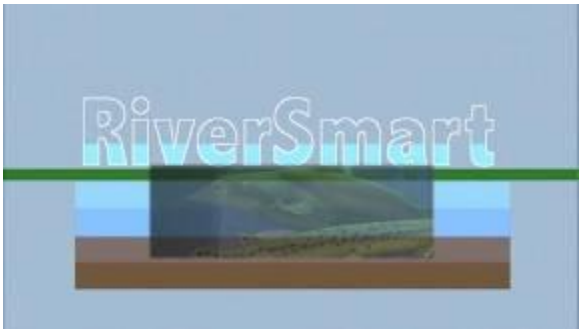
Low Impact Development (LID) Construction and Maintenance Guidance Manual

Written in conjunction with the *RiverSmart* DVD

Version 1.0, May 2009



DDOE
DISTRICT DEPARTMENT
OF THE ENVIRONMENT

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1.0 Introduction

This Low Impact Development (LID) Construction and Maintenance Guidance Manual was funded by the District of Columbia, District Department of the Environment (DDOE)/Watershed Protection Division (WPD). The Federal government, District government agencies, and developers, the Federal government, and District government agencies are all interested in Low Impact Development (LID). They are responding to the potential cost savings, superior environmental protection, and other community development and environmental improvements that they are seeing from the initial LID pilot projects in the District. These groups need to be better informed about the potential uses and benefits so they can begin an open dialogue and form strategies on how to incorporate LID into their development and operations programs. Many organizations and groups see LID as only an environmental control for stormwater, but LID can provide numerous other economic and community development features. For example, building occupants in high-density areas are long-term users and can take advantage of many of the energy and water conservation measures that LID offers.

What is LID?
LID is a stormwater management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives. LID addresses stormwater through small, cost-effective site design and landscape features that are distributed throughout the site. LID projects/programs promote public awareness, education, and participation in environmental protection.

2.0 Purpose

The purpose of this guidance manual is to accompany the *RiverSmart* DVD and provide technical information on the design, construction, inspection, and maintenance of four (4) LID practices:

1. Infiltration Devices
2. Permeable Pavers/Pavement
3. Rain Gardens/Bioretention
4. Rain Barrels/Rainwater Harvesting

The objectives of this effort are to provide outreach materials for several targeted audiences to increase awareness about LID and to facilitate dialogue between permit agencies, engineers, developers, students, and DDOE staff.

Target Audiences

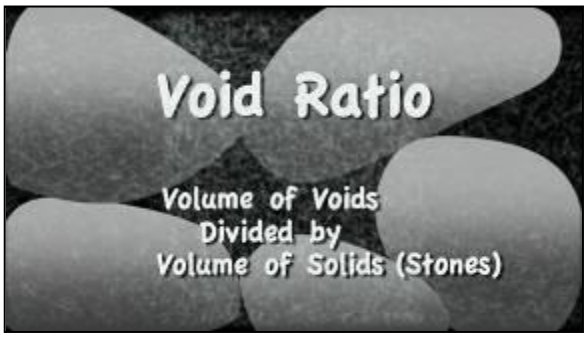
- Developers and community development corporations
- Property management companies and community associations
- District of Columbia public and private school students
- Staff persons from the District Department of the Environment (DDOE)
- Federal and District agencies involved in construction projects

Appendix A includes information on the District of Columbia stormwater regulations and permitting process, while Appendix B provides an overview of the DDOE inspection process. This will include information on how LID can be used to comply with the Department of Consumer and Regulatory Affairs (DCRA) and DDOE regulations and permit process.

3.0 LID Practice 1: Infiltration Devices (Infiltration Trenches/Dry Wells)

3.1 Infiltration Device Description

Infiltration is one example of an LID technique that retains and treats stormwater on-site. This reduces the excessive, unnatural, and destructive volume of stormwater runoff that damages the quality of our waterways. Infiltration also reduces the amount of stormwater piped to the Blue Plains Advanced Wastewater Treatment Plant (AWTP). The Blue Plains AWTP receives wastewater collected from the Maryland and Virginia suburbs and by the District of Columbia sewer system. Stormwater infiltration increases the amount of rainwater that is absorbed into the soil and helps recharge groundwater aquifers[1]. Rainwater from a roof or paved surface may be piped directly into an infiltration device. The rainwater may also flow directly across pavement into stormwater inlets or be carried via a grassed swale to an infiltration device. Infiltration trenches and dry wells are examples of infiltration devices typically used when there are suitable conditions in urban areas.

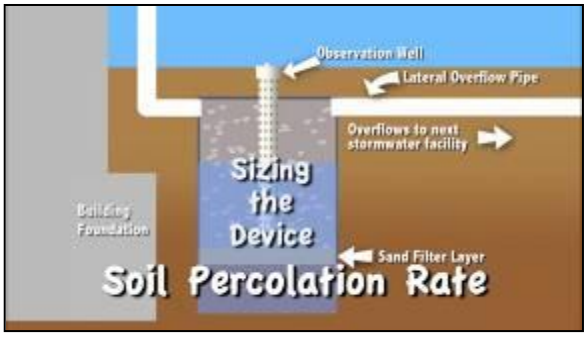


Source: *RiverSmart* DVD

Infiltration devices are trenches or basins that have been backfilled[2] with stone. These infiltration basins, trenches, or dry wells collect runoff during a storm event and release it into the soil by infiltration. This process protects nearby streams by reducing total stormwater runoff volume, filtering pollutants, recharging groundwater, and preserving baseflow. Stormwater that is treated by infiltration trenches is first stored in the spaces between stone aggregate[3] called "voids." The number and size of the voids is dependent on the size and type of aggregate being used.

3.2 Infiltration Device Location

Infiltration devices must be located more than 10 feet from a building foundation, on reasonably level ground with no steep slopes. They may not be installed where any toxic spill has occurred or where on-going soil remediation is being performed. Infiltration trenches may be used in conjunction with another stormwater management device, such as a detention pond, to provide additional water quality control and peak flow attenuation. Runoff that contains high levels of sediments or hydrocarbons (oil and grease) that may clog the trench must be pretreated with other devices such as grit chambers, water quality inlets, sediment traps, swales, or grass filter strips.

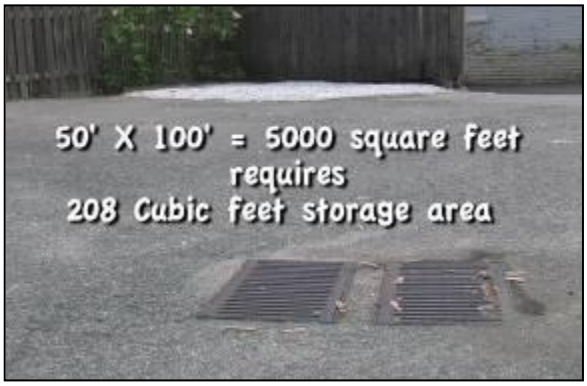


Source: *RiverSmart* DVD

[1] Aquifer: An underground bed or layer of earth, gravel, or porous stone that is saturated and sufficiently permeable to yield water to wells or springs. Typically used or could be used as a source of water, for drinking or other purposes.
[2] Backfill: The act of refilling an excavation location or material used to refill the excavation location or hole.
[3] Stone Aggregate: Crushed stone bound together.

