Bioretention Design

Lesley Brooks, P.E., CFM
Mike Wilkins, P.E., LEED AP

Agenda

15 min.: Basics of Bioretention
20 min: Design Standards and Criteria
15 min: Maintenance and Inspection
10 min: Bioretention in the Region
Basics of Bioretention

• Also called rain gardens
• Treatment through filtration, infiltration, and biological
• Applicable to small drainage areas. Less than 2 acres recommended with maximum of 5 acres

• Length to width ratio of 2:1
• Drain time of less than 48 hours

Basics of Bioretention

• **Common questions**
  – Will using bioretention create breeding grounds for mosquitos?

• Mosquito eggs and larva are aquatic, need water to survive.
• If water dries out, eggs die.
• The required drawdown rates drain the water before a pupa can develop.
Basics of Bioretention

6-12” Ponding Water
2-3” Mulch, Compost, or Landscape Rock
2-4’ Engineered Planting Soil
6” -1’ Gravel

Basics of Bioretention

PARKING LOT SHEET FLOW
CURB STOPS
OUTLET
OVERFLOW "CATCH BASIN"
STONE DIAPHRAGM
GRASS FILTER STRIP
OPTIONAL BAND LAYER
PIPE CLEANOUT WITH RISER
GRAVEL CURTAIN DRAIN OVERFLOW
UNDERDRAIN COLLECTION SYSTEM

PLATE VIEW

Bioretention Design
Basics of Bioretention
Basics of Bioretention

Charlotte-Mecklenberg Stormwater Services

Basics of Bioretention

NCDENR Stormwater BMP Manual 07/09
Basics of Bioretention

Basics of Bioretention
Bioretention Design

July 23, 2011

Basics of Bioretention

Efficiency

<table>
<thead>
<tr>
<th>%</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>60%/50%</td>
<td>Nutrients (Total Phosphorus/Total Nitrogen)</td>
</tr>
<tr>
<td>80%</td>
<td>Metals (Cadmium, Copper, Lead, and Zinc)</td>
</tr>
<tr>
<td>No Data</td>
<td>Pathogens (Coliform, Streptococci, E. Coli)</td>
</tr>
</tbody>
</table>

Basics of Bioretention

- How to Calculate the Water Quality Volume

1. Calculate the volumetric runoff coefficient

\[ R_v = 0.05 + 0.009(I) \]

where I = percent of impervious cover (%)

2. Calculate the water quality volume \( (WQ_v) \)

\[ WQ_v = \frac{1.5 R_v A}{12} \]

where:
\[ WQ_v = \text{water quality protection volume (acre-feet)} \]
\[ R_v = \text{volumetric runoff coefficient} \]
\[ A = \text{total drainage area (acres)} \]
Basics of Bioretention

Calculating the area of bioretention:

- Use Darcy’s Law equation to determine the required ponding area

\[ Af = \frac{(WQ_v)(d_f)}{[(k)(h_f + d_f)(t_f)]} \]

Where:
- \( Af \) = surface area of ponding area (ft²)
- \( WQ_v \) = water quality volume (ft³) [1 acre-feet = 43,560 cubic feet]
- \( d_f \) = Engineered planting soil depth (ft) [2 to 4 ft]
- \( k \) = design coefficient of permeability for filter media (ft/day) [use 0.5 ft./day to as a conservative design rate for bioretention soil infiltration]
- \( h_f \) = average height of water above filter bed (ft) [typically half of max depth]
- \( t_f \) = design filter bed drain time (days) [2 days or 48 hours recommended]

Basics of Bioretention

Bioretention Exercise (10 min.)

A commercial development is being planned for a 5 acre lot with an equivalent drainage area and 80% proposed impervious cover. They plan on treating their water quality volume with a bioretention pond. Assume a filter bed depth of 3 feet and a max ponding depth of 6 inches.

