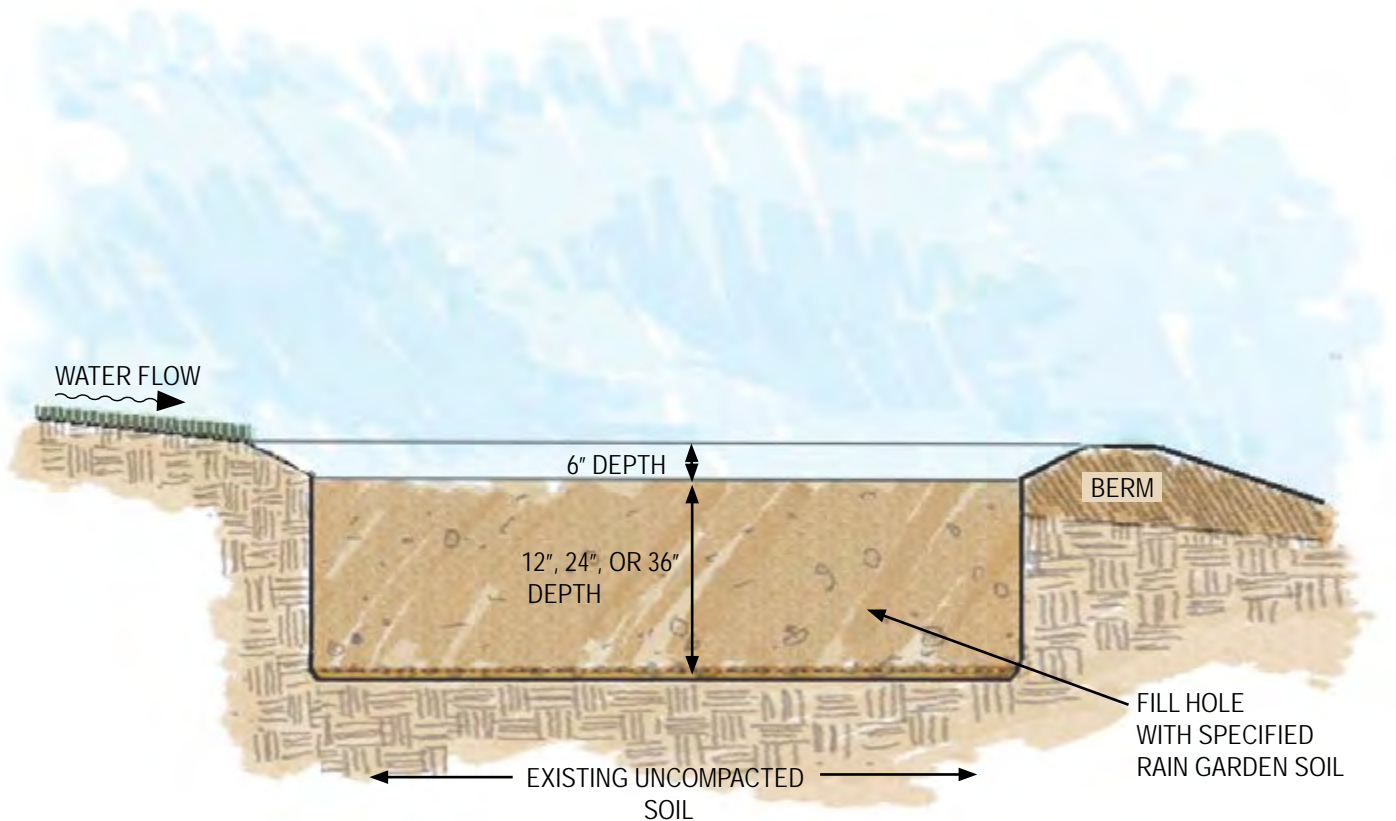


Directions:

- Use the excavated soil to build the berm, compacting the berm as it is built up.
- Berm material must be clean soil with no sod, or woody material mixed in. There should be no sod under berm.
- Berm should be the same height as the uphill side of the ponding perimeter and flat across the top to ensure that there are no unintended low spots that could overflow unevenly and become a weak point.
- If there is a designed overflow notch, then the top of the berm should be 2" to 3" higher than the uphill side of the garden's ponding perimeter.
- Install the overflow notch, if this is part of the design, and reinforce per the design with sod or stone.
- On the uphill side, measure back 1' and cut back to the mark on the slope to create a 6" deep sideslope, thus creating the ponding perimeter.

