Bioretention Area (BA)

Source: Source: Department of Environmental Resources, Prince George's County, MD

Practice Description

A bioretention area is a shallow, vegetated depression incorporated into a development's landscape. The purpose of bioretention is to restore, as much as possible, an area's pre-development hydrology and provide both water quantity and water quality benefits.

Stormwater is conveyed as sheet flow to the bioretention area that temporarily stores runoff. As stormwater percolates through the bioretention area, soils and plants remove pollutants. Filtered stormwater is then directed to the conveyance system or if underlying soils are appropriate, stormwater is allowed to infiltrate to the aquifer below and provide recharge.

A bioretention area is a suitable stormwater practice for commercial, transportation, industrial, and residential developments. Applications include parking lot islands, roadway medians, roadside swales, and residential gardens positioned to collect roof and parking lot runoff. Bioretention is particularly effective on sites of 1 acre or less. Bioretention is used on larger sites with multiple bioretention areas treating sub-drainages. In general, a bioretention area is a suitable stormwater management practice for residential subdivisions and high density/ultra urban sites but not for regional-scale control. [1]

Typical Components of the Practice

Site Preparation
Product Installation
Erosion and Sediment Control
Construction Verification

Construction [2]

Prior to start of construction, bioretention area should be designed by a qualified design professional. Throughout the construction process, field personnel should refer to plans and specifications. Bioretention areas are generally finished last during construction to minimize sediment delivery.

Site Preparation

Install erosion and sediment control measures on adjacent areas before any site clearing, grading or excavation to prevent sediment from entering into the bioretention area.

Before the site is graded, rope off the bioretention area to prevent heavy equipment from compacting the underlying soils.

Determine the exact location of underground utilities.

If practical, redirect stormwater runoff to prevent runoff and sediment from entering the site during construction by using practices such as diversions and swales.

Stabilize any disturbed ground outside of where bioretention area is to be installed with vegetation.

Remove and stockpile the topsoil from the bioretention area.

Use earthmoving equipment with tracks or oversized tires to clear, grub and grade the site. Avoid normal rubber tires because they compact the subsoil and reduce its infiltration capabilities. Earthmoving in wet conditions should be avoided.

If curb openings exist that provide stormwater to the site they should be blocked during construction to prevent drainage onto the construction area.

Excavate the bioretention area to invert depth specified in design. Scarify remaining soil surface, taking measures not to compact underlying material.

Product Installation

Install underdrain system (including gravel diaphragm) and observation wells, if specified in design.

Backfill bioretention area with previously prepared soil mixture. See project design for specifications on soil mixture. Wet soil mixture and allow soil to settle.
Note – typically settlement will take ¼ of a day.

Add or remove soil mixture to achieve proper design grade. Leave appropriate space for mulch layer.

Install selected vegetation.

Mulch area and install area's entrance energy dissipater specified

Notes relating to Materials Installation

- Inspection of underdrain system (piping, connections, gravel bed, and any filter fabric) should be performed prior to filling in bioretention area. Gravel, pipe, and filter fabric should have manufacturer's tickets.

- If gravel diaphragm is part of underdrain system design, avoid dropping gravel into area from high levels (e.g. from a backhoe or front end loader). Gravel should be spilled directly over underdrain and spread manually.

- Allow bioretention soil to settle naturally as described above to avoid over-compaction. Do not provide any additional manual compaction. If speeding up this process is desired, pre-soak soil before placing in bioretention area.

- Soil should be overfilled above proposed surface so that post-settlement level of material will be at the proper grade. Soil materials can naturally compact up to 20% depending on soil type.

Erosion and Sediment Control

The importance of effective erosion and sediment control during and after construction should be thoroughly understood by responsible construction personnel.

Erosion and sediment control measures planned for the adjacent areas must be effective to prevent failure of the bioretention area.

Construction sequencing is vital. Construction activity in the contributing drainage area should be completed and disturbed areas stabilized before construction of bioretention area. Design drawings should specify the sequence of construction.

Construction Verification

Check the finished grades and configuration for all earthwork. Check elevations and dimensions of all pipes. Check soil additions for adherence to plan. [3]

Common Problems

Consult with a qualified design professional if any of the following occur:

- Variations in topography or site geology indicate bioretention will not function as intended.
- Design specifications for fill, pipe, gravel, filter fabric and other material cannot be met. Unapproved substitutions could lead to failure.

Maintenance

Maintenance of bioretention areas is similar to the routine maintenance typical of any landscaped area. When plants native to the area are used, need of fertilizer, pesticide, and water is minimized.

Exercise caution during the application of fertilizers and pesticides in and around the bioretention area to prevent the possibility of surface and ground water contamination.

As plants mature in bioretention area, landscaping management requirement are lessened.