What is the water quality volume?
What is the required area of a bioretention pond?
Basics of Bioretention

Bioretention Exercise

Step 1) Determine the water quality volume

\[ WQ_v = \frac{1.5(0.77)(5)}{12} = 0.48 \text{ acre ft} \]

Step 2) Determine the surface area of the ponding area

\[ A_f = \frac{(20,909)(3)}{[(0.5)(0.25 + 3)(2)]} = 19,300 \text{ sq. ft.} \]

With 2:1 ratio requirement area should be approx. 196.5 ft by 98.25 ft

Cost of Bioretention

EPA Cost Estimate = 7.30 * V^{0.99}

where: V = bioretention volume in cubic feet

For example problem: 7.30 * 20,909^{0.99} = $138,182

Cost savings:
Curb, Inlets, Pipe, etc.
Design Standards and Criteria

2-3" Mulch, Compost, or Landscape Rock

Typical Section
Mulch Standards

- Commercially available double or triple shredded and screened hardwood mulch or chips
- Stock piled or stored for 6 to 12 months
- No soil or fine organics
- No grass clippings or pine straw
- Uniform in color
Design Standards and Criteria

**Engineered Soil Standards**

- Minimum of 2 feet deep. 4 feet if trees are present.
- Locate on A or B soils where possible
- Free of stones, lumps, or roots larger than 2”
- Sandy loam, loamy sand, or loam texture
- Sand content of 50-60%
- Leaf compost content of 20-30%
- Topsoil content of 20-30%
- Clay content of 5 to 8%
- Organic content (such as peat moss) of 1.5 to 3%

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**Engineered Soil Standards**

- Infiltration rate of at least 0.5 in/hr to 1.5 in/hr (1.0 ft/day to 3.0 ft/day)
- pH between 5.5 and 7.0
- Maximum soluble salt concentration of 500ppm
- Uniform mix
- Required tests include a sieve analysis, pH, and organic matter test
- Phosphorus index between 10 and 30
Design Standards and Criteria

**Engineered Soil Standards**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>ACCEPTABLE VALUES</th>
<th>TESTING REQUIRED</th>
<th>TEST METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Content (ASTM C-144 recommended)</td>
<td>80%</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Organic Material (compost, sandy loam, and loamy sand)</td>
<td>20%</td>
<td>No</td>
<td>TMECC 05.07-A</td>
</tr>
<tr>
<td>Clay Content</td>
<td>Less than 6%</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Phosphorus Index (total Phosphorus)</td>
<td>10 to 30 (12 to 36 ppm on a dry basis)</td>
<td>Yes</td>
<td>Mahlich 3 Extraction, Mehlich 2 Extraction (Mehlich 1 Extraction is acceptable but result must be multiplied by 1.7 for comparison)</td>
</tr>
<tr>
<td>pH</td>
<td>5.5 to 7.0</td>
<td>No</td>
<td>TMECC 04.11-A</td>
</tr>
<tr>
<td>Permeability</td>
<td>1 to 4 in/hr</td>
<td>No</td>
<td>ASTM D434 (compacted to 20%)</td>
</tr>
</tbody>
</table>

**Particle Size Analysis**

<table>
<thead>
<tr>
<th>Sieve 2 inch (50 mm)</th>
<th>100</th>
<th>100</th>
<th>Yes</th>
<th>ASTM D422</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve No. 4 (4.75 mm)</td>
<td>50</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 8 (3.38 mm)</td>
<td>85</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 10 (2.0 mm)</td>
<td>95</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 16 (1.18 mm)</td>
<td>70</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 30 (600 um)</td>
<td>40</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 50 (300 um)</td>
<td>10</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 100 (150 um)</td>
<td>2</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve No. 200 (75 um)</td>
<td>0</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Design Standards and Criteria**

Alternative:
- Choking stone of washed pea gravel
- 4 to 9” layer above gravel
- ASTM D448 size No. 6, 1/8” to 3/8”
- 24” wide section of filter fabric placed between the gravel layer and pea gravel layer directly above the underdrain pipe

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Bioretention Design
Filter Fabric Standards

- Placed over the gravel layer and along sloping outer walls to limit infiltration before filtration and to prevent lateral flow under pavement
- Filter fabric shall be non-woven
- Minimum permittivity rate of 75 to 125 gal/min/ft²