Construction

Step Four: Fill Hole with Soil/Planting Media

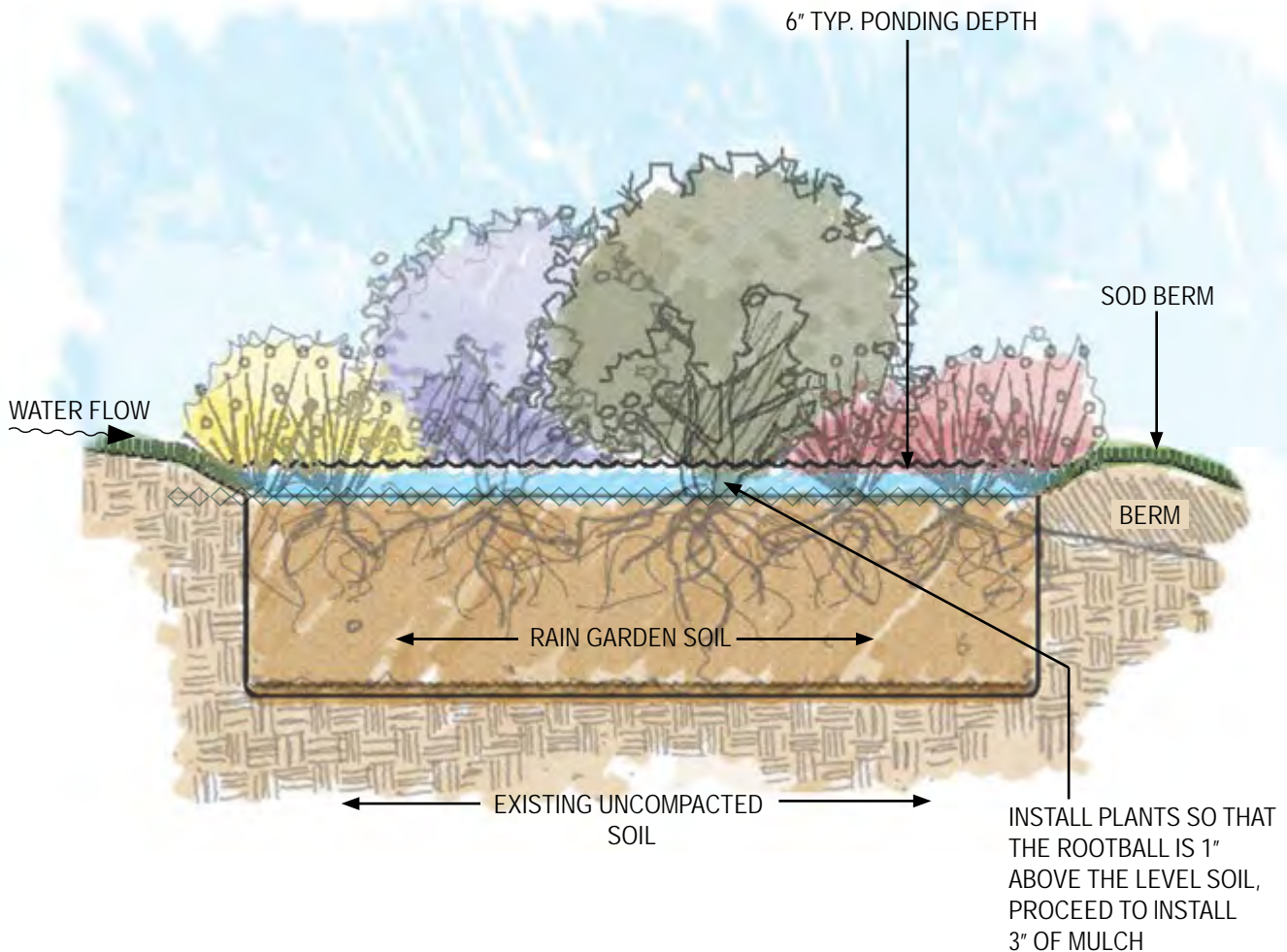


Directions:

- If possible, use existing soil that is compost amended with 30 – 50% compost by volume; mix evenly.
- If using Rain Garden soil instead of the existing soil, it should consist of 50% Sand, 25% Compost (or Shredded Hardwood Mulch) and 25% Topsoil (Max. 10% Clay).
- Add soil 6" at a time and water it, in order to let it settle. Or, estimate how much the soil will settle and fill so that the final grade will be at the designed elevation.
- Soil should be level at the surface.
- Soil should be 6" lower than the inlet and berm/overflow height.

