



## **GREEN INFRASTRUCTURE MAINTENANCE MANUAL**



**SEPTEMBER 2020**



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**Acknowledgements**

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## **WHAT IS GREEN INFRASTRUCTURE?**

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure practices capture, filter, absorb, and/or reuse stormwater to help restore the natural water cycle. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, pervious pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating runoff, these practices can help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits.

## **GREEN INFRASTRUCTURE PRACTICES**

When managing stormwater with green infrastructure practices, the overall goal is to disconnect impervious surfaces that are connected (i.e., drain directly to sewer systems or local waterways). Green infrastructure practices can be designed to capture and infiltrate stormwater. These practices tend to filter water using soil, as in the case of bioretention, or using stone, as in the case of porous asphalt. In areas where infiltration is not possible, these green infrastructure practices also can be used as a detention system to store runoff and slowly release it after the storm event. Some green infrastructure practices are used to harvest stormwater runoff for non-potable water usage such as watering gardens. Other green infrastructure practices, like bioswales, are designed to move water from one location to another while filtering pollutants.

The following sections describe some green infrastructure practices that have been proven to be successful in New Jersey. These practices include:

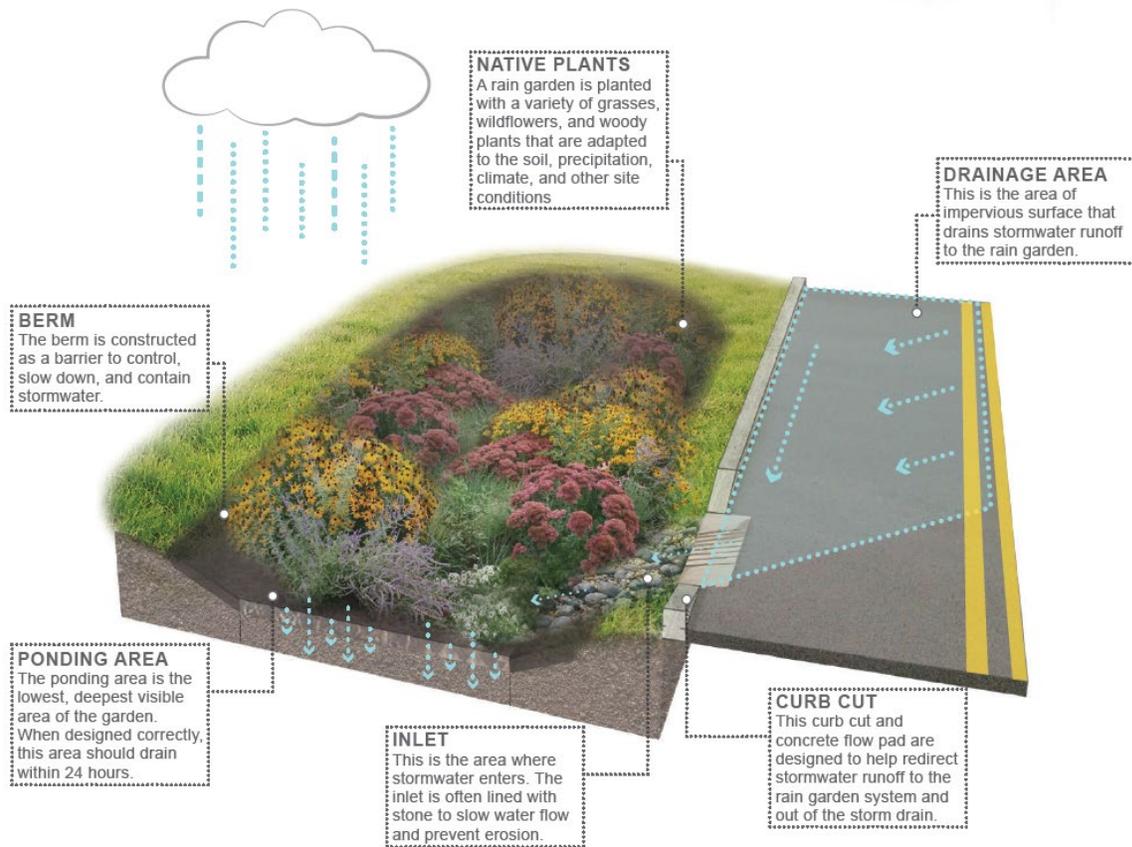
- Bioretention & rain garden systems
- Bioswales
- Downspout planters
- Permeable pavements
- Cisterns & rain barrels

## **BIORETENTION & RAIN GARDEN SYSTEMS**

A rain garden, or bioretention system, is a landscaped, shallow depression that captures, filters, and infiltrates stormwater runoff. The rain garden removes nonpoint source pollutants from stormwater runoff while recharging groundwater. A rain garden serves as a functional system to capture, filter, and infiltrate stormwater runoff at the source, while being aesthetically pleasing. Rain gardens are an important tool for communities and neighborhoods to create diverse, attractive landscapes while protecting the health of the natural environment. Rain gardens can also be installed in areas that do not infiltrate by incorporating an underdrain system.

## Design Parameters

- System is located close to the source of runoff
- Flat bottom with stable inflow and overflow
- Captures, treats, and infiltrates at least the runoff volume from the water quality storm (1.25 inches over two hours)
- Can be designed to capture the runoff volume for the two-year design storm (3.3 inches of rain over 24 hours)
- Minimum infiltration rate of 0.5 inches per hour and maximum infiltration rate of 10 inches per hour
- If infiltration rate is unknown or less than 0.5 inches per hour, system can be designed with underdrain
- No standing water may remain at the surface 72 hours after a rain event
- Amend soil with coarse sand and/or compost if necessary<sup>1</sup>



**Figure 1: Bioretention system/rain garden**

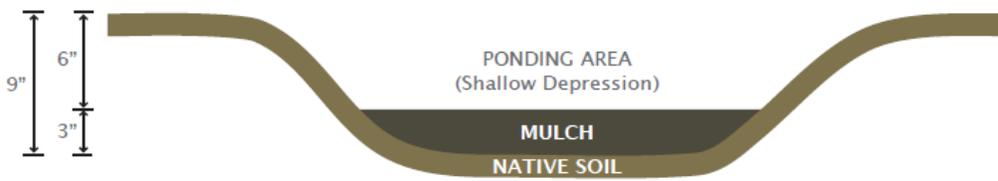
<sup>1</sup> The soil bed material must consist of the following mix, by weight: 85 to 95% sand, with no more than 25% of the sand as fine or very fine sands; no more than 15% silt and clay with 2% to 5% clay content. The entire mix must then be amended with 3 to 7% organics, by weight. The New Jersey Department of Environmental Protection recommends a soil layer of 18 to 24 inches but in many situations where bioretention systems are being used to retrofit existing development, a 12-inch layer may be all that is necessary and in some cases, the native soil may be suitable.

### Construction Details

It may be helpful for maintenance staff to understand better how bioretention systems or rain gardens are built. The standard cross-section for a rain garden is shown below. They are typically designed to have three or six inches of ponding. A three-inch ponding depth is typically contained in the design for areas that have soils with low infiltration rates or a higher groundwater table. If a rain garden is designed to manage the same volume of stormwater runoff, a three-inch deep rain garden would have to have a footprint (i.e., the size of the rain garden) that is twice as big as a six-inch deep rain garden. For example, a rain garden that is designed to capture stormwater runoff from a 1,000 square foot impervious surface would have to be 400 square feet in size and three inches deep or 200 square feet in size and six inches deep.

Appendix A contains construction details and notes for these green infrastructure practices. These details include inlet, outlet, and overflow details. Green infrastructure designers can download these details from [www.water.rutgers.edu](http://www.water.rutgers.edu).

6" DEEP RAIN GARDEN - NO SOIL AMENDMENTS



3" DEEP RAIN GARDEN - SOIL AMENDMENTS

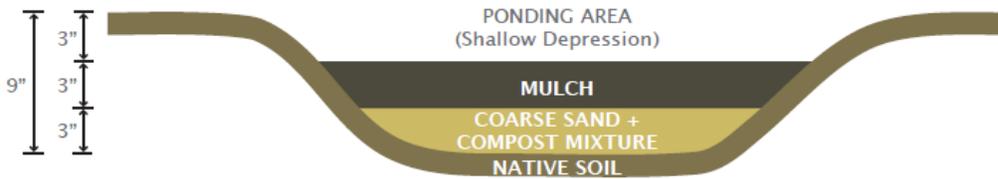


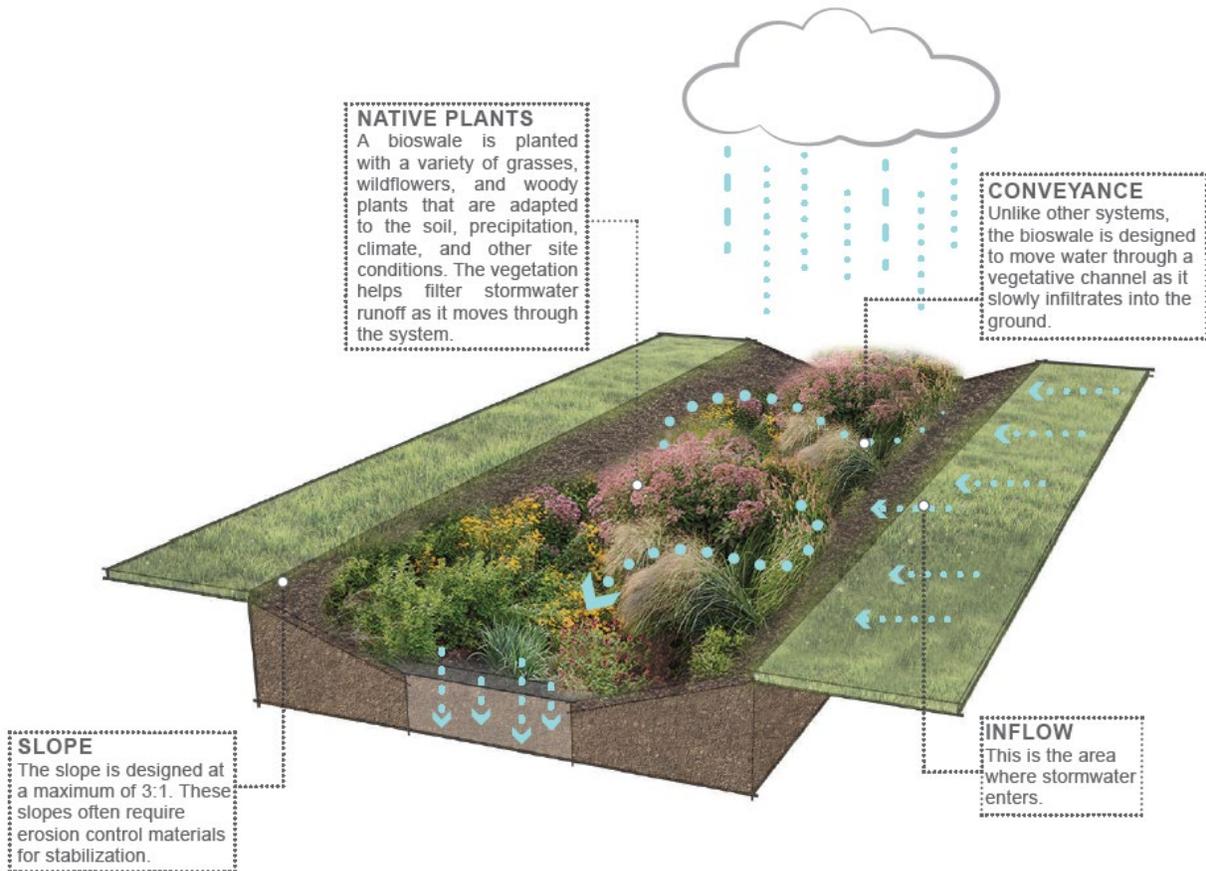
Figure 2: Standard cross-sections of rain gardens

## BIOSWALES

Bioswales are landscape features that convey stormwater from one location to another while removing pollutants and allowing water to infiltrate. Bioswales are often designed for larger scale sites where water needs time to move and slowly infiltrate into the groundwater. Much like rain garden systems, bioswales can also be designed with an underdrain pipe that allows excess water to discharge to the nearest catch basin or existing stormwater system.

### *Design Parameters*

- System is located close to the source of runoff
- The bottom has a gentle slope to prevent high velocities from causing soil erosion (typically 2 to 10%)
- No standing water may remain at the surface 72 hours after a rain event
- Maximum side slope of the bioswale is 3:1, but 4:1 is recommended
- Minimum distance between bottom of the bioswale and seasonal high water table is 1 foot



**Figure 3: Bioswale**

## Construction Details

Bioswales are very similar to rain gardens in construction. The rain garden typically has a 12-inch bioretention layer where a bioswale only has a six-inch layer. The difficulty in constructing a bioswale is to ensure the vegetation is well-established to prevent erosion. This may require stormwater runoff to be diverted around the swale while plants are becoming established. Appendix B contains construction details and notes for a bioswale. These details also can be downloaded from [www.water.rutgers.edu](http://www.water.rutgers.edu).

## DOWNSPOUT PLANTERS

Downspout planter boxes are wooden or concrete boxes with plants installed at the base of the downspout that provide an opportunity to beneficially reuse rooftop runoff. Although small, these systems have some capacity to store rooftop runoff during rainfall events and release it slowly back into the system through an overflow. Most often, downspout planter boxes are a reliable green infrastructure practice used to provide some rainfall storage and aesthetic value for property.

### Design Parameters

- Planter box must be adequately reinforced to hold soil, stone, and plants
- Limited capacity for stormwater retention – mostly infiltration
- Soil infiltration rate is 5.0 inches per hour
- Underdrains are installed to drain the water after the storm event

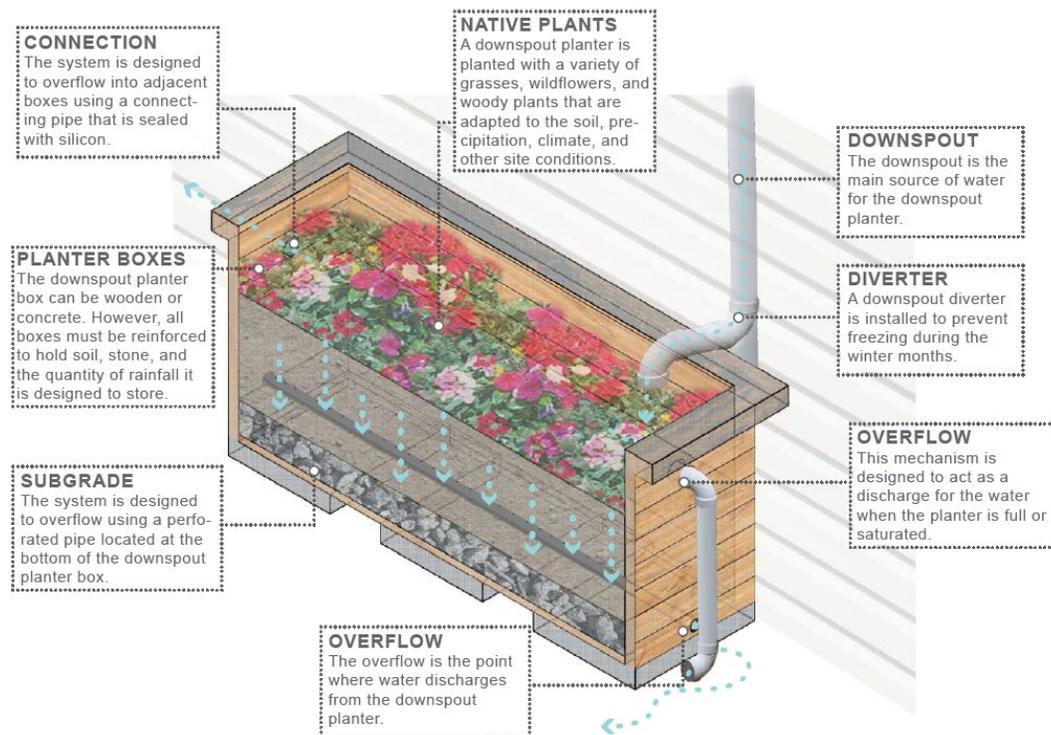


Figure 4: Downspout planter

### ***Construction Details***

The main concern with planter boxes is ensuring that they are placed on a solid foundation and are reinforced to withstand the soil, stone, and plants. Another concern is correctly installing the underdrain and overflow and directing the water from the underdrain and overflow to an appropriate location. Appendix C contains construction details and notes for a downspout planter. These details also can be downloaded from [www.water.rutgers.edu](http://www.water.rutgers.edu).

## **PERMEABLE PAVEMENTS**

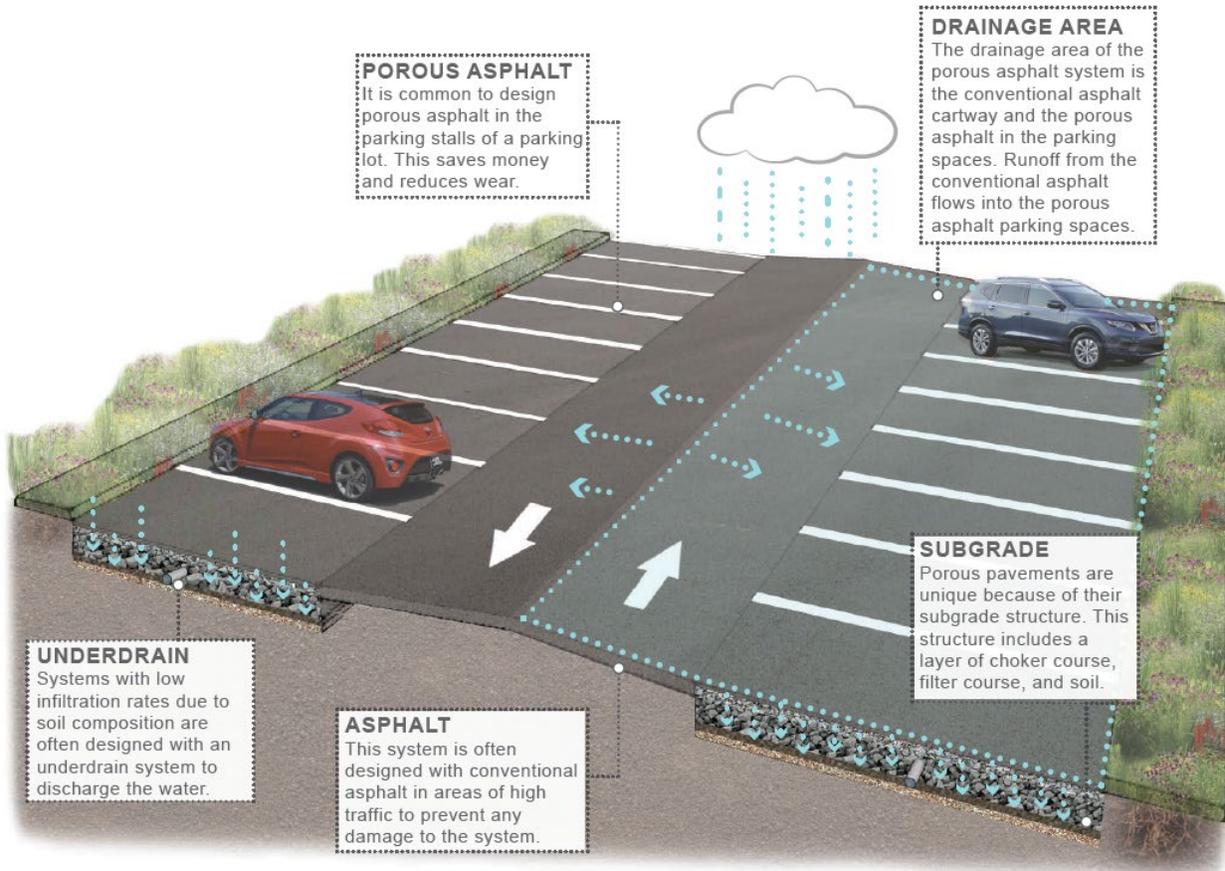
These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid/grass pavers. Pervious concrete and porous asphalt are the most common of these permeable surfaces. They are similar to regular concrete and asphalt but without the fine materials. This allows water to quickly pass through the material into an underlying layered system of stone that holds the water, allowing it to infiltrate into the underlying uncompacted soil. They have an underlying stone layer to store stormwater runoff and allow it to seep slowly into the ground. By installing an underdrain system, these systems can be used in areas where infiltration is limited. The permeable pavement system will still filter pollutants and provide storage but will not infiltrate the runoff.