<table>
<thead>
<tr>
<th>Geotextile Property</th>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezoidal Tear (lbs)</td>
<td>40 (min)</td>
<td>ASTM D4533</td>
</tr>
<tr>
<td>Permeability (cm/sec)</td>
<td>0.2 (min)</td>
<td>ASTM D4491</td>
</tr>
<tr>
<td>AOS (sieve size)</td>
<td>#60 - #70 (min)</td>
<td>ASTM D4751</td>
</tr>
<tr>
<td>Ultraviolet resistance</td>
<td>70% or greater</td>
<td>ASTM D4355</td>
</tr>
</tbody>
</table>

City of Santa Barbara Stormwater BMP Guidance Manual, June 2008
Design Standards and Criteria

**Gravel Layer Standards**

- Creates positive drainage, keeps underdrain free of sediment, aerobic conditions in the planting soil, and provides final polishing treatment.
- Gravel should be #57 (¼” – 1½”), double washed.
- AASHTO M-43 specification
- Drawdown within 72 hours

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>50</td>
</tr>
<tr>
<td>US No. 8</td>
<td>20</td>
</tr>
<tr>
<td>US No. 50</td>
<td>12</td>
</tr>
<tr>
<td>US No. 200</td>
<td>1</td>
</tr>
</tbody>
</table>

City of Santa Barbara Stormwater BMP Guidance Manual, June 2008
Design Standards and Criteria

Underdrain Standards

- 6-inch perforated PVC pipe, rigid Schedule 40 (AASHTO M 278)
- 3/8-inch perforations, spaced at 6-inch centers, with a minimum 4 holes per row
- Pipe spaced at a maximum of 10 feet on center
- Minimum grade of 0.5%
- Assume 50% capacity loss due to clogging

Underdrain Cleanout Standards

- 6-inch solid PVC cleanouts provided every 50 linear feet, at all bends, and ends of system
- Top of cleanouts should extend 6-inches above maximum ponding elevation
- One cleanout installed as emergency drain, even with top of mulch layer with a 6-inch threaded extension pipe
- All cleanouts shall have watertight, vandal-proof caps
Design Standards and Criteria

Landscaping Standards
- Tree-to-shrub ratio of 2:1 or 3:1
- Trees placed 8 feet apart
- Plants should be resistant to drought and inundation

<table>
<thead>
<tr>
<th>Commonly Used Species for Bioretention Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trees</strong></td>
</tr>
<tr>
<td>Acer rubrum, Red Maple (Zones 2, 3, 4)</td>
</tr>
<tr>
<td>Betula nigra, River Birch (Zones 4, 5)</td>
</tr>
<tr>
<td>Cercis canadensis, Eastern Redbud (Zones 4, 5)</td>
</tr>
<tr>
<td>Crataegus reverchonii, Reverchon’s Hawthorn (Zone 6)</td>
</tr>
<tr>
<td>Juglans nigra, Black Walnut (Zone 6)</td>
</tr>
<tr>
<td>Juniperus virginiana, Eastern Red Cedar (Zones 5, 6)</td>
</tr>
<tr>
<td>Platanus occidentalis, Sycamore</td>
</tr>
<tr>
<td>Quercus phellos, Willow Oak (Zones 3, 4, 5)</td>
</tr>
<tr>
<td>Quercus macrocarpa, Bur Oak (Zones 5, 6)</td>
</tr>
</tbody>
</table>
Design Standards and Criteria

<table>
<thead>
<tr>
<th>Zone #</th>
<th>Zone Description</th>
<th>Hydrologic Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>Deep Water Pool</td>
<td>1-6 feet depth (permanent pool)</td>
</tr>
<tr>
<td>Zone 2</td>
<td>Shallow Water Bench</td>
<td>Normal pool elevation to 1 foot depth</td>
</tr>
<tr>
<td>Zone 3</td>
<td>Shoreline Fringe</td>
<td>Regularly inundated</td>
</tr>
<tr>
<td>Zone 4</td>
<td>Riparian Fringe</td>
<td>Periodically inundated</td>
</tr>
<tr>
<td>Zone 5</td>
<td>Floodplain Terrace</td>
<td>Infrequently inundated</td>
</tr>
<tr>
<td>Zone 6</td>
<td>Upland Slopes</td>
<td>Seldom or never inundated</td>
</tr>
</tbody>
</table>