3.3 Infiltration Device Design and Construction

The size of the infiltration device is the first design consideration. Specific calculations are used to determine the anticipated amount of stormwater that will run off the pavement, roof, or lawn and into the infiltration device during a rain event. In the District of Columbia, an infiltration device must treat the first ½ inch of rain from a storm[4]. For example, a paved area 50 feet X 100 feet long is anticipated to produce 208 cubic feet of stormwater runoff after ½ inch of rain has fallen.



Source: *RiverSmart* DVD

The design engineer then proposes a size for the infiltration device that will accommodate the required volume of stone, while meeting other building code restrictions. A vertical pipe or observation well allows the owner, maintenance worker, or District inspector to see if the trench is functioning correctly. By looking into the observation well you can see standing water or dry stone aggregate. Standing water 72 hours after a rain event indicates that the infiltration device has a draw down time, or is dewatering[5] too slowly and may need repair or replacement. Dry stone 72 hours after a rain event indicates that the infiltration device is working as designed for stormwater treatment.


Source: *RiverSmart* DVD

A sand layer is typically at the bottom of the infiltration devices. This layer separates the stone aggregate from the subsoil. The sand provides a final filtering of the water before it is absorbed into the subsoil and becomes groundwater.

Filter cloth is used to separate the stone from the on-site soils. The filter cloth should be woven monofilament and comply with the *District Stormwater Guidebook* standards and specifications.

Infiltration trench effectiveness and life cycle is extended when pretreatment such as vegetated filter strips or grassed swales is included in the design.

3.4 Infiltration Device Maintenance

The principal maintenance objective is to prevent clogging, which may lead to failure of the infiltration device. If standing water is present three (3) days after a rain event, it indicates that the infiltration trench is draining too slowly and needs maintenance. Preventative maintenance

[4] This is the current District of Columbia water quality standard as of March 2009. The proposed new water quality treatment standard will require capturing and treating the runoff volume from one (1) inch of rainfall to meet water quality requirements, and a further enhanced stormwater quality and quantity control standard for the Anacostia Waterfront Redevelopment Zone.
[5] Dewatering: Removal or drainage of water.

(e.g. maintaining the pretreatment BMPs) will lengthen the life of the infiltration trench. Reseed any eroded areas in the grass filter strip immediately, and isolate those areas until they have recovered. The grass height should always be equal to or greater than the design flow depth. Remove accumulated debris annually from the pretreatment devices and stormwater inlets.

3.5 Infiltration Device Inspection

Periodic inspections of the construction of the infiltration device must be made by the DDOE Stormwater Inspector.

Source: *RiverSmart* DVD

1. The DDOE Stormwater Inspector will study the materials used, construction quality, and the dimensions of all components of the device.
2. The goal of the inspection is to insure that every infiltration device within the District is both safe and functional and constructed to the specifications of the approved Stormwater Plan. Once the permit is signed, but prior to final hook-up and use of the Infiltration Device, a DDOE Stormwater Inspector must conduct a final inspection of the completed Infiltration Device. Then the contractor can back fill the device, and remove the water-tight seals on the inflow pipes.
3. As with all permitted stormwater devices in the District, a final inspection of the completed device must be scheduled with the DDOE and an As-Built plan must be submitted for review and approval by the DDOE within 21 days of the final inspection date.

4.0 LID Practice 2: Permeable Pavement

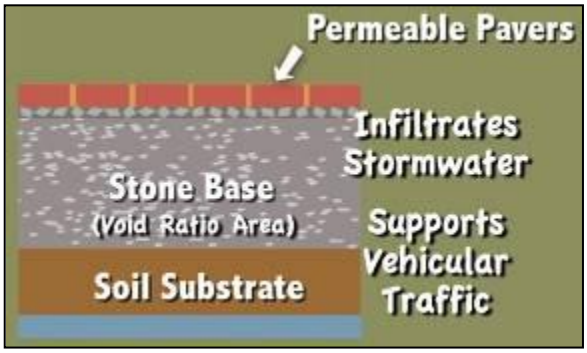
4.1 Permeable Pavement Description

Source: *RiverSmart* DVD

Permeable pavement consists of open-graded asphalt or concrete that allows for the infiltration of stormwater into the sub soils or stone aggregate for storage rather than creating runoff. Conventional pavement causes rainwater to run off, creating excessive costs for municipal stormwater systems and excessive water quality problems, flooding, and damage to the streams and aquatic life. Permeable pavement controls runoff volume and peak discharge[6], filters pollutants, and may be used to recharge groundwater by allowing rainwater to pass through the pavement and flow through voids between the aggregate and into the ground.

There are five (5) standard types of permeable pavement, including certain types that can bear the weight of a vehicle.

1. *Free-Standing Permeable Pavers* are the least stable of the five types and are therefore only recommended for light and infrequent load-bearing, such as private walkways or infrequently-used portions of driveways. This being the most basic type of permeable pavers, it uses free-standing bricks, concrete blocks or flat stones laid on a bed of sand and stone aggregate.



Source: *RiverSmart* DVD

2. *Permeable Interlocking Concrete Pavement* (PICP) is a more sophisticated form of permeable paver that is designed for:
    - Parking lots
    - Driveways
    - Patios
    - Private walkways and public sidewalks
    - Low traffic roads
    - Parking lanes
    - Nature trails & park pathways
    - Environmentally sensitive developments

Source: *RiverSmart* DVD

PICP is comprised of a layer of durable concrete pavers separated by joints filled with small stones. The blocks are impervious, but the joints allow infiltration. The joints, or

[6] The rapid flow of water is infiltrated, meaning that large storms bypass after some infiltration thus decreasing the peak discharge.

interlocking shapes, vary considerably from simple notches to built-in concrete joint spacers.

3. *Concrete Grid Pavement* (CGP) is an extensive concrete grid that uses large spaces filled with stone aggregate or with sod and turf. The reinforced concrete structure provides stability for bearing the weight of vehicles and the stone or sod-filled spaces provide permeability. There are two types of CGP:
   i) Poured-in-Place Concrete Slabs
   ii) Pre-Cast Concrete Grids.

Source: *RiverSmart* DVD

4. *Pervious Concrete* (PC) looks like conventional concrete when installed. The difference is that it will allow rainwater to flow through it to the bedding and base layers for infiltration into the ground. Pervious Concrete is Portland cement[7] with the use of sand or fines.

5. *Pervious Asphalt* (PA) is a permeable asphalt pavement, also known as porous asphalt, is similar to pervious concrete. It is standard hot-mix asphalt with reduced sand or fines and allows water to drain through it into a crushed stone reservoir.