### ***Design Parameters***

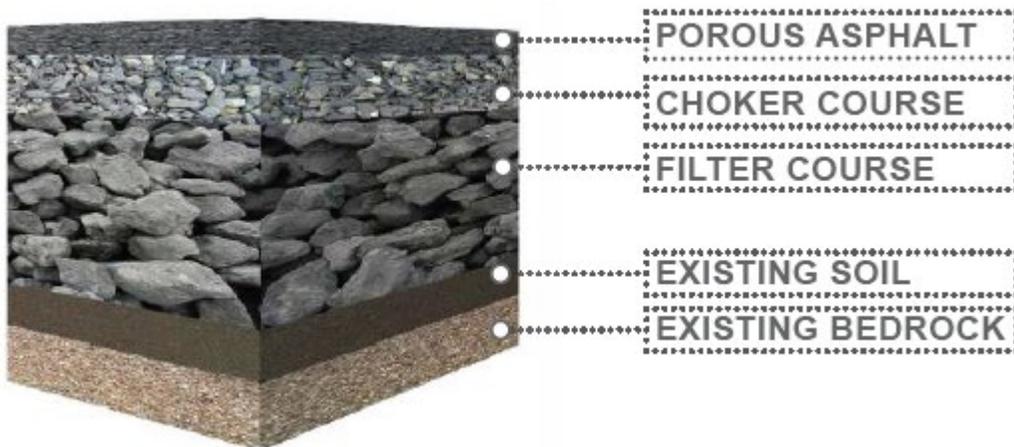
- Underlying stone reservoir
- Porous asphalt and pervious concrete are manufactured without "fine" materials to allow infiltration
- Grass pavers are concrete interlocking blocks with open areas
- Ideal application for porous pavement is to treat a low traffic or overflow parking area
- Minimize runoff from non-paved areas onto permeable pavement to prevent clogging
- Maximum ratio of inflow drainage area to surface area onto permeable pavements is 3:1

### ***Construction Details***

Porous asphalt is very similar to traditional asphalt and can be installed by most traditional asphalt contractors. Pervious concrete needs to be installed by a contractor for pervious concrete installation, or precast pervious concrete slabs can be purchased and installed by a non-certified contractor. Interlocking concrete pavers and grid/grass pavers typically can be installed by any contractor. Most landscape contractors have these capabilities. Appendix D contains construction details and notes for permeable pavements. These details also can be downloaded from [www.water.rutgers.edu](http://www.water.rutgers.edu).



**Figure 5: Porous asphalt**



**Figure 6: Cross-section of porous asphalt**

## **CISTERNS & RAIN BARRELS**

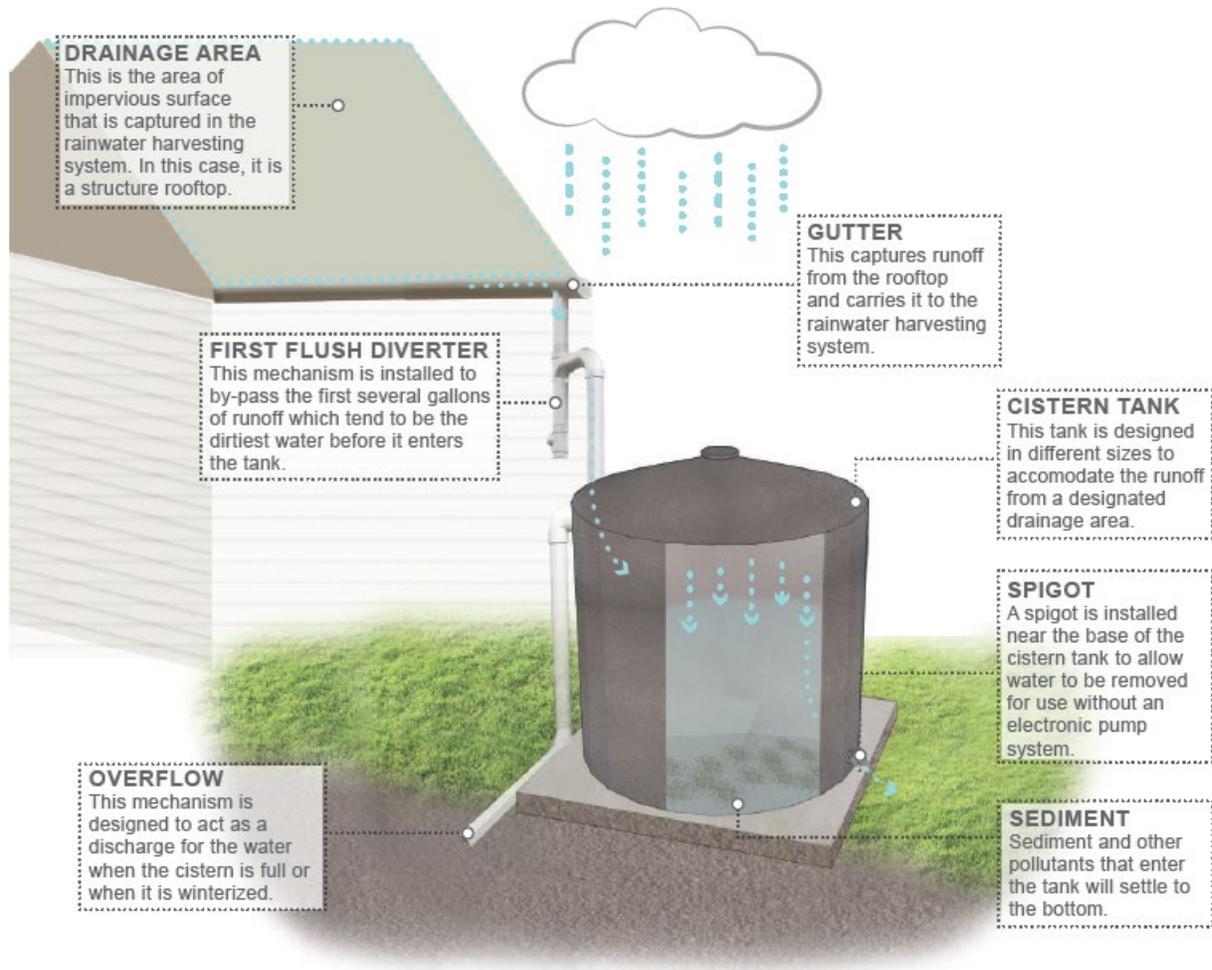
Rainwater harvesting systems capture rainwater, mainly from rooftops, in cisterns or rain barrels. The water can then be used for watering gardens, washing vehicles, or for other non-potable uses. Rainwater harvesting systems come in all shapes and sizes. These systems are good for harvesting rainwater in the spring, summer, and fall but must be winterized during the colder months. Cisterns and rain barrels are often paired with other green infrastructure practices to increase their storage capacity or efficiency. Most commonly, cistern or rain barrel systems are paired with a vegetative system (e.g., rain garden, bioswale, stormwater planter) to capture the overflow from the system when it has reached its full capacity.

### ***Design Parameters***

- 600 gallons of water per inch of rain per thousand square feet of catchment area
- Efficiency usually presumed to be 75% depending on system design and capacity
- Incorporate first flush diverter to prevent the first 10-20 gallons from entering the cistern
- Rainwater harvesting systems only work as stormwater management systems if the cisterns are drained between storms — there must be a legitimate use for the collected rainwater
- Systems must be drained and taken out of service in the winter; if harvested rainwater is needed in the winter months, the cistern may have to be placed indoors or underground to protect from freezing

### ***Construction Details***

Water is heavy so cisterns and rain barrels need a solid foundation. They may need to be secured to a wall to prevent tipping. Appendix E contains construction details and notes for cisterns. These details also can be downloaded from [www.water.rutgers.edu](http://www.water.rutgers.edu).

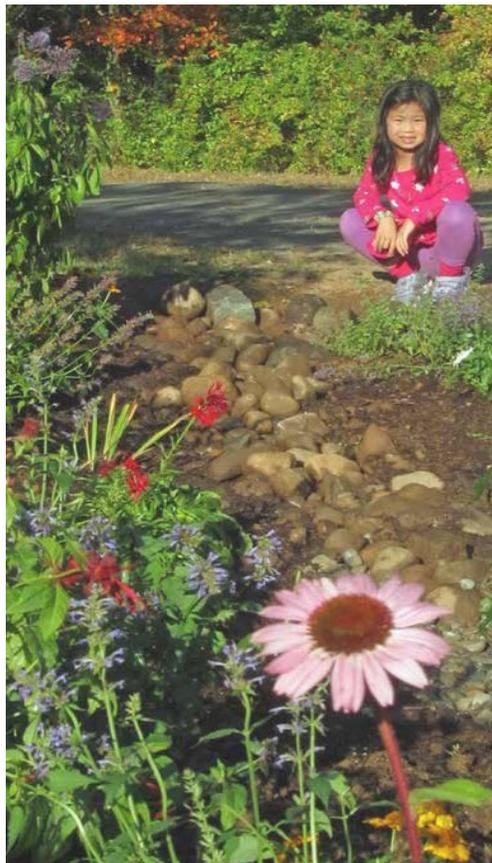


**Figure 7: Cistern**



**Figure 8: Cisterns come in all sizes and shapes**

# **BIORETENTION (RAIN GARDEN) MAINTENANCE GUIDELINES**



## **WATER**

Water is essential for the survival of your new rain garden. Please water the garden during the first three months post-planting and as needed throughout the future in times of drought. Plants should be watered every day for the first week they are in the ground and then once a week after that unless there is substantial rainfall. In hot weather or times of drought, the rain garden will need water one to two times a week to prevent the loss of plants, even if the garden is already established.

## **WEEDS**

Please remove unwanted weeds from the garden by hand. Pull them from the base of the weed to remove the roots. As your garden becomes established, the rain garden plants will spread and out-compete unwanted weeds.

## **MULCH**

Mulch is used to prevent weeds and retain moisture in the rain garden. During the first year the garden is growing, please maintain a 3" layer of mulch between plants. As your rain garden plants spread and become denser, you may find mulching the garden more difficult. Mulching beyond the first year is optional. Please be careful not to mulch the garden excessively and keep mulch away from drains.

## **INLETS/OUTLETS**

Please inspect the rain garden's inlets monthly, and be sure to remove any leaves, trash, or debris that may prevent water from passing through. Observe the inlet during rainstorms to make sure stormwater is flowing into the rain garden. After rainstorms, please check the garden to be sure drainage outlet paths are clear and that water is not ponding for more than 72 hours.

## **NO MOWING**

Please DO NOT mow or use a line-trimmer inside of the rain garden. This damages the plants and can destroy the rain garden.

## **SUPPLEMENTAL PLANTING**

Please remove and replace any dead plants in the garden as needed.



## **PRUNING**

We recommend pruning overgrown material in the garden annually when the plants are dormant.

## **PHOTOGRAPH AND DOCUMENT (See Appendix F for Green Infrastructure Maintenance Report Form)**

Please photograph your green infrastructure practice and share pictures with the Rutgers Cooperative Extension (RCE) Water Resources Program! In addition, document the maintenance of the practice, and be sure to contact the RCE Water Resources Program at [water@envsci.rutgers.edu](mailto:water@envsci.rutgers.edu) if you need assistance or have any questions.

**For more information, please visit  
[www.water.rutgers.edu](http://www.water.rutgers.edu).**



## **RAIN GARDEN, BIOSWALE, STORMWATER PLANTER/PLANT BED**

### ***Shrub and Herbaceous Plant Material General Maintenance, Weeding, Mulching***

Rain gardens and bioswales are shallow surface depressions planted with specially selected native vegetation (trees, shrubs, grasses, and perennials) to treat and capture stormwater runoff. They are often designed to be planted on top of a layer of sand or gravel storage.

Plant beds, or planters, are typically a combination of trees, shrubs, and herbaceous perennials (flowering plants) in a contained planting bed, with a covering of mulch. Planters can be contained within concrete curbs or seatwalls or are often at ground level.

Healthy plants and lawns should be able to withstand minor disease and insect damage without controls. Routine application of pesticides shall not be practiced, as this destroys natural predator-prey relationships in the environment. Where unusually high infestations or infections occur, an accurate identification of the disease or insect shall be made and the control selected with care, prior to application. All chemical controls must be applied under the supervision of a licensed and qualified pest control applicator, following the procedures set forth in the labeling of the product, as required by law.

**Type of Maintenance:** Preventative

#### **Tools and Supplies:**

- Hand pruners
- Mulch (as specified)
- Mulch fork
- Rake
- Spade shovel
- Pitchfork or spade
- Weeding fork
- Plant and weed photo identification sheet
- Trash bag, gloves

#### **Frequency:**

- Inspection: 1x/year minimum (Late May to early July, and/or late August to early September)
- Weeding: 3x/year minimum (spring cleanup, summer maintenance, fall put to bed)
- Mulching: Minimum 1x/year (spring)

**Labor Hours:** 2 people for approximately 4-6 hours depending on site size

#### **Maintenance Procedure:**

- A. Safety: Set up a safety perimeter. Protect existing plants from damage due to landscape operations and maintenance and operations of other contractors and trades.
- B. Inspection: Visually inspect for any bare areas of vegetation or for specimen vegetation that has died and needs to be removed and/or replaced. Inspect for signs of frost heave and note any plants that may need to be replaced. Inspect plants for signs of excessive drought,

disease, nutrient deficiency, and/or pest problems. Inspect planting areas for signs of soil compaction, soil subsidence, excessive salt deposits, or ponding of water. Inspect any areas of standing water for mosquito larvae. Also inspect areas (e.g., stabilized outfalls) that may experience erosion or increased sediment deposits which would inhibit infiltration.

- i. Record observations in the Green Infrastructure Maintenance Report Form and report as necessary. If possible, take photographs to document site conditions.
  - ii. Based on the above observations, determine if it is necessary for a skilled horticulture professional to conduct a follow up visit to assess any potential plant health issues. Note this in the Green Infrastructure Maintenance Report Form.
- C. Remove trash/debris: Remove any leaves, debris, and trash that may have accumulated in or around the plant beds/planters and legally dispose trash/debris off of the owner's property.
  - i. All refuse resulting from the maintenance operation of properties shall be disposed of at locations designated by the manager/owner.
- D. Weed: Weeding shall occur 3x/year at minimum (spring, summer, and fall).
  - i. Weeding is easiest if done when soil is moist. It is also recommended to pay attention to specific sites and keep track of weed presence on the Green Infrastructure Maintenance Report Form for each site. Weeding is easier and more effective if done consistently throughout the growing season and done BEFORE weeds go to seed.
  - ii. Refer to the project's plant identification sheet for photographs of plants to be able to identify what plants should remain and what plants are weeds and should be removed.
  - iii. All planting areas shall be kept free of weeds, using either mechanical or chemical methods defined below.
    - a. Carefully hand pull or dig out weeds and invasive plants taking care not to damage surrounding plants.
    - b. For control of invasive species, spot spraying with herbicide may be employed by a Certified Pesticide Applicator only after notifying the proper authorities and getting approval to apply herbicides. Spraying is allowed only after receiving approval. Before applying herbicides, the type of weed shall be identified, and the control shall be selected accordingly, using the most effective control for the species, the location, and the season.
  - iv. Weeds shall not be allowed to grow in paved areas such as driveways, walks, curbs, gutters, etc. Dead weeds shall be removed from the paved areas.
- E. Mulch: After weeding, apply specified mulch across surface of planter and/or planting bed in uniform manner; do not apply more than 3-4 inches thick. Mulching is only once/year in the spring, unless additional applications are needed after heavy rain events.

- i. Type: organic shredded hardwood mulch (or mulch specified for specific site)
  - ii. Shall be free of ceramics, man-made trash or debris of any kind, or other objectionable materials.
  - iii. Application rate: 3 inches applied to a settled thickness of 2 inches.
  - iv. Do not place mulch within 2 inches (150 mm) of plants
  - v. Do not shape mulch like a “volcano;” spread mulch evenly to a uniform level height near shrub trunks or perennial/plant stems to prevent rot from occurring
- F. Cleanup: Remove surplus mulch and waste material including trash and debris, and legally dispose of surplus and waste material off of the owner's property
- G. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- H. Safety completion: Remove safety perimeter.

### ***Riverstone/Stone Gutter Maintenance***

The riverstone/stone gutter is a 2- to 4-foot wide stone channel serving to slow water down, prevent erosion, and direct runoff into the rain garden, bioswale, or planter.

**Type of Maintenance:** Preventative

**Tools and Supplies:**

- Rake
- Clean, washed riverstone per project specifications
- Trash bag, gloves

**Frequency:** Annually in spring

**Labor Hours:** 2 people for approximately 1-2 hours depending on site size

**Maintenance Procedure:**

- A. Safety: Set up a safety perimeter.
- B. Inspection: Visually inspect the riverstone/stone gutter for any areas of riverstone that are bare and/or need to be replenished or replaced. Inspect for signs of weed growth, dumping of debris, or snow plow damage. Record observations in the Green Infrastructure Maintenance Report Form and report as necessary. If possible, take photographs to document site conditions.
- C. Remove trash/debris: Remove any large debris and trash that has accumulated in the riverstone/stone gutter area.
- D. Weed: Remove any obvious weed growth that has established itself within the limits of the riverstone/stone gutter. The riverstone should be free of vegetative growth.
- E. Rake: Gently rake riverstone/stone gutter to re-establish an even surface and even out any irregular depressions or high points (stones may have moved or shifted during the year).
- F. Replenish: Add new riverstone only if shallow and/or bare areas exist after raking has been completed. Add only enough riverstone to bring entire riverstone/stone gutter to a consistent and level grade, approximately even with the elevation of the adjacent edge of pavement.
- G. Record: Make note of any unrecorded observations on the Green Infrastructure Maintenance Report Form.
- H. Safety completion: Remove safety perimeter.

### ***Rain Garden/Bioswale/Planter Watering***

Watering for the first year after installation should be covered by a one-year maintenance agreement as outlined in project specifications and contract/warranty provisions.

This watering procedure takes effect once the contractor warranty period expires.

**Type of Maintenance:** Preventative

#### **Tools and Supplies:**

- Hose
- Sprinkler
- Hydrant
- Water backpack (for small areas)
- Water truck (if no access to water hydrant)

#### **Frequency:**

- Initial establishment (1st year after plant installation): Water in absence of rainfall to maintain a rate of 1" of water per week.
- Year 2, Year 3: Water as needed (generally up to ½" of water per week) during the first 4-6 weeks of the growing season and then only during extended periods of drought and only when ground is not frozen.
- Year 4 and beyond: Water to supplement rainfall only during extended periods of drought and only when ground is not frozen.

**Labor Hours:** 2 people for approximately 1-5 hours per site depending on site size

#### **Maintenance Procedure:**

- A. Safety: Set up a safety perimeter.
- B. Inspection: Visually inspect for any bare areas within rain gardens/bioswales/ planters/plant beds and also for specimen vegetation that has died and needs to be removed and/or replaced. Inspect plants for signs of excessive drought, disease, and/or pest problems. Inspect any areas of standing water for mosquito larvae. Record observations in the Green Infrastructure Maintenance Report Form and report as necessary. If possible, take photographs to document site conditions.
- C. Remove trash/debris: Remove any large debris and trash that has accumulated in the plant beds/planters.
- D. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- E. Water:
  - i. During the first year after plant installation, water to supplement rainfall throughout the growing season (April through November) if soil conditions are dry. Do not water if ground is frozen. The amount of water recommended (combination of rainfall and/or

- supplemental watering) is 1" of water per week. If resources permit, 2" of water per week is recommended during extreme drought conditions for ideal plant growth and peak performance.
- ii. During the second and third year after plant installation, water to supplement rainfall in the first 4-6 weeks of each growing season (April through May) if soil conditions are dry and there is not adequate spring snow melt to provide soil moisture. Do not water if ground is frozen. Also water throughout the growing season if there is extreme drought. The amount of water recommended (combination of rainfall and/or supplemental watering) is 1" of water per week). If resources permit, 2" of water per week is recommended during extreme drought conditions for ideal plant growth and peak performance.
  - iii. There is no need to water plants if rainfall has fulfilled the 1" of water per week requirement.
  - iv. Discontinue watering activities once temperatures create frozen soil conditions. Start again in spring when tree buds swell and sprout new leaves.
  - v. Water as necessary so planting soil remains moist 2-3 inches below the finished grade. Use a trickling hose if possible to ensure steady, slow water flow. Water plant roots and avoid watering plant leaves (foliage). Water deeply to promote deeper root growth, which will ultimately enable plants to be more tolerant of drought in the long term.
- F. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- G. Safety completion: Remove safety perimeter.

### ***Shrub and Herbaceous Groundcover Pruning, Division, Cut Back, Removal of Dead Vegetation***

Plants are chosen for their natural shape and growth habit. Maintenance should encourage vegetation health and enhance the natural form of plant material. Activities such as trimming and pruning should not alter plant form considerably.

**Type of Maintenance:** Preventative

#### **Tools and Supplies:**

- Hand pruners
- Trowel
- Spade shovel
- Pitchfork
- Bow saw (if necessary)
- Trash bag, gloves

**Frequency:** 1x/year, see below:

- Shrubs: 1x/year in March/April or September/October depending on species
- Perennials: 1x/year cut back in March/April or September/October (March/April recommended)
- Grasses: 1x/year cut back as needed in March/April

**Labor Hours:** 2 people for approximately 1-8 hours per site depending on site size

#### **Maintenance Procedure:**

- A. Safety: Set up a safety perimeter. During pruning, keep adjacent paving and construction area clean and work area in an orderly condition. Protect plants from damage due to landscape maintenance operations and operations of other contractors and trades.
- B. Inspection: Visually inspect for any bare areas of vegetation or for specimen vegetation that has died and needs to be removed and/or replaced. Inspect plants for signs of excessive drought, disease, and/or pest problems. Inspect any areas of standing water for mosquito larvae. Record observations in the Green Infrastructure Maintenance Report Form, and report as necessary. If possible, take photographs to document site conditions.
- C. Remove trash/debris: Remove any large debris and trash that has accumulated in and around planters/plant beds, and legally dispose of large debris and trash off of the owner's property.
- D. Prune:

#### **Shrubs**

Prune, thin, and shape shrubs according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by an arborist, remove only injured, dying, or dead branches from shrubs and prune to retain natural character/form. Do not prune for shape.