Maintenance and Inspection
**Table 2.1 Typical Maintenance Activities for Bioretention Areas**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pruning and weeding to maintain appearance.</td>
<td>As needed</td>
</tr>
<tr>
<td>• Mulch replacement when erosion is evident.</td>
<td>As needed</td>
</tr>
<tr>
<td>• Remove trash and debris.</td>
<td>As needed</td>
</tr>
<tr>
<td>• Inspect inflow points for clogging (off-line systems). Remove any sediment.</td>
<td>Semi-annually</td>
</tr>
<tr>
<td>• Inspect filter strip/grass channel for erosion or gullying. Re-seed or sod as necessary.</td>
<td>Semi-annually</td>
</tr>
<tr>
<td>• Trees and shrubs should be inspected to evaluate their health and remove any dead or severely diseased vegetation.</td>
<td>Semi-annually</td>
</tr>
<tr>
<td>• The planting soils should be tested for pH to establish acidic levels. If the pH is below 5.2, limestone should be applied. If the pH is above 7.0 to 8.0, then iron sulfate plus sulfur can be added to reduce the pH.</td>
<td>Annually</td>
</tr>
<tr>
<td>• Replace mulch over the entire area.</td>
<td>2 to 3 years</td>
</tr>
<tr>
<td>• Replace pea gravel diaphragm if warranted (or when the voids are obviously filled with sediment and water is no longer infiltrating).</td>
<td>2 to 3 years</td>
</tr>
</tbody>
</table>

(Source: EPA, 1999)

**North Carolina Division of Water Quality**

12.4.2. Sample Operation and Maintenance Provisions

Important operation and maintenance procedures:
- Immediately after the bioretention cell is established, the plants will be watered twice weekly if needed until the plants become established (commonly six weeks).
- Snow, mulch or any other material will NEVER be piled on the surface of the bioretention cell.
- Heavy equipment will NEVER be driven over the bioretention cell.
- Special care will be taken to prevent sediment from entering the bioretention cell.
- Once a year, a soil test of the soil media will be conducted.

After the bioretention cell is established, I will inspect it once a month and within 24 hours after every storm event greater than 1.0 inches (or 1.5 inches if in a Coastal County). Records of operation and maintenance will be kept in a known set location and will be available upon request.

Inspection activities shall be performed as follows. Any problems that are found shall be repaired immediately.
Maintenance and Inspection

Prince George’s County, Maryland – Bioretention Manual

• Sequence of Construction for Bioretention
• Bioretention Inspection Checklist
• Bioretention Plan Review Checklist
Sequence of Construction For Bioretention

1. Install sediment control devices as shown on the plans.
   -Construction time: ___________ Day(s)

2. Grade site to elevations shown on plan. If applicable, construct curb openings, and/or remove and replace existing concrete as specified on the plan. Curb openings shall be blocked or other measures taken to prohibit drainage from entering construction area. At the end of each workday, all excavations shall be protected by construction safety fencing or temporary backfill as needed.
   -Construction time: ___________ Day(s)

3. Stabilize grading within Limit of Disturbance except for Bioretention Area. Bioretention areas may be utilized as sediment traps if the proposed invert of the bioretention facility is 1' lower then the sediment trap.
   -Construction time: ___________ Day(s)

4. Excavate bioretention area to proposed invert depth and scarify the existing soil surfaces, taking care not to compact the in-situ materials.
   -Construction time: ___________ Day(s)

4a. Install underdrain system and observation wells, if specified
   -Construction time: ___________ Day(s)

5. Backfill bioretention area with planting soil as shown in the plans and detailed in the specifications. Overfilling is recommended to account for settlement.
   -Construction time: ___________ Day(s)

6. Presoak the planting soil prior to planting vegetation to allow for settlement. This can be done by water truck or allowing water to enter the pit from a rain event.
   -Construction time: ___________ Day(s)

7. Excavate or fill to achieve proper design grade, leaving space for the upper layer of mulch and/or topsoil that will bring the surface to final grade and ready for planting.
   -Construction time: ___________ Day(s)

8. Plant vegetation specified in the planting plan for Bioretention Area.
   -Construction time: ___________ Day(s)

9. Mulch and install erosion protection at entrance points; remove sediment control practices or entrance blocks with inspector authorization.
   -Construction time: ___________ Day(s)