4.2 Permeable Pavement Design and Construction

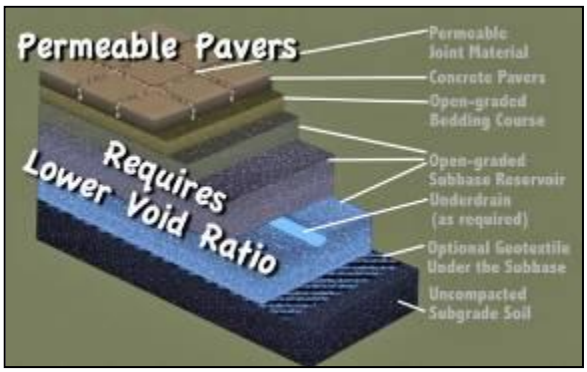

Installation of permeable, or porous asphalt in the parking lanes and conventional asphalt in the drive lanes in Portland, OR.
Source: Portland Bureau of Environmental Services (BES)

Permeable pavers may be used for parking lots, driveways, road shoulders, and pedestrian paths. Such paving should not be used in areas with the potential for spills, such as gas stations or loading docks. Construction of permeable pavers is similar to that of conventional pavements. Installation of paver blocks will require additional time for placement of the blocks. Similar materials and construction techniques are required for permeable and conventional pavements. The largest difference is the depth of the aggregate subbase, which is used for additional storage volume of stormwater and the addition of geotextile material.

With all five (5) types of permeable pavement, there are basic installation considerations:

[7] Portland Cement: The most common type of cement used. It is a hydraulic cement made by heating a limestone and clay mixture in a kiln and pulverizing the resulting material. Typically used with water and sand or gravel to make concrete or mortar.

1. As with most pavement, never install during rain or over frozen base material.
2. Permeable pavement works best on level ground.
3. Landscape the site so that no stormwater drains to the pavers from the surrounding landscape. Such drainage may carry silt, which would clog the drainage spaces between the pavers or the permeable surface.



Source: *RiverSmart* DVD

4. Minimize all opportunities for the spillage of toxic liquids onto the permeable pavement. Such toxins would infiltrate into the soil and groundwater.
5. Permeable pavers work best if the base of the structure is at least 3 feet above the high water table[8] level of the soil. If the high water table is closer than 3 feet, an underdrain pipe may need to be installed in the base layer to drain excess water to another stormwater device. The purpose of the underdrain is to prevent standing water on the paved surface when the soil becomes super-saturated.
6. While installation costs may be higher in some instances for permeable pavers than for conventional pavement, these cost increases can be offset by the decreased costs of stormwater management.
7. In the case of the *RiverSmart* Home Program, the District government may be able to assist you financially if you install permeable pavers. For more information on this program, go to ddoe.dc.gov/riversmarthomes or call (202) 535-2240.


Source: DDOE

4.3 Permeable Pavement Maintenance


Source: DDOE

The primary purpose of cleaning and maintaining your permeable paver system is to make sure that the drainage voids, or openings, in the surface are clean and clear from all kinds of debris and maintain efficiency. Debris will clog up the drainage voids of your pavement and in turn reduce the flow capacity of the system. If you installed grass pavers you should treat them as you would your lawn, by regularly watering, mowing, and weeding.

[8] Water Table: Generally referring to the water level, or upper surface of the groundwater. Level fluctuates seasonally and year to year as climatic conditions change.

Interlocking concrete pavers and porous concrete require more care. These surfaces need to be kept clean and free of debris, so it is necessary to vacuum and wash these types of permeable paver systems, so as to keep the voids clear and to allow them to function as they should for treatment of stormwater. You can use street sweepers and vacuums to maintain these types of pavers, and should carry out the procedure about four (4) times a year. It is also a good idea to check the level of the fill material in the voids of interlocking pavers, and re-fill them when necessary, particularly after pressure cleaning.

Source: *RiverSmart* DVD

Five (5) general maintenance considerations:

1. You should inspect your site on a regular basis; after the installation. You should inspect it once a month for about four (4) to six (6) months. After this time period you can inspect the site annually, or after a particularly heavy rain event when the drainage voids can become clogged with debris.
2. Every three (3) months you should get into the habit of sweeping and vacuuming your permeable surface. You can use street sweepers that have a vacuum and brushes, which help clean out the voids in your paver system, restoring permeability.
3. It is also a good idea to apply high pressure hosing to the site after you have swept and vacuumed it thoroughly. Check that the voids are still well-filled with aggregate. It may be necessary to refill them regularly, using clean stone or gravel.
4. Settlement[9] of paver block systems may require resetting. Cracks and settlement in asphalt or concrete may require cutting and replacing the pavement section.
5. The application of abrasive materials for snow treatment should be prohibited in order to prevent clogging.

Source: Interlocking Concrete Pavement Institute (ICPI)

[9] Settlement: Occurs when individual pavers or groups of pavers near curbs, site fixtures, walls, or at locations where pavers meet other surfacing materials.

5.0 LID Practice 3: Rain Garden/Bioretention

5.1 Rain Garden/Bioretention Description

A simple, yet effective method to control stormwater is through the use of rain gardens, also known as bioretention cells. Rain gardens are small vegetated depressions that collect, store, and in some cases, infiltrate stormwater runoff. They contain a special soil mix, or media, typically consisting of 50 percent sand, 30 percent organic material, and 20 percent topsoil (by volume). It uses very little of the onsite soils and tends to be sandy. The size and depth of a rain garden, or bioretention cell, varies depending on the drainage area and location of the storm sewer. Beyond its use for stormwater control, the rain garden provides aesthetically pleasing landscaping and a natural habitat for birds and butterflies. Finally, rain gardens promote sustainable design practices while encouraging environmental stewardship and community pride.

Source: DDOE

5.2 Rain Garden/Bioretention Location

Rain gardens/biorentention cells proposed for compliance with the District of Columbia storm water regulations as part of the Building Permit process must have a Geotechnical Report[10] prepared by an engineer registered with the District. The report must document that the proposed location for bioretention has soils that will infiltrate one (1) inch of water or better within 24 hours.

Source: DDOE

Rain gardens/bioretention cells are generally sited uphill of existing stormwater inlets for retrofit projects and allow stormwater to enter via curb cuts or grass swales for parking lots and residential areas. For new construction, they are typically located at the lowest elevation on the site closest to the storm sewer.

Finding a good location for a rain garden involves balancing a number of different factors:

[10] Geotechnical Report: Prepared by a geotechnical engineer or geologist. It provides details on the effects of drainage and drainage facilities on soil characteristics, geology and groundwater.