Shrubs shall be pruned to maintain growth within space limitations, to maintain or

enhance the natural growth habit, or to eliminate diseased or damaged growth. Some species shall be trimmed appropriately to influence flowering and fruiting or to improve vigor.

Shrubs must be trimmed as needed to permit unobstructed passage to residents or vehicles. Trimming shrubs within site clearance restricted areas at intersections is appropriate and shall have a maximum height of 2.5 feet from vehicular surface. Any curbs or raised planting areas shall be factored into the maximum 2.5-foot height. Shrubs must be trimmed 4" from the edges of sidewalks and curbs.

Shrubs shall be pruned to conform to the design concept of the landscape. Individual shrubs shall not be clipped into balled or boxed forms except where specifically instructed.

### **Perennials and Herbaceous Plants**

Established plants bordering sidewalks or curbs shall be edged as often as necessary to prevent encroachment. Plants shall not be allowed to cover the crowns of shrubs or trees.

Refer to a plant identification sheet to identify weeds from intended plants.

Perennial cut back/cleanup/removal of dead vegetation: Removing dead vegetation (on perennials) shall occur a minimum of 1x/year during the spring or fall, with a recommendation towards mid-spring before new vegetated growth has emerged or when plant is dormant. Use hand shears to remove dead vegetation and cut back perennials to 6-8" above root crown.

If dried seed pods or dried flowers are considered desirable by the property owner, then the dead vegetation may be allowed to remain through the winter and should be cut back in the spring.

Some species have seed pods that act as food for birds/wildlife and/or decorative dried features; however, other species may spread seed or look unkempt when dried, and this may not be desired.

Perennial division and thinning: Depending on the species, perennials may need dividing every 3–5 years. This is because as certain plants get older, they die back starting from the center.

Division is also done to prevent crowding as a plant grows and becomes larger in size. To divide perennials, dig up the old plant, remove the dead vegetation entirely, and replant the healthier sections. To thin perennials, selectively remove individual plant stems (either healthy or dead) if overcrowding is occurring. Thinning of perennials is done to prevent overcrowding and mildew by encouraging air circulation between individual plants.

## Grasses

Refer to a plant identification sheet to identify weeds from intended plants.

Grass cut back: Cut back foliage to 6–10" above root crown in mid-spring before warm season grasses emerge but when cool season weeds are actively growing. Leave a minimum 4-6" of previous growing season's growth depending on the ornamental grass species. Shorter species such as Blue Fescue will be 4" while taller species such as Switchgrass will be 6".

Grass division: Ornamental and/or clumping grasses shall also be divided every 3 to 5 years to increase vigor. Groundcover grasses and meadow grasses do not need dividing.

*List of example grasses that require division:*

Sedges (*Carex* spp.)

*Pennisetum* (Fountain Grass)

*Andropogon gerardii* (Big Bluestem)

*Schizachyrium scoparium* (Little Bluestem)

*Panicum virgatum* (Switchgrass)

*Calamagrostis x acutiflora* (Feather Reed Grass)

- E. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- F. Safety completion: Remove safety perimeter

### ***Shrub and Herbaceous Plant Material Plant Replacement***

Plant (shrub and herbaceous plant material) replacement involves replacing missing, dead, or diseased shrubs and herbaceous plant material (perennials, forbs, grasses) in planter beds, planters, rain gardens, and/or bioswales if replacement has been deemed necessary.

**NOTE:** Tree replacement is not part of this procedure and will occur separately.

**Type of Maintenance:** Replacement

#### **Tools and Supplies:**

- Safety cones
- Safety gear (clothing, gloves, etc.)
- Planting and mulching equipment – shovels, pitchfork, rake, etc.
- Shrubs, plants, and seeds (to be planted)
- Mulch (as specified)
- Trash bags for debris, weeds, etc.

**Frequency:** Spring and fall, replacement as necessary

**Labor Hours:** 2 people for approximately 2-6 hours per site depending on scope of replacement

#### **Maintenance Procedure:**

- A. **Safety:** Set up a safety perimeter. Protect existing plants from damage due to landscape operations and maintenance.
- B. **Inspection:** Visually inspect for any bare areas of vegetation or specimen vegetation that has died and needs to be removed and/or replaced. Inspect areas where plants will be planted (replaced), and note signs of soil subsidence, soil compaction, standing water, evidence of disease/fungus, and animal burrowing.
  - a. Record observations in the Green Infrastructure Maintenance Report Form, and report as necessary. If possible, take photographs to document site conditions.
- C. **Remove trash/debris:** Remove any leaves, debris, and trash that have accumulated in or around the plant beds/planters.
  - a. All refuse resulting from the maintenance operation of properties shall be disposed of at locations designated by the manager/owner.
- D. **Replacement:** Follow the below instructions if shrub and herbaceous groundcover replacement has been deemed necessary. Tree replacement will occur separately.
  - a. **Replacement requirements for shrubs and groundcover:**
    - Shrubs: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

- Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required.
  - Set balled and potted and container-grown stock plumb and in center of planting pit or trench with the root flare at 1 inch (25 mm)
  - Pit should be twice as wide as it is deep above adjacent finish grades.
    - Use planting soil for backfill for types specified and scheduled.
    - Carefully remove root ball from container without damaging root ball or plant.
    - Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
    - If amending soil, place amendment tablets or incorporate amendments in each planting pit when pit is approximately half filled in amounts recommended in soil reports from soil testing laboratory. If using amendment tablets, place tablets beside the root ball about 1 inch (25 mm).
    - Continue backfilling process. Water again after placing and tamping final layer of soil.
  - Groundcover and Perennial Plugs: For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
    - Set out and space ground cover and plants in swaths to fill in vegetated gaps in plant bed.
    - Dig holes large enough to allow spreading of roots.
    - Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
    - Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
    - Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.
    - Planting Restrictions: Plant during one of the following periods listed below. Coordinate planting periods with maintenance periods to provide required maintenance from date of substantial completion.

Shrubs:

- spring planting: March 1 to May 1

- fall planting: September 1 to November 1

Grass & Perennial Plugs:

- spring planting: April 1 to June 15
- fall planting: August 1 to September 15

Bulbs:

- fall planting: September 15 to October 30

- E. Cleanup: Stones, debris, tools, equipment, rope, pruned branches, tree debris, etc. shall be removed from the site upon completion of work. Excess soil outside of the saucer areas shall be removed and the area raked smooth. Paved areas shall be broom cleaned.
- F. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- G. Safety completion: Remove safety perimeter.

## ***Invasive Species Inspection and Control Measures***

Invasive species inspection consists of a visual inspection, trash/debris removal, and invasive species management.

Healthy plants and lawns should be able to withstand minor disease and insect damage without controls. Routine application of pesticides shall not be practiced, as this destroys natural predator-prey relationships in the environment. Where usually high infestations or infections occur, an accurate identification of the disease or insect shall be made and the control selected with care prior to application. All chemical controls must be applied under the supervision of a licensed and qualified pest control applicator following the procedures set forth in the labeling of the product as required by law.

**Type of Maintenance:** Preventative

### **Tools and Supplies:**

- Hand pruners
- Trowel
- Spade
- Pitchfork and weed fork
- Plant and weed photo identification sheet
- Trash bag, gloves

### **Frequency:**

- Inspection: Minimum 3x/year (spring, summer, fall)
- Monitor monthly during growing season for invasive species during the first 2 to 3 years

**Labor Hours:** 2 people for approximately 4-8 hours depending on site size

### **Maintenance Procedure:**

- A. Safety: Set up a safety perimeter. Protect existing plants from damage due to landscape operations and maintenance.
- B. Inspection: Visually inspect for any bare areas of vegetation or specimen vegetation that has died and needs to be removed and/or replaced. Inspect plants for signs of excessive drought, disease, nutrient deficiency, and/or pest problems.
  - i. Inspect any areas of standing water for mosquito larvae. Inspect meadow area for evidence of invasive species and woody plant establishment. Monitor meadow monthly during growing season for invasive species during the first 2 to 3 years. Examples of invasive species include thistle, knapweed, *Phragmites*, and general weeds such as dandelions.
  - ii. Record observations in the Green Infrastructure Maintenance Report Form and report as necessary. If possible, take photographs to document site conditions.
  - iii. Based on the above observations, determine if it is necessary for a skilled horticulture professional to conduct a follow up visit to assess any potential plant health issues.

Note this in the Green Infrastructure Maintenance Report Form.

C. Control of Invasive Species:

- i. Managing invasive species in meadows is primarily done through mowing. Mowing helps prevent/control woody plant and weed establishment, and helps to disperse seeds of desirable species.
- ii. Refer to the project's plant identification sheet for photographs of plants to be able to identify what plants should remain and what plants are weeds and should be removed.
- iii. For the control of certain types of invasive species not able to be managed by mowing, such as crown vetch, spot spraying and hand pulling should be conducted as directed below:

D. Carefully hand pull or dig out invasive plant species taking care not to damage surrounding plants.

E. For control of invasive species, spot spraying with an herbicide may be employed only by a certified pesticide applicator after notifying the proper authorities and getting approval to apply herbicides. Spraying is allowed only after receiving approval. Before applying herbicides, the type of weed shall be identified and the control selected accordingly, using the most effective control for the species, the location, and the season. Suggested herbicides for control of invasive plants include:

i. **Glyphosate**

Glyphosate herbicide may be used for total vegetation control and is safe to use immediately prior to planting and up to four days after seeding. Glyphosate may also be used to target individual weeds as a careful spot spraying after planting, but some non-target plants are likely to be damaged and killed as well. A specific formulation can be used for total vegetation control prior to planting in the grassland and mow strip areas. A formulation approved for wetland use can be used in stormwater infiltration basins and swales.

ii. **Plateau** (best application for areas near rain gardens)

Plateau herbicide is a very good herbicide for pre- and post-emergent weed control for establishing warm-season grasses. Pre-emergent application prior to planting is best. Plateau's utility is limited when wildflowers or cool season grasses are incorporated into the seeding mix. Native forbs, depending on the species, may or may not be tolerant of Plateau. Cool season grasses are not very tolerant of Plateau. Switch grass is not as tolerant to Plateau as other warm season grasses.

iii. **Transline**

Transline is a selective herbicide for the control of composites, polygonums, and legumes such as crown vetch. If carefully used as directed, it is an effective post-planting spot spray, because it will not kill all the desired vegetation that is touched by over-spray. Transline can be sprayed over the top of grass plantings where crown vetch

is abundant and where there are no desired composite wildflowers or legumes. Control of crown vetch will likely require at least 2 to 3 years of scouting and retreating with spot spray applications. Legumes and composites should be planted sparingly in the successional grassland in treated crown vetch areas.

*Note: All products mentioned here are for information only and are not an endorsement of a particular brand.*

- F. Remove trash/debris: Remove any leaves, debris, and trash that have accumulated. All refuse resulting from the maintenance operation of properties shall be disposed of at locations designated by the manager/owner.
- G. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- H. Safety completion: Remove safety perimeter.

# **PERMEABLE PAVEMENT MAINTENANCE GUIDELINES**

## **LANDSCAPE CARE**

Permeable pavements allow water to infiltrate into the ground, decreasing the amount of stormwater and pollution that drains to nearby waterways. The ability for the water to infiltrate depends on the porosity of the pavement. Soil and sediment draining from adjacent sites can cause the permeable pavement to clog and slow filtration. By maintaining the lawns and planting beds adjacent to the pavement, clogging can be prevented.

## **WINTER CARE**

Permeable pavements are more durable during the winter than conventional pavements. When deicing permeable pavements, it is recommended to use salt and not sand. Sand will clog the pores, and therefore decrease the amount of water that can flow through the pavement. Salt, on the other hand, will dissolve into the water and drain through the pavement. Check with the manufacturer of the pavers for guidelines on salt application.



## **PAVER DRAINAGE**

The gravel in the spaces between the pavers allows for the flow of water. This gravel also helps prevent weeds from taking root between the pavers. Over time this gravel may condense or wash away and therefore should be regularly checked and replaced when needed.

## **CLEANING**

Permeable pavements will naturally collect sediment, and infiltration could decrease over time; therefore, cleaning the pavement may be necessary. Accumulated sediment and debris can be removed using a high pressure hose or power washer. For pavers, the spaces between pavers should be re-filled with gravel.

For larger sites, street sweepers and commercial vacuums can be used to remove the sediment buildup within permeable pavements.

## **PHOTOGRAPH AND DOCUMENT**

Please photograph your green infrastructure practice and share pictures with the Rutgers Cooperative Extension (RCE) Water Resources Program! In addition, document the maintenance of the practice, and be sure to contact RCE Water Resources Program at [water@envsci.rutgers.edu](mailto:water@envsci.rutgers.edu) if you need assistance or have any questions.



**For more information, please visit  
[www.water.rutgers.edu](http://www.water.rutgers.edu).**



## **POROUS PAVEMENTS**

### ***Vacuumping***

Vacuumping is done to remove sediment that may lead to a clogging of the porous surface, preventing water from infiltrating through the pavement into the stone reservoir.

Porous pavement vacuumping applies to several types of porous pavements as described below.

Porous pavers are an alternative to traditional hardscape paving which allows water to infiltrate between the pavers and through permeable layers below ground. When vacuumping porous pavers, the setting should be adjusted to a lower power to prevent complete removal of aggregate between voids (unless more intensive vacuumping is required to alleviate clogged areas).

Porous concrete is a type of concrete that has a high porosity due to an increased void space to facilitate water infiltration through the porous concrete into a stone reservoir and then into the ground.

Porous asphalt is a type of asphalt that has a high porosity due to an increased void space to facilitate water infiltration through the porous asphalt into a stone reservoir and then into the ground.

### **Tools and Supplies:**

- Porous pavement vacuum
- Water source
- Safety cones, trash bags, gloves, street broom

**Frequency:** Semi-annually for porous concrete, porous asphalt, and flexible porous pavement; annually for porous pavers (spring)

**Labor Requirements:** 2 people for approximately 1 hour per 10,000 square feet

### **Maintenance Procedures:**

- A. Safety: Set up safety perimeter. Ensure that no vehicles are parked in the vicinity of the location and that the area is closed to the public. Notice to property owner should be given and required permissions secured.
- B. Inspection: Visually inspect porous pavement for damage, including holes, cracks, excessive scuffing, settlement, and areas of standing water. Inspect status of aggregate between voids in porous pavers before and after vacuumping to see if additional replacement aggregate is needed. Record observations/damage on the Green Infrastructure Maintenance Report Form; include photos if possible, and report required repairs as necessary.
- C. Preparation: Prepare site for vacuumping. Remove (by hand) bulky debris and waste materials from surface of porous pavement that may be too large to be picked up and/or will block/clog the vacuum hose (i.e., litter, tree branches, wire, car parts) prior to using

vacuum. Use a rigid street broom to loosen debris as needed. Pay particular attention to pavement edges and heavily loaded areas.

- D. Vacuum: Vacuum porous pavement per the vacuum manufacturer's recommendations. Note: If vacuuming porous pavers, set vacuum at a lower power to prevent complete removal of aggregate between voids (unless more intensive vacuuming is required to alleviate clogged areas). Vacuum machine speed should be adjusted so that the vacuum draws out the first inch or so of stone and dirt in the openings between porous pavers as this is where most unwanted sediment/debris typically collects. Follow all steps in the manufacturer's operation checklist for the specified vacuum.
- E. Post-vacuuming inspection: After two passes, visually inspect porous pavement to ensure adequate debris removal. Any areas with visible debris/sediment still present should be vacuumed again until debris is removed. In the event that the surface of the porous pavement becomes clogged with fine dirt or sand, follow maintenance tasks outlined in Power Washing Procedure. Record observations on the Green Infrastructure Maintenance Report Form.
- F. Cleanup: Clean work area and vacuum equipment (per manufacturer's operation manual).
- G. Safety completion: Remove safety perimeter and re-open area for parking/public access.

## ***Power Washing***

Power washing applies to several types of porous pavements described below. Power washing should be done if porous pavement surfaces become clogged with fine dirt or sand. Power washing of the pavement surface allows partial restoration of the original void space and therefore permeability and should immediately follow the porous pavement vacuum task (once every three years or more often as necessary). Power washing of porous pavers should never occur as it may damage pavers and/or remove aggregate between pavers.

### **Tools and Supplies:**

- Power washer
- Water source
- Safety cones, trash bags, gloves, street broom

**Frequency:** Once every three years (perform immediately after thorough vacuuming) or more frequently if necessary; recommended time is spring

**Labor Requirements:** 2 people for approximately 1 hour per 10,000 square feet

### **Maintenance Procedure:**

- A. Safety: Set up safety perimeter. Ensure that no vehicles are parked in the vicinity of the location and that the area is closed to the public. Notice to the property owner should be given and required permissions secured.
- B. Inspection: Visually inspect porous pavement for damage, including holes, cracks, settlement, excessive scuffing/raveling and areas of standing water. Record observations/damage in the Green Infrastructure Maintenance Report Form.
- C. Preparation: Prepare site for power washing. Remove (by hand) bulky debris and waste materials from surface of porous pavement that may block or impede power washer access to the surface (i.e., litter, tree branches, wire, car parts). Use a rigid street broom to loosen debris as needed. Pay particular attention to pavement edges and heavily loaded areas, take photos if possible, and report as necessary.
- D. Power wash: Follow manufacturer's recommendations for use of the power washer unit. Ensure that the water inlet valve and pump are both on.
- E. Set the pressure levels to be no greater than 500 PSI.
- F. Perform two passes over surface of pavement with wand spraying at a 45 degree angle. Do not keep water flow on one location for longer than 5 seconds.
- G. Vacuuming: Power washing may need to be followed immediately by vacuuming. Refer to vacuuming procedure for detailed instructions. If sediment is exposed (brought to the surface) during power washing, this sediment must be immediately removed through vacuuming instead of allowing the sediment to migrate and re-enter the porous pavement.
- H. Post-power washing inspection: Visually inspect porous pavement to ensure adequate sediment/debris removal. Any areas with visible debris/sediment still present should be

washed again until debris is removed. Note if water remains ponded in any areas of the porous pavement. Record observations in the Green Infrastructure Maintenance Report Form.

- I. Store equipment: Shut off pump and return hose and wand to proper storage place.
- J. Safety completion: Remove safety perimeter and re-open lot for parking/public access.

### ***Porous Paver Maintenance (Restoring Aggregate)***

Porous pavers are an alternative to traditional hardscape paving which allows water to infiltrate between the pavers and through the permeable layers below them. Pavers are laid out on the surface and clean, washed aggregate material (also called screening or gravel) are placed in the spaces (voids) between paver units to provide stability and surface drainage while keeping unwanted debris out of the system.

This procedure refers specifically to the task of refilling the voids between pavers with additional aggregate material to replace any material that has been lost by vacuuming and/or due to natural migration, settlement, and erosion.

**Type of Maintenance:** Preventative

#### **Tools and Supplies:**

- Safety cones
- Rigid street broom
- Shovel
- Manhole pick
- Wheelbarrow
- Clean, washed small aggregate (gravel) per project specifications

**Frequency:** As needed when gravel infill is not within ½ inch of the paver surface, immediately following vacuuming

**Labor Requirements:** 2 people for approximately 1 hour per 10,000 square feet

#### **Maintenance Procedure:**

- A. **Safety:** Set up safety perimeter. Ensure that no vehicles are parked in the vicinity of the location and that area is closed to the public. Notice to property owner should be given and required permissions secured.
- B. **Inspection:** Visually inspect porous pavers for damage, including broken pavers, cracks, settlement, and any areas of standing water or evidence of standing water. Inspect status of aggregate infill material in the voids between porous pavers to see if additional replacement aggregate is needed. Evaluate if voids (joints) between porous pavers are clogged or not.
  - i. Inspect to see if pavers themselves are missing from any areas and note need for replacement pavers. Record observations/damage on the Green Infrastructure Maintenance Report Form; include photos if possible, and report as necessary.
- C. **Preparation:** Remove (by hand) bulky debris and waste materials from the surface of the pavers; include photos if possible, and report as necessary.
- D. **Cleaning clogged voids:** If voids (joints) between porous pavers are still clogged even after area has been vacuumed, use a manhole pick to tool out joint until clean aggregate is found. Follow aggregate replacement instructions below.

- E. Add aggregate: Using a shovel, spread aggregate over the surface of the pavers. Using a broom, sweep aggregate into the voids between porous paves, taking care to fill in any obvious holes. Once the aggregate has been added to the pavers and the voids have been filled, perform a final sweeping pass with the hand broom to remove any excess gravel from the paver surface.
- F. Cleanup: Clean up work area.
- G. Safety completion: Remove safety perimeter and re-open area for parking/public access.

