FROM: AFCEC/DD
139 Barnes Drive, Suite 1
Tyndall AFB, FL 32403-5319

SUBJECT: Engineering Technical Letter (ETL) 14-1: Construction and Operation and Maintenance Guidance for Storm Water Systems

1. Purpose. This ETL provides procedures and practices for minimizing storm water pollution from Air Force construction activities, guidance for construction inspectors regarding temporary sediment and erosion controls, operations and maintenance (O&M) guidance for storm water infrastructure (i.e., separate storm sewers, associated appurtenances, and drainage areas), and permanent storm water best management practices (BMP).

Note: Use of the name or mark of a specific manufacturer, commercial product, commodity, or service in this ETL does not imply endorsement by the Air Force.

2. Application: All Air Force installations, including Air National Guard and Air Force Reserve. This ETL is not intended for use at contingency locations.

2.1. Authority:
   - Air Force policy directive (AFPD) 32-10, Installations and Facilities
   - AFPD 32-70, Environmental Quality

2.2. Effective Date: Immediately

2.3. Intended Users:
   - Major command (MAJCOM) engineers
   - Base civil engineers (BCE)
   - Construction managers
   - Construction contractors
   - Base inspection and maintenance personnel
   - Shop technicians
   - Equipment operators
   - U.S. Army Corps of Engineers (USACE) and U.S. Navy offices responsible for design and construction of Air Force facilities
   - Environmental managers responsible for installation industrial storm water permits

2.4. Coordination:
   - MAJCOM/A7 (Installations and Mission Support)
   - AFCEC/CF (Facility Engineering Directorate)
3. References. See Attachment 17, References.


5. Introduction and Regulatory Guidance.

5.1. How to Use this ETL.

5.1.1. This ETL provides guidance for three areas related to storm water management on Air Force bases:

1. Storm water requirements associated with construction activities;
2. Inspection of temporary erosion and sediment control (E&SC) BMPs on construction sites; and
3. O&M of permanent storm water BMPs.

5.1.2. Construction site storm water guidance is in paragraph 6. A troubleshooting guide for temporary E&SC BMPs (e.g., silt fence and sediment basins) for construction inspectors is provided as Attachment 1. Attachment 2 provides guidance for routine grounds procedures, storm water management of general conveyances, safety considerations, and other general information for the technician performing storm water management duties.

5.1.3. Integration of the construction storm water plan with the permanent storm water plan is discussed in paragraph 7. Paragraph 8 provides post-construction storm water management guidance. This is supplemented by troubleshooting guides (Attachments 3 through 12) for operating and maintaining permanent storm water BMPs (e.g., detention basins, bioretention basins). The attachments also include information such as advantages and disadvantages of control types, labor estimates for maintenance of permanent storm water controls (see Attachment 15 for preventive maintenance worksheets), and storm water planning recommendations.

5.1.4. Checklists have been provided in Attachments 3 through 12 for inspecting construction and permanent BMPs and include directions for using and completing the checklists. The checklists should be used to document maintenance activities.
5.1.5. Generally, the information provided in this ETL follows Environmental Protection Agency (EPA) guidelines, permits, and regulations. Most states have authority to regulate storm water in their jurisdiction, but typically follow the precedent set by the EPA. Nonetheless, some variation should be expected and users of this ETL must familiarize themselves with the Energy Independence and Security Act (EISA) and local requirements. If there is a conflict with this ETL, follow local requirements; personnel located at bases outside of the U.S. should follow the Final Governing Standards (FGS). This ETL is not intended for use at contingency locations.

5.2. Regulatory Guidance.

5.2.1. Water Quality Compliance Program. A water quality compliance program must be established at all Air Force installations to assess, attain, and sustain compliance with applicable federal, state, and local water quality regulations and permits. With regard to construction and permanent storm water requirements, all Air Force installations must maintain compliance with EPA’s National Pollutant Discharge Elimination System (NPDES) permit requirements as mandated by the Clean Water Act (CWA) and applicable state and local storm water management requirements. Refer to Air Force instruction (AFI) 32-7041, *Water Quality Compliance*, for establishing and maintaining a water quality compliance program.

5.2.2. EISA Section 438.

5.2.2.1. In addition to the CWA and NPDES programs, installations are also required to comply with EISA. EISA was enacted in December of 2007 with Section 438 mandating storm water runoff requirements for federal development and redevelopment projects. The EISA refers to storm water runoff requirements for federal development projects:

*The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.*

This means that any applicable construction project involving a federal facility that disturbs 5,000 square feet (464.5 square meters) or more of ground area is subject to EISA Section 438. Existing facilities that have an overall footprint of 5,000 square feet (464.5 square meters) or greater that disturb less than 5,000 square feet (464.5 square meters) of land area as part of any single development or redevelopment project are not subject to Section 438 requirements. Consistent with the purpose of Section 438 to preserve or
restore pre-development hydrology, the term “footprint” includes all land areas disturbed as part of the project (EPA, 2009). Refer to Deputy Under Secretary of Defense, Installation and Environment (DUSD(IE)), Memorandum, *DOD Implementation of Storm Water Requirements Under Section 438 of the Energy Independence and Security Act (EISA)*, 19 January 2010, for additional information related to implementing EISA Section 438. 

5.2.2.2. EISA Section 438 states that it applies to any development or redevelopment project involving a federal facility with a gross footprint greater than 5,000 square feet (464.5 square meters). The EPA’s technical guidance on EISA Section 438 states on page 10: "2. What is a 'Federal facility'? Section 438 provides that its requirements apply to the “sponsor of any development or redevelopment project involving a Federal facility…." EISA Section 401(8) states: “The term 'Federal facility' means any building that is constructed, renovated, leased, or purchased in part or in whole for use by the Federal Government.”

5.2.2.3. A DOD definition for “building” is provided in DODI 4165.14, *Real Property Inventory and Forecasting*, page 9, Enclosure 2: "A roofed and floored facility enclosed by exterior walls and consisting of one or more levels that is suitable for single or multiple functions." Therefore, a project involving a federal facility that does not include a building structure is not applicable to EISA Section 438, e.g., runway repair projects, runway extension projects, road rehab or extension/construction. If there is no building work associated with the project then EISA Section 438 does not apply.

5.2.3. Green Infrastructure (GI) and Low Impact Development (LID). To remain in compliance with EISA regulations, Air Force installations must focus on maintaining or restoring pre-development site hydrology conditions during the development or redevelopment process by implementing GI and LID practices (EPA, 2009). Refer to Unified Facilities Criteria (UFC) 3-210-10, *Low Impact Development*, for more information on technical criteria, technical requirements, and references for planning and design practices needed to comply with the requirements of EISA Section 438.

5.2.4. State and Local Permits.

5.2.4.1. In addition to remaining in compliance with EISA requirements, installations are to adhere to NPDES permit requirements that are site-specific and vary at the state and local level. It is not uncommon for installations to have specific construction and permanent BMP (or “post-construction”) requirements detailed in an NPDES permit. Base storm water program managers should refer to their state agency or EPA regional office (see paragraph 9 of this ETL) to ensure they are maintaining compliance with existing permits. Ultimately, it is recommended that the Air Force utilize a storm water master planning approach, which will address existing regulations on a base-wide scale. The master plan should be developed by
coordinating with base organizations that represent future construction projects, including a unified approach to planning, construction, O&M, and environmental considerations. The development of a base-wide storm water master plan will aid in establishing an early understanding of BMPs that are best suited for achieving storm water compliance at construction and permanent sites.

5.2.4.2. Construction projects covered by this ETL will typically be required to obtain an NPDES construction storm water permit and comply with its substantive and procedural requirements. If NPDES coverage is required, all permit provisions must be complied with completely and permit coverage must be obtained before commencement of construction, with lead-time dependent upon the jurisdiction. The storm water pollution prevention plan (SWPPP) must contain or reference a declaration that the project either does or does not require an NPDES storm water construction permit and include an explanation of the reason for either circumstance.

5.2.4.3. Overseas installations should refer to their FGS or Overseas Environmental Baseline Guidance Document (OEBGD) (if no FGS exist) to determine if NPDES-type permits are applicable.

5.2.4.4. Attachments 1 through 12 of this ETL provide guidance on the following construction and post-construction SCMs:

5.2.4.4.1. Construction Controls: brush barriers, compost berms/socks, compost blankets, earthen berms/temporary diversions, fiber check dams/rock check dams, fiber rolls/wattles, gravel construction entrances, inlet protection, sediment basins, silt fence, silt traps, temporary slope drains, and vegetated buffers.

5.2.4.4.2. Permanent Controls: vegetated swale, bioretention basin, level spreader, filter strip, and vegetated buffer, wet detention basin, dry detention basin, infiltration SCMs (infiltration basin, infiltration trench, and dry well), storm water wetland, water harvesting (rain barrels and cisterns), permeable pavement, and reforestation.


6.1. Construction Site Storm Water Control Goals.

6.1.1. Proper construction site drainage is critical for efficient and timely completion of earthwork. Air Force construction projects should be designed and implemented with consideration of the following:

- Offset temporary or permanent increases in imperviousness of an affected construction area to the maximum extent possible with SCMs that will
reduce site storm water discharges and sediment pollutant loadings to pre-construction levels or better.

- Use construction management and operations practices that focus on source control before committing to collection, storage, and treatment.
- Plan and schedule installation of the final storm drainage facilities and post-construction SCMs to render maximum usage during the construction period.

6.1.2. The construction project itself must and will have drainage and storm water management features that are an integral part of the designed construction project and remain permanently as part of the final completed project. The structural BMPs chosen to manage storm water during the construction phase must be consistent with these final features. Straw wattles, gabions, riprap, or any other structural BMPs used during the construction phase for E&SC must be validated by the project design and may be used during the construction period at less than their final design specifications until they are upgraded at project completion.

6.2. Construction-Specific Environmental Compliance. Overseas installations should refer to their FGS or OEBGD (if no FGS exist) to determine if NPDES-type permits are applicable.

6.2.1. Storm Water Construction (NPDES) Permits. Construction projects covered by this ETL will be required to obtain an NPDES storm water construction permit if the construction activities disturb an area greater than 1 acre or are part of a development plan that will disturb more than 1 acre. If NPDES coverage is required, compliance with all substantive and procedural permit requirements is necessary. Permit coverage must be obtained before commencement of construction, with lead-time dependent upon the jurisdiction. The SWPPP (whether elements of or a complete SWPPP) must contain or reference a declaration that the project either does or does not require an NPDES storm water construction permit and include an explanation of the reason for either circumstance. See Attachment 13 for suggested permit declaration language.

6.2.2. Notice of Intent (NOI). NPDES permit coverage for a construction project is obtained through a construction general permit (CGP). To obtain this coverage, submit a complete and accurate NOI, when required, in accordance with the format and within the timeframe prescribed by the applicable federal, state, or municipal jurisdiction. Comply fully with the terms of the corresponding general permit.

6.2.3. Storm Water Pollution Prevention Plan (SWPPP). The primary means to achieve compliance with a CGP is to prepare and implement a construction SWPPP in accordance with the terms of the permit. Guidance detailing what is typically included in a SWPPP is provided in paragraph 6.3.2 and Attachment 14.
In the event a permit is not required, land-disturbing activity must still be evaluated and managed to reduce impacts to storm water quality. Elements from the SWPPP can be implemented to meet this requirement.

6.2.4. Small Municipal Separate Storm Sewer System (MS4). If the base is designated as a regulated, small MS4, it must have its own MS4 NPDES permit and a base-wide storm water management program (SWMP) that includes construction and post-construction SCMs. Plans developed for any activities or practices undertaken during a specific construction project must be consistent with base-wide plans.

6.2.5. Overseas Environmental Baseline Guidance Document (OEBGD) and Country Final Governing Standards (FGS). Overseas installations should refer to the FGS or OEBGD (if no FGS exist) to determine if any NPDES-type permits are applicable. While the OEBGD and FGS typically do not directly address storm water infrastructure O&M requirements, CES/CEIEC and CES/CEOIU personnel at installations outside the U.S. should confirm there are no applicable FGS requirements and use the relevant components of this ETL as guidance to ensure proper O&M of storm water BMPs.