**Total Estimated Construction Time:** ___________ Day(s)

Note: The times above represent construction time only and not the full duration of the individual activities. For example, activity six (presoak) may be one month long allowing for natural settlement to occur before proceeding to activity 7.
4.17 Inspectors Checklist for Bioretention

The following checklist has been derived and modified from a checklist developed by the Community Standards Division, Site Development Inspection Section for use when evaluating a bioretention facility during different phases:

4.17.1 Bioretention Inspection Checklist

1. Pre-construction Meeting
   - Approved Stormwater Management Plan
   - Disseminate inspection requirements; what needs inspection
   - Ticket and tag requirements & a copy of the geotechnical report (if available)

2. Excavation of Bioretention Area
   - Suitable sub-grade materials
   - Presence of moisture or water
   - Dimensions and placement of excavation conforms with plans
   - Sediment and erosion control devices in place

3. Installation Phase
   - Optional sand layer placed per plan
   - Backfill soil conforms with specifications and placed per details and specifications
   - Correct placement of ground cover or mulch cover
   - Correct placement of underdrains (size, schedule, location) where required
   - Correct placement of filter fabric
   - Proper placement of plant materials (type, size, quantity, tags)
   - Proper grade establishment

4. Final Inspection and As-Built
   - Original signed/sealed Certification Letter (for private facilities) and/or As-Built Plan (for public facilities) from a Maryland Registered Professional Engineer
   - Changes in grading, facility depth, size, soil medium, plant materials, etc., shall require an As-built Plan whether private or public to reflect the changes.
   - Maintenance Agreement/Covenant for bioretention facilities located on private property
   - All landscaping installed/landscape warrantee documentation received
   - Bioretention configuration, size and depth are in accordance with approved plans
   - Landscaping certification documentation for bioretention facility(ies)
   - Drainage area conforms to approved plan
   - Drainage area completely stabilized
2.16 Bioretention Site Submittal Requirements

BIORETENTION PLAN REVIEW CHECKLIST

Project Name: _______________________________________  Date Received: ____________
Project Address: ___________________________________________________________________
Case #: __________________________________

Accepted □ Not Accepted □ N/A

**Plan Standard Notes & Specifications**

- Notes on sediment & erosion controls.
- Sequence of Construction.
- Sediment control notes for bioretention facilities during construction.
- Specifications for construction materials.
- Specifications for planting soil medium requirements.
- Compaction Notes.
- Easements.
- Copy of concept letter.
- Storm drain notes.
- Stormwater management construction specifications.

**Plan Layout**

- Vicinity map.
- Owner / developer information.
- Approval box.
- Plan view of site & facilities.
- Cross-section along centerline of bioretention.
- Cross-section along stormdrain or flow path.
- Existing grades and proposed grades.
- Elevation at surface, ponding elevation.
- Standard detail for bioretention.
- Landscaping plan.
- Soil map.
- Inflow and discharge points/connections.
**Drainage Area to Facilities**

- DAM delineated to each facility.
- Drainage area less than 2 acres max.
- Facilities located near source.
- Facilities not to be placed where concentrated water discharge exceeds 3 cfs.

**Grading**

- Existing and proposed contours with limits of disturbance.
- Spot elevations at entrance invert.
- Underdrain invert elevation and facility invert elevation.
- ½ inch contours for detail at facility.
- Not crossing properties and 2-foot min. from property lines.
- Not to be built in public right of ways.
- Not to be built where wooded areas would need to be cleared to make room for the facility.
- Sloped areas exceeding 20% shall not be used for bioretention except “weep-gardens” designs.
- 25 ft. setback from the home foundation.

**Facility Components**

- Pretreatment - Erosion protection: RipRap, Reno mattress, etc.
- Flow entrance – Curb cut, curb deflector, pipe outfall, etc.
- Ponding area – depth 6 inch max.
- Planting soil medium – 50% construction sand, 20-30% organic leaf compost, and 20-30% topsoil with a max. of 5% clay content.
- Mulch and/or groundcover
- Filtering mechanism
  - Gravel & Filter Cloth
  - Peagravel
  - Other
- Underdrain or outlet - Approved pipe material, pipe size perforation size.
- Safe overflow allowance
Design Computations

Facilities designed for water quality and/or water quantity control

Method of Sizing:
- MD Unified Sizing Methodology
- Prince George’s LID Methodology
- Prince George’s % DA Methodology

Post Development RCN Value

Geotechnical Report.