Construction

Step Five: Install Plants; Mulch and Water Garden



Directions:

- Remove plants from their containers. Plants should be planted slightly high, with approximately 1/8" to 1/4" of potting soil above the rain garden soil.
- Do not directly walk on the rain garden soil while planting; planting media should remain decompacted. Use boards or bags of mulch to move around the garden during planting.
- If planting media is wet, do not plant until it is dry.
- Mulch the garden with 3" of shredded hardwood mulch. (Do not use pine bark, wood chips, rubber or dyed mulch)
- Sod berm and other areas specified for sod.
- For the first watering, put a sprinkler on until the garden is ponding and overflowing.
- Water throughout the first year as needed. Usually, this is weekly for the first growing season; if soil appears saturated, do not water. Wait until the soil is dried to the point of damp before watering again.

Maintenance

Rain garden maintenance is straightforward and similar to usual gardening tasks. Plants are key to the long-term function of a rain garden and are an important part of the investment in time and money. It is strongly recommended that homeowners follow the guidelines below for plant care and other maintenance activities.

Watering

- a) Ensure that plants are well-watered during the growing season (May to October) until they are established (one to three years). If there is no rain, add approximately one inch of water once a week for herbaceous perennials, shrubs, and trees. The watering frequency may need to be doubled during plant establishment if ferns are used.
- b) To minimize evaporation, do not water in the middle of the day.
- c) After plants are established, rainfall and runoff coming to the rain garden should provide sufficient water for plant vitality. Established rain gardens should need watering only if there are periods of three weeks or more without rain during the growing season.

One inch of water

To gauge one inch of water, place an empty tuna can in the rain garden before watering. When the can is full, you have successfully applied 1" of water.

Vegetation

- a) Do not use fertilizer, herbicides, or pesticides in rain gardens.
- b) Remove weeds, dead vegetation, turfgrass, invasives, and undesirable volunteer plants. Pay special attention to weeding while plants are becoming established.
- c) Prune any dead, diseased, or damaged portions of plants when the problem is noticed.
- d) Cut back perennials and grasses to a height of 6 to 12 inches in late February to early March.
- e) Prune shrubs annually to maintain desired shape and size.
- f) Remove cuttings from the rain garden; do not leave them in place to decay.
- g) Clumping grasses and perennials should be divided approximately every three years. Division in the fall is preferred.

Planting media and mulch

- a) Inspect the rain garden for erosion or instability after the first several rain events and the first major storm.
- b) Remove and replace mulch every three years or as needed.
- c) Inspect the mulch depth seasonally and add mulch as needed to maintain the maximum three-inch depth.
- d) Gently loosen the mulch with a hand rake twice annually to prevent clogging.
- e) Remove accumulated sediment and debris, and replace any areas of mulch that have become clogged.

Maintenance

- f) The planting media may settle over time. If significant settling occurs, remove and set aside mulch and add additional planting media to reach the original depth. Restore the mulch layer to the full three-inch depth.
- g) Prevent excess sediment loads from entering the rain garden from eroded areas or from other site work. Remove sediment if it collects at the inlet.
- h) If erosion is a chronic problem, place cobbles or stiff grasses along the upslope edge of the rain garden. If a swale is used for inflow or outflow, add small cobble check dams to the swale to slow the flow. Decrease the slope of the downspout extension if possible.
- i) If erosion occurs at the overflow weir, replace or augment the turf or cobbles.
- j) If erosion is observed on the side slopes of the rain garden, repair the eroded area and stabilize with erosion control fabric or mulch. Use cobble or additional plantings to redirect or spread out the flow that is causing the erosion.