Typical aspects of bioretention maintenance include sediment and debris removal from the system, replacement of dead plant material, regulation of soil pH, repair of eroded areas, re-mulching, unclogging of underdrain, and repair of overflow structure repair.

Sediment must be kept from entering the bioretention area after construction.

An operation and maintenance checklist is helpful in ensuring that maintenance activities are scheduled appropriately. A template is available in one of the references.[4]

References

[1] Georgia Stormwater Management Manual, Volume 2 – Technical Manual. Section 3.2.3 Bioretention Areas

[2] The Bioretention Manual. Prince George's County, Maryland. Access manual at http://www.goprincegeorgescounty.com/government/agencyindex/der/lid/bioretention.asp

[3] Templates provided by http://stormwatercenter.net
Inspection checklist available at
http://www.stormwatercenter.net/Manual_Builder/CHECKLISTS/Filters/Construction/Bioretention%20construction%20inspection%20checklists.pdf

[4] Operation and Maintenance checklist available at
http://www.stormwatercenter.net/Manual_Builder/CHECKLISTS/Filters/Operation%20and%20Maintenance/operation%20maintenance%20and%20management%20inspection%20checklists%20-%20Bioretention.pdf

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Porous Pavement (PP)

Practice Description

Porous pavement is a permeable load-bearing layer that reduces runoff by providing infiltration, and can be underlain by a stone reservoir for stormwater storage. The practice with a stone reservoir is designed to intercept storm runoff and allow it to gradually infiltrate into the subsoil. In addition, porous pavement may provide groundwater recharge, augment low flow in streams during dry periods, reduce downstream flooding and protect water quality. The practice is applicable for areas with low traffic, such as overflow parking lots and lightly used access roads that are on relatively gentle slopes and permeable soils.

Porous pavement falls into 3 different categories based on the extent of storage provide by the stone reservoir: a full exfiltration system (stores the entire design storm), a partial exfiltration system (stores a portion of the design storm) and a water quality exfiltration system (provides infiltration only or stores the first flush or some portion of a design storm and conveys the excess runoff to a conventional stormwater management facility).

Concrete grids, modular pavement, or similar products will be considered as a part of this practice.

Typical Components of the Practice

Site Preparation
Product Installation
Full Exfiltration Systems
Partial Exfiltration Systems
Water Quality Exfiltration Systems
Concrete Grids & Modular Pavements
Erosion and Sediment Control
Construction Verification

Construction

Prior to start of construction, porous pavement should be designed by a qualified design professional. Plans and specifications should be referred to by field personnel throughout the construction process.

Consider the following guidance as construction proceeds.

Site Preparation

Before the site is graded, rope off the porous pavement area to prevent heavy equipment from compacting the underlying soils.

Determine the exact location of underground utilities.

Install Diversions to prevent runoff and sediment from entering the site during construction.

Use earthmoving equipment with tracks or oversized tires to clear, grub and grade the site. Avoid normal rubber tires because they compact the subsoil and reduce its infiltration capabilities. Earthmoving in wet conditions should be avoided.

Remove and stockpile topsoil.

Grade the site to design elevations and dimensions shown for the reservoir subgrade.

The subgrade should be reasonably smooth and free of loose rocks and clods, holes, depressions, muddy conditions or flowing water.

Product Installation

For All Products (based on the design plan)

Line the bottom and sides of the reservoir area with filter fabric, and install observation well, filler and filter stone. Typical installations include the following actions:

- using anchors to ensure the fabric is secured to the subgrade;
- installing the observation well at a designed location and elevation;
- placing stone of the specified gradation in uniform layers to the designed thickness and compacting each layer of stone lightly after it is placed;

Additional actions specific for the type of installation include the following guidelines.

Full Exfiltration System

After stone placement, install an emergency overland channel (curb or swale) to carry flows greater than the design storm.

Partial Exfiltration System

After stone placement, install perforated drainpipe and associated outlet structures at the locations and grades shown in the design plan. Drainpipes should be installed near the top of the stone reservoir.

Water Quality Exfiltration

After stone placement, install perforated drainpipe and associated outlet structures at the locations and grades shown in the design plan. Drainpipes should be installed near the top of the stone reservoir.

Concrete Grids and Modular Pavements

After stone placement, install perforated drainpipe and associated outlet structures at the locations and grades shown in the design plan. Drainpipes should be installed near the top of the stone reservoir.

Install the product and fill the open spaces within the pavement with gravel or other material according to the design plan and manufacturer's recommendations.

Notes relating to Materials Installation

- Rolling required for permeable asphalt, grid and modular pavement is critical and must be done strictly according to the design plan to prevent problems with infiltration and load bearing strength.
- After rolling is complete, all traffic should be kept out of the porous pavement area for a minimum of 1 day to allow proper hardening.