### ***Winter Maintenance for Porous Pavements***

During the winter, porous pavement surfaces require different maintenance practices from standard pavement surfaces to maintain performance and promote infiltration. Specifically, sanding of porous pavement surfaces is prohibited, salting must be minimal, and plow blade heights may need to be set higher in some instances. In addition, plowed snow should not be stockpiled directly on top of porous pavement if possible.

**Type of Maintenance:** Preventative

**Tools and Supplies:**

- Truck with snow plow
- Salt/deicers and appropriate machinery as needed
- Hand shovel

**Frequency:** As necessary following snowfall or icy conditions

**Labor Hours:** 2 people for approximately 1-2 hours per acre (varies with snow conditions)

**Maintenance Procedure:**

- A. Safety: Set up a safety perimeter.
- B. Inspection: Visually inspect entire area to be plowed prior to plowing snow and/or salting the porous pavement surface. Refer to project site plan if necessary to identify location of landscape elements and porous pavement surfaces. Note presence of trees, shrubs, landscape features, and wheel stops or bollards so that plow does not hit them during plowing and cause physical damage. Record observations in the Green Infrastructure Maintenance Report Form and report as necessary. If possible, take photographs to document site conditions.
- C. Remove trash/debris: Remove any large debris and trash from porous pavement surface prior to plowing and report as necessary. If possible, take photographs to document site conditions.
- D. Plow: If plowing on top of porous pavers, raise plow blade to a slightly higher level (1" higher) than for other types of porous pavement (asphalt, concrete, or flexipave) to prevent the plow from catching paver edges and dislodging paver units. If possible, use a rubber plow blade for plowing porous pavement surfaces.
- E. Storage of snow piles: If possible, do not leave plowed snow piles on top of porous pavement surfaces to melt. This may result in sediment from the plow operations entering the porous pavement which can lead to clogging. Move snow piles to standard/conventional pavement area or to grassy/lawn area nearby. Refer to project site plan if necessary to identify location of landscape elements, porous and non-porous pavement surfaces, and snow stockpiling areas.
- F. Salting: Use road salt in moderation on porous pavement surfaces. If possible, use an environmentally safe road salt/deicer. Use approximately only 25% of the amount of deicing salt that is routinely applied to standard pavement parking lots or the amount that

is needed to maintain acceptable driving conditions. (*This is approximately a 75% reduction in salt use.*)

- i. Recommended environmentally safe road salts: Calcium magnesium acetate (CMA) and potassium acetate (KA) are highly recommended. A second suggestion is calcium chloride (CaCl), which is similar to sodium chloride but can be used in smaller amounts. A mix of sodium chloride or calcium chloride and CMA or KA is better than one of the salts alone. Recommended products include GEOMELT, ECO Salt, and GEOSALT.
- G. Record: Make note of any additional observations in the Green Infrastructure Maintenance Report Form.
- H. Safety completion: Remove safety perimeter and re-open area for parking/public access.

# **RAINWATER HARVESTING MAINTENANCE GUIDELINES**

## **DIVERTER FILTER**

Rainwater harvesting systems allow for the slow and controlled use of stormwater. To ensure that the rainwater harvesting system functions properly, filters must be checked for debris on a regular basis. The rainwater harvesting system contains a diverter filter. The diverter filter serves as a barrier against clogging, directly catching the debris that flows off of the roof and into the downspout. This filter should be regularly checked and cleaned. Failure to clean the diverter filter may cause the rainwater harvesting system to clog and malfunction.

## **OVERFLOW**

The overflow pipe allows water to flow out of the rainwater harvesting system when the tank gets too full. This prevents the system from overflowing and backing up through the downspout. To help reduce the amount of water that flows directly into nearby storm drains, direct the overflow so that excess water can be dispersed along a lawn, field, garden, or other planted area. By simply using the water that is stored in your rainwater harvesting system in between storms, you can also help prevent water from flowing out of the overflow.



## **WINTER**

The constant freezing and thawing of water in the wintertime can cause many pieces of the rainwater harvesting system to crack and break. Therefore, before the temperature falls below freezing, the rainwater harvesting system should be fully drained and disconnected at the diverter. For a rain barrel, disconnect the downspout from the barrel, place the original downspout onto the gutter, and then turn the barrel upside down.

## **USE**

The stormwater held in the rainwater harvesting system is great for watering trees and gardens. However, it SHOULD NOT be used for bathing or drinking. If the water is to be used for a vegetable garden, water the soil not the vegetables. If concerned, feel free to get the water tested.

## **PHOTOGRAPH AND DOCUMENT**

Please photograph your green infrastructure practice and share pictures with the Rutgers Cooperative Extension (RCE) Water Resources Program! In addition, document the maintenance of the practice, and be sure to contact the RCE Water Resources Program at [water@envsci.rutgers.edu](mailto:water@envsci.rutgers.edu) if you need assistance or have any questions.

**For more information, please visit [www.water.rutgers.edu](http://www.water.rutgers.edu).**



## **APPENDIX A**

### **Details for Rain Gardens/Bioretenion Systems**

Reference:

*Green Infrastructure Guidance Manual for New Jersey, RCE Water Resources Program, 2016  
Technical Details for Construction, pp. 76-86*

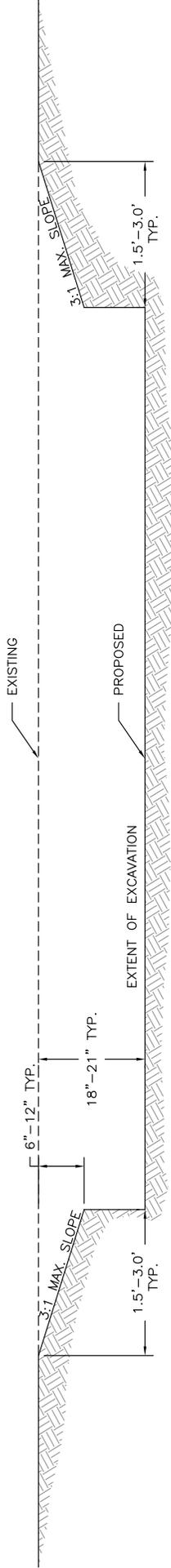
<http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html>

# TECHNICAL DETAILS FOR CONSTRUCTION

All details have been made available for download at [water.rutgers.edu](http://water.rutgers.edu)

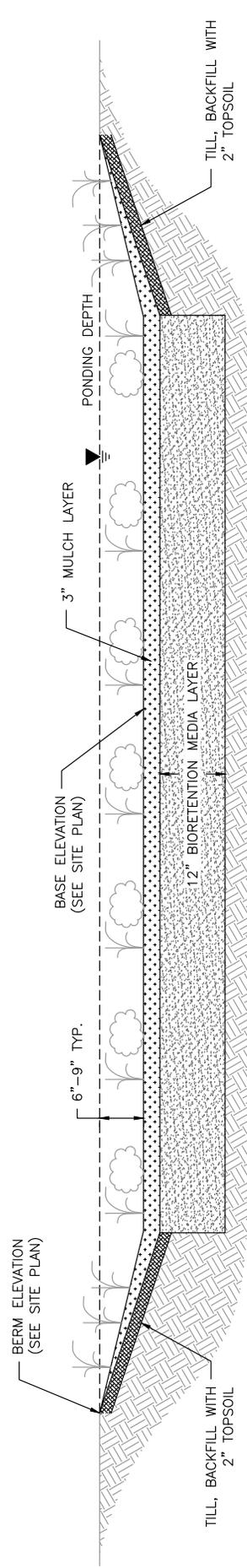
## 1.0 BIORETENTION

Landscaped feature designed to capture, treat, and infiltrate stormwater



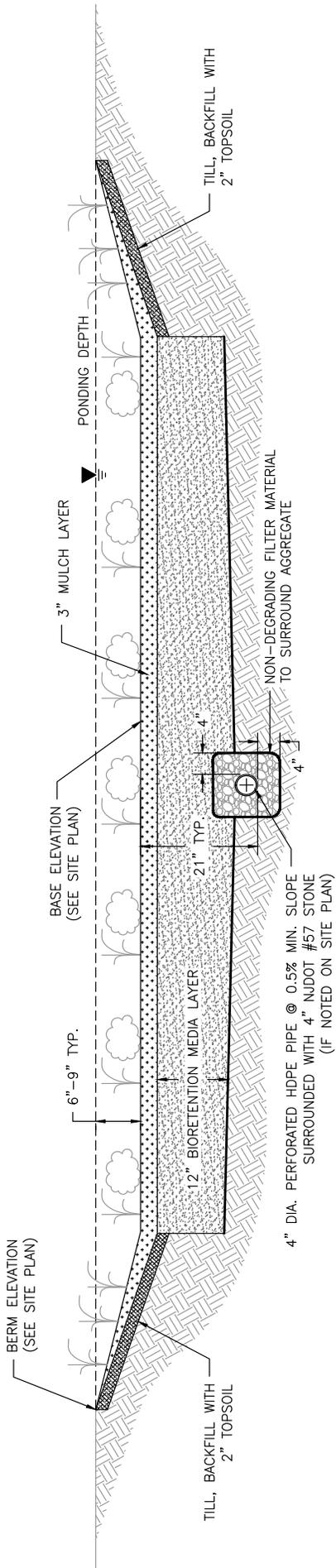
## 1.1 RAIN GARDEN EXCAVATION SECTION

This detail is necessary for all design plans that specify a rain garden. Depth of rain garden assumes 3" of mulch, 3" to 9" of storage above the mulch, and 12" of soil replacement with bioretention media. *Note: bioretention media may not be necessary if existing soils have appropriate infiltration capabilities*

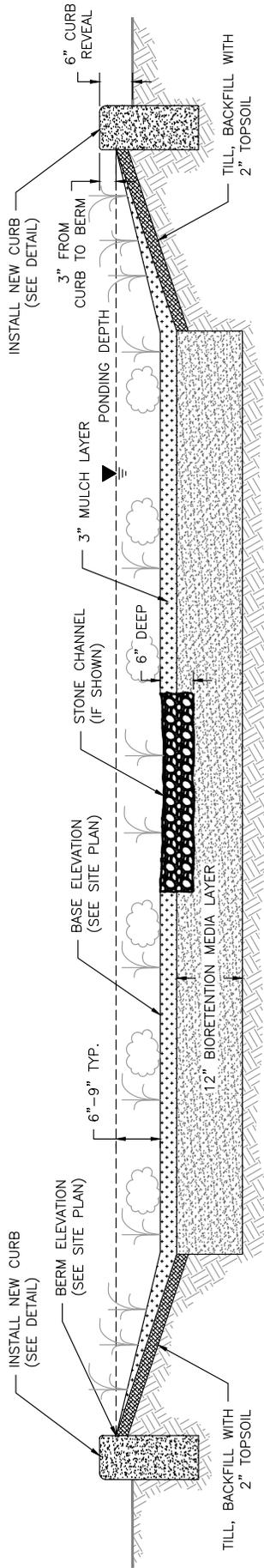


## 1.2 RAIN GARDEN SECTION

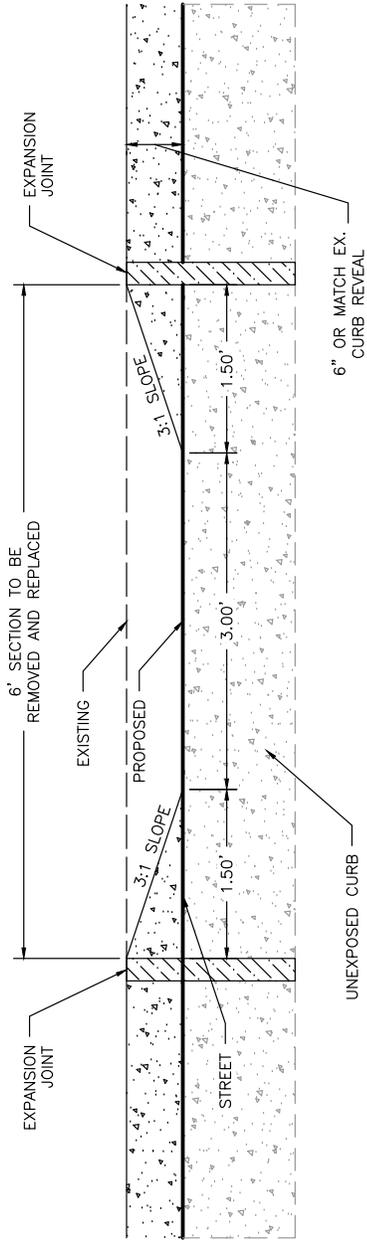
see detail 1.3 RAIN GARDEN CROSS SECTION W. UNDERDRAIN PIPE for designs in high clay content soils  
 see detail 1.7 INLET/OUTLET CURB CUT PROTECTION for water flow entrance  
 see detail 1.10 ROCK-LINED OVERFLOW for water to overflow from the system



**1.3 RAIN GARDEN CROSS SECTION W. UNDERDRAIN PIPE**  
 see detail 1.7 INLET/OUTLET CURB CUT PROTECTION for water flow entrance  
 see detail 1.11 DRAINFTECH OUTLET for water to overflow from the system

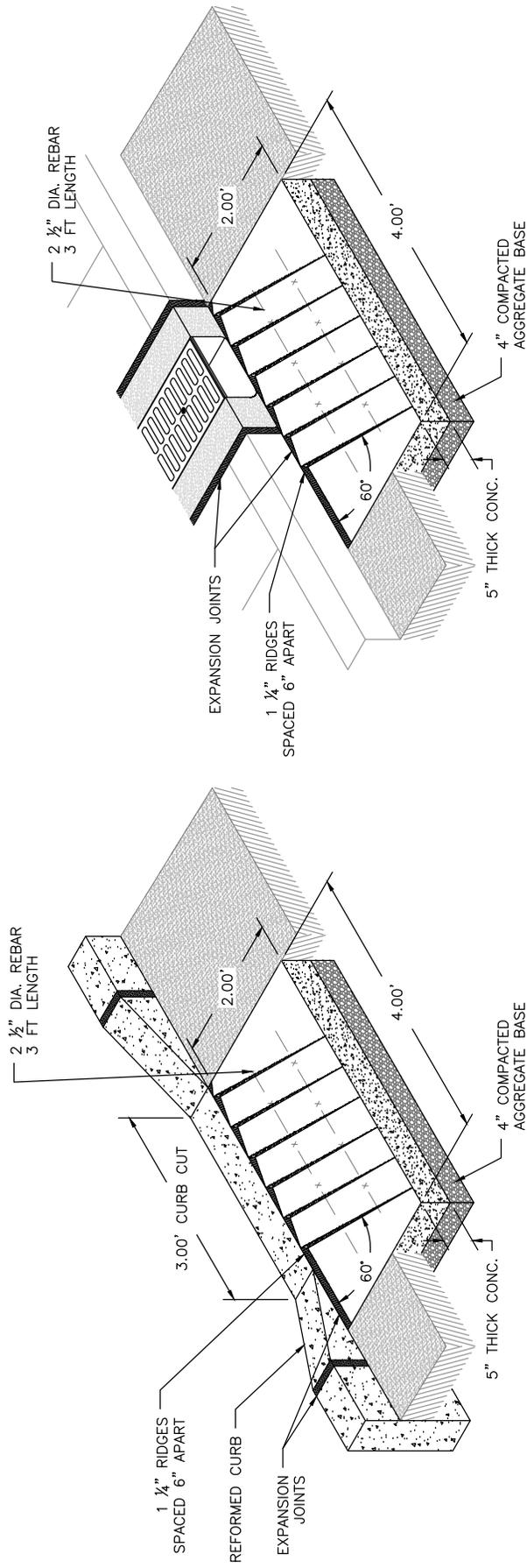


**1.4 RAIN GARDEN SECTION**  
 see detail 1.3 RAIN GARDEN CROSS SECTION W. UNDERDRAIN PIPE for designs in high clay content soils  
 see detail 1.7 INLET/OUTLET CURB CUT PROTECTION for water flow entrance  
 see detail 1.8 STONE-LINED CHANNEL, if shown  
 see detail 1.10 ROCK-LINED OVERFLOW for water to overflow from the system



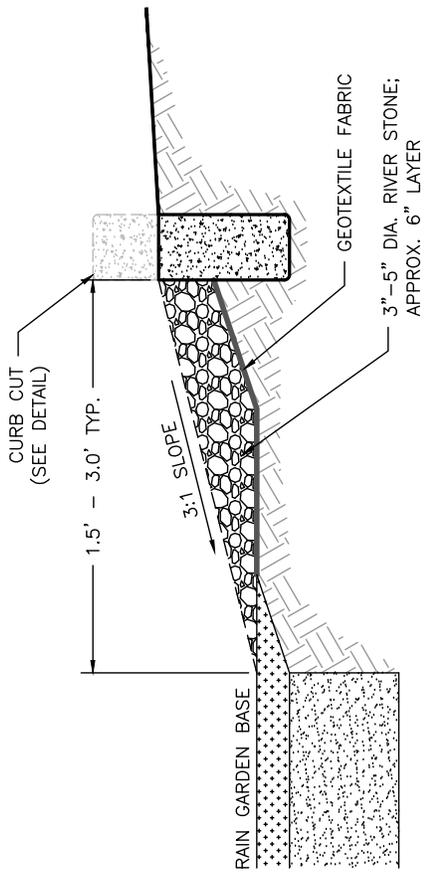
**1.5 CURB CUT CROSS SECTION**

see detail 1.6 CONCRETE FLOW PAD for all designs using a curb cut that is roadside  
 see detail 1.7 INLET/OUTLET CURB CUT PROTECTION for designs using a curb cut

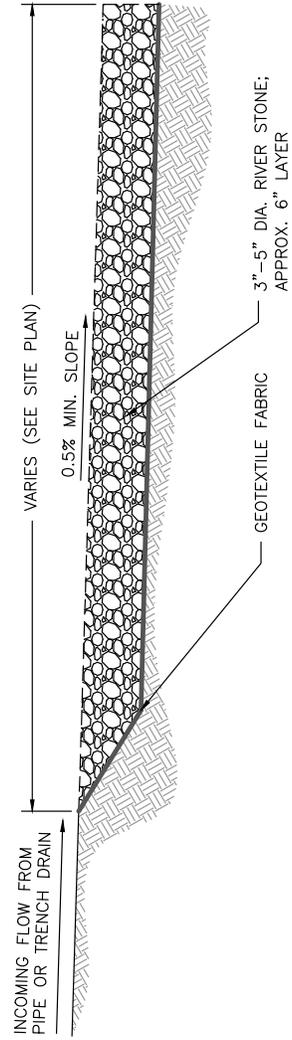


**1.6 CONCRETE FLOW PAD**

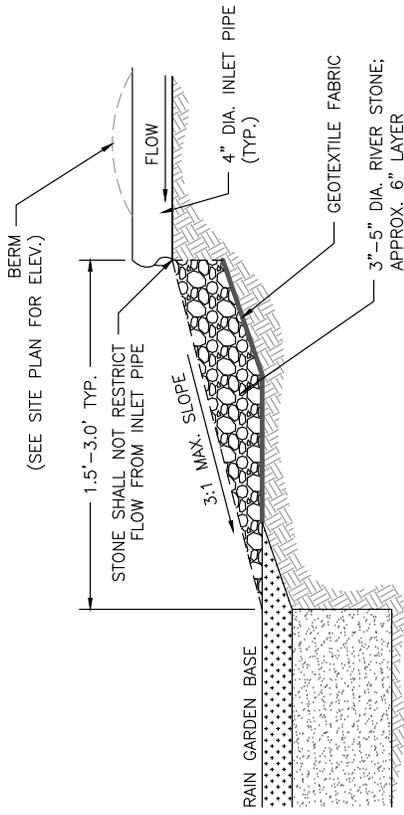
see detail 1.13 SAWCUT EXISTING SLAB TRENCH DRAIN INSTALLATION for designs using a trench drain  
 see detail 1.14 TRENCH DRAIN BAR SCREEN for designs using a trench drain  
 see detail 1.15 TRENCH DRAIN PLAN VIEW for designs using a trench drain