A properly maintained rain garden

Trouble Shooting Guide

Symptom	Possible Cause	Solution
Standing water in the facility	If standing water occurs for over 48 hours, and it is past the establishment phase, the facility could be clogged or, in the case of an underdrained rain garden, the underdrain may be blocked. Another cause would be an overactive sump pump emptying water into a rain garden.	Inspect all pipes first and clean out any debris found. Redirect sump pump away from the garden if needed. Evaluate the depth of ponding to determine if soil has settled / there is a proper ponding depth. If there is too much ponding (>6" above the soil), remove the mulch. Evaluate plant health and density. If plants seem OK, remove and replant them after raising the soil level before replacing mulch with a 3" layer of fresh mulch. If, after these measures are taken, there is still standing water, there may need to be more roots / plants density increased to provide sufficient uptake of water or a vertical sump may need to be installed. Vertical sump: Do a perk test hole in the garden to a depth a foot below the depth of the planting soil and evaluate whether the water drains through.
Erosion or bare soil	The runoff is moving too fast and/or the vegetation has died.	Stabilize the soil by planting new stiff vegetation like grasses or shrubs. If needed, use rocks to slow the flow.
Erosion or bare soil on the overflow notch	<ol style="list-style-type: none"> The notch is too narrow for typical overflow volume. The garden is undersized for the amount of water coming in, so it overflows frequently. The notch was not properly stabilized when the garden was built. Site conditions have changed (upstream increase in impervious area adds more water, or plants have shaded out planted materials in the notch). 	<ol style="list-style-type: none"> Widen the notch and restabilize. You may need to provide temporary reinforcement or a temporary alternative outlet if the garden is receiving water on an ongoing basis (i.e. you can't exclude water flow.) Create an alternative flow path which diverts incoming water away from the area once the garden is full of water. Rework the notch and reinforce it with greater compaction. If already highly compacted, and vegetation has failed, consider adding river cobble to the notch. If site conditions have changed, determine the changes before determining the best solution. If shade is a factor, select more shade tolerant species for the notch if feasible. If not feasible, reinforce the notch with river cobble.
Dead or dying plants	Your plants may be the wrong plant type for your shade and moisture conditions, or they may be smothered by weeds. Or light conditions may have changed, and you need more shade/sun tolerant plants.	Plant new vegetation. For ideas, consult <i>RainScapes Suggested Plant List</i> in the "Resources and Calendar" section of rainscapes.org , or go to the "Planting Palette" list on page 65.
Weeds taking over facility	Established weeds that have already seeded may take multiple years to kill.	Manually remove weeds as soon as they are seen. Do not allow weeds to go to seed. Use good quality double-shredded mulch to minimize weed introduction through the mulch source.
No mulch or visibly reduced mulch	Mulch naturally decomposes over time. Large storms can also move mulch.	Replenish mulch to a total depth of 3 inches over the entire facility.

Materials and equipment

Equipment

- ¾ ton pickup truck or larger
- Lightweight, wide-tracked mini excavator or backhoe loader
- Trailer for excavator
- #2 shovel
- Flat headed shovel
- Dirt tamper
- Wheelbarrow
- String level or laser level
- Chalk line
- Tarp to cover stone prior to installation
- Hose and water source
- Ground protection matting

Labor

- Foreman
- Equipment operator
- Landscape installation crew

Materials

- If required, planting media (2 to 10 cu. yd. typical). Media must contain 50% sand, 25% topsoil, and 25% Leafgro®, by volume. Use ASTM C-33 washed sand. Topsoil must have a clay content of less than 5%. If compost amending, calculate the compost volume based on a depth of 2" of compost.

$$\text{Formula: } .16 \times \text{square feet of ponding footprint} = \text{cubic feet of compost needed.}$$
- Aged, undyed, double-shredded hardwood mulch (0.25 to 2.5 cu. yd. typical). Grass clippings, bark nugget, or leaf mulch must not be used.
- Rounded cobble, washed, two to six inch diameter (0.1 to 0.2 ton typical)
- Sod (20 to 80 sq. ft. typical). It may be possible to set aside and reuse existing sod from the area taken up by the rain garden.
- Haul-away for excavated soil, if performing a media replacement (5 to 15 cu. yd. typical). To minimize hauling, some soil will be used in the berm and the rest may be able to be redistributed on site. Compost amended rain gardens will typically not have soil to haul away unless the garden is in a very flat site.
- Vegetation (grasses, perennials, shrubs, trees)
- Wall blocks, if needed (dimensions vary)
- Underdrain, if needed, must be six-inch, schedule 40 PVC. Perforations must be 3/8 inch in diameter and must be located four inches on center, every 90 degrees around the pipe. The far end of the underdrain must be fitted with a removable cap perforated with seven holes 3/8 inches in diameter.