- A rain garden should be located in a place where it will receive runoff. Check to make sure runoff flows to your site, or could flow with minor modifications, such as cutting a space out of a curb.
- Rain gardens are typically located at least ten (10) feet from the building to avoid damage to the foundation depending on the geotechnical report for permitted rain gardens. A ten (10) foot separation from the building is a good rule of thumb for homeowner retrofit rain garden projects.
- Find out where underground utilities are buried. Common utilities may include water, sewer, electrical, gas, telephone and cable lines, as well as sprinkler systems. Before construction, you can contact Miss Utility, which will locate utilities for free. Please visit the Miss Utility website for more information. www.missutility.net/

5.3 Rain Garden/Bioretention Design and Construction

5.3.1 Design: Sizing Bioretention for Water Quality Volume (V_w) Requirements

Source: *RiverSmart* DVD

A simplified bioretention sizing method for water quality treatment in the District may use the following criteria. First the Water Quality Volume (V_w) is calculated:

Where:

$$V_w = \frac{(R \times I_a)}{12}$$

V_w = Water quality volume to be treated (cubic feet)
R = Runoff depth, use 0.5 (for treatment of one half inch of rain)
I_a = Impervious area to be treated = length x width (square feet)
12 = Conversion factor (for conversion of feet to inches)

Example: An impervious area 60 ft long x 12 ft wide (60'x 12') equals 720 square feet (sf) of imperviousness.

$$V_w = \frac{(0.5 \text{ ft} \times 720 \text{ sf})}{12}$$

V_w = 30 cubic feet of stormwater to be treated

> ***Note regarding ½" of runoff:*** *This is the current District of Columbia water quality standard as of March 2009. The proposed new water quality treatment standard will require capturing and treating the runoff volume from one (1) inch of rainfall to meet water quality requirements. In addition, a further enhanced stormwater quality and water quantity standard will be required for the Anacostia Waterfront Development Zone.*

5.3.2 Design: Volume

The available storage for a proposed bioretention/rain garden size is then computed. For our example a 4'x 10' rain garden is proposed. The total amount of area available for storage is a combination of the surface ponding area plus the storage area available from the void space within the media.

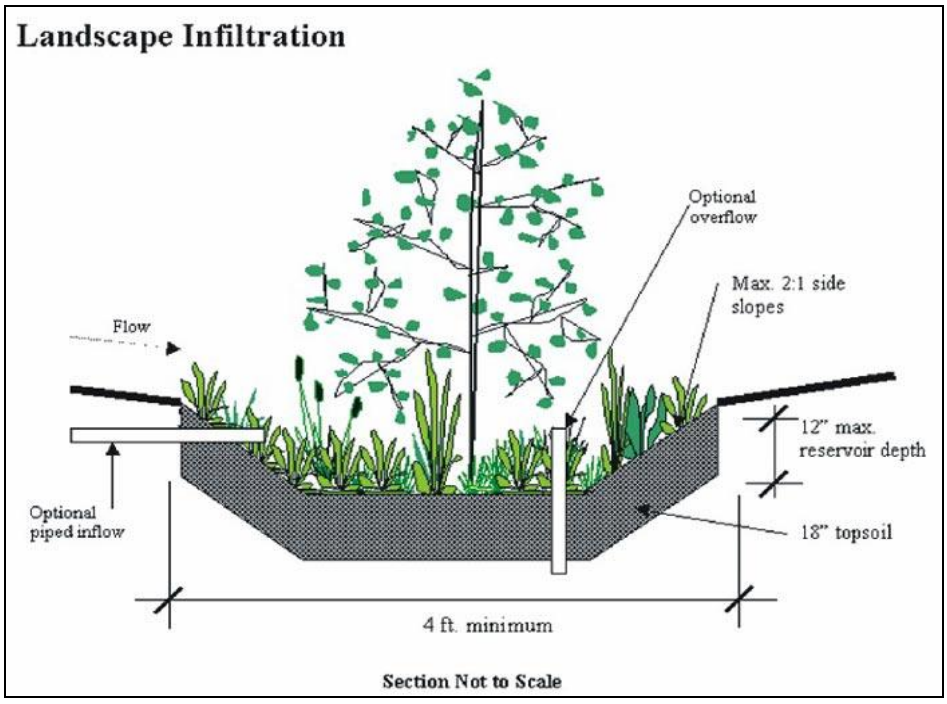
(Proposed surface ponding area) + (Proposed available surface area x Media depth x Void space)

Where:

Surface ponding area = 4' x 10' = 40 square feet (sf)

(40 sf x 1' ponding area) + (40 sf x 2' media x 0.35 void space) = 42 cubic feet available for storage and treatment of the anticipated runoff for a one half inch storm.

Bioretention/rain gardens are generally 5 to 7 percent of the total drainage area, and should be able to store 75 percent of the stormwater runoff before it infiltrates or bypasses the remaining 25 percent of stormwater. More detailed information for sizing Low Impact Development stormwater best management practices can be found in the *District Department of the Environment Stormwater Guide Book.*



Typical Bioretention Cross-section
Source: U.S. Environmental Protection Agency

5.3.3 Construction

Construction includes soil excavation (digging), construction of plumbing components, surface grading, soil replacement, and planting native plants. Because rain gardens/bioretention cells are sensitive to sediment loading, the surrounding area needs to be completely stabilized before the rain garden is put into place.

Source: DDOE

The rain garden site should be well protected with silt fence[11] or other erosion and sediment control best management practices. These precautions are needed to ensure that construction debris and sediment do not foul the rain garden bed. A rock weir[12] that serves as an energy dissipater for inflow of stormwater at the curb opening or inlets should be at least two (2) times the width and at least three (3) times the length as the required curb opening in order to prevent erosion of the rain garden bed from the inflow of stormwater. Large rip-rap stone 6" in depth minimum on a liner of filter fabric is required.

After construction is complete and all plumbing components have been connected and final back filling and grading of the rain garden bed has occurred, a shredded hard wood mulch cover, uniform in color and free of foreign materials, is required to cover the entire rain garden bed to a depth of 2-3 inches.

5.4 Rain Garden Inspection

1. For permitted rain garden construction, the contractor shall arrange a "preconstruction meeting" with the permit applicant or their agent and the DDOE stormwater inspector prior to beginning work on the rain garden/bioretention facility.
2. Inspections shall be performed:
    a. At the completion of excavation to inspect the sub grade preparation;
    b. During underdrain and plumbing components construction and connection, and for the soil or media or installation;
    c. During backfilling. "Soil Certification" for backfill is required.
3. The final top soil shall be thoroughly wetted to achieve the design top soil elevation.
4. Additional back fill should be placed to reach the design elevations.
5. The final grading shall be inspected by the DDOE stormwater inspector before planting.
6. Sediment and erosion control measures may be removed upon approval by the DDOE stormwater inspector.

[11] Silt Fence: Temporary barrier made of woven, synthetic filtration fabric supported by steel or wood posts. It prevents sediment carried by sheet flow from leaving the construction site.
[12] Weir: A structure, or barrier, placed across an opening or conduit to interrupt flow.

What alternatives are available for capturing rainwater from storms greater than ½ inch?

1. Overflow Drain
2. Underdrain
3. No Plan – Not recommended

Source: *RiverSmart* DVD

5.5 Rain Garden/Bioretention Maintenance

Immediately after the completion of construction, water plant material for 14 consecutive days unless there is sufficient natural rainfall. After storm events, inspect the area and make sure that drainage paths are clear and that ponding water dissipates over 24 hours. The inlet is a particular focus for maintenance. If inlets are not clear and cleaned out regularly, they clog up and the water by-passes.

Source: *RiverSmart* DVD

Routine maintenance should include a visual inspection for removal of accumulated sediment, trash, and debris; repair of erosion; repair to stone weirs; visual inspection of the rain garden bed and inlets; and visual inspection of the condition of the perennials, shrubs, and tress. Add a fresh mulch layer every year and remove any mulch that has become fouled with oil and grease or other hazardous.