**1.7 INLET/OUTLET CURB CUT PROTECTION**

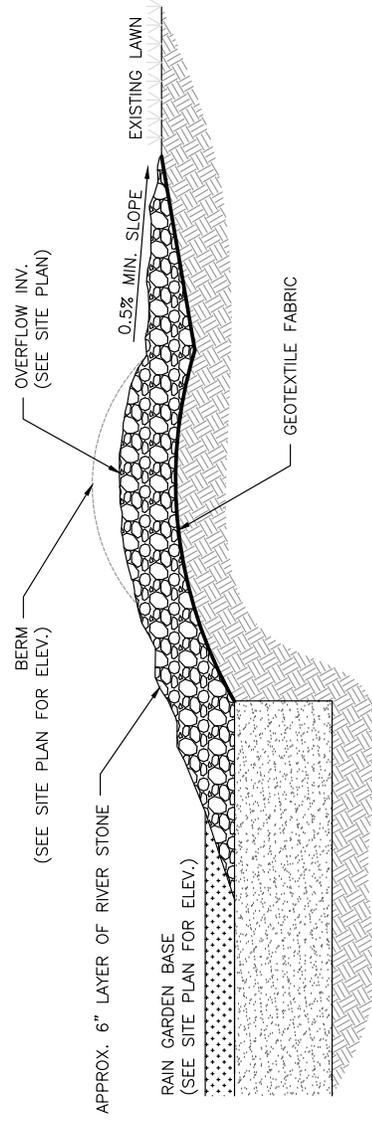


**1.8 STONE-LINED CHANNEL**

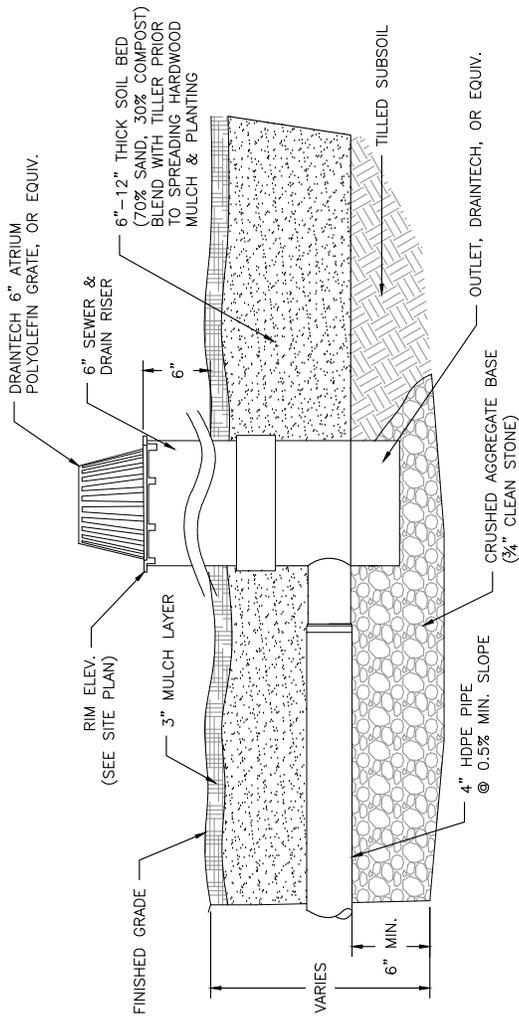


**1.9 INLET PROTECTION CROSS SECTION**

see detail **1.3 RAIN GARDEN CROSS SECTION W. UNDERDRAIN PIPE** for designs in high clay content soils  
 see detail **1.7 INLET/OUTLET CURB CUT PROTECTION** for water flow entrance  
 see detail **1.8 STONE-LINED CHANNEL** for water to overflow from the system

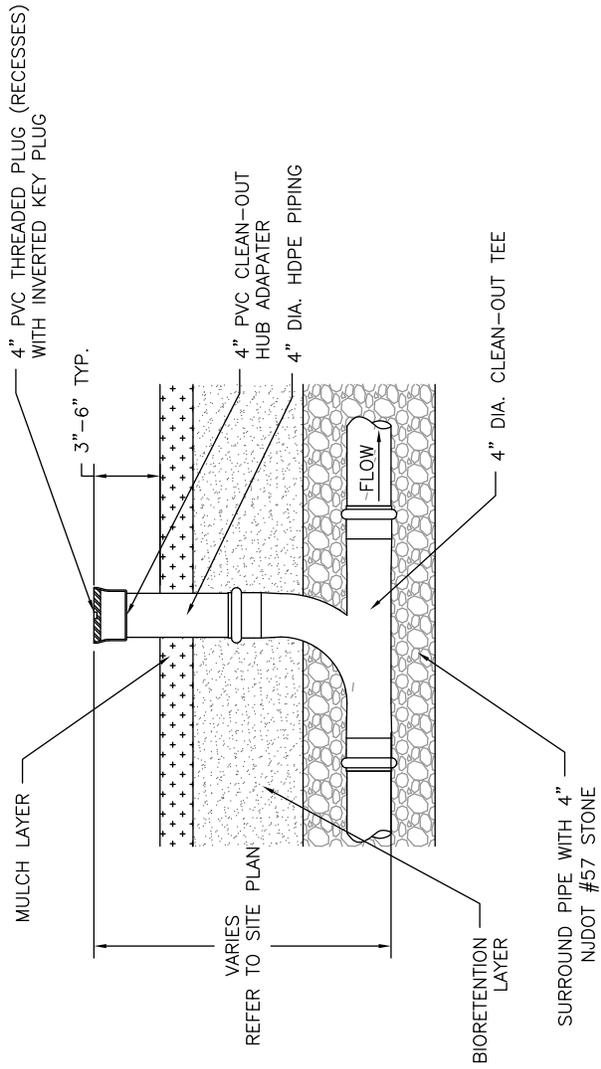


**1.10 ROCK-LINED OVERFLOW**

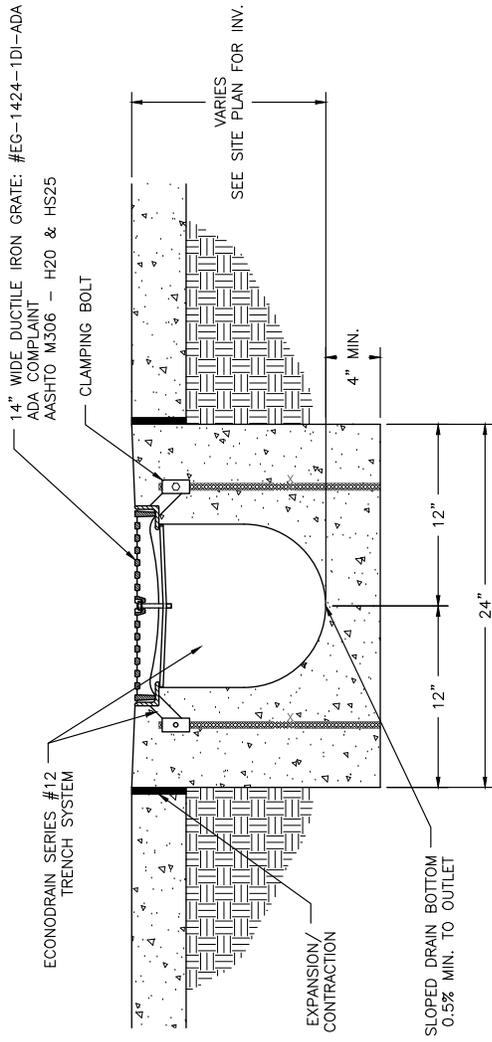


**1.11 DRAINECH OUTLET**

see detail 1.3 RAIN GARDEN CROSS SECTION W. UNDERDRAIN PIPE for designs in high clay content soils

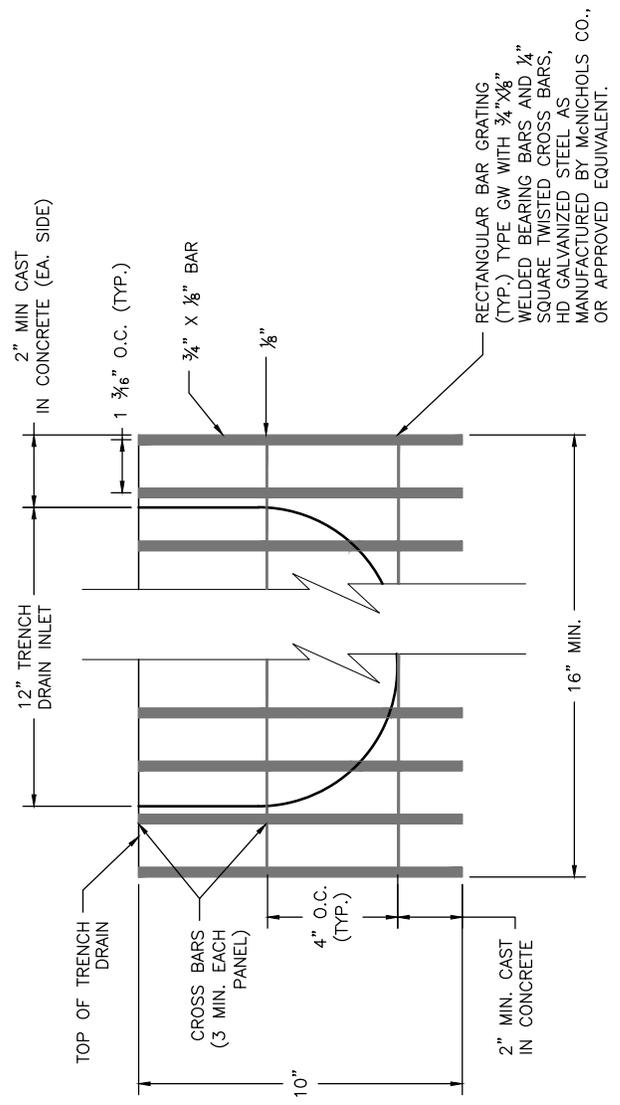


**1.12 RAIN GARDEN CLEANOUT**

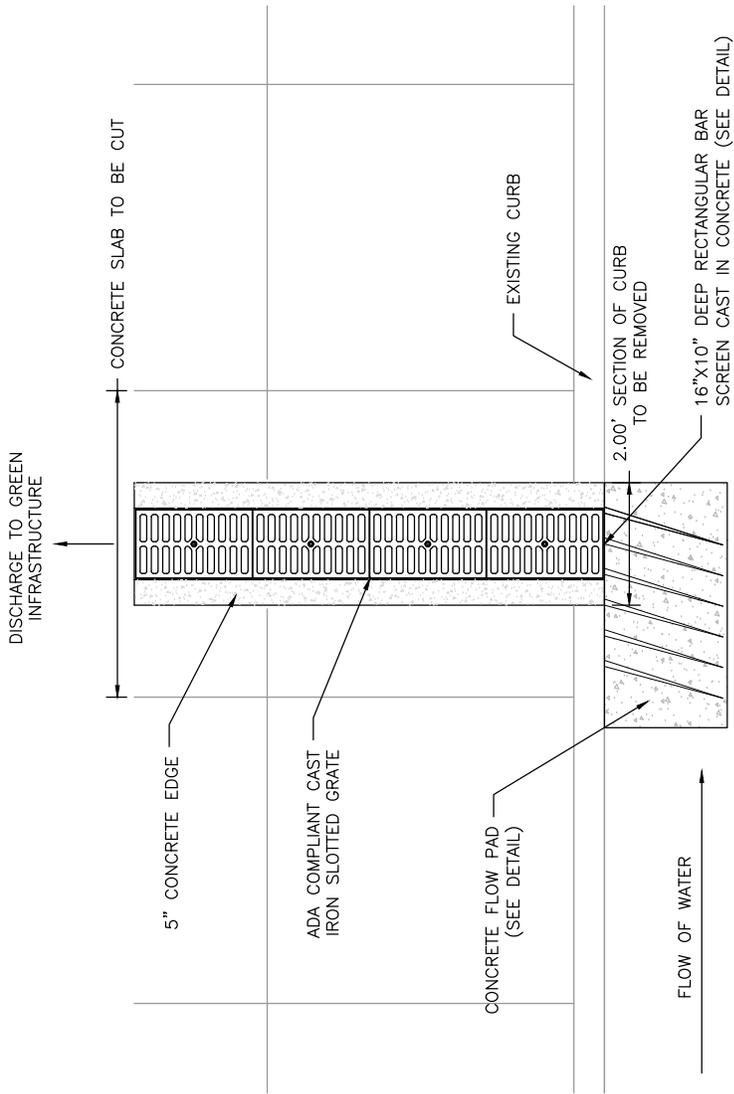


1.13 SAWCUT EXISTING SLAB  
TRENCH DRAIN INSTALLATION

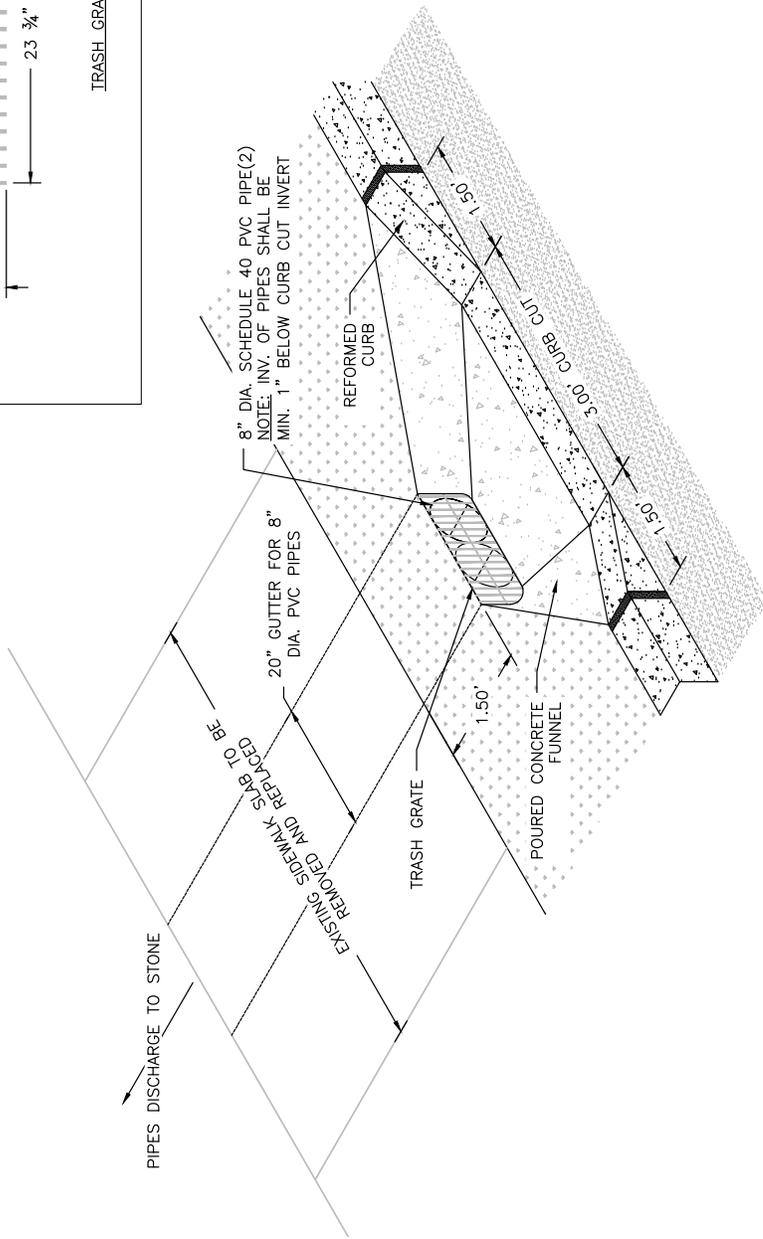
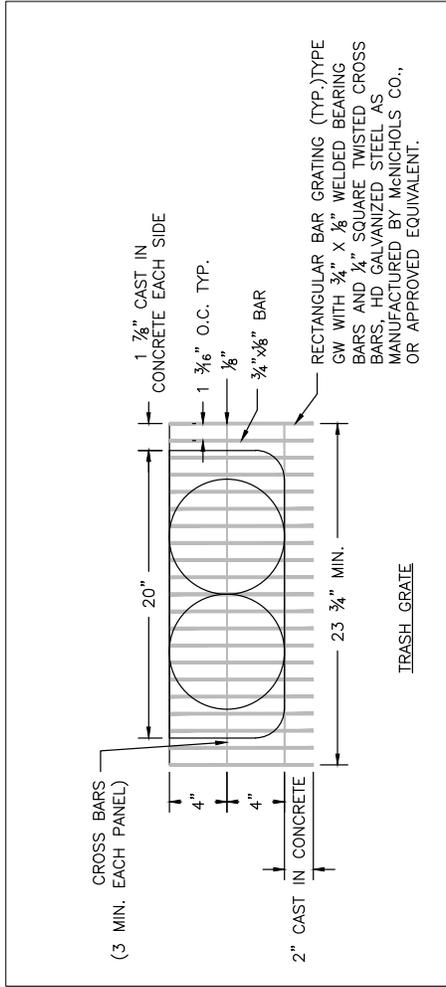
see detail 1.14 TRENCH DRAIN BAR SCREEN for screen installation  
see detail 1.15 TRENCH DRAIN PLAN VIEW for proper installation and location



1.14 TRENCH DRAIN BAR SCREEN



**1.15 TRENCH DRAIN PLAN VIEW**



**1.16 CURB CUT AND CONCRETE FUNNEL**

## 1.17 BIORETENTION - GENERAL SPECIFICATIONS

### CONSTRUCTION NOTES

1. The contractor shall verify all information prior to excavation including elevations and locations of existing utilities.
2. The contractor shall notify the engineer immediately if any field conditions differ materially from those represented on these drawings and the specifications or if, in the contractor's opinion, said conditions conflict with the designs shown hereon.
3. The engineer shall inspect all planting bed areas before mulching to ensure that adequate drainage exists. If any areas to be mulched show evidence of poor drainage, the contractor shall take corrective action.
4. The contractor shall avoid disturbing all existing trees. Any disturbance to trees or tree roots must be coordinated with the property owner.
5. Dimensions and shape will vary, refer to site plan.
6. River stone protection dimensions are typical and may vary per site. Consult the engineer and site plan for dimensions on a per site basis.
7. River stone protection shall slope to rain garden base.
8. Refer to site plan to determine outlet type (rock-lined overflow or draintech riser).
9. Refer to site plan for all elevations and inverts.
10. The contractor shall excavate 12 inches lower than the base elevation shown on the site plans. The slopes of the rain garden shall be at a 2:1 maximum.
11. The subgrade of the rain garden shall be level to ensure proper drainage. The contractor shall obtain engineer approval prior to backfilling with 12 inches of bioretention media.
12. The contractor shall install overflow if specified in site plans prior to backfilling with bioretention media.

13. The bioretention layer shall be level to ensure proper drainage. The contractor shall obtain engineer approval prior to spreading mulch and planting.
14. Inlet and outlet protection shall be underlain with geotextile fabric.
15. Inlets and outlets shall not inhibit the flow of water from the street. The river stone shall be placed below the bottom of the pipe.
16. The contractor shall fill the berm section and backfill with topsoil.
17. All disturbed areas exclusive of rain garden and sloped berm shall be restored to original conditions by contractor.
18. The contractor shall have a pre-construction meeting with the project engineer prior to any work on site.

### SPECIFICATIONS

1. Max cover over top of pipe is 4 feet. Contact ADS (pipe manufacturer) if greater.
2. The approval of materials and mixing of sand, compost, and soil shall be done under the supervision of the project engineer/landscape architect. Bioretention media shall consist of 70% sand and 30% compost mixture.
3. Sand shall at the minimum conform to the sieve analysis for concrete aggregate sand (ASTM c-33). USGA tee/green sieve gradation mix is preferable where available.
4. Underlying soils shall be filled/scarified prior to spreading/mixing of bioretention media.
5. All bioretention media shall be placed from the sides of the facilities, and in no event shall any tracked or wheeled equipment be permitted to cross the rain garden.
6. Rain garden shall be constructed to dimensions indicated on the site plan.
7. 3-5-inch diameter washed river stone shall be used for stone

channel and inlet/outlet protection.

8. Non-dyed, triple-shredded hardwood mulch shall be used.
9. Planting of rain garden and sloped berm shall be completed as indicated on the site plan.
10. The contractor shall perform all work in conformance with the NJDOT Standard Specifications for Road and Bridge Construction, 2007 or latest version.

## **1.18 TRENCH DRAIN AND CURB CUT - GENERAL SPECIFICATIONS**

### **CONSTRUCTION NOTES**

1. The contractor shall verify all information prior to excavation including elevations and locations of existing utilities.
2. The contractor shall notify the engineer immediately if any field conditions differ materially from those represented on these drawings and the specifications or if, in the contractor's opinion, said conditions conflict with the designs shown hereon.
3. The contractor shall avoid disturbing all existing trees. Any disturbance to trees or tree roots must be coordinated with the property owner.
4. Inlet and outlet protection shall be underlain with geotextile fabric.
5. Inlet and outlet curb cuts shall not inhibit the flow of water from the street. The curb cut shall be slightly lower than the road. The concrete slab shall be placed just below the bottom of the curb cut.
6. The contractor shall sawcut, remove, and replace a 6-foot section of curb for the concrete funnel. The entire curb shall be reinstalled with a 3-foot depressed section flush with the pavement and adjoining 18-inch 3:1 sloped sections.
7. The contractor shall pour the concrete flow pad as shown with 60° ridges. The ridges shall be 1 1/4 inches in height.
8. All areas exclusive from the trench drain and/or curb cut shall be restored to original conditions.

9. The contractor shall have a pre-construction meeting with the engineer prior to any work on-site.

### **SPECIFICATIONS**

1. Trench drain shall be Econodrain® Series #12 as manufactured by Econodrain®, or approved equivalent.
2. The grate for the trench drain shall be cast iron ADA grate part number EG-1424-2 CI-ADA with locking fasteners, or equal.
3. End cap cutouts are to be removed upon approval.
4. Stone for protection shall be 3-5-inch diameter washed river stone.
5. The contract shall be performed in conformance with the NJDOT Standard Specifications for Road and Bridge Construction, 2007 or latest version.
6. The contractor shall only use concrete with 4,500 psi strength.