- If new utility lines are buried beneath the porous pavement site, do not construct the stone reservoir until all trench settlement has taken place.

Erosion and Sediment Control

Sediment control is critical during and after construction; therefore, erosion and sediment control measures planned for the adjacent areas must be effective to prevent loss of infiltration capacity of the porous pavement.

Vegetated filter strips should be placed around the porous pavement, concrete grids and modular pavements.

Reinforced silt fences should be placed around porous pavement, concrete grids and modular pavements while vegetation is being established.

Signs should be posted and construction personnel advised not to enter the parking lot or access area with muddy tires.

Store all construction materials and waste material well away from the porous pavement site.

Provide temporary fencing and post warning signs around the porous pavement until vegetation in the filter strip is established.

Install additional planned measures that are needed to drain and control stormwater runoff from the site.

Construction Verification

Check the finished grades and configuration for all earthwork. Check elevations and dimensions of all pipes and structures.

Common Problems

Consult with a qualified design professional if any of the following occur:

- Variations in topography or site geology indicate porous pavement will not function as intended.
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- Design specifications for fill, pipe, gravel, filter fabric and asphalt paving material cannot be met. Unapproved substitutions could lead to failure.

Maintenance

Inspect the porous pavement after each storm event. Inspectors should check for ponding on the surface which might indicate local or widespread clogging.

The condition of the vegetative filter strip should be inspected.

The observation well should be checked several times in the first few months after construction. Water depth in the well should be measured at 0, 24, and 48 hour intervals after a storm.

The porous pavement site should be posted with signs indicating the nature of the surface, and warning against resurfacing the site with conventional pavement or the use of materials which could affect the infiltration capacity of the surface.

Sediment must be kept completely away from a porous pavement site after construction.

Asphalt type porous pavements should be vacuum swept at least 4 times per year, followed by high-pressure jet hosing to keep the asphalt pores open.

Potholes and cracks in asphalt porous pavement can be repaired using conventional, nonporous patching mixes as long as the cumulative area repaired does not exceed 10% of the parking lot area.

Spot clogging of the asphalt porous pavement layer can be relieved by drilling ½" holes through the porous asphalt layer every few feet. In cases where clogging occurs in a low spot in the parking lot, it may be advisable to install a drop inlet to route water into the stone reservoir.

Follow guidelines for porous pavement maintenance to maintain concrete grids and modular pavements. Where vegetation is planted in the grids, mowing, fertilizing and irrigation may be needed.

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Stormwater Detention Basin (SDB)

Practice Description

A stormwater detention basin is a dam-basin practice designed to hold stormwater runoff and release the water slowly to prevent downstream flooding and stream erosion. The practice is an extremely effective water quality and peak discharge reduction measure. Its usage is best suited to larger, more intensively developed sites. Structure life is 10 years or more. A stormwater detention basin can have a permanent pool of water or be designed to have a dry basin (typical). A detention basin can be designed to also serve as a sediment basin during the construction period.

Typical Components of the Practice

- Site Preparation
- Keyway Trench
- Principal Spillway
- Skimmer and Baffles
- Embankment
- Emergency Spillway
- Erosion Control
- Safety
- Construction Verification

Construction

Prior to start of construction, the stormwater detention ponds should be designed by a qualified design professional.

Plans and specifications should be referred to by field personnel throughout the construction process. The measure should be built according to the planned grades and dimensions and include all essential components. Follow all federal, state and local requirements on impoundments.

Consider the following guidance as construction proceeds.

Site Preparation

Locate all underground utilities to ensure avoidance.

Clear, strip, grub and excavate the dam location, removing all woody vegetation, rocks and other objectionable material, such as soft, wet, or sandy soils. Stockpile surface soils with high organic content for later use. Dispose of trees, limbs, logs and other debris in designated disposal areas.

If possible, construct the dam prior to clearing and disturbance of the pool area. Stockpile any surface soil having high amounts of organic matter for later use.

Where practical, maintain existing vegetation of at least 25 feet around the pool as a filter strip (see *Preservation of Vegetation* practice).

Keyway Trench

Excavate the keyway trench along the centerline of the planned embankment to a depth determined by the qualified design professional (at least 2 feet). The trench bottom elevation should extend up both abutments to the emergency spillway elevation and have a bottom width of at least 8 feet and have side slopes no steeper than 1.5:1 or flatter. Compaction requirements for the keyway backfill will be the same as those for the embankment.

Principal Spillway

Prepare the pipe bedding and situate the spillway barrel (pipe) and riser on a firm, even foundation.