6.3. Construction Site Management to Control Storm Water. Any activity that disturbs or breaks the topsoil or results in the movement of earth at an Air Force construction site must implement measures to manage and control storm water runoff while the construction activity is taking place and must stabilize the site when the activity is completed. This applies even if the construction activities: (1) do not disturb an area greater than 1 acre; or (2) are not part of a development plan that will disturb more than 1 acre.

6.3.1. Applicability.

6.3.1.1. Construction sites with an affected construction area of greater than 1 acre (Note: Some states may have lower thresholds) must obtain an NPDES permit and develop a SWPPP. The SWPPP should be developed by a qualified storm water professional prior to obtaining the NPDES permit and both must be in effect before groundbreaking begins. Prepare the SWPPP as part of the project design or develop a set of specifications that require submittal of a SWPPP as part of the construction contractor’s project bid. A combination of these two methods offers the best means to produce a SWPPP. A SWPPP must contain an NPDES permit declaration.

6.3.1.2. Construction sites having an affected construction area smaller than 1 acre must still be evaluated for its potential to generate and/or contaminate storm water runoff. When warranted, measures equivalent to those that would be specified in a SWPPP must be developed and implemented. Ensure that measures chosen are consistent with the size and nature of the project.
6.3.2. SWPPP. The applicable storm water construction permit may be the driving force behind the required content of the SWPPP. EPA’s NPDES CGP requirements were used as a baseline in this ETL and are summarized in Attachment 14. Refer to the NPDES CGP for additional details and requirements. The required content varies slightly from location to location, depending on the permitting jurisdiction, and the substance and level of effort for this content can vary dramatically, depending on location and other site-specific factors. This ETL may be used as a guide for content and adjusted accordingly to meet site-specific permit requirements and/or project-specific construction activity.


6.4.1. Checklists have been provided in Attachments 3 through 12 as guidance for inspecting construction site storm water management features. Directions for using and completing the checklists and documenting findings are included. The Construction Controls Troubleshooting Guide (Attachment 1) and/or the associated attachment should be used to address maintenance concerns found during the inspection. The checklists should be used to document maintenance activities.

6.4.2. Preventive maintenance worksheets are included in Attachment 15. These worksheets summarize the labor hours and estimated costs of preventive maintenance activities associated with each of the SCMs in Attachments 3 through 12.

7. Integrating the Construction Storm Water Plan with the Permanent Storm Water Plan.

7.1. During the preliminary engineering phase, the site will be evaluated for temporary construction SCMs and permanent (post-construction) SCMs. The designer should identify areas where both temporary and permanent SCMs can be integrated, phased, and transitioned throughout project development. Generally, most opportunities for transition exist where a temporary sediment impoundment structure is planned during the construction phase and a permanent impoundment or detention structure is planned for the post-construction phase.

7.2. Initial design considerations for the transition of SCMs include:
   - Locating the structural SCM outside the final section limits
   - Accommodating the maximum volume and footprint of the permanent structural SCM
   - Documenting elevations associated with the outlet and emergency spillway
   - Retrofitting the temporary draw down device to the permanent outlet structure
   - Confirming structural integrity of the embankment

7.3. Transition items to consider from the temporary construction phase to the permanent final phase:
• Stabilizing drainage area upgradient of the structural SCM
• Utilizing temporary construction storm water measures
• Installing a permanent draw-down orifice in the outlet structure
• Staging the final stabilization of the structural SCM to provide good vegetative ground cover and avoid clogging or compaction of soil and any media in the SCM

7.4. Final considerations for the permanent structure:
• Certification by a licensed professional affirming elevations, conforming to specifications
• Producing as-built plans
• Developing an O&M manual
• Training maintenance personnel for routine inspections and maintenance tasks
• Annual inspection and documentation by a licensed/qualified professional


8.1. Post-Construction Storm Water Management Requirement. Post-construction storm water management in areas undergoing new development or redevelopment is necessary because runoff from these areas can significantly affect receiving water bodies. Prior planning and design for minimizing pollutants in post-construction storm water discharges is often the most effective approach to storm water quality management.

8.2. Post-Construction Runoff Impacts. There are two types of post-construction runoff impacts:

8.2.1. The first is caused by an increase in pollutants in storm water runoff. Post-construction runoff can pick up harmful pollutants such as sediment, oil and grease, pesticides, metals, and nutrients (e.g., nitrogen and phosphorus). These pollutants often become suspended in runoff and carried to receiving waters (e.g., creeks, rivers) and can eventually enter the tissues of fish and humans.

8.2.2. The second type of post-construction runoff impact occurs by an increase in quantity of runoff delivered to receiving waters during storms. Increased impervious surfaces (e.g., parking lots, airfields, and rooftops) interrupt infiltration of storm water through vegetation and soil. Storm water is collected from impervious surfaces and routed to drainage systems where large volumes of runoff quickly flow to the nearest receiving water. The effects of this process include stream bank scouring, flooding, and ultimately loss of aquatic life and property damage. (EPA, 2005)

8.3. Permanent Storm Water Controls O&M Guidance. Checklists have been provided for inspecting permanent storm water controls and associated infrastructure. Directions for using and completing the checklists and documenting
findings are included. The respective Troubleshooting Guides (Attachments 3 through 12) should be used to address maintenance concerns found during the inspection. The checklists should be used to document maintenance activities.

9. State Storm Water O&M Contacts. A list of continental U.S. environmental regulatory agencies and contacts that can provide assistance with implementation and O&M of construction and post-construction SCMs is provided in Attachment 16.

10. Disclaimer. This ETL provides guidance for O&M procedures for typical SCMs owned and operated by the Air Force. This ETL is not intended to be a comprehensive reference on SCM inspection and maintenance. Additional references should be consulted as needed to maintain a safe and functional facility. Further, it is not possible to properly address every configuration or issue that might arise. Unique circumstances may require deviation from this ETL. Sound professional judgment, resourcefulness, and ingenuity are expected and encouraged.

11. Point Of Contact. Questions or comments about this ETL are encouraged and should be directed to the Water and Wastewater Subject Matter Expert, AFCEC/COSC, DSN 523-6465, commercial (85) 283-6465, afcec.rbc@tyndall.af.mil.

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Deputy Director

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1. Construction Controls Troubleshooting Guide
2. General Storm Water Infrastructure Operation and Maintenance Guide
3. Vegetated Swale Troubleshooting Guide
4. Bioretention and Filtration Basin Troubleshooting Guide
5. Level Spreader, Filter Strip, and Vegetated Buffer Troubleshooting Guide
6. Wet Detention Basin Troubleshooting Guide
7. Dry Detention Basin Troubleshooting Guide
8a. Infiltration Basin Troubleshooting Guide
8b. Infiltration Trench and Dry Well
8a-b. Infiltration Basin, Trench, and Dry Well Troubleshooting Guide
8c. Infiltration Basin Operation & Maintenance Inspection Checklist
9. Storm Water Wetland Troubleshooting Guide
10. Rainwater Harvesting Troubleshooting Guide
11. Permeable Pavement Troubleshooting Guide
12. Reforestation Troubleshooting Guide
13. Storm Water Construction Permit Declaration
14. SWPPP Content Outline
15. Preventive Maintenance Worksheets
16. State Storm Water Contacts
17. References
18. Acronyms and Glossary
19. Distribution List
It is usually easier and less expensive to prevent erosion than it is to control sediment from leaving a construction site (EPA, 2007). Follow the Key Considerations, conduct proper and timely inspections, and respond with needed maintenance to minimize erosion and sedimentation.

**Construction Storm Water Controls in this Attachment**

This attachment provides inspection and maintenance guidance for the following construction storm water controls: brush barriers, compost berms/socks, compost blankets, earthen berms/temporary diversions, fiber check dams/rock check dams, fiber rolls/wattles, gravel construction entrances, inlet protection, sediment basins, silt fence, silt traps, temporary slope drains, and vegetated buffers.

**Key Considerations**

- Follow your erosion and sediment control plan
- Control the perimeter of your site
- Protect receiving waters adjacent to your site
- Stabilize the site as soon as possible and be sure to use fertilizer
- Properly manage erosion controls to minimize the cost and effort needed for sediment controls
- Minimize the area and duration of exposed soils
- Protect slopes and channels
- Preserve existing vegetated buffers
- If excessive, the length of the filter strip/buffer may allow storm water to reconcentrate, depending on site conditions, and should be designed with this in mind. An additional level spreader or collection berm/channel may be used to prevent reconcentration of flow.

**Erosion Controls**

- Erosion control measures (e.g., mulch, compost blankets, mats, vegetative cover) protect the soil surface and prevent soil particles from being dislodged and carried away by wind or water.

**Sediment Controls**

- Sediment control measures (e.g., silt fences, gravel construction entrances, compost berms) remove soil particles after they have been dislodged, typically through settling or filtration. Preventing erosion will drastically reduce sedimentation.

(EPA, 2009)
### Construction Controls Troubleshooting Guide

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<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
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<tbody>
<tr>
<td>1. Brush Barrier</td>
<td>• A short barrier (typically 2 to 5 feet [0.6 to 1.5 meters] tall) composed of brush removed from the site during clearing and grubbing</td>
<td>• Filter fabric is damaged or installed incorrectly</td>
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<td>• Typically installed along the perimeter of the site and may be used at the toe of slopes</td>
<td>• Barrier is bypassed, undercut, or blown out</td>
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<td>• Typically should be trenched in and compacted using large machinery (e.g., a loader)</td>
<td>• Excessive sediment accumulation</td>
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<td>• Filter fabric may be added to the bottom of the upslope side to increase effectiveness</td>
<td>• Filter fabric should be keyed in to a depth of 6 inches and the top side of the filter fabric should be fastened to the barrier. Replace filter fabric when it becomes damaged or brittle.</td>
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<td>• Eroded areas should be repaired and the barrier should be reconstructed as needed. Confirm whether the barrier is properly trenched in at the bottom and keyed into the slope at the sides. Additional or alternative measures should be installed if the brush barrier is inadequate.</td>
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<td>• Sediment should be removed when it accumulates to 50% of the height of the barrier.</td>
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### Advantages

- Material from onsite is used to construct the barrier
- Living plant materials can be encouraged to take root during trenching installation, offering additional protection

### Limitations

- May not be desirable where aesthetics are a concern
- May be more susceptible to failure than other perimeter controls
- Small sites or sites with limited woody vegetation may have insufficient material available to construct the barrier
- Not suitable for concentrated flows
- If there is insufficient fine brush material or if the material decays, the barrier will offer little protection

See photos 1A and 1B for typical configurations and common problem examples.
## Construction Controls Troubleshooting Guide

### BMP Element

<table>
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<tr>
<th>Problem</th>
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<tr>
<td>2. Compost Berm/Sock</td>
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</table>

- A compost filter berm is a dike of compost placed perpendicular to sheet flow runoff to control erosion in disturbed areas and retain sediment. It can be used in place of a traditional sediment control, such as a silt fence.
- Compost socks are similar but are in the form of a mesh/fabric sock filled with compost.

- The area behind the berm is filled with silt
- Significant washout has occurred
- Filter berm is no longer intact
- Sock is torn or slumping

- Accumulated sediment should be removed from behind the berm when the sediment reaches approximately 50% of the height of the berm.
- Any areas that have been washed out should be replaced. If the berm has experienced significant washout, a filter berm alone may not be the appropriate storm water control for this area.
- If washout is not significant, consider increasing the size of the filter berm or adding another perimeter control in this area, such as an additional compost filter berm, compost filter sock, or silt fence.
- Socks should be replaced when damaged or slumping.