**APPENDIX B**  
**Details for Bioswales**

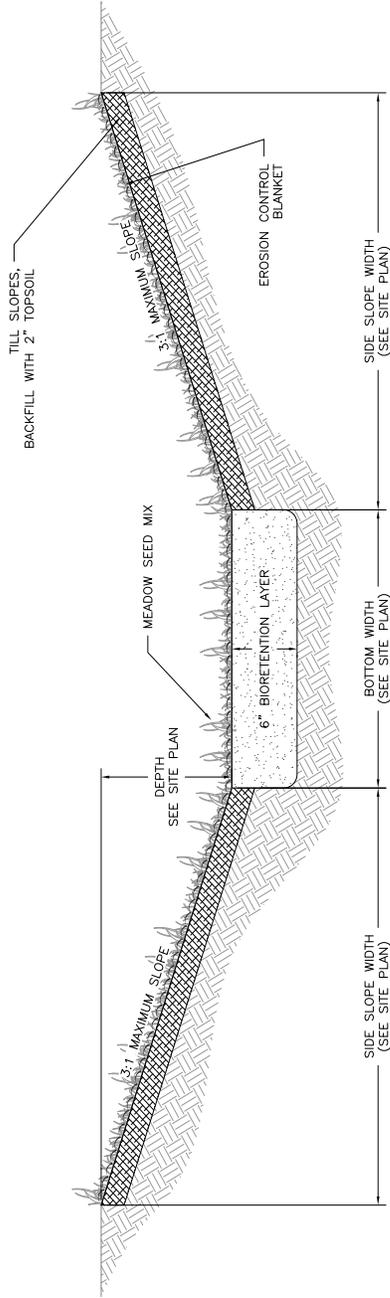
*Reference:*

*Green Infrastructure Guidance Manual for New Jersey, RCE Water Resources Program, 2016  
Technical Details for Construction, pp. 87-89*

*<http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html>*

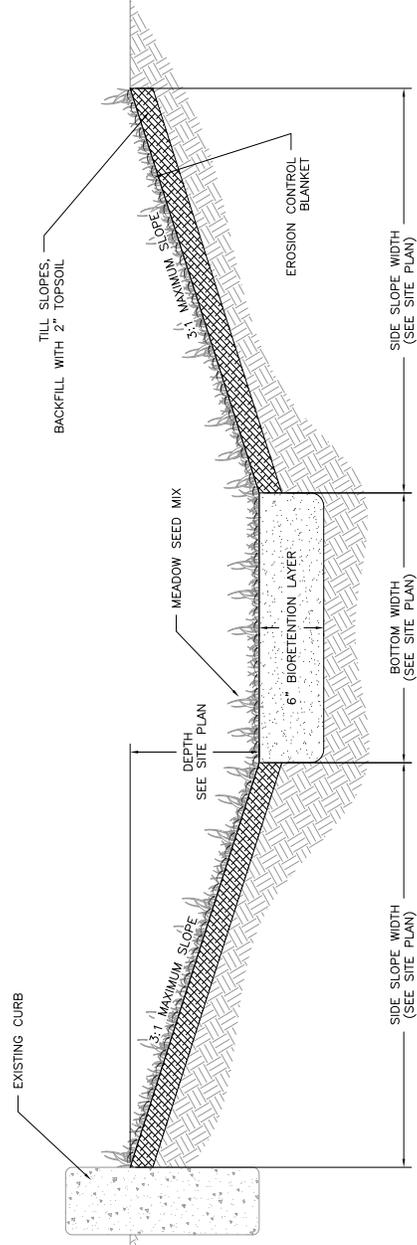
## 2.0 BIOSWALE

Landscaped features that convey stormwater from one location to another while removing pollutants and providing water an opportunity to infiltrate

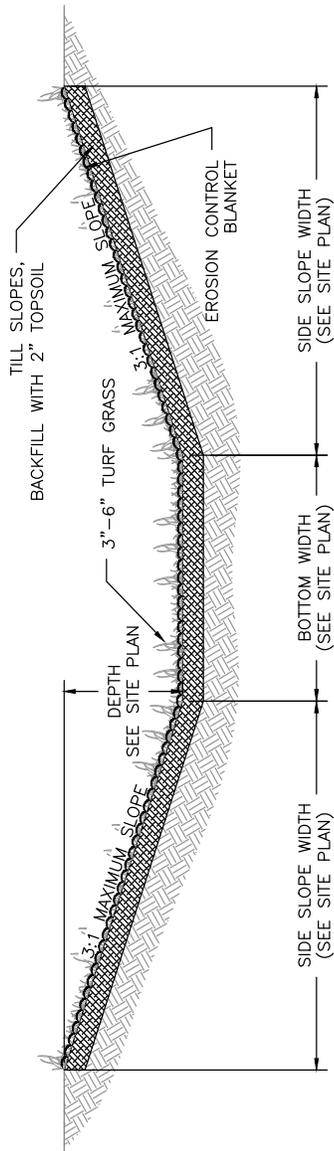


## 2.1 BIOSWALE CROSS SECTION

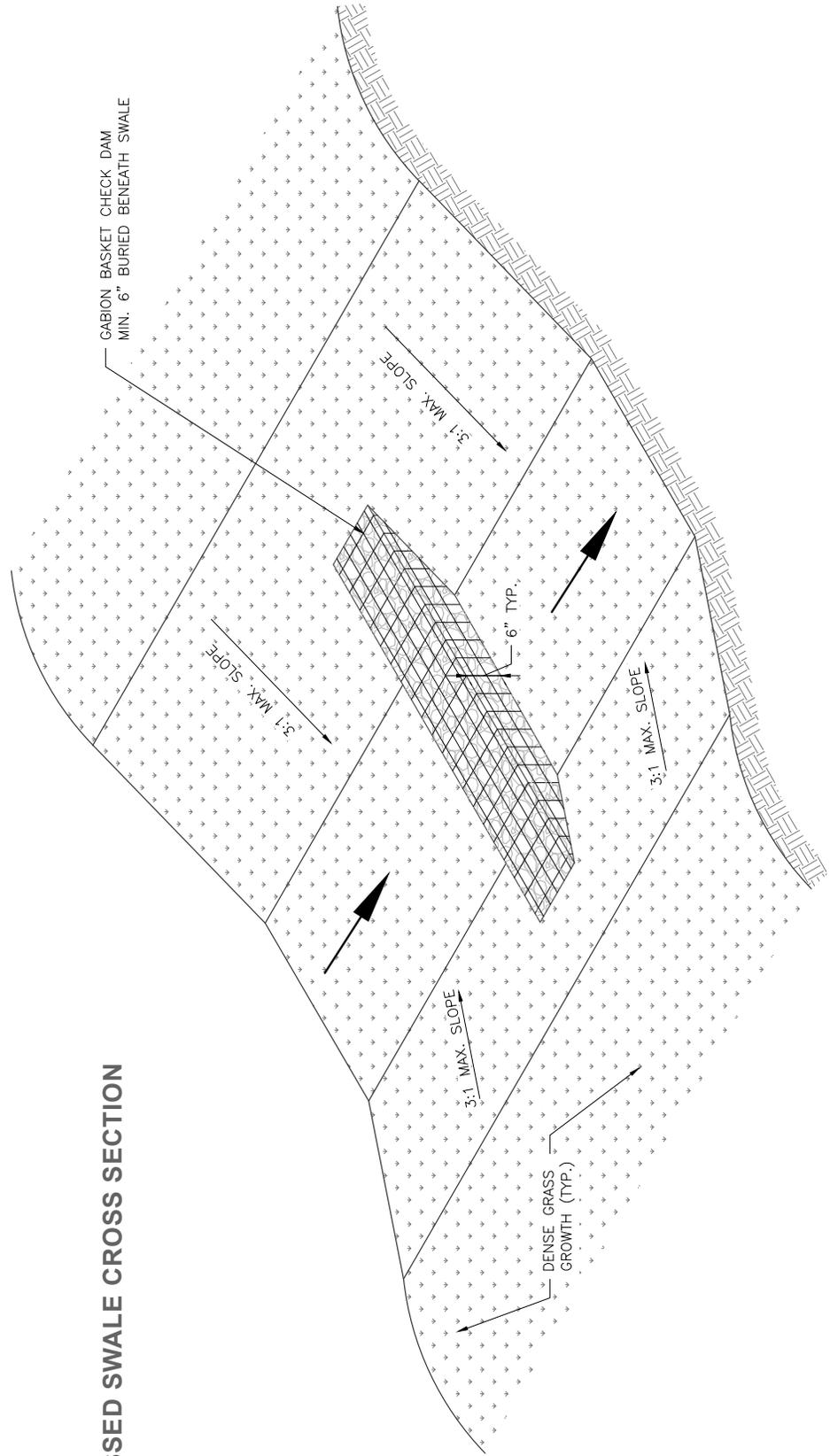
see detail 2.2 **CURBED BIOSWALE CROSS SECTION** for designs adjacent to curbs  
see detail 2.3 **GRASSED SWALE CROSS SECTION** for designs with only turfgrass



## 2.2 CURBED BIOSWALE CROSS SECTION



### 2.3 GRASSED SWALE CROSS SECTION



### 2.4 CHECK DAM ISOMETRIC

This detail is necessary for all swale designs with a slope greater than 8%.

## 2.5 BIOSWALE - GENERAL SPECIFICATIONS

### CONSTRUCTION NOTES

1. The contractor shall verify all information prior to excavation including elevations and locations of existing utilities.
2. The contractor shall notify the engineer immediately if any field conditions differ materially from those represented on these drawings and the specifications or if, in the contractor's opinion, said conditions conflict with the designs shown hereon.
3. The engineer shall inspect all planting bed/seeding areas before planting/seeding to ensure that adequate drainage exists for bioswales. If any areas to be planted/seeded show evidence of poor drainage, the contractor shall take corrective action.
4. The contractor shall have all utilities marked before any excavation. If any utilities interfere with the project, the contractor shall notify the engineer.
5. The contractor shall avoid over-compacting the existing materials to avoid poor infiltration.
6. The contractor shall verify that the swale will capture stormwater runoff from the desired drainage area.
7. The contractor shall establish all elevations and lines as shown on the site plan for review by the engineer prior to construction.
8. The contractor shall verify that the subgrade is consistent with line, grade, and elevations as indicated on the site plan. Any areas showing erosion or potential ponding shall be regraded before subbase installation.
9. Immediately after the subgrade is approved by the engineer, the contractor shall begin subbase construction which includes all materials below the swale base and above the native subgrade.
10. Prior to backfilling the bioswale with bioretention media, the contractor shall scarify native soil to promote infiltration into the underlying subgrade.

11. The bioretention media layer shall be installed evenly over the native subgrade.
12. The bioswale shall have an infiltration of at least 5-30 ft/day or 50% of the hydraulic conductivity (D2434).
13. The contractor shall install a gabion basket check dam (if specified) as shown on site plans. A minimum of six inches of the basket shall be buried.
14. The contractor shall install erosion control blanket along the base and side slopes of the newly constructed swale for stabilization.

### SPECIFICATIONS

1. The bioretention layer shall be comprised of 70% sand and 30% compost mixture.
2. Inlet protection for the swale shall be comprised of 3-5-inch diameter washed river stone. Stone shall be placed on geotextile fabric.
3. The gabion basket check dam shall be dura-weld galvanized and PVC coated baskets. Baskets are typically 6'x3'x1'; refer to site plan for basket size.
4. Gabion stone shall be 4-10-inch diameter washed.
5. The swale shall be seeded with contractor turf mix unless specified otherwise on plans.

## **APPENDIX C**

### **Details for Downspout Planters**

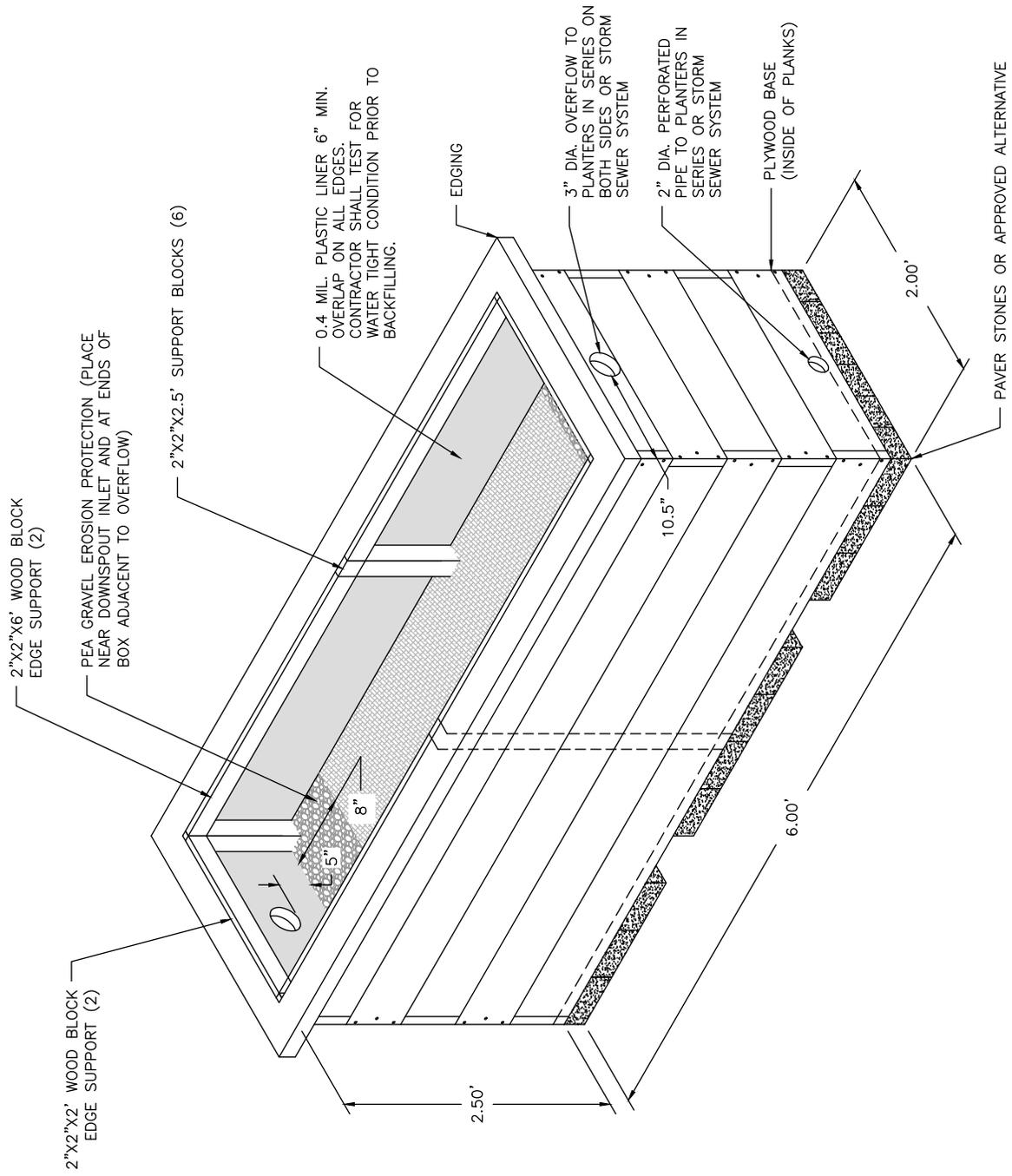
Reference:

*Green Infrastructure Guidance Manual for New Jersey, RCE Water Resources Program, 2016  
Technical Details for Construction, pp. 94-99*

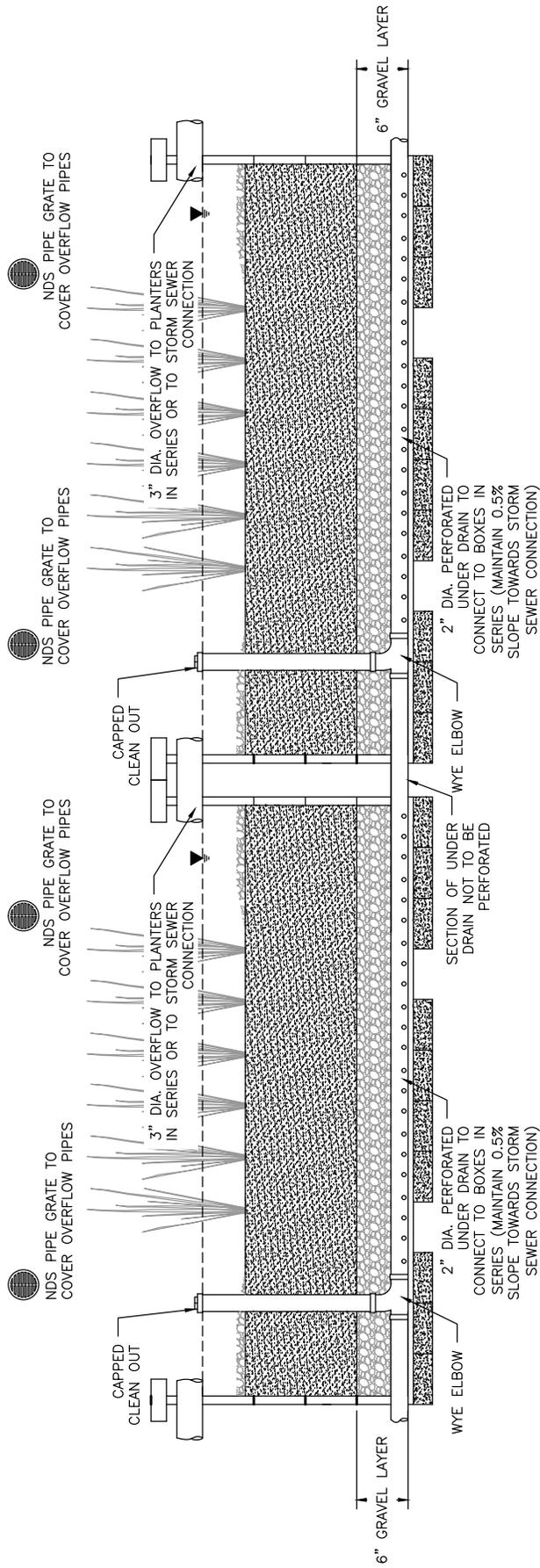
<http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html>

## 4.0 DOWNSPOUT PLANTER

Wooden boxes with plants installed at the base of the downspout that provide an opportunity to beneficially reuse rooftop runoff