Pre-maintenance
Embedded stone weir and over grown with weeds.
Source: DDOE

Post-maintenance
Removal of weeds and repair of stone weirs at inlets.
Source: DDOE

6.0 LID Practice 4: Rain Barrel/Rainwater Harvesting

6.1 Rain Barrel/Rainwater Harvesting Description

A rainwater harvesting/collection system is a tank modified with a filter, plus an inflow, outflow, and overflow piping network that captures stormwater runoff from the downspouts of buildings. The system safely stores this chlorine-free water for later use during dry weather. Most residential systems use tanks that are installed above-ground, which is cost-effective and allows for energy-free, gravity-based release of harvested stormwater.

Source: *RiverSmart* DVD

Rain barrels are low-cost water conservation devices that can be used to reduce runoff volume and, for smaller storm events, delay and reduce the peak runoff flow rates (i.e. maximum instantaneous flow rate during a storm event). By storing and diverting runoff from impervious areas such as roofs, these devices reduce the undesirable impacts of runoff that would otherwise flow swiftly into receiving waters and contribute to flooding and erosion problems.

Source: *RiverSmart* DVD

6.2 Rain Barrel/Rainwater Harvesting Location

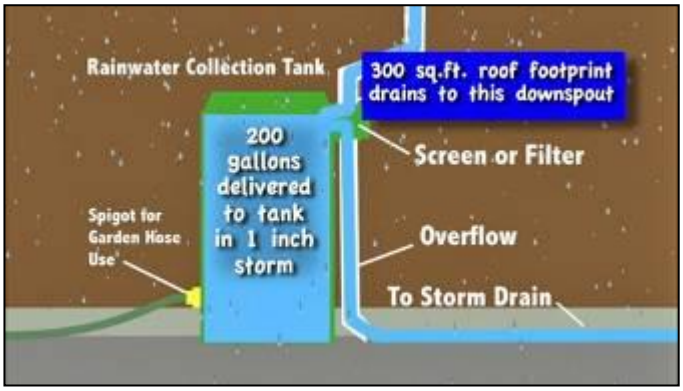
Rain barrels are placed outside of a building at roof downspouts to store rooftop runoff for later use in lawn and garden watering.

6.3 Rain Barrel/Rainwater Harvesting Design and Construction

Rain barrel sizing is relatively simple. Rain barrels store between 55 and 100 gallons and may be connected in series for additional capacity. Space constraints and frequency and volume of water used will determine the number of rain barrels needed. Rain barrels can be purchased from a supplier or, for a lower cost option, you can make your own.

Homemade rain barrels are relatively easy to construct. Basic components consist of the following:

1. One or more 55-gallon barrels
2. A child-resistant top, or screen, that allows easy access for cleaning. Screens may be used at the inflow points to strain coarse sediment and reduce the potential for mosquito breeding.



Source: *RiverSmart* DVD

3. Connections to the downspout, overflow pipe, and spigot, and hoses to connect barrels in series (if applicable).

Installing a rainwater collection system involves the use of a simple formula to determine how much water can be collected from a downspout.

1. First, decide which downspout will be used to collect the rooftop stormwater runoff.
2. Next, determine what portion of the floor space of the house is under the portion of the roof that drains into that downspout.
3. Estimate or measure, in feet, the length and the width of the roof area that drains to the downspout that will be connected to the rain barrel or cistern. Then, multiply the length by the width to determine the square footage. For example, if the length is 20 feet and the width is 15 feet, then the product is 300 square feet.
4. During an average rain event, a reasonable estimate of the amount of rain that will drain through a downspout is about two-thirds of a gallon of rainwater per square foot. For example, a rough estimate of rooftop runoff in a one-inch rainstorm can then be represented as two-thirds of a gallon of stormwater runoff multiplied by the square footage of the floor space under the roof.

Source: *RiverSmart* DVD

5. In our example, the estimated runoff would be two-thirds of a gallon per square foot times 300 square feet. The product would then be 200 gallons of water that could be collected in a tank for every one-inch of rainfall. Since the average rain per event in the District is a one-half inch rainfall, the average rainfall would deliver 100 gallons into the tank for this home.
6. A homeowner can have a successful system with any size tank. It is important to consider that the smaller the tank, the more important it is to have a large overflow system that can deliver the overflow volume to a place that will not create flooding anywhere. The larger the tank, the less concern is needed for overflow and the more water will be available for irrigation during dry days.
7. Tanks can range from 50 gallons to 20,000 gallons of storage capacity.
8. Filters can be purchased or built and range from simple leaf collectors to highly efficient commercial filters. A filter should be installed that keeps mosquitoes out of the tank. All filters must be placed between the downspout outfall and the entry point into the tank.

Source: *RiverSmart* DVD

9. The inflow, outflow, and overflow holes in the tank are generally drilled by the tank manufacturer or installer. A homeowner installing a tank can use a 3-4" hole saw to drill the inflow holes and a smaller hole saw for a hose fitting for the out flow.

10. The inflow area must be at the top of the tank and be the same size or larger than the downspout.
11. The overflow needs to be at least the same size as the downspout, but preferably larger. A larger overflow allows for the tank to overflow more efficiently. Polyethylene or ABS pipe is recommended for the overflow pipe. The overflow pipe can be drained into another *RiverSmart* feature, such as a rain garden, or directed to the municipal stormwater system. Be sure it drains much more than 10 feet from the foundation of any structure and never drains onto neighboring property.
12. The outflow or spigot for release of the water must be as close to the bottom of the tank as possible. The seal on the spigot needs to be water-tight and checked regularly, as the water pressure on the spigot can be significant.
13. Connect a standard garden hose for irrigation and you are ready to begin watering your garden with your own supply of chlorine-free rain water. While at the same time you have helped to reduce some of the impacts associated with stormwater runoff from your roof.

6.4 Rain Barrel/Rainwater Harvesting Maintenance

Maintenance requirements for rain barrels are minimal and consist only of regular inspection by the homeowner of the unit as a whole and any of its constituent parts and accessories. The unit and attachments should be inspected for clogging several times a year and after major storms. Minor parts such as spigots, screens, downspouts, and connections may need to be replaced.

Source: *RiverSmart* DVD

NOTE: Make sure to empty the rain barrel between rainstorms and during winter prior to a freeze.

7.0 Appendix A: Permitting Requirements

7.1 Stormwater Regulations in the District

District of Columbia Stormwater Management Regulations, §509 through §518 of D.C. Municipal Regulations, Title 21, Chapter 5, of the D.C. Water Pollution Control Act of 1984, authorizes the District to ensure that best management practices (BMPs) are used to control stormwater runoff from new development and redevelopment projects. Additionally, all land disturbing activities are regulated under D.C. soil erosion and sedimentation control regulations outlined in D.C. Municipal Regulations, Title 21, Chapter 5. The primary function of DDOE's Compliance and Enforcement Program is to enforce these laws and associated regulations.