Montgomery County RainScapes 2014 Plant Palette

Choose one plant per key from each category (Sun or Shade/Part Shade):

Key	Sun Options	Shade/Part Shade Options
A 42" O.C.	<i>Ilex verticillata</i> 'Cacapon' / Winterberry**	<i>Aronia arbutifolia</i> 'Brilliantissima' / Chokeberry
	<i>Ilex glabra</i> 'Shamrock' / Inkberry*	<i>Myrica pensylvanica</i> / Bayberry*
	<i>Viburnum dentatum</i> / Arrowwood Viburnum	<i>Lindera benzoin</i> / Spicebush
B 42" O.C.	<i>Panicum virgatum</i> 'Shenandoah' / Red Switchgrass	<i>Clethra alnifolia</i> 'Sixteen Candles' / Summersweet
	<i>Eupatorium fistulosum</i> / Joe Pye Weed	<i>Hydrangea arborescens</i> 'Annabelle' / Smooth Hydrangea
	<i>Baptisia australis</i> / Blue False Indigo	<i>Leucothoe fontanesiana</i> 'Scarletta' / Scarletta Fetterbush
C 24" O.C.	<i>Aster novae angliae</i> 'Purple Dome' / New England Aster	<i>Amsonia hubrechtii</i> / Willowleaf Bluestar
	<i>Schizachyrium scoparium</i> 'The Blues' or 'Standing Ovation' / Little Bluestem	<i>Aster divaricatus</i> / White Wood Aster
	<i>Iris versicolor</i> / Blue Flag	<i>Aruncus dioicus</i> / Goat's Beard
D 24" O.C.	<i>Monarda didyma</i> / Bee Balm	<i>Chasmanthium latifolium</i> / Northern Sea Oats (Note: Will tolerate sun)
	<i>Eupatorium coelestinum</i> / Mist Flower	<i>Polystichum acrostichoides</i> / Christmas Fern*
	<i>Rudbeckia fulgida</i> / Black Eyed Susan	<i>Osmunda cinnamomea</i> / Cinnamon Fern
E 18" O.C.	<i>Penstemon dig.</i> 'Huskers Red' / Beardtongue*	<i>Carex stricta</i> / Tussock Sedge
	<i>Liatris spicata</i> 'Kobold' / Purple Gayfeather	<i>Chelone glabra</i> / Turtlehead
	<i>Asclepias tuberosa</i> / Butterfly Milkweed	<i>Heuchera americana</i> / Alumroot*
F 12" O.C.	<i>Sisyrinchium graminoides</i> / Blue-Eyed Grass	<i>Phlox divaricata</i> / Wild Blue Phlox
	<i>Geranium maculatum</i> / Wild Geranium*	<i>Phlox stolonifera</i> 'Blue Ridge' / Creeping Phlox
	<i>Phlox subulata</i> / Moss Phlox	<i>Tiarella cordifolia</i> 'Brandywine' / Foam Flower*
G	<i>Betula nigra</i> 'Heritage' / River Birch	<i>Amelanchier canadensis</i> / Serviceberry
	<i>Crataegus virdis</i> 'Winter King' / Green Hawthorn	<i>Chionanthus virginicus</i> / White Fringetree
	<i>Cercis canadensis</i> / Eastern Redbud	<i>Magnolia virginiana</i> / Sweetbay Magnolia*
H 36" O.C.	<i>Clethra alnifolia</i> 'Hummingbird' / Pepperbush	<i>Rhododendron periclymenoides</i> / Pinxterbloom
	<i>Hypericum densiflorum</i> / Dense St. John's Wart	<i>Itea virginica</i> 'Henry's Garnet' / Sweetspire
	<i>Baptisia australis</i> / Blue False Indigo	<i>Viburnum trilobum</i> 'Compactum' / Viburnum

*Denotes Evergreen / Semi-Evergreen

**Denotes Female plant; requires 1 male counterpart; For Winterberry, provide one 'Jim Dandy' (male) for each grouping of 'Cacapon' (female.)

Note: O.C.= On Center Spacing

References

General references

- **Montgomery County RainScapes Program:** <http://www.montgomerycountymd.gov/rainscapes>
- **Montgomery County RainScapes Manuals:** <http://www.montgomerycountymd.gov/DEP/DEPcommon/Pamphlets.html#>
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- RainScapes plant lists. www.rainscapes.org; click on the “Resources and Calendar” button.

For Montgomery County RainScapes projects, this guide should take precedence over external resources when there are discrepancies in guidance.

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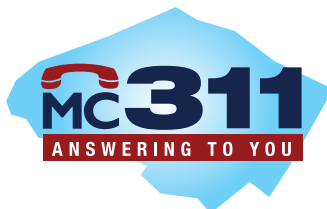
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