### Advantages
- Effective perimeter sediment control barrier
- Socks can be an effective inlet protection barrier
- Berms can be retained onsite at project completion or bladed to facilitate positive drainage
- Utilizes the site's wooded clearing and grubbing debris, if ground

### Limitations
- Generally requires specialized equipment to install
- Limited to areas with sheet flow or minimal concentrated flow from small drainage areas

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See photos 2A through 2C for typical configurations and common problem examples.
### 3. Compost Blanket

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<tr>
<th>BMP Element</th>
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<th>Corrective Action</th>
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| A compost blanket is a layer of loosely applied, composted material placed on soil in disturbed areas to reduce storm water runoff and erosion. This material fills in small rills and voids to limit channelized flow, provides a more permeable surface to facilitate storm water infiltration, and promotes revegetation. | Areas of the compost blanket have washed out  
    - Rills or channelized flow are present | When washed out, another layer of compost should typically be applied. In some cases, it may be necessary to add another storm water control, such as a compost filter sock or silt fence. Generally, the maximum slope on which compost blankets should be used is 2:1.  
    - Compost blankets should not be placed in locations that receive concentrated or channeled flows, either as runoff or a point source discharge. |

#### Advantages
- Provides supplemental soil conditioners and slow release nutrients for vegetative establishment
- Beneficial on granular soils void of moisture-holding capacity and at arid to semi-arid sites
- Immediate groundcover in the form of composted mulch material
- Good option on irregular surfaces or locations requiring spot stabilization
- Can supplement with granular flocculants to enhance moisture-holding capacity, promote soil binding, and reduce turbidity in runoff

#### Limitations
- Installation generally requires specialized equipment
- Higher initial cost than conventional soil stabilization methods
- Limited applicability on steeper slopes (2:1 maximum) and conveyances; see guidance above.

See photos 3A through 3C for typical configurations and common problem examples.
### Construction Controls Troubleshooting Guide

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<tr>
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<tbody>
<tr>
<td>4. Earthen Berm/Temporary Diversion</td>
<td>- Earthen berms are sometimes used as a perimeter control to keep runoff onsite or direct it to a more suitable outlet location.</td>
<td>Sediment should be removed or the berm built up to maintain original height.</td>
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<td>- A vegetated conveyance or ditch is often constructed on the upslope side of the berm to convey runoff.</td>
<td>Eroded areas should be filled in and compacted then stabilized with appropriate erosion protection materials where needed.</td>
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<td>- Earthen berms are often used upgradient of fill slopes to prevent erosion of the slope and to direct runoff to temporary slope drains.</td>
<td>Damaged berms should be restored to original dimensions; consideration should be given for redesigning areas under traffic to include additional outlets.</td>
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<td>- Excessive sediment accumulation</td>
<td>Outlets should be stabilized and some type of sediment control practice is generally needed.</td>
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<td>- Erosion of the berm or conveyance</td>
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<td>- Berm damage from vehicular traffic</td>
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<td>- Inadequate erosion protection and sediment control practice at outlet</td>
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**Advantages**

- Can help maintain good working conditions when used upslope of construction operations
- One of the most cost-effective practices
- Can be used to divert run-on away from the site, thereby preventing unnecessary contamination of clean storm water and making it easier to manage runoff from the site

**Limitations**

- The resulting concentrated flow can increase erosion if improperly managed
- Can be easily damaged by vehicular traffic

See photos 4A through 4C for typical configurations and common problem examples.
## Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
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| **5. Fiber Check Dam/Rock Check Dam** | • Fiber and rock check dams reduce scour and channel erosion by reducing flow velocity and encouraging sediment settlement. A fiber check dam is constructed of a fiber roll or other proprietary product placed across a natural or man-made channel or drainage ditch. A rock check dam is a small device constructed of rock and washed aggregate, placed across a natural or man-made channel or drainage ditch. | • Sediment accumulation
• Debris accumulation
• Dam is damaged or losing form
• Erosion is occurring at the side of the dam
• Erosion is occurring in the channel between dams
• There is standing water upstream of the dam
• Dam has been removed but area is not stable
   • Remove sediment deposits when they reach 50% of the height of the barrier. Replace stone or fiber roll as needed.
   • Remove debris that has the potential to negatively impact flow.
   • Add rock as needed to maintain design height and cross-section. Replace fiber check dam.
   • Confirm that the check dam has adequate length to span the width of the ditch. Confirm that the center of the dam is 6 to 9 inches (152 to 229 millimeters) lower than the outside edges. Repair and re-stabilize eroded areas.
   • Install additional dams as needed or line the ditch with riprap or other approved material.
   • If the aggregate becomes clogged with sediment such that standing water remains and no treatment is provided, replace with clean aggregate.
   • If the dam is removed after construction activities are completed, immediately stabilize the disturbed area with seed and mulch or other approved method. |

---

**Atch 1**

(6 of 31)
## Construction Controls Troubleshooting Guide

### Fiber Check Dam

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Slows runoff velocity to minimize erosion and scour in conveyances to initiate settling of sediments</td>
<td>• Periodic replacement needed based on sediment loading from site</td>
</tr>
<tr>
<td>• Promotes impounding of runoff to facilitate settling of suspended sediment</td>
<td>• Composition of fiber will generally determine longevity and effectiveness</td>
</tr>
<tr>
<td>• Natural fibers (e.g., grain, wood, coir) provide additional surface area to trap sediment</td>
<td>• Limited to low to moderate channel gradients with limited drainage area</td>
</tr>
<tr>
<td>• Can apply flocculants on fibers to treat runoff and promote turbidity reduction</td>
<td>• Susceptible to bypass and undermining when improperly installed</td>
</tr>
<tr>
<td>• Relatively easy to install with conventional hand tools</td>
<td></td>
</tr>
<tr>
<td>• No construction equipment needed for installation</td>
<td></td>
</tr>
</tbody>
</table>

### Rock Check Dam

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Slows runoff velocity to minimize erosion and scour in conveyances to initiate settling of sediments</td>
<td>• Requires construction machinery to transport and install stone and for removal at project completion</td>
</tr>
<tr>
<td>• Promotes impounding of runoff to facilitate settling of suspended sediment</td>
<td>• Susceptible to runoff bypassing or cutting around when installed without a low point or weir</td>
</tr>
<tr>
<td>• Can be used in low to aggressive channel gradients</td>
<td>• Can be undermined when inadequate amount of stone used or improperly constructed</td>
</tr>
<tr>
<td>• Relatively easy to construct with construction equipment</td>
<td>• Requires routine maintenance to remove sediment accumulations and refurbish stone</td>
</tr>
</tbody>
</table>

See photos 5A through 5C for typical configurations and common problem examples.
## Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6. Fiber Roll/Wattle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• A long mesh sock filled with straw or similar fibrous material installed along the contour of a slope.</td>
<td>• Improper installation</td>
<td>• Fiber rolls should generally be trenched and staked to prevent undermining.</td>
</tr>
<tr>
<td>• Functions similar to silt fence.</td>
<td>• Excessive sediment accumulation</td>
<td>• Sediment should be removed and properly disposed of when it accumulates to a depth one-half of the way between the ground surface and the top of the fiber roll.</td>
</tr>
<tr>
<td></td>
<td>• Damaged or degraded fiber rolls</td>
<td>• Fiber rolls should be replaced if torn or slumping.</td>
</tr>
</tbody>
</table>

### Advantages

- Effective perimeter sediment control barrier
- Effective inlet protection barrier
- Natural fibers (e.g., grain, wood, coir) provide additional surface area to trap sediment
- Relatively easy to install with conventional hand tools

### Limitations

- Limited to areas with sheet flow or minimal concentrated flow from small drainage areas
- Susceptible to bypass and undermining when improperly installed
- Fiber may break down over time

See photos 6A through 6C for typical configurations and common problem examples.
# Construction Controls Troubleshooting Guide

## BMP Element

<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Gravel Construction Entrance</td>
<td></td>
</tr>
<tr>
<td>• Vehicles entering and leaving the site have the potential to track</td>
<td>• Confirm that all traffic is directed to enter/exit the site via gravel</td>
</tr>
<tr>
<td>significant amounts of sediment onto streets. Identify and clearly mark</td>
<td>construction entrance(s).</td>
</tr>
<tr>
<td>one or two locations where vehicles will enter and exit the site and</td>
<td>• Sweep or vacuum roadway (if equipment is available or accessible) to remove</td>
</tr>
<tr>
<td>focus stabilizing measures at those locations.</td>
<td>visible sediment accumulations.</td>
</tr>
<tr>
<td>• Use of other areas for site ingress/egress</td>
<td>• Remove spent aggregate. Replace and supplement with new additional aggregate</td>
</tr>
<tr>
<td>• Accumulated sediment on adjacent roadway</td>
<td>if needed.</td>
</tr>
<tr>
<td>• Aggregate is clogged with sediment</td>
<td>• Repair entrance. Provide supplemental aggregate when surface voids are visible.</td>
</tr>
<tr>
<td>• Entrance is damaged or deficient</td>
<td>• A wash rack with sediment trap may be needed to avoid overloading the entrance</td>
</tr>
<tr>
<td>• Repeated clogging of aggregate or entrance fails to retain sediment</td>
<td>with sediment.</td>
</tr>
<tr>
<td>onsite</td>
<td>• Repair entrance is sufficiently long to remove sediment.</td>
</tr>
<tr>
<td>• Signs of vehicles &quot;cutting corners&quot;</td>
<td>• Widen construction entrance where it meets the road or provide barricades.</td>
</tr>
</tbody>
</table>

## Advantages

- Facilitates removal of sediment from tires of construction traffic
- Minimizes tracking of sediment onto airfield and roadways
- Relatively simple installation with geotextile and properly graded stone

## Limitations

- Not as effective at sediment removal when inadequate depth of stone installed
- Requires frequent maintenance to consistently provide effectiveness
- Improperly sized stone may become lodged on dual wheel equipment creating safety or foreign object damage (FOD) hazards

See photos 7A through 7C for typical configurations and common problem examples.
### Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| 8. Inlet Protection | • Small protective device surrounding inlet that receives light to moderate flow.  
• Slows flow and allows suspended solids to settle prior to reaching inlet.  
• Used for inlets with high flows  
• Use of silt fence in place of stone  
• Damage due to vehicular traffic  
• Stone migration away from inlet. | • A more robust inlet protection device can be constructed using rock and washed aggregate for areas with high flow.  
• Remove incorrectly installed materials and replace with correct material.  
• Frequently inspect and repair or replace damaged inlet protection devices and use markers to increase visibility.  
• Frequently inspect and reshape or refurbish stone. |

Note: presume stone or hardware cloth system is used, not silt fence fabric

#### Advantages
- Promotes impoundment and settlement of suspended sediment in construction site runoff
- Can withstand minimal concentrated flows from small drainage areas
- Minimal initial installation cost
- Structural components (i.e., hardware cloth/aggregate) provide longevity for longer-duration projects

#### Limitations
- Runoff can bypass inlet with inadequate management of storm water flows
- Active traffic patterns may result in limitations for use
- Requires machinery to transport and handle washed aggregates used around inlet and for final removal
- Clogging occurs from fine-grained soils when not frequently maintained

See photos 8A through 8C for typical configurations and common problem examples.
## Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **9. Sediment Basin** | • A basin used to treat runoff from disturbed drainage areas of greater than 5 acres. Runoff exits the basin via a riser structure or surface outlet.  
• The riser may be perforated (may or may not be surrounded by stone), may use a floating skimmer, or may use a similar device for dewatering. | • Excessive sediment accumulation  
• Erosion around the embankment, spillways, and discharge  
• Embankment settling and piping  
• Trash and debris accumulation  
• Inadequate treatment (i.e., sediment observed at the discharge)  
• Riser, outlet, or skimmer clogging  
• Skimmer becomes buried in sediment and is prevented from floating | • Sediment should be removed and properly disposed when it accumulates to one-half the design depth.  
• Erosion should be repaired and riprap or liners installed as needed.  
• Embankment should be regraded and compacted. An anti-seep collar should be installed if necessary.  
• The basin should be routinely monitored for trash and debris.  
• Advanced treatment measures, such as flocculants and active treatment systems, may be used if warranted.  
• Debris should be removed and a trash rack installed where applicable. Stone should be replaced when it becomes clogged.  
• The skimmer should be frequently monitored and consideration should be given for installing a mechanism that holds the skimmer off the basin bottom. |

### Advantages

- Can be integrated into the final drainage plan and modified to function as a permanent BMP  
- Can remove smaller particles than a silt trap when properly designed

### Limitations

- Requires a larger footprint than other controls  
- Likely ineffective for removing fine (e.g., clay) particles  
- May allow mosquitoes to breed  
- Size and location may be limited by dam safety rules