7.2 Submitting a Project Plan and Permit Acquisition

7.2.1 Why Do I Need a Plan and Permit?

Land disturbing activities are regulated under law. As such, no person may engage in any land disturbing activity on any property within the District until that person has secured a construction permit from the District. Approval of a Construction Permit (dcra.dc.gov) is based upon the simultaneous submission by the permit applicant of an Erosion and Sediment Control Plan, a Stormwater Management Plan, or both, depending on the nature of the development activity. An erosion and sediment control plan is required for 50 square feet or greater of land disturbance. A Stormwater Management Plan is required for 5000 square feet of land disturbance. The regulations governing stormwater management, erosion and sediment control, and floodplain management are outlined in Chapter 5 of Title 21, District of Columbia Municipal Regulations (DCMR). Copies of the DCMR can be purchased at the Office of Documents and Administrative Issuances (ODAI), Room 520, 441 4th Street, NW, Washington, D.C. 20001. os.dc.gov

Exceptions for Homeowners
An Erosion and Sediment Control Plan is not required when earth disturbing activities are limited to individual spread footings to support columns, fence post holes, and utility service connection and repairs. Participants in the RiverSmart Homes program must have a home audit to determine exemption from stormwater permits.

7.2.2 Where Can I Obtain General Information Involving the Submission of Project Plans and Permit Acquisition?

The Department of Consumer and Regulatory Affairs (DCRA) has established a "Permit Service Center" on the second floor at 941 North Capitol Street, NE, Washington, D.C., to assist businesses, developers, and other permit applicants seeking general information regarding permits, application materials, and technical assistance. The center is open for business from 8:30 a.m. to 4:45 p.m., Monday through Friday. The Department of the Environment has staff persons stationed at the "Permit Service Center" to provide assistance to customers to ensure that permit applications, construction plans, and environmental forms and documents that are submitted to acquire a permit, meet regulatory requirements. For inquiries, you may call any of the phone numbers listed below: (202) 442-4696 or (202) 442-4686 or (202) 442-9518 or go to dcra.dc.gov/.
Note: All SWM BMPs must also be recorded at the Recorder of Deeds in the Office of Tax and Revenue. Go to otr.cfo.dc.gov for more information.

7.2.3 Where Should I Submit My Application and Plan?

All plans along with permit applications and other related documents (if required) must be submitted to the "Permit Service Center" at 941 North Capitol Street, NE, 2nd floor, for screening. Projects that qualify for immediate approval will be handled at the "Permit Service Center" by the Department of the Environment staff located at the center. All other projects (file jobs) will be forwarded to the Technical Services Branch - Watershed Protection Division (51 N Street, NE, 5th Floor, Washington D.C. 20002) for review.

7.2.4 How Do I Request a Pre-Development Meeting?

A preliminary meeting between the developer/designee(s)/applicant and the technical review staff of the Technical Services Branch is recommended during the conceptual phase of project design to discuss design strategy or issues related to best management practices for stormwater management and sediment control. To request and schedule a meeting, please call the Watershed Protection Division's main line: (202) 535-2240.

7.2.5 What are the Plan Review and Approval Procedures?

Within 10 to 30 working days of the submission of a plan, the technical review staff of the Sediment and Stormwater Technical Services Branch shall review the plan and make a determination to approve or disapprove the plan. If it is determined that more information is needed or that a significant number of changes must be made before the plan can be approved, the applicant will be informed in writing to make the necessary changes and resubmit the revised plan. All re-submissions must contain a list of the changes made. A new 10 to 30 day review period begins on the date of the re-submission. If plan approval is denied, the reason(s) for the action shall be communicated to the applicant in writing.

7.2.6 How Do I Obtain Information on Flood Zones?

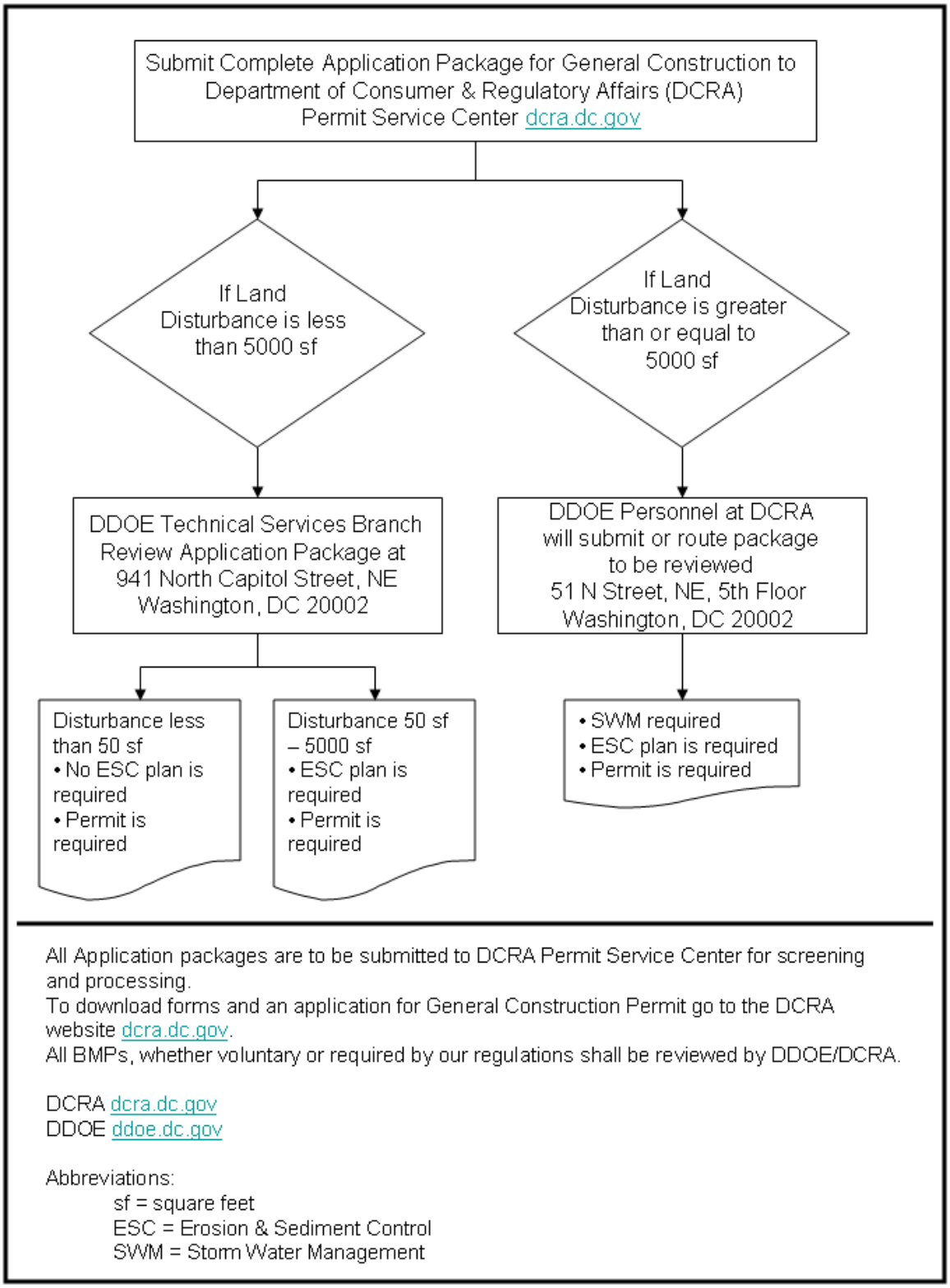
If you need to know whether a specific property is located in a flood zone as defined by the Federal Emergency Management Agency (FEMA), you can call the Watershed Protection Division for assistance at (202) 535-2240.