Place around the barrel a 4” layer of moist, clayey, workable soil (not pervious material such as sand, gravel or silt), and compact with hand tampers to at least the density of the foundation soil. Do not raise the pipe from the foundation when compacting under the pipe haunches. Continue with backfill of the pipe in 4” to 6” uncompacted layers scarifying the surface between each compacted layer. All backfill material within 2 feet of the pipe (beside the pipe and above the pipe) should be compacted with hand tampers only.

Install the anti-seep collars or sand drainage diaphragm according to the design specifications.

Set the top of the riser at the elevation shown on the design drawings to allow the detention pond to store the design runoff. Install the 4 inch dewatering orifice at the designed elevation on the side of the riser pipe and complete with a trash rack device.

Embed the riser into the concrete anti-flotation block as shown on the design drawing. The concrete block should be constructed to the dimensions shown on the drawings to balance the buoyant force acting on the riser.

Install the trash rack around the riser inlet. The trash rack should have the minimum dimensions shown on the design.

At the pipe outlet, install outlet protection according to the design plan (if not specified, use a riprap apron at least 5 feet wide to a stable grade).

Skimmer and Baffles

Skimmer and baffles will be required if the stormwater detention basin is to serve as a sediment basin during the construction phase of the project.

Assemble the skimmer following the manufacturer's instructions, or as designed.

Lay the assembled skimmer on the bottom of the basin with the flexible joint connected water tight at the base of the riser pipe. Be sure to attach a rope to the skimmer and anchor it to the side of the basin. This will be used to pull the skimmer to the side for maintenance.

Prevent the skimming device from settling into the mud by excavating a shallow pit under the skimmer or providing a low support under the skimmer of stone or timber.

Install a minimum of 3 porous coir baffles as specified and ensure flows do not go under or around the baffles.

Embankment

Scarify the embankment foundation before placing fill.

Use fill from predetermined borrow areas. It should be clean, stable, mineral soil free of organic material, roots, woody vegetation, rocks and other debris; and must be wet enough to form a ball without crumbling, yet not so wet that water can be squeezed out.

Place the most permeable soil in the downstream toe and the least permeable in the center portion of the dam.

Place the fill material in 6” to 9” continuous uncompacted layers over the length of the dam. Fill should then be compacted to a 4” to 6” thick continuous layer (one way is by routing pneumatic tired construction equipment over the dam so that each layer is traversed by at least 4 passes of the equipment). Compacted layers with a slick surface should be scarified prior to the next lift being placed in order to promote bondage between the layers.

Protect the principal spillway barrel with 2 feet of hand tamped, compacted fill before traversing over the pipe with equipment.

Construct and compact the dam to an elevation 10% above the design height to allow for settling. The embankment should have a minimum 8 feet top width and 2.5:1 side slopes (3:1 for mowable slopes), but the design may specify additional width and gentler side slopes.

Place a stake marking the depth of sediment accumulation at which sediment must be cleaned out of the basin (50% of design storage volume).

Emergency Spillway

Construct the spillway at the site located, to the dimensions, and utilizing the surface treatments specified by a qualified design professional according to the design plan. In most all cases, the emergency spillway will be constructed in undisturbed soil around one end of the embankment so that any flow will return to the receiving channel without damaging the embankment.

Erosion Control

Minimize the size of all disturbed areas. At the completion of each phase of construction, stabilize the disturbed areas to minimize erosion.

Stabilize the spillway with vegetation as soon as grading is complete; or install paving material to finished grade if the spillway is not to be vegetated.

Use temporary diversions to prevent surface water from running onto disturbed areas.

Divert sediment-laden water to the upper end of the sediment pool to improve trap effectiveness.

Direct all runoff into the pond at low velocity.

Establish vegetation on all disturbed areas not previously treated including the bottom and side slopes of the basin.

Safety

Because stormwater detention basins that impound water are hazardous, the following precautions should be taken:

Provide a means of dewatering the basin between storm events.

Fence area and post with warning signs if trespassing is likely.

Construction Verification

Check the finished grades and configuration for all earthwork. Check elevations and dimensions of all pipes and structures.

Common Problems

Consult with a qualified design professional if any of the following occur:

- Variations in topography on site indicate detention pond will not function as intended.
- Seepage is encountered during construction; it may be necessary to install drains.
- Design specifications for fill, pipe, seed variety or seeding dates cannot be met; substitutions may be required. Unapproved substitutions could lead to failure.

Maintenance

Inspect the stormwater detention basin after each storm event.

Remove and properly dispose of sediment when it accumulates to ½ the design volume.

Periodically check the embankment, emergency spillway and outlet for erosion damage, piping, settling, seepage or slumping along the toe or around the barrel; and repair immediately.

Remove trash and other debris from the riser, skimmer, emergency spillway and pool area. Remove nuisance vegetation on embankment.

Remove animals that burrow into the dam.

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