---

See photos 9A through 9C for typical configurations and common problem examples.
## Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **10. Silt Fence** | • A short barrier that intercepts sheet flow to retain sediment on site.  
• Typically installed at the toe of slopes or the boundaries of the project. | • Used for concentrated or high flows  
• Improper installation  
• Excessive sediment accumulation | • Use rock check dams or other appropriate measures in areas with concentrated or high flows.  
• Oversee installation or inspect immediately following installation to confirm proper configuration.  
• Frequently monitor and remove sediment accumulation; remove sediment when accumulation is half the fence height. |

### Advantages
- Generally installed with hand tools without mobilizing machinery  
- Effective perimeter sediment control for small drainage areas when installed properly  
- Reasonably low initial cost  
- Minimal resources to remove  
- Can recycle metal T-posts

### Limitations
- Commonly installed incorrectly or incompletely  
- Subject to damage by construction traffic and foot traffic  
- Cannot be used in concentrated flow conveyances  
- Limited to small drainage areas  
- Can channelize and undermine when not installed on the contour  
- Must landfill spent geotextile fabric after establishing final surface stabilization

See photos 10A through 10C for typical configurations and common problem examples.
## Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11. Silt Trap</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Small impoundments created by excavation and/or construction of a small embankment made of riprap and washed aggregate.</td>
<td>• Excessive sediment accumulation</td>
<td>• Sediment should be removed and properly disposed of when the storage capacity is reduced by 50%.</td>
</tr>
<tr>
<td>• Silt traps are used to impound runoff from small, disturbed drainage areas and capture larger sediment particles.</td>
<td>• Eroded slopes or embankment</td>
<td>• Erosion should be repaired by regrading and adding riprap, washed aggregate, or liners as appropriate.</td>
</tr>
<tr>
<td></td>
<td>• Clogged or damaged outlet</td>
<td>• Clogged or damaged outlets should be corrected by removing debris and ensuring spillway is maintained at least 1 foot below top of embankment.</td>
</tr>
<tr>
<td></td>
<td>• Riprap displacement</td>
<td>• Riprap should be replaced as needed to maintain the structural integrity of the sediment trap and to protect against erosion.</td>
</tr>
<tr>
<td></td>
<td>• Reduced performance of aggregate</td>
<td>• Aggregate should be replaced when it has become clogged with sediment.</td>
</tr>
</tbody>
</table>

### Advantages
- Can be integrated into the final drainage plan and modified to function as a permanent BMP
- A sediment control practice that treats concentrated runoff from disturbed areas while taking up a relatively small area

### Limitations
- Often inadequate to treat large drainage areas (greater than 5 acres) or sites with fine soil particles such as clay; sediment basins should be used in these areas

See photos 11A through 11C for typical configurations and common problem examples.
### 12. Temporary Slope Drain

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
|              | • Temporary slope drains are designed to collect runoff at the top of a disturbed slope (usually from an earthen berm) and properly convey runoff to the bottom of the slope through a flexible pipe. | • Inadequate or no inlet and outlet protection  
• Flow bypasses the slope drain inlet  
• Inadequate or no anchoring  
• Inadequate pipe size  
• Damage by vehicular traffic  
• Blockages | • Inlets and outlets should be protected by riprap and other appropriate materials.  
• The earthen berm should be repaired or modified and the inlet adjusted as needed.  
• Anchors should be placed along the pipe every 10 feet to secure it to the ground surface.  
• A larger pipe should be installed if the capacity is exceeded during normal storm events.  
• Markers or barriers may be used to protect the slope drain from traffic. Repairs should be made immediately.  
• Slope drains should be continually monitored and blockages promptly removed. |

### Advantages

- Effective means of conveying storm water down a disturbed slope to a suitable outlet

### Limitations

- Slope drains are limited in the drainage area they can accommodate
- Significant erosion problems can be expected should the slope drain fail

See photos 12A through 12C for typical configurations and common problem examples.
### Construction Controls Troubleshooting Guide

<table>
<thead>
<tr>
<th>BMP Element</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **13. Vegetated Buffer** | • An area surrounding receiving waters where vegetation is preserved or encouraged.  
                    | • The vegetation intercepts sheet flow, allowing silt to settle out and encouraging infiltration.  
                    | • Vegetated buffers may be required in some areas and the width may be dictated by regulations (e.g., the EPA requires that a 50-foot [15.2 meters] undisturbed natural buffer be maintained for all surface waters).  | • Sediment accumulation  
                    |                           | • Erosion within the buffer  
                    |                           | • Buffer disturbed by construction activity  | • Sediment should be removed when it covers one-third the length of the buffer and plants should be replaced as needed.  
                    |                           |  | • The buffer should be repaired and stabilized immediately. Additional controls should be provided upgradient of the buffer to minimize concentrated flow.  
                    |                           |                           | • Buffer boundaries should be marked if deemed necessary.  |

Note: Inspectors should first familiarize themselves with any applicable buffer rules as activities within buffers are often regulated.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| • Effective perimeter erosion and sediment control barrier  
• Can be retained and utilized on existing sites or newly established if not already present on site  
• Minimal maintenance required and very cost-effective when correctly applied | • Limited applicability on arid and semi-arid sites  
• Limited to areas with sheet flow or minimal concentrated flow from small drainage areas  
• Wooded buffers require additional widths to provide equal protection as compared to vegetated buffers |

See photos 13A and 13B for typical configurations and common problem examples.
1. Brush Barrier

1A. Brush barrier installation.

1B. An example of a brush barrier. (photo courtesy of Mississippi Department of Environmental Quality)

2. Compost Berm/Sock

2A. A well-functioning compost berm. (photo courtesy of Filtrexx Int’l)

2B. Berm maintenance and sediment removal needed.

2C. A well-functioning compost sock (photo courtesy of Filtrexx Int’l).
3. Compost Blanket

3A. Slope before and after compost blanket application.

3B. Compost blanket installation requiring additional application.

3C. Divert run on water to minimize potential for erosion.

4. Earthen Berm/Temporary Diversion

4A. Example of an earthen berm diverting runoff away from an adjacent environmentally sensitive area.

4B. Example of an earthen berm with a temporary slope drain.

4C. Earthen berm with temporary slope drains.
5. Fiber Check Dam/Rock Check Dam

5A. Rock check dams during a storm.

5B. Rock check dam sediment removal needed.

5C. Fiber check dam maintenance required for sediment removal.

6. Fiber Roll/Wattle

6A. A good example of a fiber roll.

6B. Wattle alternative use at strategic location.

6C. Wattle in need of repair. Greater overlap needed where wattle ends come together. The fiber roll may also need to be better trenched.
7. Gravel Construction Entrance

7A. A good example of a gravel construction entrance.

7B. Gravel construction entrance requires clearly defined ingress/egress points.

7C. Gravel construction pad missing where construction traffic enters road.

8. Inlet Protection

8A. Properly installed inlet protection.

8B. Inlet protection damaged by vehicular traffic.

8C. Failing inlet protection due to improper installation and inadequate maintenance.
9. Sediment Basin

9A. A sediment basin equipped with a floating skimmer. Riprap is used to prevent the skimmer from becoming stuck in the saturated soil beneath.

9B. Example of a sediment basin outlet structure.

9C. Slope drains that lead to a sediment basin that is full of sediment.

10. Silt Fence

10A. Properly installed and well-maintained silt fence.

10B. Silt fence where sediment removal is required.

10C. Silt fence failure due to construction traffic.
### 11. Silt Trap

<table>
<thead>
<tr>
<th>11A</th>
<th>A good example of a silt trap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11B</td>
<td>A silt trap that is full of sediment. Remove sediment and assess if additional erosion protection practices are required upgradient.</td>
</tr>
<tr>
<td>11C</td>
<td>A poorly constructed sediment trap: sidewalls are too steep, embankment is susceptible to erosion, and there is no clearly defined weir or low point at the stone outlet.</td>
</tr>
</tbody>
</table>

### 12. Temporary Slope Drain

<table>
<thead>
<tr>
<th>12A</th>
<th>Example of a temporary slope drain.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12B</td>
<td>Temporary slope drain outlet.</td>
</tr>
<tr>
<td>12C</td>
<td>A temporary slope drain that was undercut and bypassed.</td>
</tr>
</tbody>
</table>
13. Vegetated Buffer

13A. Example of a vegetated buffer maintained in an area of residential construction.

13B. Example of a vegetated buffer maintained in an area of commercial construction.
### General Information Section

#### General Information
(see following page for instructions)

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Project No.</th>
<th>Inspection Date</th>
</tr>
</thead>
</table>

#### Inspector Name, Title & Contact Information

#### Present Phase of Construction

#### Inspection Location
(if multiple inspections are required, specify location where this inspection is being conducted)

#### Inspection Frequency
(Note: You may be subject to different inspection frequencies in different areas of the site. Check all that apply.)

- **Standard Frequency:**
  - Weekly
  - Every 14 days and within 24 hours of a 0.25” rain

- **Increased Frequency:**
  - Every 7 days and within 24 hours of a 0.25” rain (for areas of sites discharging to sediment or nutrient-impaired waters or other specific water quality classifications in your permit)

- **Reduced Frequency:**
  - Once per month (for stabilized areas)
  - Once per month and within 24 hours of a 0.25” rain (for arid, semi-arid, or drought-stricken areas during seasonally dry periods or during drought)
  - Once per month (for frozen conditions where earth-disturbing activities are being conducted)

Was this inspection triggered by a 0.25” storm event?  
- Yes  
- No

If yes, how did you determine whether a 0.25” storm event had occurred?

- Rain gauge on site
- Weather station representative of site. Specify weather station source:

Total rainfall amount that triggered the inspection (in inches):

#### Project Area Summary and Disturbed Area (DA)

<table>
<thead>
<tr>
<th>Total Project Area</th>
<th>Field Estimate of Active DAs</th>
<th>Field Estimate of Non-Active DAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>____________________</td>
<td>____________________________</td>
<td>____________________________</td>
</tr>
</tbody>
</table>

#### Contractor or Subcontractor Certification and Signature

Signature of Contractor or Subcontractor: __________________________ Date: __________________

Printed Name and Affiliation: __________________________

#### Certification and Signature by Permittee

Signature of Permittee or Duly Authorized Representative: __________________________ Date: __________________

Printed Name and Affiliation: __________________________
Instructions for Completing “General Information” Section

**Project Name**
Enter the name for the project.

**Project No.**
Enter the project number that was assigned to your Notice of Intent (NOI) application for permit coverage.

**Inspection Date**
Enter the date you conducted the inspection.

**Inspector Name, Title & Contact Information**
Provide the name of the person(s) (either a member of your organization’s staff or a contractor or subcontractor) that conducted this inspection. Provide the inspector’s name, title, and contact information as directed in the form.

**Present Phase of Construction**
If this project is being completed in more than one phase, indicate which phase it is currently in.

**Inspection Location**
If your project has multiple locations where you conduct separate inspections, specify the location where this inspection is being conducted. If only one inspection is conducted for your entire project, enter “Entire Site.” If necessary, complete additional inspection report forms for each separate inspection location.

**Inspection Frequency**
Check the box that describes the inspection frequency that applies. Note that you may be subject to different inspection frequencies in different areas of your site. If your project does not discharge to a “sensitive water” (i.e., a water impaired for sediment or nutrients), choose your frequency – either weekly, or every other week and within 24 hours of a 0.25-inch (6.4 mm) storm event. For any portion of your site that discharges to a sensitive water, your inspection frequency for that area is fixed weekly and within 24 hours of a 0.25-inch (6.4 mm) storm event. If portions of your site are stabilized, are located in arid, semi-arid, or drought-stricken areas, or are subject to frozen conditions, consult your permit for the application inspection frequency. Check all the inspection frequencies that apply to your project.

**Was this inspection triggered by a 0.25” storm event?**
If you were required to conduct this inspection because of a 0.25 inch (or greater) rain event, indicate whether you relied on an on-site rain gauge or a nearby weather station (and where the weather station is located). Also, specify the total amount of rainfall for this specific storm event.

**Project Area Summary and Disturbed Area (DA)**
Record the total acreage for the project site. Also, estimate the acreage of the active disturbed areas and non-active (graded but idle) areas.

**Contractor or Subcontractor Certification and Signature**
Where a contractor or subcontractor is relied upon to carry out the inspection and complete the inspection report, you should require the inspector to sign and certify each report. Note that this does not relieve the permitted operator of the requirement to sign and certify the inspection report as well.