7.2.7 How Do I Obtain Information on Soil Characteristics?

If you need to know whether a specific property is located in problem soils in the "Urban land-Christiana-Sunnyside association[13]" as identified by the District of Columbia Soil Survey Manual, which was produced for the District by the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), you can call the Watershed Protection Division for assistance at (202) 535-2240, or go to the D.C. GIS website (dcgis.dc.gov/)

[13] Urban land-Christiana-Sunnyside association: The most prevalent general soil association in the District portion of the watershed. These predominantly upland soils are deep, nearly level to steep, well-drained soils that are underlain by unstable clayey sediment.

7.2.8 Flow Chart of Permit Plan Process



8.0 Appendix B: General Inspection Requirements

8.1 Why Would I Need an Inspection?

Land disturbing activities of greater than 50 square feet are regulated under law. The Inspection and Enforcement Branch of DDOE performs the functions listed below as part of its mandate to implement the inspection and enforcement component of the soil erosion and sedimentation control and stormwater management regulations. These regulations are outlined in Chapter 5 of Title 21, District of Columbia Municipal Regulations.

8.2 Types of Inspections the Branch Performs

8.2.1 Soil Erosion and Sedimentation Control Inspection

Inspectors are authorized to conduct periodic inspections of all land disturbing activity at construction sites to ensure compliance with approved plans and to determine if the measures in the approved plans are providing effective control. Inspectors also conduct final inspections within four (4) weeks after receiving notice of project completion to ensure compliance with final site stabilization as specified in the approved plan.

8.2.2 Stormwater Management Construction Inspection

Inspectors are authorized to conduct on-site inspections of all stormwater management facilities constructed in the District of Columbia. A pre-construction meeting is the first step in a stormwater management facility inspection. At this meeting an inspection schedule and requirements are discussed. Inspections are then performed at different stages of construction as specified in the sequence of construction to ensure compliance with the approved plans.

The owner/contractor is responsible for notifying the Inspection and Enforcement Branch at least 24 hours before construction for a pre-construction meeting and within one (1) week after completion of the permitted facility for final inspection. The registered professional engineer with responsibility to certify the As-Built plan is required to submit the As-Built plan for the stormwater management facility to the Branch within twenty-one (21) days after final inspection.

8.2.3 Stormwater Management Facility Inspection for Preventive Maintenance

Inspections are performed after servicing of all stormwater management facilities in operation in the District of Columbia. If maintenance is required after initial inspection of the facility, a letter of notification is sent to the property owner or person designated as being responsible for maintenance (usually the property owner). Inspectors also ensure that the maintenance schedule and agreements are recorded with the Recorder of Deeds in the Office of Tax and Revenue as a specific Declaration of Covenant.

8.3 How Do I Schedule an Inspection?

All land disturbing activities require a building permit. After obtaining a building permit from the D.C. Department of Consumer and Regulatory Affairs, the owner/contractor is required to call the Inspection and Enforcement Branch at least 24 hours before the start of excavation or grading to schedule a pre-construction meeting or an initial site inspection.
Please call (202) 535-2977 for inspection scheduling.

8.4 Infiltration Device Construction Inspection Report

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DISTRICT DEPARTMENT OF THE ENVIRONMENT
OFFICE OF NATURAL RESOURCES
WATERSHED PROTECTION DIVISION/INSPECTION AND ENFORCEMENT BRANCH

Infiltration Device Construction Inspection Report

Building Permit # _____ Plan # _____ Lot: _____ Square: _____

Project Name and Address: _____

_____ Ward: _____

Contractor: _____ Telephone # _____

Engineer: _____ Telephone # _____

Responsible For Maintenance: _____ Telephone # _____

Date Started: _____ Final Inspection Date: _____

Structure Type: Infiltration Trench _____ Dry Well _____ Other _____

As-Built Plan Due Date: _____

Inspection Items:	Yes	No	Remarks	Date Completed
Site Plan and Infiltration Test Information: Is subgrade suitable?				
Is soil consistent with test results?				
Infiltration device: Is the infiltration device located as per approved plan?				
Are dimensions per approved plan specifications? (width, depth, length or diameter and depth)				
Is Geotextile fabric installed per approved plan specifications?				
Does stone type conform to approved plan specifications?				
Are invoices provided for all materials ?				
Overflow/Bypass: Are underdrains or bypass required?				
Outflow to public sewer, wetland, other? (CSS or MS4)				
Are cleanouts installed per approved plan?				

Contractor/Engineer _____ Inspector _____ Date _____

DDOE(WHITE) OWNER/AGENT(YELLOW) INSPECTOR (PINK)

DOH/WPD Infiltration 06/2007

8.5 Stormwater Infiltration Facility Dewatering Log

Inspection Date	Rain Date	Dewatering Date	Maintenance Service Date

8.6 Infiltration Device Maintenance Inspection Report

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DISTRICT DEPARTMENT OF THE ENVIRONMENT
OFFICE OF NATURAL RESOURCES
WATERSHED PROTECTION DIVISION/INSPECTION AND ENFORCEMENT BRANCH

Storm Water Infiltration Facility
MAINTENANCE INSPECTION

Name / Address: _____ WPD No: _____

Mailing Address: _____ Ward:_____

Owner/ Agent: _____ Telephone: _____ Lot: _____ Square:_____

Last Inspection Date:_____ Last ServiceDate:_____

Infiltration Device Type: Dry Well _____ Infiltration Trench_____Other_____

List all other Storm Water Management Facilities on Site:_____

1. Above Ground Condition:

Vegetation and Ground Cover Type: _____ Surface Erosion Present? Yes /No

Observations_____

_____

2. Inlets:

Type _____ Total Number _____Repair _____ Clear of Debris ____

Observations _____

_____

3. Structural Components and Function:

Observation Wells_____ Condition of Infiltration Area _____Over flow Devices_____

Sediment Accumulation _____Standing Water _____Debris Accumulation _____ Last Rain Event >1" +/- _____ Days/Hours

Observations _____

_____

Inspector _____ Received By _____ Date _____

Referral/Enforcement

Infiltration facility 8/2006

8.7 Bioretention Construction Inspection Report (Page 1)

GOVERNMENT OF THE DISTRICT OF COLUMBIA **Page 1 of 2**
DISTRICT DEPARTMENT OF THE ENVIRONMENT
OFFICE OF NATURAL RESOURCES
WATERSHED PROTECTION DIVISION/INSPECTION AND ENFORCEMENT BRANCH