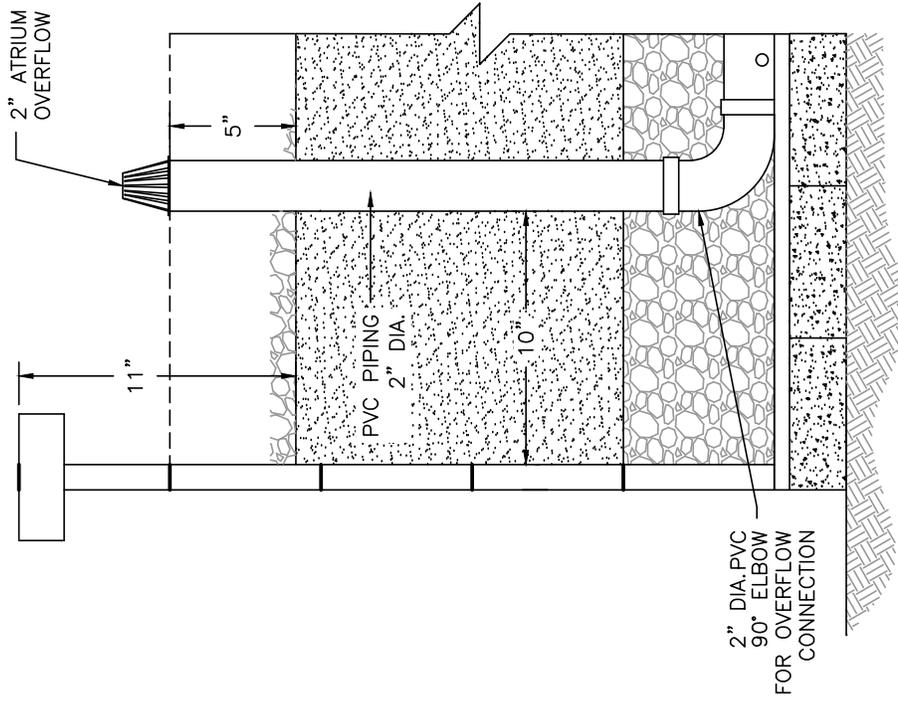


## 4.1 DOWNSPOUT PLANTER ISOMETRIC

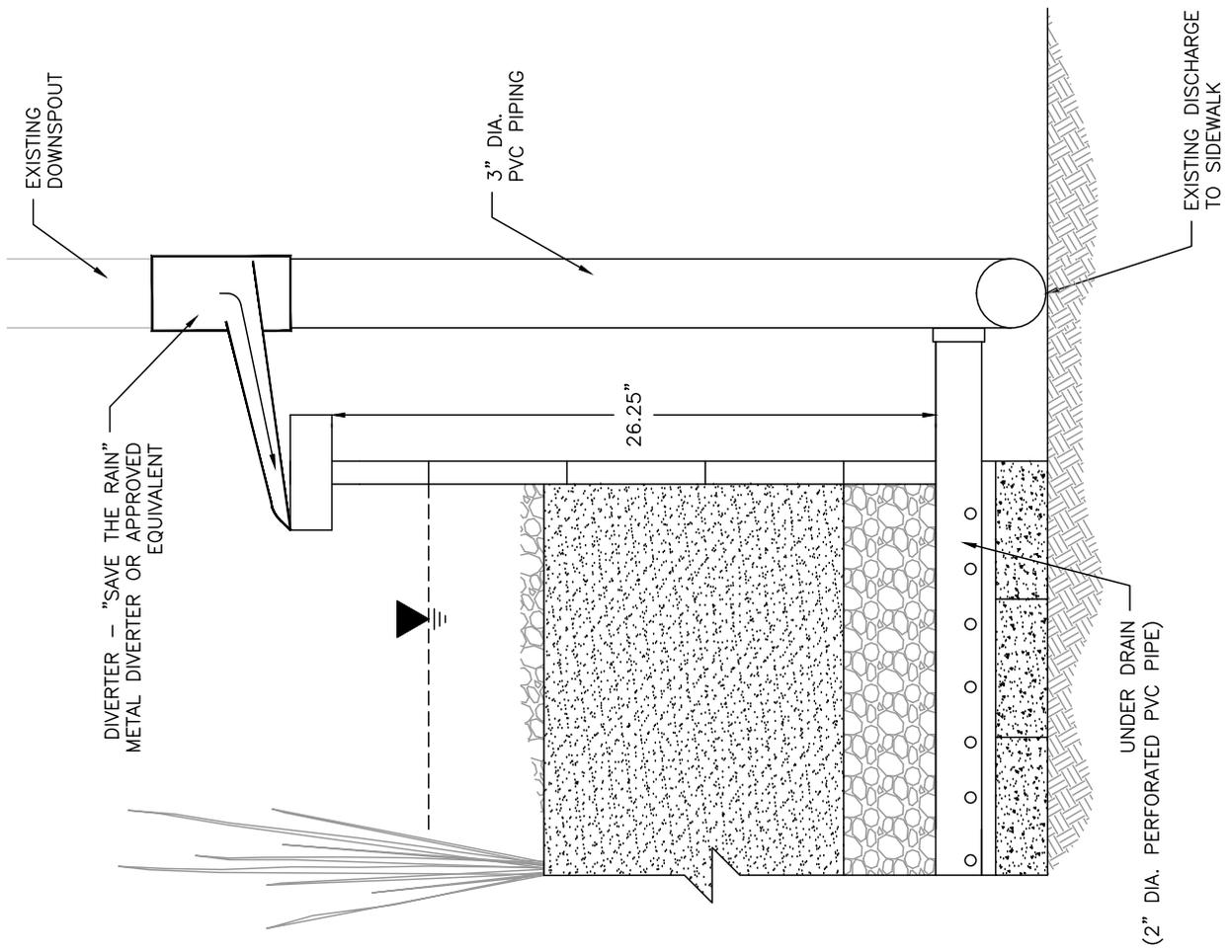


**4.2 DOWNSPOUT PLANTER  
CROSS SECTION**

see detail **4.3 OVERFLOW CONNECTION CROSS SECTION & 4.4 UNDERDRAIN  
CONNECTION CROSS SECTION** for detailed view of overflow and underdrain mechanisms



4.3 OVERFLOW CONNECTION CROSS SECTION



4.4 UNDERDRAIN CONNECTION CROSS SECTION

## 4.5 DOWNSPOUT PLANTER BOX - GENERAL SPECIFICATIONS

### CONSTRUCTION NOTES

1. The planter box shall be built according to the dimensions in detail 4.1 and as indicated on the plans.
2. An existing downspout shall be modified to enter the 1st planter box in series. The downspout shall be fitted with a diverter allowing flow to be directed to the box or existing storm sewer connection.
3. Planter boxes in series shall be placed flush against each other as shown in the site plan.
4. The contractor shall discuss any modifications with the engineer and property owner before action is taken.
5. The paver stone base or approved alternative shall be positioned prior to any other construction.
6. The planter box shall be built as shown in detail 4.1. Supports shall be used on the inside of the box as shown.
7. The contractor shall position and level the planter box and then install waterproof liner prior to backfilling with materials.
8. All overflow piping shall be comprised of 3-inch diameter PVC piping. Overflow pipes shall be placed as shown and connected to planter boxes in series. Ends that are positioned inside the planter shall be capped with a PVC pipe grate. See specification items #12 and #13.
9. The underdrain pipe shall be a 2-inch perforated PVC pipe.
10. All pipes shall be fitted and secured with adhesive that is in conformance with local plumbing codes.
11. The existing downspout shall be directed into the first planter box in series.
12. The last box in series (farthest from downspout) shall have a 2-inch atrium grate for overflow. The overflow shall discharge to the existing storm sewer connection.
13. The contractor shall place and compact each aggregate and soil

14. layer once the planter box is constructed.
14. Planter boxes connected in series shall have the overflow and underdrain connect throughout the entire system.

### SPECIFICATIONS

1. The planter boxes shall be level when installed.
2. Prior to installation, the contractor shall provide engineer shop drawings of downspout connections and piping.
3. The gravel layer shall be comprised of No. 57 washed stone.
4. The sandy compost mix shall be comprised of 85% washed sand and 15% compost.
5. The diverter shall be 'Save the Rain' metal diverter or approved equivalent.
6. All PVC piping shall be schedule 40.
7. The erosion protection shall be comprised of 3-5-inch diameter washed river stone.
8. The plants shall be specified by the planting schedule.
9. All wood material is to be 2-inch dimensional lumber (2"x4", 2"x6", and/or 2"x8") and pressure treated for use in exterior applications.
10. The planter base shall be pressure treated or marine grade plywood suitable for use in exterior applications.
11. All connecting screws and hardware are to be galvanized or coated and approved for exterior use with treated lumber.
12. The overflow pipe grates shall be NDS 3-inch structural-foam polyolefin grate model #16 or equivalent.
13. The overflow atrium shall be NDS 2-inch atrium grate, part #270 or approved equivalent.
14. Upon engineers request, the paver stone base may be replaced with 4'x4' pressure treated wood blocking or concrete formed pad.

## **4.5 DOWNSPOUT PLANTER BOX - GENERAL SPECIFICATIONS**

15. The underdrain pipe (2-inch diameter) shall have holes drilled manually by the contractor. The perforations shall not be made in the sections of the underdrain that are exposed between planter boxes as shown in detail. Perforation hole size shall be 3/8"; hole spacing shall be 5"( $\pm 1/8$ "); number of rows shall be 2 @ 120° ( $\pm 5^\circ$ ).

## **APPENDIX D**

### **Details for Permeable Pavements**

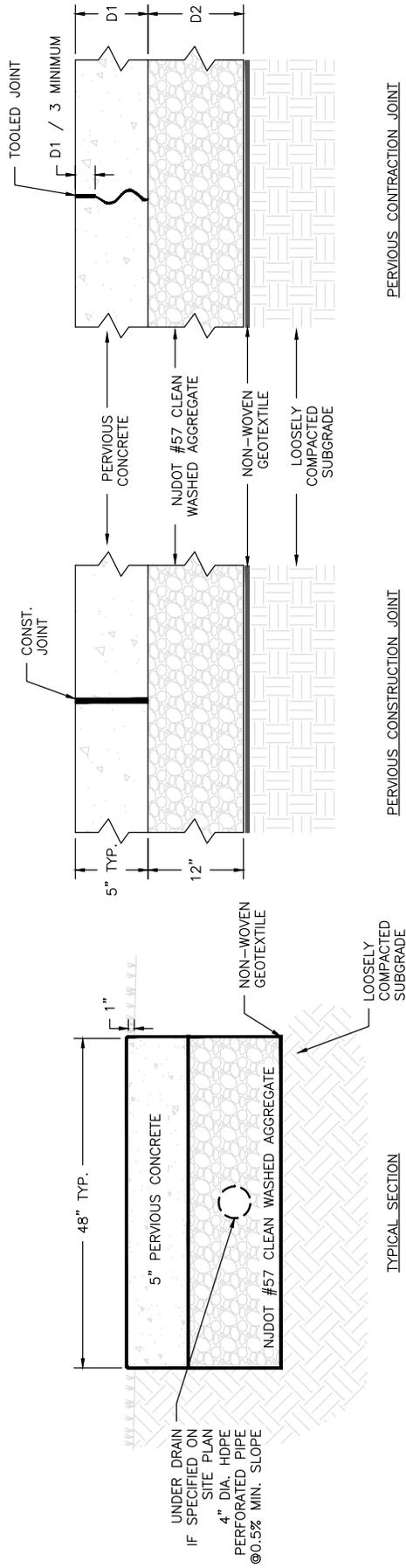
Reference:

*Green Infrastructure Guidance Manual for New Jersey, RCE Water Resources Program, 2016  
Technical Details for Construction, pp. 115-120*

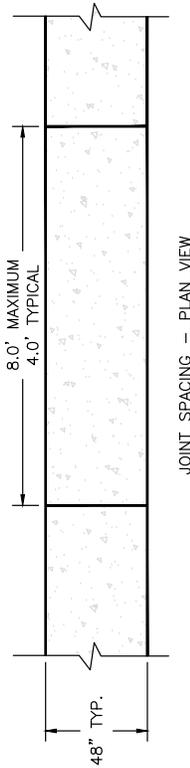
<http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html>

# 7.0 PERMEABLE PAVEMENT

Surfaces that are hard and support vehicle traffic but also allow water to infiltrate through the surface



- NOTES:
1. PERVIOUS CONCRETE MUST BE SUPPLIED AND INSTALLED BY NRMCA CERTIFIED PRODUCERS AND CONTRACTORS.
  2. JOINT TO BE CUT IN FRESH PAVEMENT WITH A PERVIOUS CONCRETE JOINT TOOL ONLY.
  3. PERVIOUS CONCRETE MUST BE COVERED WITH 6 MIL. PLASTIC, SECURELY FASTENED, FOR SEVEN (7) DAYS.
  4. EXPANSION JOINTS TO BE PLACED EVERY THIRD JOINT OR 20 FEET (WHICHEVER IS LESS) AND AT EACH DRIVEWAY CUT AS PER THE DETAIL AND SPECIFICATIONS. A FULL-DEPTH SAWCUT CAN BE USED IN LIEU OF EXPANSION JOINTS.



INSTALLATION

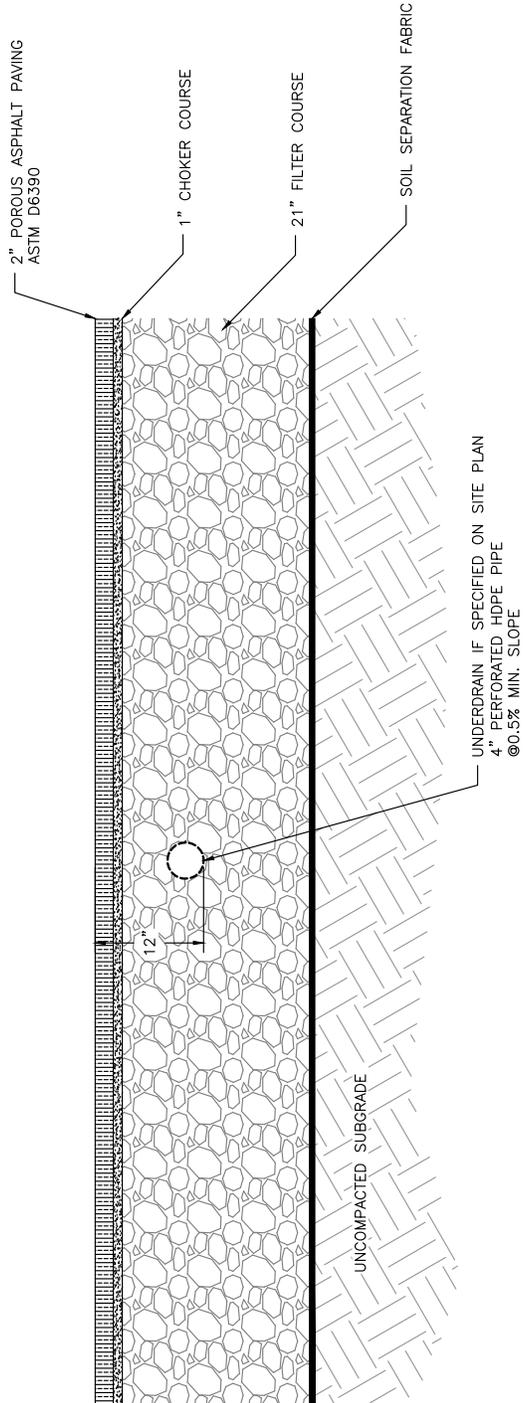


JOINT CUTTING

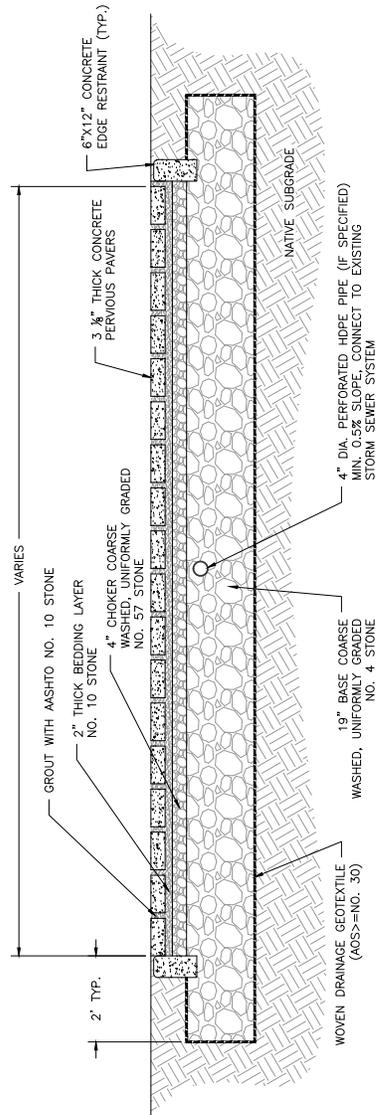


CURING

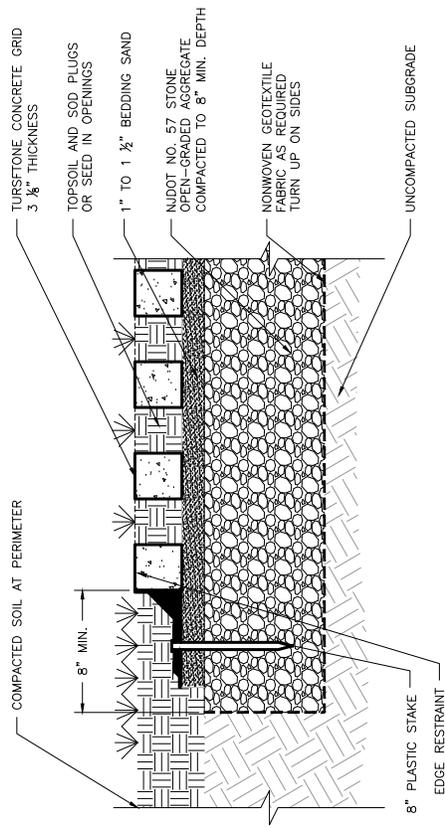
# 7.1 PERVIOUS CONCRETE CROSS SECTION



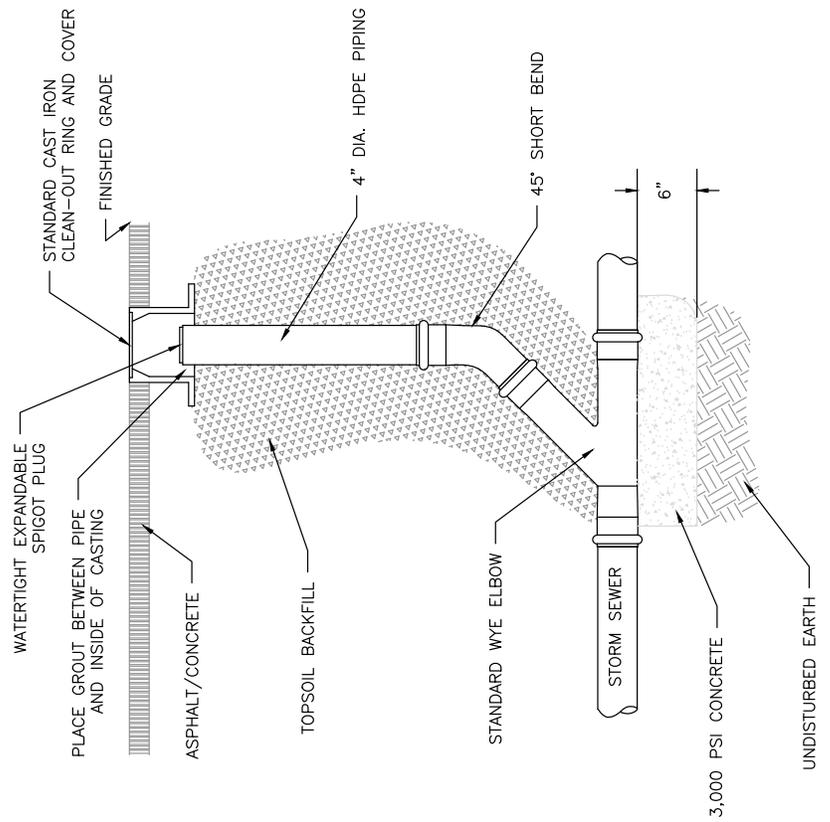
## 7.2 POROUS ASPHALT CROSS SECTION



## 7.3 INTERLOCKING PAVERS CROSS SECTION



#### 7.4 GRASS PAVERS CROSS SECTION



#### 7.5 PERMEABLE PAVEMENTS CLEANOUT

ASPHALT AND SUB-BASE MATERIALS					
PROPOSED ELEVATION	LAYER	DEPTH	PROPERTIES	STONE	
100.00	POROUS ASPHALT	0'-2"	SEE SPECIFICATIONS	-	
99.83	CHOKER COURSE	0'-3"	SAND	BC SAND	
99.75	FILTER COURSE	2'-0"	WASHED CRUSHED STONE	AASHTO No. 57	
98.00	SOIL SEPARATION FABRIC	2'-0"	NON-WOVEN GEOTEXTILE	-	

### 7.6 POROUS ASPHALT MATERIALS TABLE

TABLE 901.03-1 STANDARD SIZES OF COARSE AGGREGATE																	
No.	NOMINAL SIZE	AMOUNTS FINER THAN EACH LABORATORY SIEVE, % BY WEIGHT										No. 100					
		4"	3 1/2"	3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"		No. 4	No. 8	No. 16	No. 50	No. 100
1	3 1/2" - 1 1/2"	100	90-100		25-60		0-15		0-5								
2	2 1/2" - 1 1/2"			100	90-100	35-70	0-15		0-5								
3	2" - 1"				100	90-100	35-70	0-15		0-5							
4	1 1/2" - 3/4"					100	90-100	20-55	0-15		0-5						
5	1" - 1/2"						100	90-100	20-55	0-10	0-5						
57	1"-No. 4						100	95-100		25-60		0-10	0-5				
67	3/4" - No. 4							100	90-100			0-10	0-5				
7	1/2" - No. 4								100	40-70	0-15	0-5					
8	3/8" - No. 8									85-100	10-30	0-10	0-5				
9	No. 4 - No. 16									100	85-100	10-40	0-5				
10	No. 4 - No. 200									100	85-100	10-30	0-5				

### 7.7 NJDOT STANDARD SPECIFICATION FOR AGGREGATE

## 7.8 PERMEABLE PAVEMENTS - GENERAL SPECIFICATIONS

### CONSTRUCTION NOTES

1. The contractor shall verify all information prior to excavation including elevations and locations of existing utilities.
2. The contractor shall notify the engineer immediately if any field conditions differ materially from those represented on these drawings and the specifications or if, in the contractor's opinion, said conditions conflict with the designs shown hereon.
3. The contractor shall have a pre-construction meeting with the engineer prior to any work on site.
4. The contractor shall avoid over compacting the existing materials to avoid poor infiltration.
5. The contractor shall establish all elevations and lines as shown in the site plan for review by the engineer before any construction begins.
6. The contractor shall verify that the subgrade is consistent with line, grade, and elevations as indicated in the site plan. Any areas showing erosion or potential ponding shall be regraded before subbase installation.
7. Immediately after the subgrade is approved by the engineer, the contractor shall begin subbase construction which includes all materials below the pavement and above the existing subgrade.
8. The contractor shall place geotextile fabric in conformance with manufacturer's specifications. All adjacent fabric shall be overlapped by at least 16 inches. The fabric shall be secured at least four feet outside of the excavated base.
9. The filter course aggregate shall be installed in 8-inch maximum lifts and compacted to a maximum of 95% standard proctor (ASTM d698/AASHTO t99).
10. The choker course shall be installed evenly over the filter course;

11. The infiltration rate shall be at least 5-30 ft/day or 50% of the hydraulic conductivity (D2434).
12. Subbase courses densities shall be approved by the engineer; rolling and shaping shall resume until densities are acceptable. Water shall be poured over subbase course materials during compaction.
13. The contractor shall perform all rolling and shaping from the low side to the high side until each layer conforms to grade as indicated and layers are smooth.
14. After subbase aggregate installation, the geotextile fabric shall be folded back along all bed edges. The fabric shall remain secure until adjacent soils establish vegetation. Any necessary measures shall be taken to prevent sediment from washing into beds.
15. The asphalt and concrete mixing plant, hauling and placing equipment, and installation shall be in conformance with National Asphalt Pavement Association's *Porous Asphalt Pavements for Stormwater Management* (NAPA IS-131) and the NJDOT Standard Specifications for Road and Bridge Construction, 2007 or latest version.