**Signature and Certification by Permitee**
At a minimum, the inspection report must be signed by either (1) the person who signed the NOI, or (2) a duly authorized representative of that person.
## Construction Site Erosion and Sediment Control Inspection Checklist

### Condition and Effectiveness of Erosion and Sediment (E&S) Controls

(Refer to instruction sheet following table)

<table>
<thead>
<tr>
<th>Type of E&amp;S Control (Add an additional sheet if necessary)</th>
<th>Repairs or Routine Maintenance Needed?*</th>
<th>Urgent Corrective Action Required?*</th>
<th>Date on Which Maintenance or Corrective Action Needs First Identified?</th>
<th>Notes (include locations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preservation of Existing Vegetation</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Construction Entrances</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Perimeter Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Concentrated Flow Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Inlet Protection Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Routine needs attention within 5 days; Urgent needs attention within 24 hours

### Construction Controls

**Preservation of Existing Vegetation**
Vegetated buffers, vegetation outside construction limits.

**Perimeter Controls**
Silt Fence, fiber rolls, compost berms, and compost socks.

**Concentrated Flow Controls**
Diversions, rock dams, fiber check dams or equivalent.

Atch 1
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<table>
<thead>
<tr>
<th>Type of E&amp;S Control (Add an additional sheet if necessary)</th>
<th>Repairs or Routine Maintenance Needed?*</th>
<th>Urgent Corrective Action Required?*</th>
<th>Date on Which Maintenance or Corrective Action Needs First Identified?</th>
<th>Notes (include locations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sediment Basins/Traps</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Slope Protection Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Stockpile Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Dewatering Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Wind Erosion Controls</td>
<td>☐ Yes ☐ No</td>
<td>☐ Yes ☐ No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Routine needs attention within 5 days; Urgent needs attention within 24 hours
Instructions for Completing the Construction Site Erosion and Sediment Control Checklist

Type and Location of E&S Controls
Provide a list of all erosion and sediment (E&S) controls that your Storm Water Pollution Prevention Plan (SWPPP) indicates will be installed and implemented at your site. Include any natural buffers. Buffer requirements apply if your project’s earth-disturbing activities will occur within 50 feet of surface water. You may group the E&S controls on your form if you have several of the same type of controls (e.g., you may group “Inlet Protection Measures,” “Perimeter Controls,” and “Stockpile Controls” together on one line), but if there are any problems with a specific control, you must separately identify the location of the control, whether repairs or maintenance or corrective action are necessary, and in the Notes section you must describe the specifics about the problem you observed.

Repairs or Other Maintenance Needed?
Answer “yes” if the E&S control requires a repair of any kind (due to normal wear and tear, or as a result of damage) or requires maintenance for the control to continue operating effectively. At a minimum, maintenance is required in the following specific instances: (1) for perimeter controls, whenever sediment has accumulated to half or more the above-ground height of the control; (2) where sediment has been tracked-out onto the surface of off-site streets or other paved areas; (3) for inlet protection measures, when sediment accumulates, the filter becomes clogged, and/or performance is compromised; and (4) for sediment basins, as necessary to maintain at least half of the design capacity of the basin. Note: In many cases, “yes” answers are expected and indicate a project with an active operation and maintenance program. You should also answer “yes” if work to fix the problem is still ongoing from the previous inspection.

Corrective Action Needed?
Answer “yes” if during the inspection any of the following conditions were present: (1) a required E&S control was never installed or was installed incorrectly; (2) you become aware that the inadequacy of the E&S control has led to an exceedance of an applicable water quality standard; or (3) requires corrective action for an E&S control as a result of a permit violation found during an inspection carried out by regulators. Note: You should answer “yes” if work to fix the problem from a previous inspection is still ongoing.

Date on Which Maintenance or Corrective Action Need First Identified?
Provide the date on which the condition that triggered the need for maintenance or corrective action was first identified. If the condition was just discovered during this inspection, enter the inspection date. If the condition is a carryover from a previous inspection, enter the original date of the condition’s discovery.

Notes
For each E&S control and the area immediately surrounding it, note the locations and whether the control is properly installed and whether it appears to be working to minimize sediment discharge. Describe any problem conditions observed, such as the following, and why you think they occurred as well as actions (e.g., repairs, maintenance, or corrective action) you will take or have taken to fix the problem:

1. Failure to install or to properly install a required E&S control
2. Damage or destruction to an E&S control caused by vehicles, equipment, or personnel, a storm event, or other event
3. Mud or sediment deposits found downslope from E&S controls
4. Sediment tracked out onto paved areas by vehicles leaving construction site
5. Noticeable erosion at discharge outlets or at adjacent stream banks or channels
6. Erosion of the site’s sloped areas (e.g., formation of rills or gullies)
7. E&S control is no longer working due to lack of maintenance

For buffer areas, make note of whether they are marked off as required, whether there are signs of construction disturbance within the buffer, and whether there are visible signs of erosion resulting from discharges through the area.

If repairs, maintenance, or corrective action is required, briefly note the reason. If repairs, maintenance, or corrective action have been completed, make a note of the date it was completed and what was done.
<table>
<thead>
<tr>
<th>Type of Pollution Prevention Control (Add an additional sheet if necessary)</th>
<th>Repairs or Routine Maintenance Needed?*</th>
<th>Urgent Corrective Action Required?*</th>
<th>Date on Which Maintenance or Corrective Action Need First Identified?</th>
<th>Notes (include locations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Waste Management</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Building Material Handling &amp; Staging Areas</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Washout Areas</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Equipment/Vehicle Fueling, Cleaning, &amp; Maintenance</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Spill Prevention</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
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<tr>
<td>8.</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>10.</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Routine needs attention within 5 days; Urgent needs attention within 24 hours
Instructions for Completing the Construction Site Pollution Prevention Practice Checklist

Type and Location of Pollution Prevention Controls
Provide a list of all pollution prevention practices implemented at your site. This list must include all pollution prevention practices described in your SWPPP.

Repairs or Other Maintenance Needed?
Answer “yes” if the pollution prevention practice requires a repair of any kind (due to normal wear and tear, or as a result of damage) or requires maintenance for the control to continue operating effectively. Note: In many cases, “yes” answers are expected and indicate a project with an active operation and maintenance program.

Corrective Action Needed?
Answer “yes” if during your inspection you found any of the following conditions to be present: (1) a required pollution prevention practice was never installed, or was installed incorrectly; (2) you become aware that the inadequacy of the pollution prevention practice has led to an exceedance of an applicable water quality standard; (3) one of the “prohibited discharges” is occurring or has occurred; or (4) requires corrective action for a pollution prevention practice as a result of a permit violation found during an inspection carried out by regulators. Note: You should answer “yes” if work to fix the problem from a previous inspection is still ongoing.

Date on Which Maintenance or Corrective Action First Identified?
Provide the date on which the condition that triggered the need for maintenance or corrective action was first identified. If the condition was just discovered during this inspection, enter the inspection date. If the condition is a carryover from a previous inspection, enter the original date of the condition’s discovery.

Notes
For each pollution prevention control and the area immediately surrounding it, note whether the control is properly installed, whether it appears to be working to minimize or eliminate pollutant discharges, and whether maintenance or corrective action is required. Describe problem conditions you observed such as the following, and why you think they occurred, as well as actions you will take or have taken to fix the problem:

1. Failure to install or to properly install a required pollution prevention control
2. Damage or destruction to a pollution prevention control caused by vehicles, equipment, or personnel, or a storm event
3. Evidence of a spill, leak, or other type of pollutant discharge, or failure to properly clean up a previous spill, leak, or other type of pollutant discharge
4. Spill response supplies are absent, insufficient, or not where they are supposed to be located
5. Improper storage, handling, or disposal of chemicals, building materials or products, fuels, or wastes
6. Pollution prevention practice is no longer working due to lack of maintenance

If repairs, maintenance, or corrective action is required, briefly note the reason. If repairs, maintenance, or corrective action have been completed, make a note of the date it was completed and what was done. If corrective action is required, note that you will need to complete a separate corrective action report describing the condition and your work to fix the problem.
## Construction Site Stabilization of Exposed Soil and Description of Discharges Inspection Checklist

### Stabilization of Exposed Soil
(see following page for instructions)

<table>
<thead>
<tr>
<th>Stabilization Area [Add an additional sheet if necessary]</th>
<th>Stabilization Method</th>
<th>Have You Initiated Stabilization?</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>[ ] YES □ NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If yes, provide date:</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>[ ] YES □ NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If yes, provide date:</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>[ ] YES □ NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If yes, provide date:</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>[ ] YES □ NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If yes, provide date:</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>[ ] YES □ NO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If yes, provide date:</td>
<td></td>
</tr>
</tbody>
</table>

### Description of Discharge
(see following page for instructions)

Was a storm water discharge or other discharge occurring from any part of your site at the time of the inspection? □ Yes □ No
If “yes,” provide the following information for each point of discharge:

<table>
<thead>
<tr>
<th>Discharge Location [Add an additional sheet if necessary]</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>At points of discharge and the channels and banks of surface waters in the immediate vicinity, are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? □ Yes □ No If yes, describe the discharge:</td>
</tr>
<tr>
<td>2.</td>
<td>At points of discharge and the channels and banks of surface waters in the immediate vicinity, are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? □ Yes □ No If yes, describe the discharge:</td>
</tr>
</tbody>
</table>

Atch 1
(30 of 31)
Instructions for Completing the Construction Site Stabilization of Exposed Soil Checklist

Stabilization Area
List all areas where soil stabilization is required to begin because construction work in that area has permanently stopped or temporarily stopped (i.e., work will stop for 14 or more days), and all areas where stabilization has been implemented.

Stabilization Method
For each area, specify the method of stabilization (e.g., hydroseed, sod, planted vegetation, compost blanket, erosion control blanket, mulch, and rock).

Have You Initiated Stabilization?
For each area, indicate whether stabilization has been initiated.

Notes
For each area where stabilization has been initiated, describe the progress that has been made and what additional actions are necessary to complete stabilization. Note the effectiveness of stabilization in preventing erosion. If stabilization has been initiated but not completed, make a note of the date it is to be completed. If stabilization has been completed, make a note of the date it was completed. If stabilization has not yet been initiated, make a note of the date it is to be initiated, and the date it is to be completed.

Instructions for Completing the Description of Discharges Checklist

You are only required to complete this section if a discharge is occurring at the time of the inspection.

Was a storm water discharge or other discharge occurring from any part of your site at the time of the inspection?
During your inspection, examine all points of discharge from your site, and determine whether a discharge is occurring. If there is a discharge, answer “yes” and complete the questions below regarding the specific discharge. If there is not a discharge, answer “no.”

Discharge Location (repeat as necessary if there are multiple points of discharge)
Location of discharge. Specify the location on your site where the discharge is occurring. The location may be an outlet from a storm water control or constructed storm water channel, a discharge into a storm sewer inlet, or a specific point on the site. Be as specific as possible; it is recommended that you refer to a precise point on your site map.

Describe the discharge. Include a specific description of any noteworthy characteristics of the discharge such as color; odor; floating, settled, or suspended solids; foam; oil sheen; and other obvious pollution indicators.

Are there visible signs of erosion or sediment accumulation? At each point of discharge and the channel and stream bank in the immediate vicinity, visually assess whether there are any obvious signs of erosion and/or sediment accumulation that can be attributed to your discharge. If you answer “yes,” include a description in the space provided of the erosion and sediment deposition that you have found, specify where on the site or in the surface water it is found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue.
General Storm Water Infrastructure Operation and Maintenance Guide

1. Introduction

This Attachment 2 and Attachments 3 through 12 are practical tools to aid in the O&M of permanent storm water drainage and treatment infrastructure. This attachment presents basic information to prepare O&M personnel for maintenance activities and provides a troubleshooting guide for common storm water collection system components. It also provides guidance for O&M of outlet control structures that are common to many BMPs.