Bioretention Facility Construction Inspection Report

Building Permit # _____ Plan and File # _____ Lot: _____ Square: _____

Project Name and Address: _____ Ward: _____

Contractor: _____ Telephone # _____

Engineer: _____ Telephone # _____

Responsible For Maintenance: _____ Telephone # _____

Date Started: _____ Final Inspection Date: _____

As-Built Plan Due Date: _____

Inspection Items	Yes	No	Remarks	Date Completed
Flow Splitter/Over Flow Drain: Is overflow invert at correct elevation? Is inflow pipe to filter plugged with watertight seal (Prior to Stabilization)?				
Basin and Liner (where Applicable): Basin graded as per approved plan? Basin liner material and installation meets specification of approved Plan? (attach labeled sample)				
Collector System: Does collector pipes meet specifications with correct hole pattern and correct geotextile wrap? **(Attach Materials Invoice)** Does collector stone and stone beneath sand meet specifications and is installed to design depth?				
Filter Components: Does filter sand meet specifications? (attach lab report/certification) Does planting soil meet design specifications? Planting soil installed to design depth and compacted on _____ (date) and refilled to designed depth.				

8.8 Bioretention Construction Inspection Report (Page 2)

GOVERNMENT OF THE DISTRICT OF COLUMBIA **Page 2 of 2**
DEPARTMENT OF THE ENVIRONMENT
OFFICE OF NATURAL RESOURCES
WATERSHED PROTECTION DIVISION/INSPECTION AND ENFORCEMENT BRANCH

Bioretention Facility Construction Inspection Report

Inspection Items	Yes	No	Remarks	Date completed
Bioretention Plant Materials: Do plants meet size and variety specifications? Are all plants installed as per landscape plan? Is mulch and cover crop installed as per plan specifications? Are plant/ trees staked as per specifications? Has watering of plant material been provided at the end of each day for fourteen consecutive days after planting has been completed.				
Clear well Manholes and Inlets: Is clear well free of construction debris and soil? Is outflow pipe invert at the design elevation?				

Note: A qualified professional must treat disease plants. Deficient stakes and wires must be replaced. Dead plants or plants diseased beyond treatment must be replaced by plant meeting original specifications. New plants must be watered every day for the first 14 days after planting.

Owner/Agent_____Inspector_____Date_____

DDOE (WHITE) OWNER/AGENT (YELLOW) INSPECTOR (PINK)

Bioretention construction inspection 7/2007/wpd

8.9 Bioretention Maintenance Inspection Report

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DISTRICT DEPARTMENT OF THE ENVIRONMENT
OFFICE OF NATURAL RESOURCES
WATERSHED PROTECTION DIVISION/INSPECTION AND ENFORCEMENT BRANCH

Bioretention Facility
MAINTENANCE INSPECTION

Name / Address:_____WPD No_____

Mailing Address: _____Ward:_____

Owner / Agent : _____Telephone :_____Lot: _____ Square: _____

As-Built Plan Available Y/N Last Inspection Date: _____Last Service Date:_____

List all other Storm Water Management Facilities on Site: _____

1. Inlets and Drainage Area Stabilization:

Inlet Type (s)_____Total Number_____ Repair Needed _____Clear of Debris/ Sediment_____

Evidence of erosion in drainage area _____Area mowed and clippings removed_____ Drainage area clear of debris _____

Observations _____

_____

2. Bioretention Facility:

Evidence of filter surface clogging _____ Overflow structure clear of debris_____ Grates in good repair_____ Evidence of erosion _____

Under drains and cleanouts _____ Mulch covers entire area to specific thickness _____ Bioretention basin clean of sediments _____

Observations _____

_____

3. Plants:

Specific number and types of plants in place _____ Dead or diseased plants _____ Stakes and wires_____Watering adequate _____

Observations _____

_____

Note: A qualified professional must treat disease plants. Deficient stakes or wires must be replaced. Dead plants or plants beyond treatment must be replaced by plants meeting original specifications. New plants must be watered every day for the first 14 days after planting.

Inspector_____ Received By_____ Date_____

DDOE(WHITE) OWNER/AGENT(YELLOW) INSPECTOR (PINK)

Bioretention maintenance inspection 7/2007/wpd

9.0 Additional Resources

District of Columbia Department of the Environment (DDOE). May 2001. *Stormwater Management Guidebook.*

Schueler, T. 1995. *Site Planning for Urban Stream Protection*. Metropolitan Washington Council of Governments. Washington, D.C.

Natural Resources Defense Council (NRDC). May 1999. *Stormwater Strategies: Community Responses to Runoff Pollution*. www.nrdc.org/water/pollution/storm/stoinx.asp

National Resources Defense Council (NRDC). July 2002. *Out of the Gutter: Reducing Polluted Runoff in the District of Columbia.* www.nrdc.org/water/pollution/gutter/gutterinx.asp

LID Techniques

General
www.lid-stormwater.net/site_map.htm
www.epa.gov/owm/mtb/mtbfact.htm
www.duluthstreams.org/stormwater/toolkit/tools.html

Infiltration Devices
www.epa.gov/npdes/pubs/infltrenc.pdf

Miss Utility
www.missutility.net/

Permeable Pavement
www.lid-stormwater.net/permpavers_benefits.htm
www.epa.gov/owow/nps/pavements.pdf
www.icpi.org/
www.nrmca.org/

Rain Garden/Bioretention
www.raingardens.org/Index.php
www.mninter.net/~stack/rain/
www.lowimpactdevelopment.org/raingarden_design/

Rain Barrels
www.mapc.org/regional_planning/LID/cisterns_barrels.html
www.stormwatercenter.net/Pollution_Prevention_Factsheets/rain_barrels.htm
www.lid-stormwater.net/raincist_home.htm

Research
www.udc.edu/dc_water_resources/about_us.htm (University of the District of Columbia)
www.ence.umd.edu/~apdavis/Bioongoing.htm (University of Maryland)

10.0 Acknowledgements

David Eckert	Producer, Virginia Village Productions
Michael Hamilton	Videographer, Hamilton Video
Sheila Besse	Associate Director, Watershed Protection Division, District Department of the Environment
Walter Caldwell	Environmental Protection Specialist, District Department of the Environment
Joanne Goodwin	Grants Coordinator, Fisheries and Wildlife Division, District Department of the Environment
George Hawkins	Director, District Department of the Environment
Dr. Hamid Karimi	Deputy Director, District Department of the Environment
Bryan King	Associate Director, Fisheries and Wildlife Division District Department of the Environment
Timothy Karikari	Branch Chief, Sediment Storm Water and Technical Review Branch District Department of the Environment
Abdi Musse	Acting Chief of Inspection and Enforcement, District Department of the Environment
Tari Caldwell	Development Researcher, The Nature Conservancy
Ann English	Landscape Architect, Low Impact Development Center, Inc.
Megan Kirby	Office Assistant, Low Impact Development Center, Inc.
Robb Lukes	Environmental Engineer, Low Impact Development Center, Inc.
Michelle Pawlish	Environmental Scientist, Low Impact Development Center, Inc.
Neil Weinstein	Executive Director, Low Impact Development Center, Inc.