### SPECIFICATIONS

1. The contract shall be performed in conformance with the NJDOT Standard Specifications for Road and Bridge Construction, 2007 or latest version.

2. Finished pavements shall show no marks from rollers and be free from low lying spots subject to puddle formation. The entire surface shall drain properly. All elevations must be within 0.1 feet. All work must meet the standards of the engineer before payment. Additional work and testing will be necessary if standards are not met.
4. The thickness of No. 57 aggregate is 12 inches under pervious concrete sidewalks.
5. Porous asphalt mix design criteria:

Sieve size (inch/mm)	percent passing (%)
0.75/19	100
0.50/12.5	85-100
0.375/9.5	55-75
No.4/4.75	10-25
No.8/2.36	5-10
No.200/0.075 (#200)	2-4

Binder content (AASHTO t164)	6-6.5%
Binder performance grade	64-22
Fiber content by total mixture mass	0.3%
Cellulose or 0.4% Mineral	
Rubber solids (SBR) content by weight of the bitumen	1.5-3%
Air void content (ASTM d6752/ASSHTO t275)	16.0-22.0%
Draindown (ASTM d6390)* < 0.0%	

- Retained tensile strength (AASHTO 283)\*\* > 80%
- Cantabro abrasion test engaged samples (ASTM d7064-04) < 20%
- Cantabro abrasion test on 7 day aged samples < 30%
- \*Cellulose or mineral fibers may be used to reduce draindown.
- \*\*If the RTS (retained tensile strength) values fall below 80% when tested per NAPA IS-131 (with a single freeze thaw cycle rather than 5), then in step 4, the contractor shall employ an antistrip additive, such as hydrated lime (ASTM c977) or a fatty amine, to raise the RTS value above 80%.

**APPENDIX E**  
**Details for Cisterns**

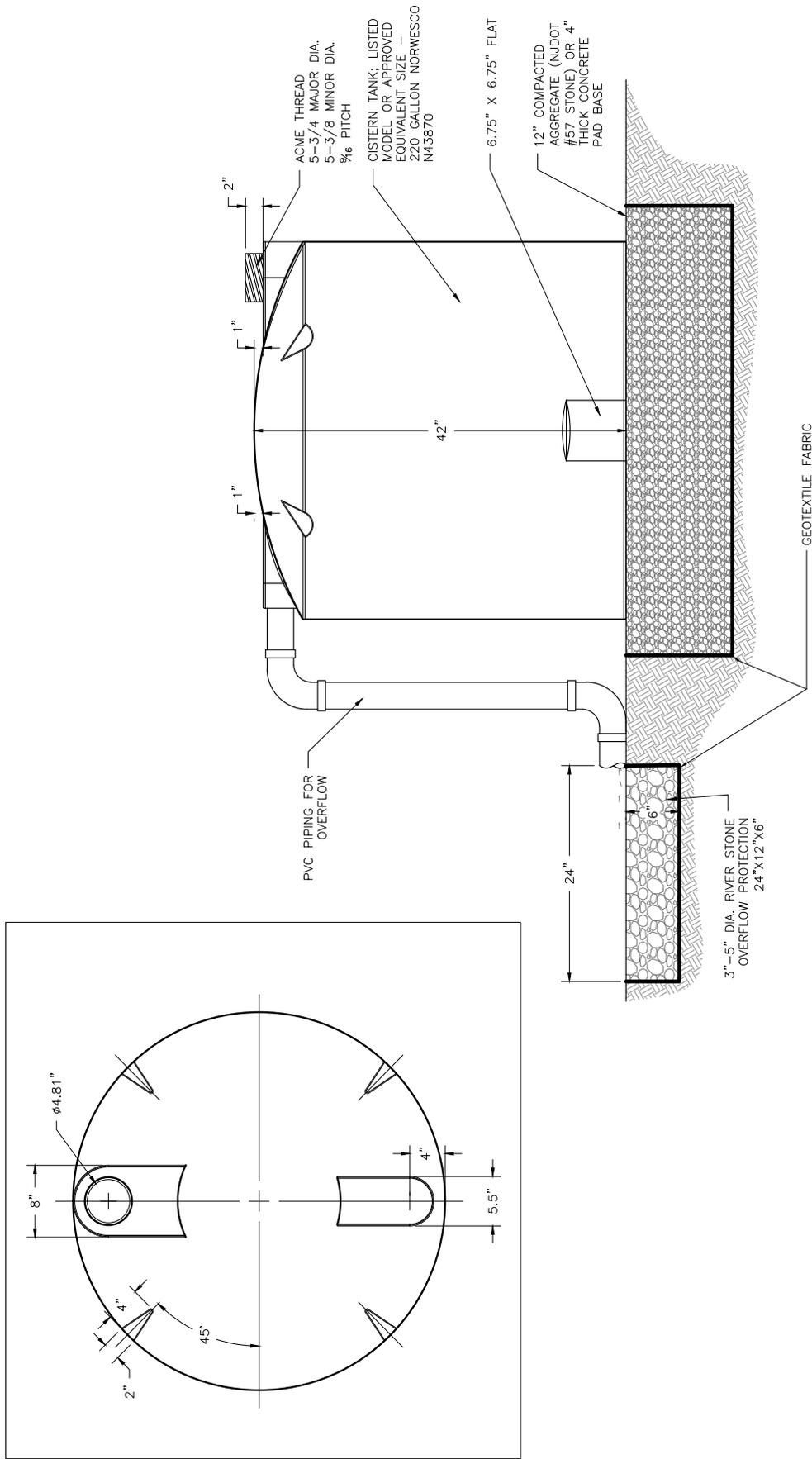
Reference:

*Green Infrastructure Guidance Manual for New Jersey, RCE Water Resources Program, 2016  
Technical Details for Construction, pp. 104-108*

<http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html>

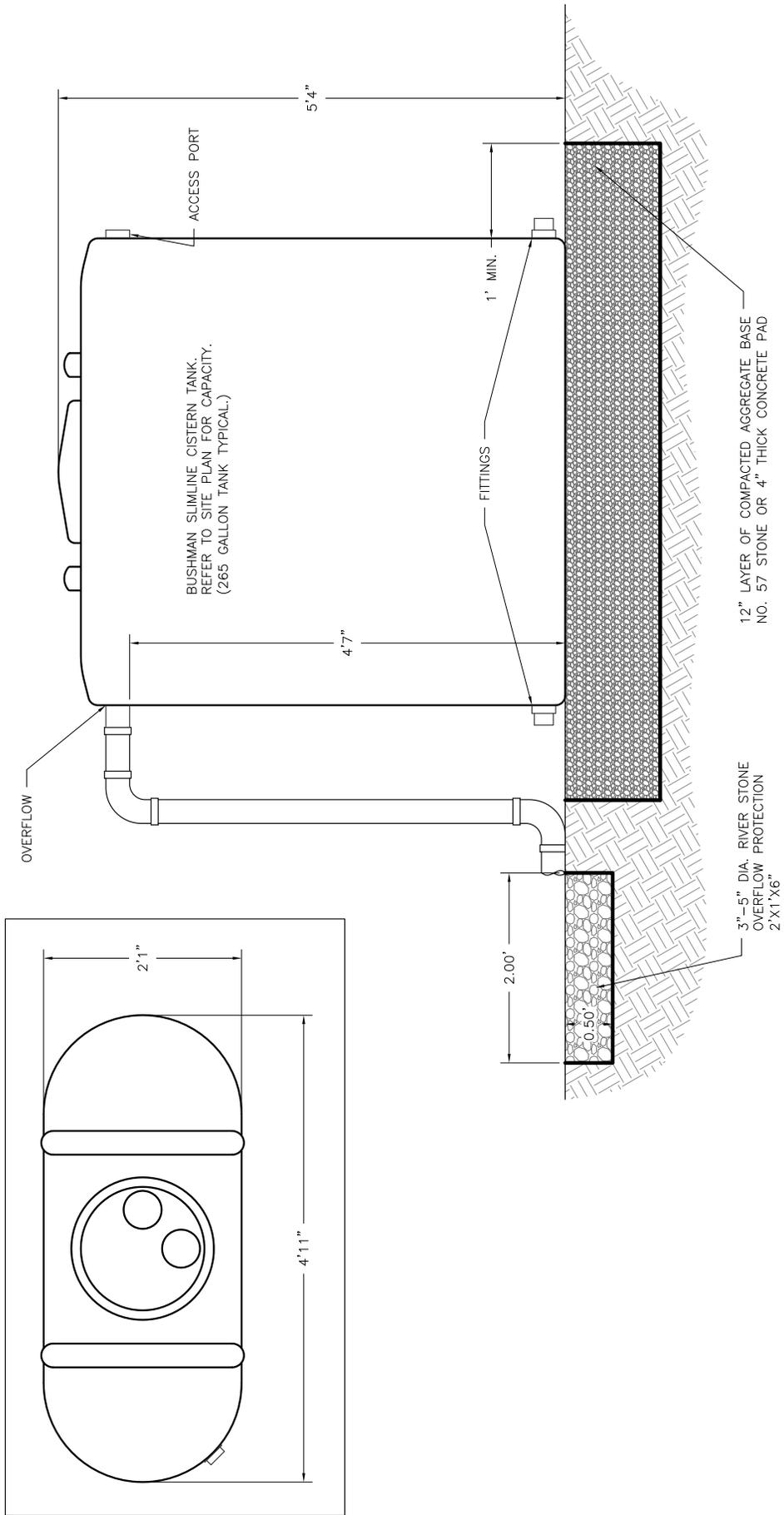
## 6.0 CISTERN

Systems designed to capture rainwater, mainly from rooftops, in cisterns or rain barrels

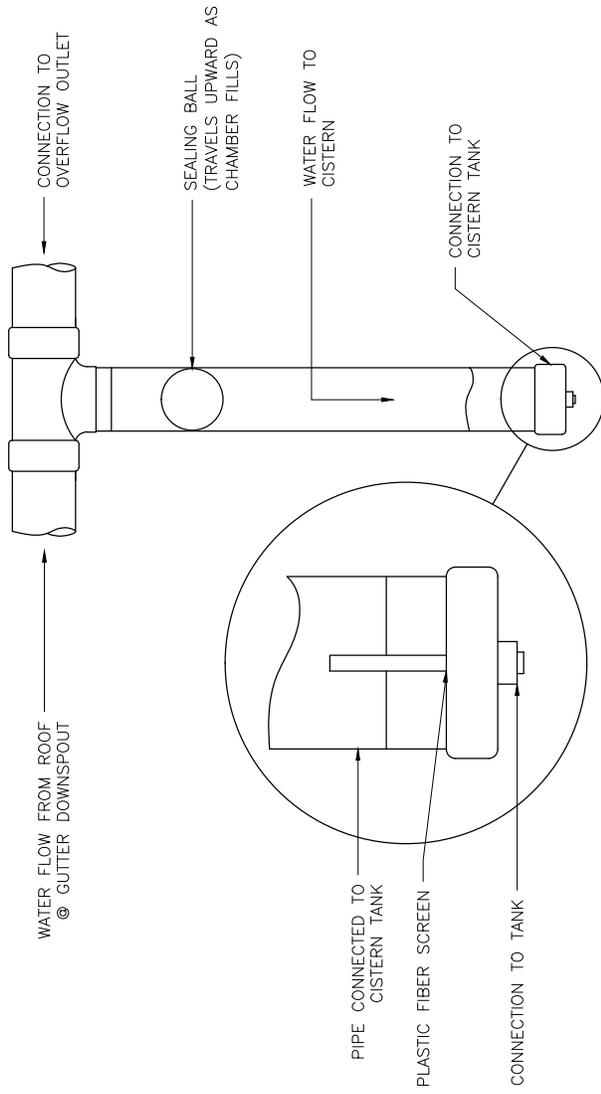


6.1 CISTERN TANK (gal. sizes vary)

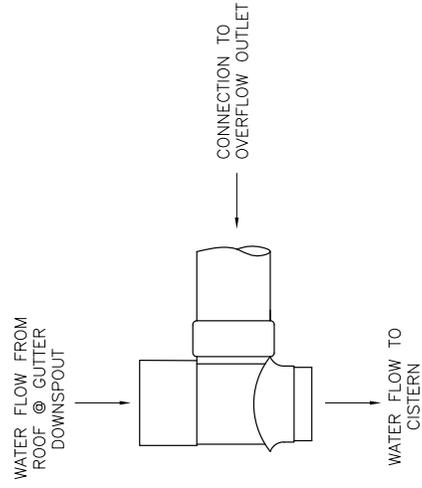
see detail 6.3 *FIRST FLUSH DIVERTER* for designs that will be used in community gardens  
see detail 6.4 *Y-SHAPED CISTERN DIVERTER* for designs that will be winterized



**6.2 BUSHMAN SLIMLINE CISTERN** (gal. sizes vary) see detail **6.3 FIRST FLUSH DIVERter** for designs that will be used in community gardens see detail **6.4 Y-SHAPED CISTERN DIVERter** for designs that will be winterized

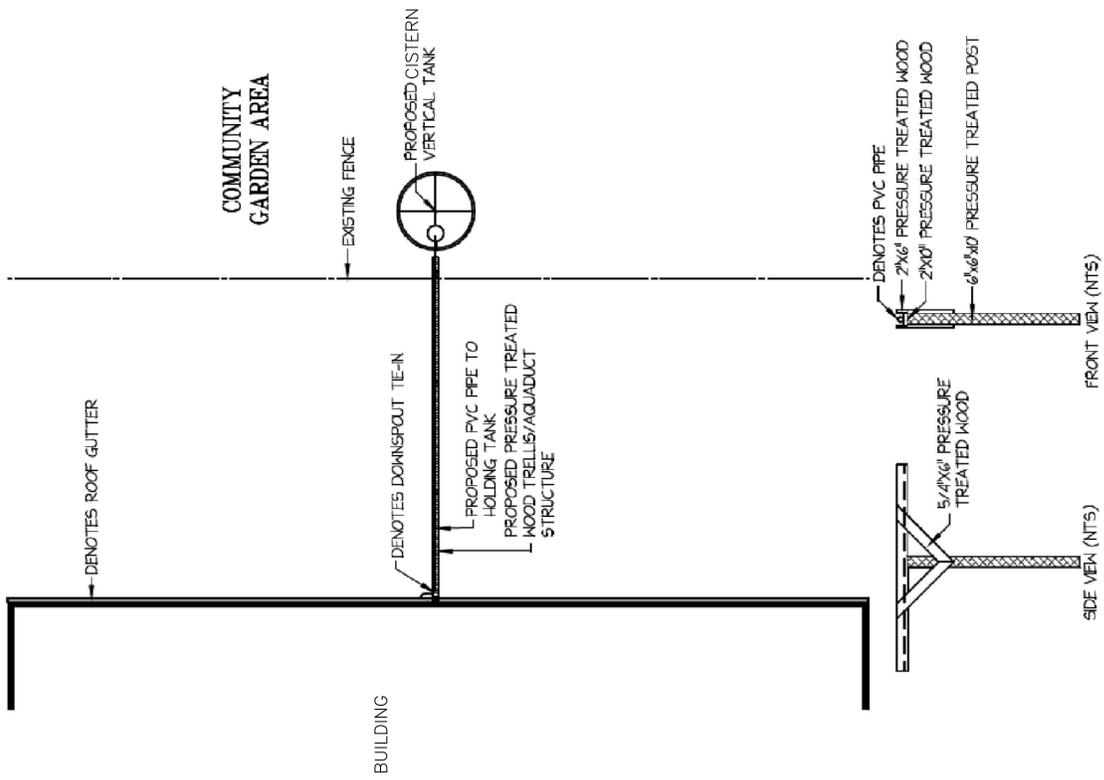


**6.3 FIRST FLUSH DIVERTER**



NOTE: ALL PIPING AVAILABLE IN 3" AND 4" SYSTEMS.

**6.4 Y-SHAPED CISTERN DIVERTER**



This detail is used for designs that collect rooftop runoff but are not adjacent to the roof.

### 6.5 TRELLIS

## 6.6 CISTERN - GENERAL SPECIFICATIONS

### CONSTRUCTION NOTES

1. The contractor shall verify all information prior to installation including elevations and locations of existing utilities.
2. The contractor shall notify the engineer immediately if any field conditions differ materially from those represented on these drawings and the specifications or if, in the contractor's opinion, said conditions conflict with the designs shown hereon.
3. The contractor shall have a pre-construction meeting with the engineer prior to any work on site.
4. The contractor shall avoid disturbing the existing area. Any disturbance to sidewalks or landscaped vegetation and trees must be coordinated with the property owner.
5. The contractor shall use PVC piping for connection from roof to cistern.
6. All pipes used for connection from rooftop to cistern shall be clear of any clogs or obstructions. All pipes shall be fitted and secured with adhesive in conformance with local plumbing codes.
7. The contractor shall provide a crushed aggregate base or concrete slab with 4,500 psi strength to support the cistern as indicated on the plan.
8. The overflow from the cistern shall connect to the nearest storm sewer catch basin inlet.
9. The contractor shall not make any modifications at the site until consulting with the engineer.
10. The contractor is required to submit shop drawings of all materials and construction methods to the engineer for review and approval prior to purchase and installation.
11. All systems shall be tested by the engineer for leaks and water tight fittings prior to acceptance and payment.
12. The contractor shall use Simpson Strong Ties in connectors for

13. the shade structure.
14. The contractor shall use pressure treated lumber.
15. The contractor shall install concrete footings with a minimum 3-foot depth.
16. The contractor shall not make any modifications at the site until consulting with the engineer.
17. The contractor is required to submit shop drawings of all materials and construction methods to the engineer for review and approval prior to purchase and installation of the gutter.

### SPECIFICATION

1. Crushed aggregate base shall be comprised of DOT No. 57 stone. The alternative concrete pad shall be concrete with 4,500 psi strength.
2. The cistern shall be 220 gallon Norwesco n43870, 130 Gal. Bushman Slimline BSLT130, Bushman Slimline BSLT265e, or approved equivalent.
3. All disturbed areas exclusive of the cistern shall be restored to original conditions by the contractor.
4. The contractor shall provide shop drawings of downspout connections to the cistern for engineers approval prior to installation.
5. The diverter filter box shall be a Rainharvesting® first flush downspout diverter (product code: wdds9x) or equivalent.
6. Overflow shall discharge to a lawn area unless specified otherwise. Stone protection comprised of 3-5-inch diameter washed river stone shall be installed as shown in the detail.

**APPENDIX F**  
**Green Infrastructure Maintenance Report Form**



## Green Infrastructure Maintenance Report Form

### GENERAL INFORMATION

Name(s) of person/people inspecting the green infrastructure:

Date:

Location address and cross street/site location name:

Property owner/tax parcel block & lot:

Contact information:

Name of the practice:

### STRUCTURAL COMPONENTS

Description of the current conditions:

GENERAL OBSERVATIONS	YES	NO	COMMENTS
1) Are there reports of the infrastructure malfunctioning?			
2) Are there any unauthorized or malfunctioning structures located in the infrastructure?			
3) Is the infrastructure overgrown with vegetation?			
4) Is there standing water or evidence of standing water?			
5) Are there signs of breakage, damage, corrosion, or rusting of structure?			
6) Is there debris or sediment accumulation in or around the inlet clogging the inlet opening/pipe?			
7) Are there signs of erosion, scour, or gullies; rock or vegetation above or around the inlet structure?			
8) Are there tree roots, woody vegetation growing close to or through the inlet structure, or a situation impacting the structure's integrity?			
9) If the inlet has a pretreatment structure (trash rack, forebay, etc.), is it filled with debris or sediment?			

### ADDITIONAL OBSERVATIONS



<b>RECOMMENDATIONS FOR WATER QUALITY IMPROVEMENTS</b>	
1) Reduce mowing 2) Plant buffers 3) Establish meadows 4) Retrofit with infiltration structures or other strategies 5) Other	
<b>PERFORMED MAINTENANCE</b>	
1) Was weeding needed? Were they invasive plants (if known)?	
2) Was replacement of materials needed? (plants, mulch, or riverstone)	
3) Were you able to water the plants?	
4) Did you winterize the structure? If so, what did you do? (Where did you put the parts for the cisterns?)	
<b>SUMMARY AND NOTES: Identify unique characteristics and/or opportunities</b>	