This attachment is organized as follows:

1. Introduction
2. Background
3. Record keeping
4. Safety considerations
5. Tools, equipment, and supplies that may be needed in the field
6. O&M of storm water collection systems
7. O&M of common storm water control measure (SCM) elements

Detailed guidance for O&M of individual SCMs is presented in Attachments 3 through 12:

Attachment 3 Vegetated Swale
Attachment 4 Bioretention and Filtration Basin
Attachment 5 Level Spreader, Filter Strip, and Vegetated Buffer
Attachment 6 Wet Detention Basin
Attachment 7 Dry Detention Basin
Attachment 8 Infiltration SCMs – Infiltration Basin, Infiltration Trench, and Dry Well
Attachment 9 Storm Water Wetland
Attachment 10 Rainwater Harvesting – Rain Barrels and Cisterns
Attachment 11 Permeable Pavement
Attachment 12 Reforestation

Included in these attachments are checklists to aid in documenting inspections and maintenance activities.

2. Background

When it rains or snow melts, part of the water soaks into the ground, part of it evaporates, and part of it flows over land. The part that flows over land is called storm water runoff. In natural settings, water from storm events is slowed by vegetation and other obstacles as it flows over land. As a result, most of the storm water infiltrates into the soil. This is beneficial to the environment because it helps to maintain a relatively constant source of groundwater to streams, rivers, and other bodies of water.

Unfortunately, this is not the case in developed areas. In developed areas, much of the land is covered by hard surfaces such as buildings and pavement. These hard surfaces, due to their impervious nature, allow little to no infiltration, and storm water in essence becomes a transportation system for pollutants. Figure 2-1 illustrates these concepts for natural and developed areas.
As storm water flows over hard surfaces it picks up fuel, oil, antifreeze, trash, deicers, and other pollutants. It also picks up soil and organic material as it flows from hard surfaces and erodes less stable surfaces. Pollutants transported by storm water are deposited into streams, rivers and other bodies of water where they can harm habitats and have a detrimental effect on aquatic insects, fish, birds, and mammals.

To counteract the negative effects of development on receiving waters, permanent SCMs or BMPs are installed. These are engineered structures or devices designed to slow down or hold the water for a short time and remove pollutants before it is released to a stream. The term “permanent” differentiates these structures from temporary measures installed at construction sites and removed when construction is complete.

SCMs must be routinely inspected and maintained to ensure they continually function as designed. If proper maintenance is not provided, adverse environmental impacts such as the discharge of pollutants into ground and surface waters may occur.

It is common for Air Force bases to be issued storm water NPDES permits that allow bases to discharge runoff if certain requirements are met. O&M of storm water BMPs is often included in these requirements.

### 3. Record Keeping

Personnel responsible for O&M of permanent BMPs and storm water collection systems are encouraged to develop an inspection program to schedule, document, and track O&M efforts. It is especially important to develop an accurate inventory of permanent SCMs. The base Geographic Information System (GIS) is a good tool to aid in O&M tracking. BMPs and storm water collection system components should be added to the base GIS by marking up hardcopy maps or taking Global Positioning System (GPS) points and working with CES/CEPT to enter the data. Figure 3-1 gives an example of typical GIS storm water data.
Record keeping is a very important aspect of storm water O&M and is generally required by law. Records for construction activities (e.g., corrective action documentation) should be kept for at least three years following the expiration or termination of the construction NPDES permit (EPA, 2012).

Records relating to O&M of storm water collection systems and permanent BMPs should be kept for at least five years (EPA, 2012). These records must be made available to regulators upon request.

4. Safety Considerations

Consider the following potential safety hazards while planning and conducting O&M. Avoid working alone when possible.

Confined Space

Confined spaces are defined by the Occupational Safety and Health Administration (OSHA) as follows:

Confined Space

- Is large enough for an employee to enter fully and perform assigned work;
- Is not designed for continuous occupancy by the employee; and
- Has limited or restricted means of entry and exit.

Permit-Required Confined Space

- Contains or has the potential to contain a hazardous atmosphere;
- Contains material with the potential to engulf someone who enters the space;
- Has an internal configuration that might cause an entrant to be trapped or asphyxiated by an inwardly converging wall or by a floor that slopes downward and tapers to a smaller cross-section; and/or
- Contains any other recognized serious safety or health hazards.

Personnel performing O&M of storm water systems should be aware of confined space rules and restrictions. Personnel conducting confined space entry must be properly trained and follow applicable rules. See 29 CFR...
1910.146 for additional information concerning permit-required confined spaces. Contact base-level Confined Space Entry Program personnel for assistance. Examples of confined spaces include box culverts and catch basins.

Traffic

A significant portion of storm water collection systems is typically located in and around areas frequented by vehicular traffic. Proper high-visibility clothing (e.g., safety vest) should be worn. Park vehicles with flashing lights and place barricades and cones to alert and safely direct traffic away from work areas. Have someone direct traffic and use proper signage when needed. Strictly adhere to all rules when working around the airfield.

Chemical/Biological Hazards

Watch out for chemical hazards such as fuels and cleaners that have been inappropriately discharged to the storm water system. Biological hazards such as spiders, especially black widows (Figure 4-1; see Figure References for all remaining figures at the end of this attachment), are commonly found on the underside of manhole lids and near the entrance to dark and damp structures. Wasps and hornets like to build nests inside storm structures. Ticks, snakes, and other animals are often encountered in areas surrounding permanent SCMs.

Lifting

Work associated with storm water collection systems and SCMs typically requires some lifting of heavy objects. Use proper tools (i.e., manhole hook) and proper lifting technique, get help when needed, or use power equipment if warranted.

Slips/Trips/Falls

Numerous hazards regarding slips, trips, and falls can be expected. Open manholes, catch basins, and other structures present an especially dangerous hazard. Be vigilant for wet or muddy surfaces and animal holes or sinkholes. Riprap is extremely difficult to walk on and should be avoided whenever possible. Never leave an open manhole or catch basin unattended!

Weather and Working Around Water

Follow general guidelines for working (or not working) during adverse weather conditions with an increased awareness for the risks associated with working around drainage systems. Rapid increases in the depth and velocity of water should be expected during and after rain events. Although it may not be raining in the immediate area, rainfall upstream may still lead to hazardous and life-threatening conditions. Even shallow running water can present a serious hazard to workers as surfaces are often slippery and uneven.

5. Tools, Equipment, and Supplies

Consider bringing the following items during regular O&M activities:

- A copy of this ETL or applicable attachments
- Inspection checklists, clipboard, pens/pencils
- Camera
- GPS receiver
- Flashlight and/or mirror
- Tape measure and/or measuring stick
- Tools for removing grates/lids:
  - Manhole hook
  - Large screw driver or pry bar
  - Sledge hammer
- Hand tools:
  - Shovel(s)
• Rakes(s)
• Wheelbarrow

• Minor erosion repair and revegetation supplies:
  o Topsoil
  o Seed
  o Straw, mulch, or erosion netting or matting

• Vegetation management:
  o Mower
  o Chainsaw
  o Pruners

• Trash bags

• Personal protective equipment (PPE) and related items:
  o Steel-toe boots
  o Leather gloves
  o Rubber gloves
  o Safety glasses
  o Safety vest
  o Hardhat (if entering a structure or equipment will be overhead)
  o Hearing protection
  o Sunscreen and bug repellant
  o Personal flotation device (if working near open water)
  o Confined space equipment (if applicable)
    ▪ Permit form
    ▪ Gas monitor
    ▪ Harness
    ▪ Retrieval device

• Other BMP-specific items necessary for O&M

Corrective maintenance needs may be identified during inspections and may require the use of additional or specialized equipment. Such equipment may include, but is not limited to:

• Closed circuit television (CCTV) equipment or pole camera
• Vactor truck
• Water truck/trailer
• Backhoe/excavator
• Loader
• Tiller

6. O&M of Storm Water Collection Systems
6a. General O&M Items

Preventive maintenance and minor corrective maintenance is performed by CES/CEOHP. If maintenance needs are identified that are beyond in-house capabilities, it should be brought to the attention of the installation cross-functional water quality team or the engineering flight chief so a project can be programmed to correct the problem.

• Perform inspections after storms when debris accumulation occurs and major problems will be evident.
• Keep an eye out for areas that flood or are slow to drain following storms, as well as bare areas, evidence of erosion, and sinkholes.
• Sinkholes can be caused by damaged catch basin/manhole structures or pipes as soil is washed in through cracks or breaks. Sinkholes are a safety concern and can undermine roads and other structures.
They also release sediment to receiving waters.
- Keep an eye out for illicit discharges, sheens (see Figure 6a-1), or other unusual water characteristics (e.g., excessive algae, strange water color, foam, odors).

<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Ground cover      | - In non-arid climates, be mindful of areas of significant bare soil on base.  
- Any large areas of bare soil should be repaired.  
- Try to determine the source of the issue (e.g., poor soil, pest infestations, prolonged drought conditions).  
- Perform soil testing and consult a landscaping professional or soil scientist if needed.  
- Apply compost or topsoil to improve soil and seed where needed.  
- Apply pesticides and fertilizers where needed, but only in accordance with local regulations. Never over-apply.  
- Select native and hardy species (resistant to pests and dry or wet conditions) whenever possible.  
- In arid regions, natural vegetation should be preserved. Utilize xeriscaping where practicable and apply rock or gravel to areas susceptible to erosion. |
| Erosion (see Figure 6a-2) | - While traveling on base, be mindful of erosion.  
- Erosion results in greater sedimentation in storm water collection systems, SCMs, and receiving water bodies.  
- Repair erosion by filling, regrading, applying topsoil, and seeding/mulching, or sodding.  
- Apply erosion control matting, riprap, or liners where needed. |
| Sediment disposal | - Storm water O&M activities can generate significant quantities of sediment.  
- How the sediment is disposed depends on from where it was removed and other pollutants that may be present.  
- Consult with base environmental when handling and disposing sediment.  
- It is generally a good idea to perform laboratory analysis on sediment samples to determine the proper disposal method. Analysis is required if anything out of the ordinary is noticed, such as a strong fuel odor.  
- Clean sediment can be used as fill while contaminated sediment should be disposed in a solid waste landfill.  
- Sediment should generally be dewatered to facilitate handling. Based on the nature of the contaminants present in the sediment, determine whether it is appropriate to discharge dewatering drainage to the sanitary sewer. |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Bird/Wildlife Aircraft Strike Hazards (BASH)                           | • The BASH program was implemented to reduce the risk of bird strikes and collisions with other animals such as deer. Refer to AFPAM 91-212 for additional information.  
  • There are many BASH considerations that relate to O&M of storm water collection systems and SCMs. Grass height and species are among them.  
  • Trees and tall vegetation surrounding permanent pools of water discourage waterfowl by creating obstructions for the birds’ landing and takeoff and by providing areas for predator concealment.  
  • BASH management techniques vary from location to location. Contact the airfield manager for location-specific information. |
| 6b. Storm Water Inlets, Catch Basins, and Manholes                      | Storm water structures such as inlets, catch basins, and manholes require periodic O&M to prevent blockages flooding, and to correct structural problems. All structures should be accessible for O&M activities. Containers and other materials should not be stored on storm water structures (see Figures 6b-1 and 6b -2).                                                                                       |
| Sediment, trash, debris built up on grates (see Figure 6b-3)           | • Remove all debris. Typically, rakes work well for this.  
  • Dispose of trash and recyclable materials appropriately. Dispose of sediment and vegetative debris where it will not be washed away by runoff again.  
  • Perform this action before the wet season to remove debris accumulated during the drier months and immediately after large rain events when large amounts of debris get caught around grates. |
| Sediment, trash, debris inside structures (see Figure 6b-3)             | • Some catch basins have capacity built in to store sediment to prevent it from reaching receiving waters. Sediment should be removed before it fills 60% of the catch basin capacity below the outgoing line.  
  • For other catch basins, remove any substantial sediment or debris accumulations before it fills 20% of the outgoing line.  
  • Inspect any areas where sediment/trash/debris build up more frequently and correct the issue.  
  • Material may be removed manually or by vacuum truck/trailer. |
| Structural damage (see Figure 6b-4)                                    | • Grates or manhole covers should be replaced if they are cracked or otherwise present a hazard to vehicle or pedestrian traffic.  
  • Structures with significant damage should be repaired or replaced immediately.  
  • Cracks within a catch basin or manhole that compromise structural integrity or allow soil to enter the structure should be repaired.  
  • Repair cracks with non-shrink or chemical grout as appropriate. |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Illegal dumping                 | • Try to determine the source of the dumping and notify the offender that they should cease the activity.  
  • Notify CES/CEIEC, SFS, and/or other base authority if the activity continues or is severe enough to warrant it.  
  • Paints and mop water are common wastes inappropriately discharged to storm sewers.  
  • Stenciling storm drains is a good practice to discourage dumping. Stencils often include text such as “NO DUMPING, DRAINS TO STREAM” (see Figure 6b-5).  
  • Remove any material if it is safe to do so.  
  • Notify CES/CEIEC of any suspected hazardous wastes. |
| Illicit discharge/cross-connection | • These are piped sources of wastewater that have been inappropriately connected to the storm water collection system.  
  • Try to identify the source and notify Environmental.  
  • Smoke testing, dye testing, and CCTV may be used to aid in determining the source. |
| Structure becoming buried (see Figure 6b-6) | • Manholes, catch basins, and inlets that are becoming buried should have soil and vegetation cleared away if possible.  
  • If possible, bring the structure up to grade by adding grade rings/risers. |
| Sinkholes                        | • Inspect the area surrounding drainage structures for sinkholes.  
  • Sinkholes may indicate a structural defect that is allowing soil to be washed into the structure and contribute to sedimentation.  
  • Make the necessary structural repairs and fill in and seed any sinkholes. |

6c. Pipes

There are many problems that can occur within pipes that can restrict or completely cut off flow. However, pipes are often difficult to access for inspection and cleaning. There are many tools available to help.