Landscaping Detail

- Plan view of landscaping.
- Plant list.
- Planting notes.
- Planting schedule and specifications.
- Standard detail for planting.
- Use bioretention plant list – (No exotic or invasive plants).

Permitting

- Sediment / Erosion Control.
- Stormdrain permit for construction.
- Easement or Maintenance Covenant

COMMENTS:
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

First Review: Reviewer ____________________________ Date ____________
Please complete all items checked “Not Accept” and return with corrections.

Second Review: Reviewer ____________________________ Date ____________
Please complete all items checked “Not Accept” and return with corrections.

I hereby approve all items listed above being completed as per County specifications.

Reviewer’s Signature ____________________________ Date ____________
BIORENTENTION INSPECTION CHECKLIST

Sign and date each phase of construction, as each one is completed. This is to confirm that each phase was completed in compliance with County approved plans and specifications. Refer to the Bioretention Guidelines located in The Bioretention Manual for any questions on bioretention installation and specifications.

1) Arrange a pre-construction meeting with the County Inspector. Review sequence of construction, dimensions and location of the facility, soil specifications and landscaping, and required inspections and certifications.

受限: Required Inspections: Site engineer shall be present during the construction of the facility in order for the engineer to certify the installation and completion of the facility. The following inspections shall be approved in writing by the County inspector prior to proceeding to next activity.

Contractor/Developer ________________________________ Inspector ________________________________

Excavation of Bioretention Area

1) Inspect the subgrade for proper depth, permeability, and presence of water. Also inspect the dimensions and location of the area for conformity with the approved stormdrain plan.

Contractor/Developer ________________________________ Inspector ________________________________

Installation

1) Scarify the bottom and sides of the facility before installation of any materials. Inspect correct placement of the underdrain system, which includes pipe size, perforations, pipe schedule, gravel bedding, filter cloth, and location of system.

* Inspectors must obtain tickets for materials used in the installation of the underdrain.

2) Inspect the planting soil medium for conformity with specifications and placed per details and specifications. Avoid compaction of the soil.

* A soil certification for the planting soil medium will be required by the inspector.
3) Inspect for proper placement of mulch layer. Also inspect for proper placement of landscaping, including type, size, and quantity of plants.
   * Inspectors must obtain tags for planting materials to verify plantings.

4) Inspect proper pooling depth of the facility.

Contractor/Developer

Inspector

Final Inspection

1) Inspect the bioretention configuration, size, and depth are in accordance with approved plans.

2) Inspect the landscaping to verify compliance with approved plans.

3) Drainage area must conform to approved plan. Drainage area must be permanently stabilized. Sediment controls devices shall remain in place until the contributing drainage area to the bioretention facilities is permanently stabilized.

For final inspection of a private facility, submit a copy of the Maintenance Agreement/Covenant and an original signed/sealed certification letter from a Maryland registered professional engineer for the completed facility. If any changes to the facility (location, size, etc.), approved As-Builts are required.

- OR -

For final inspection of a public facility, submit a certified As-Built plan, original landscaping certification, and release of liens.

Contractor/Developer

Inspector

COMMENTS:
Bioretention in the Region

Rayzor Ranch, Denton
Rayzor Ranch, Denton

Rayzor Ranch, Denton
Denton, TX

Recently received a Section 319 Grant to proceed with a number of BMP projects

- Bioretention system at Denton Municipal Airport

Elm Fork, Dallas
Elm Fork, Dallas

Bioretention Design

July 23, 2011
Elm Fork, Dallas

Elm Fork, Dallas
Merritt Road, Rowlett

- Approx. 9,070 foot roadway project
- Approx. 3,600 feet of bioretention swales
- Between Liberty Grove Road and Pleasant Valley Road
- To be constructed Fall 2011 to Spring 2013
References

• iSWM Technical Manual
  – Site Development Controls
  – Landscaping
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