**Line Lamping**

Line lamping illuminates the pipe and allows inspectors to see a certain distance up the line. Line lamping can be performed using an ordinary digital camera (with flash) or a specialized pole camera. A digital camera may capture the first 20 to 50 feet (6 to 15 meters) of the pipe. Pole cameras with zoom features may see as far as 300 feet (91 meters).

**Closed Circuit Television (CCTV)**

CCTV equipment is self-propelled or pushed up the pipe. The equipment illuminates the pipe and sends a video feed of the pipe back to the operator where its condition is evaluated. CCTV is very useful in identifying root intrusion, structural problems, blockages, and illicit cross-connections. CCTV equipment may be available to borrow from CES/CEOIU. Personnel should obtain proper training before using the equipment or have an experienced operator assisting.

**Jet/Vacuum (Vactor) Trucks**

Vactor trucks or trailers are often used to clean out catch basins and pipes (see Figure 6c-1). A vactor truck may be available from the utilities shop. Personnel should get proper training before using the equipment and/or have an experienced operator assisting. Serious injury can result from improper use. Review the equipment’s or manufacturer’s operating manual prior to use.
This work is typically performed over an open hole. Be aware of your surroundings at all times. This equipment is typically loud while operating and hearing protection is usually required. High-pressure water is shot out of a jet nozzle that can cause a reacting force on the hose similar to a fire hose. Good footing is important—the operator should brace for this force. Familiarize yourself with pinch points and ensure the nozzle is never directed toward anyone. Familiarize yourself with controls, indicators, and emergency shutoffs.

Many vactor-type trucks or trailers consist of a jetting hose and a vacuum hose. The jetting hose is on a motorized reel that helps feed and retract the hose. The jet nozzle also helps propel the hose forward as it cleans the pipe. A short section of flexible pipe around the jet hose protects the hose where it enters the pipe. The vacuum hose is used to clean catch basins where sediment has accumulated.

For pipe cleaning, the crew should set up at the upstream manhole or inlet, send the jet downstream, and pull material back so that sediment is not flushed downstream toward receiving waters. The vacuum hose is used to remove material that is pulled back. Measures should be taken to capture any sediment accidentally flushed towards outfalls. The truck’s holding tank should only be emptied at approved locations.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Sediment and debris buildup      | • Pipes should be cleaned on a regular schedule or when sediment accumulates to 20% of the pipe’s capacity using a vactor truck.  
• If sediment and debris buildup is a severe or reoccurring problem, identify and correct the source. |
| Broken, cracked, or collapsed pipes (see Figure 6c-2) | • Damaged pipes may be identified by line lamping or CCTV.  
• Repair or replace damaged piping as appropriate.  
• Cracks that could compromise the structural integrity of the pipe or allow infiltration of sediment should be corrected.  
• Cracked pipes can sometimes be repaired through trenchless technologies such as cured in-place liners or pipe bursting. |
| Joint damaged or offset (see Figure 6c-3) | • Pipe joints that are offset or damaged to the point that they are allowing infiltration of sediment should be corrected.  
• Offset pipe joints can also trap debris and contribute to blockages. |
| Illicit cross-connections        | • Illicit cross-connections within pipes are most accurately identified and located using CCTV.  
• Strange odors, discolored water, and flows during dry weather are telltale signs of cross-connections.  
• Alert base environmental of any suspected cross-connections. |
| Root intrusion                   | • Plant roots often find their way into storm systems through cracks or defective joints.  
• Roots obstruct flow and collect debris.  
• Roots can be removed by mechanical cutting devices or chemical treatment. The specialized equipment used for root treatment may not be available at all bases and a project may need to be programmed to remove roots.  
• Ensure any chemicals used are approved for use in storm water systems prior to use. |
### Problem | Corrective Action
--- | ---
**Sinkholes** | • Inspect the ground surface over pipes for sinkholes.  
• Sinkholes can indicate a defect that is allowing soil to be washed into the pipe and contribute to sedimentation.  
• Repair the pipe and fill in and seed any sinkholes.

**Security grates and barriers (see Figures 6c-4 and 6c-5)** | • Security grates are typically installed on pipes greater than 10 inches (254 millimeters) in diameter that traverse underneath fences to keep intruders out.  
• Security grates require frequent cleaning to clear debris.  
• Work closely with SFS when performing maintenance on security grates.  
• Ensure that grates inside and outside of the fence are being maintained and kept clear of debris.  
• Inspect for corrosion and other damage and repair or replace as needed.  
• Notify SFS of vandalism, defeated barriers, or signs of unusual activity.  
• Notify SFS of washed-out areas underneath the fence so it may be corrected.

### 6d. Culverts

Culverts are pipes that generally daylight on both sides and are often large in diameter (or length/width for box culverts). Culverts often function similar to bridges and convey water under driveways, roads, or similar structures (see Figure 6d-1).

O&M of culverts is similar to pipes; refer to section 6c of this attachment for detailed guidance. Culverts often convey streams under roadways. It is common for streams to have forested buffer areas. As such, stream culverts are susceptible to log jams and often become overgrown (see Figure 6d-2). Vegetation should be removed periodically so the area can be inspected and accessed for maintenance. Note that overly aggressive vegetation removal can lead to soil erosion, especially on slopes near culverts. Be aware that some stream culverts are designed to have a natural bottom and personnel should only attempt to remove debris if it appears to restrict flow. Furthermore, although maintenance activities are generally encouraged, personnel should be familiar with state and local requirements that may restrict activities within streams or require permits.

For work on culverts conveying live streams that involves large amounts of soil disturbance, seek advice from CES/CEIEC whether a Section 404 Clean Water Act or other type of permit is applicable. If a permit is applicable, a notice of intent to work may be required prior to start of work.

### 6e. Open Conveyances

Open conveyances include ditches, swales, and other channels. The guidance in this section is intended for drainage channels rather than live streams. Live streams or natural water courses typically do not require maintenance. If a large amount of soil disturbance in live streams is needed, seek advice from CES/CEIEC in determining if a Section 404 Clean Water Act or other type of permit is applicable. If a permit is applicable, an NOI may be required prior to start of work. Drainage channels may be lined with grass, riprap, concrete, or other materials. Attachment 3, Vegetated Swale Troubleshooting Guide, includes detailed O&M information for grassed channels. General O&M guidance for open conveyances follows.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Sediment/trash/debris (see Figure 6e-1) | • Remove any significant accumulations of sediment using shovels and rakes (use mini track loader for large concrete channels).  
• Remove other debris by hand, rake, or other method. |
Vegetation overgrowth
- Mow or remove vegetative growth that inhibits flow.
- Note that overly aggressive vegetation removal can lead to soil erosion.

Inadequate vegetation
- Seed and mulch or sod where needed.
- Install matting, riprap, liners, or other materials when warranted.

Erosion
- Fill and regrade eroded areas.
- Reestablish vegetation.

Missing, inadequate, or damaged erosion protection material/riprap
- Repair or replace liners or other erosion protection materials.
- Add riprap where needed and ensure appropriately sized riprap is used.

Damaged channel lining (pavers or concrete)
- Replace or reset pavers as needed.
- Saw-cut and patch concrete.

See Figures 6e-2 and 6e-3 for photos of concrete and grass channels in good condition.

6f. Outlet Protection and Energy Dissipation Devices
Outlet protection and energy dissipation is typically provided at the downstream end of pipes and some open conveyances. These measures help protect the ground surface from erosion. In addition, energy is dissipated and flow is generally spread over a larger area to help protect downstream features from erosion.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Inadequate erosion protection materials/riprap (see Figures 6f-1 and 6f-2) | - Adequate erosion protection is essential. Without it, significant erosion will occur and pipes and other structures may be undermined and fail.  
- Add or repair erosion protection materials where needed. |
| Sediment/trash/debris                                           | - Remove all debris and any significant accumulations of sediment.                 |
| Vegetation overgrowth                                           | - Remove vegetation that has the potential to inhibit flow, collect debris, or prevent O&M activities. |

See Figure 6f-3 for a good example of outlet protection.

6g. Street Sweeping
Street sweeping is often performed for motorist safety and general aesthetics, but is also a beneficial storm water BMP as it reduces the amount of debris and pollutants transported to storm water drainage systems and SCMs. Staff should be properly trained to operate street sweeping equipment. Street sweeping should be performed with storm water management principles in mind. Try to minimize the amount of debris swept into storm water inlets. Ensure debris is disposed of in accordance with applicable regulations.

6h. Storm Water Pump Stations
Storm water pump stations are maintained by CES/CEOIU. Nonetheless, CES/CEOHP personnel should be familiar with the location and operation of storm water pump stations. Preventive/routine maintenance should be performed in accordance with the pump station’s O&M manual provided by the designer.

6i. Storm Water Monitoring Equipment
Storm water monitoring equipment is generally not maintained by CES/CEOHP personnel; however, it is important to be aware of the equipment. Many bases are required to conduct monitoring of storm water at major outfalls where it leaves the base (see Figure 6i-1). Monitoring helps bases and regulators determine the amount and nature of storm water pollution and how best to manage storm water. Monitoring also helps to alert CES/CEIEC of spills that may otherwise go unnoticed.

CES/CEIEC should be notified if monitoring equipment appears to be damaged or in need of maintenance.
### 7. O&M of Common SCM Elements

#### 7a. Outlet Control Structures

Outlet control structures are often found in SCMs that utilize an earthen impoundment. These may include:

- Bioretention basins
- Dry detention basins
- Filtration basins
- Infiltration basins
- Storm water wetlands
- Wet detention basins

Outlet control structure configurations vary for different SCMs; however, O&M requirements are generally consistent. Figures 7a-1 and 7a-2 show varying configurations. Note that in most cases only one of the components described in Notes 2 through 4 of Figure 7a-1 will be present depending on the type of BMP. Infiltration basins typically do not have any of these components.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Water is not flowing freely to the outlet control structure | • If the outlet appears to be clogged or blocked and standing water prevents access to the structure, waders or a small boat may be needed to make the necessary repairs. Do not enter the standing water unless you have been trained to do so. Trained contractors can be hired to make needed repairs.  
  • If the water level in the basin is above the orifice, follow proper safety precautions before opening the sluice gate or pumping out the basin.  
  • Remove sediment or debris around the trash screen. After the basin has been drained, remove the trash screen to access the orifice. Remember to return the sluice gate to its original position.  
  • Remove sediment and debris blocking the flow into the orifice. Replace the steel orifice plate if there are signs of excessive corrosion. |
| Note: Prolonged standing water above the drawdown orifice indicates that the orifice is blocked. (see Figure 7a-3) | |
| Trash and debris present in or clogging trash rack or trash rack is damaged or corroded (see Figure 7a-4) | • Remove trash and debris from trash rack.  
  • Replace trash rack if it is corroded or damaged. Replace the trash rack according to design specifications for the BMP. |
| Sluice gate is not operable through intended range of motion | • Remove sediment or debris within and near the sluice gate.  
  • If lubrication is necessary, lubricate with a marine-type grease. For screw-type sluice gates, a PVC cover is recommended for the worm gear to protect it from corrosion.  
  • If the sluice gate is damaged beyond repair, consult a design professional for guidance on replacement. |
| Water is not flowing freely from the outlet structure | • Remove any built-up sediment or debris within the structure.  
  • Clear the outlet and outlet pipe of any obstructions. |
| Cracks or leaks in the outlet control structure | • Cracks or leaks should be patched with non-shrink or chemical grout as appropriate (see Figures 7a-5 and 7a-6). |
| Structural damage | • Repair structural damage if possible or notify the Water Board or engineering flight chief that a project needs to be programmed for the repairs. |

See Figures 7a-7 through 7a-11 for various examples of outlet control structures.
### 7b. Sediment Measurement in Permanent Pools

Sediment depths within SCMs with permanent pools (i.e., wet detention basins and storm water wetlands) should be measured periodically (typically annually). Ideally, record drawings showing the final grade of the basin and sediment storage depth would be available for comparison to measured values. For smaller facilities where depths are below 3 or 4 feet (1 to 1.2 meters), waders should be used to enter the permanent pool (see Figure 7b-1). A small boat should be used for larger facilities with greater depths. Measurements should include areas where sediment is most likely to settle. Typically, measurements are taken along the longitudinal section of submerged forebays and main pool areas. A consistent method should be used each time sediment is measured so that an accurate comparison of records can be made. One of the three following methods is often used:

1. Topographic survey capturing horizontal and vertical coordinates using a total station or similar device.
2. Level survey using sight level and survey rod. Use a 300-foot (91 meters) measuring tape to record horizontal distance along the section. Take a shot of a point with a known elevation for a frame of reference.
3. Water depth measurement
   - Measure the height of the water level from some known elevation on the outlet structure (e.g., the drawdown orifice).
   - Measure water depths using a survey rod or similar device.
   - Use a 300-foot (91 meters) measuring tape to record horizontal distance along the section.

Consult a professional if assistance is needed in determining sediment depth. Sediment should be removed from the main pool and forebays when it exceeds the design storage depth. If this is unknown, sediment should be removed when it reaches a depth of 1 foot (0.3 meter) or if it shows signs of being washed out of the pond during storm events.
Figure 4-1. Common biological hazard (e.g., Black Widow)

Figure 6a-1. A sheen visible on the water surface is an indication that POL is inappropriately discharging to the storm system

Figure 6a-2. Soil erosion in need of repair

Figure 6b-1. Fence obstructing manhole

Figure 6b-2. Materials stored on top of manhole

Figure 6b-3. Inlet clogged with sediment and debris
**Figure References**

**Figure 6b-4.** Inlet in need of repair and presenting a safety hazard

**Figure 6b-5.** Example of a marking identifying the structure as a storm drain

**Figure 6b-6.** Catch basin that was becoming buried

**Figure 6c-1.** Example of a vactor truck used to clean catch basins and pipes

**Figure 6c-2.** Example of a collapsed pipe that should be excavated and repaired

**Figure 6c-3.** Example of an offset joint that could cause a sink hole and sedimentation
Figure 6c-4. Example of a good security grate

Figure 6c-5. A security grate in need of repair

Figure 6d-1. Example of a good culvert

Figure 6d-2. Culvert becoming overgrown

Figure 6e-1. Concrete channel filled with sediment

Figure 6e-2. Example of a concrete channel in good condition
Figure 6e-3. Example of a grass channel in good condition

Figure 6f-1. Outlet in need of repair and additional erosion protection

Figure 6f-2. Inadequate erosion protection resulting in undermining of concrete channel

Figure 6f-3. Example of good outlet protection

Figure 6i-1. Example of monitoring equipment; vegetation should be removed before solar panel becomes blocked
Figure References

Figure 7a-1. Various outlet control structure configurations

Figure 7a-2. A flashboard riser outlet structure often installed in storm water wetlands

Note 1. Water level when basin is full after a storm event (typical of all BMPs with earthen basins).
Note 2. Drawdown orifice/device used to maintain a permanent pool designed to prevent clogging by floating debris (typical of wet detention basins and storm water wetlands only).
Note 3. Drawdown orifice and trash screen (typical of dry detention basins only).
Note 4. Underdrain (typical of bioretention and filtration basins only).

Figure 7a-3. Water is not flowing freely to the outlet control structure

Figure 7a-4. Trash and debris present in or clogging trash rack or trash rack is damaged or corroded
Figure 7a-5. Small leak in the invert of an outlet structure

Figure 7a-6. Same outlet structure after the leak was repaired

Figure 7a-7. Outlet control structure for a storm water wetland

Figure 7a-8. Outlet control structure for a wet detention pond

Figure 7a-9. Bioretention outlet control structure clogged with debris (photo courtesy of NCDOT)

Figure 7a-10. Outlet control structure for a bioretention basin (photo courtesy of NCDOT)
**Figure References**

**Figure 7a-11.** Outlet control structure for a dry detention basin (photo courtesy of NCDOT)

**Figure 7b-1.** Sediment depth measurement in a storm water wetlands forebay
Vegetated Swale Troubleshooting Guide

Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Est. Labor Hours per Task (per 100 ft [30 m] of swale)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Routine maintenance (e.g., mowing)</td>
<td>8</td>
<td>Monthly</td>
</tr>
<tr>
<td>3 Corrective maintenance</td>
<td>32</td>
<td>Every 4 years</td>
</tr>
</tbody>
</table>

Key Considerations

Important design criteria
- Side slopes should be no steeper than 3:1

Common maintenance requirements/problems
- Mowing to maintain proper vegetation height
- Vegetation management
- Inlet/outlet maintenance (e.g., clogging and erosion)

Advantages
- Can reduce the use of costly development infrastructure, (e.g., curb and gutter.)
- Can be aesthetically pleasing.
- Wetland vegetation can be utilized, which can provide additional treatment.
- Unmowed systems not adjacent to roadways can provide valuable “wet meadow” habitat.

Disadvantages
- Could be subject to standing water and mosquito infestations.
- May be subject to channelization due to concentrated flows.
- Essentially no volume control. Must be used with other BMPs to meet most storm water rule requirements.

(NCDENR, 2012)
Vegetated Swale Troubleshooting Guide

Typical bioretention basin configuration

Atch 3
(2 of 11)
# Vegetated Swale Troubleshooting Guide

<table>
<thead>
<tr>
<th>Vegetated Swale Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inlet and Outlet</strong></td>
<td>A1. Trash/debris/sediment</td>
<td>• Remove all trash, debris, and sediment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remove vegetative debris that has the potential to inhibit flow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pay special attention to inlets and outlets as their failure will cause the BMP to fail.</td>
</tr>
<tr>
<td></td>
<td>A2. Evidence of erosion or undercutting of riprap</td>
<td>• Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of design professional.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Identify and control source of erosion when native soil is exposed or erosion channels are forming.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check the upstream areas for bank stability and evidence of piping or scour holes.</td>
</tr>
<tr>
<td></td>
<td>A3. Damaged or plugged pipes of the inlet or outlet</td>
<td>• Repair or replace damaged piping if needed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If plugged, remove material and identify and remediate source of sedimentation or blockage.</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> Some swales will not include structural inlets/outlets</td>
<td></td>
</tr>
<tr>
<td><strong>Side Slopes</strong></td>
<td>B1. Evidence of erosion, rills or gullies forming</td>
<td>• Repair erosion after heavy storms. Replace eroded soil to conform to the original geometry.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rake, seed, and provide soil amendments (mulch or compost) to re-establish vegetation.²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provide lime and a one-time fertilizer application if needed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Install matting in steep areas.</td>
</tr>
<tr>
<td><strong>Vegetation</strong></td>
<td>C1. Unhealthy or dead grass cover</td>
<td>• Remove dead vegetation and reseed/resod and stabilize as needed. Keep the grass healthy at all times, as it is the primary erosion protection for the channel.²</td>
</tr>
<tr>
<td></td>
<td>C2. Evidence of minor erosion - soil is exposed</td>
<td>• Add reinforcement planting to maintain 90% turf cover.²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Typically, rakes, shovels, and other hand tools are adequate for common, minor issues.</td>
</tr>
<tr>
<td></td>
<td>C3. Evidence of erosion channels or gullies forming</td>
<td>• Replant and restore bare spots using sod, where possible.²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provide lime and a one-time fertilizer application if needed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Avoid driving in swales and mowing during wet conditions as this can cause pitting and swale failure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reoccurring erosion problems indicate the original vegetation planted is not adequate to stabilize the channel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Contact civil engineering to assist in selecting a hardier vegetation or special liner.</td>
</tr>
<tr>
<td></td>
<td>C4. Undesirable plant species</td>
<td>• Prune vegetation, large shrubs, or trees that interfere with swale operation. Remove invasive vegetation if covering more than 25% of swale area.</td>
</tr>
<tr>
<td>Vegetated Swale Component</td>
<td>Problem</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>--------------------------</td>
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</tr>
</tbody>
</table>
| Vegetation               | C5. Sediment accumulation | • Remove sediment accumulation while taking care to minimize damage to vegetation. Sediment must be removed when it reaches a depth of 4 inches (100 mm) or when it covers the grass. Dispose of sediment properly and in such a way that the swale is not impacted.  
  • Typically, sediment can be gathered using rakes and removed with shovels and wheelbarrows, causing only minimal damage to vegetation.  
  • The use of loaders, backhoes, and excavators will require additional repair.  
  • If frequent or excessive sediment accumulations are experienced, ensure upstream areas are stabilized and that any construction sites located upstream are implementing adequate erosion and sediment controls.  
  • If vegetation is damaged during removal, replant using sod where possible.  
  • If sheen is visible on sediment, contact CES/CEIEC for assistance with disposal. |
| Vegetation               | C6. Vegetation cut too short | • Notify landscapers of proper grass height (typically 4 to 6 inches [100 to 150 mm]; check plan drawings). Most species of grass should not be cut shorter than 4 inches (100 mm) when planted in a swale.  
  • Install signage or other means of marking swale boundary, if needed. |
<p>| Vegetation               | C7. Fallen leaves and debris from deciduous plant foliage are excessive | • Remove and properly dispose of materials so they do not impact the BMP. |
| Vegetation               | C8. Vegetation requires soil amendment | • Rake, seed, and provide soil amendments (mulch or compost) to re-establish vegetation.² |
| Vegetation               | C9. Evidence of ponded water that is not infiltrating or evaporating after several days | • Determine cause of standing water (e.g., depression from driving in swale or use of heavy equipment, significant erosion) and re-grade if necessary. Standing water can result in a mosquito breeding ground. |</p>
<table>
<thead>
<tr>
<th>Vegetated Swale Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Check Dams (if present)   | D1. Trash, debris, undesirable vegetation or excessive sediment is present | • Remove and properly dispose of trash, debris, undesirable vegetation, and sediment.  
• Use handheld equipment when mowing around check dams to avoid damaging check dam’s structure. |
|                           | D2. Evidence of erosion around the sides of the rock check               | • Replace riprap and stone as needed and repair erosion; rebuild or reshape check dams as necessary. |

1. Adapted from the WERF BMP and LID Whole Life Cost Models Version 2.0 (2009).
2. Note that in desert regions, swales may be designed without a vegetative lining. In such cases, gravel, stone, and other erosion protection materials should be used rather than attempting to maintain a healthy stand of vegetation.
A1. Trash, debris, or sediment
A2. Evidence of erosion or undercutting of the inlet or outlet
A3. Damaged or plugged pipes of the inlet or outlet
B1. Evidence of erosion, rills, or gullies forming
C1. Unhealthy or dead grass cover
C2. Evidence of minor erosion - soil is exposed
C3. Evidence of erosion channels or gullies forming
C4. Undesirable plant species
C5. Sediment accumulation
C6. Vegetation cut too short
C7. Fallen leaves and debris from deciduous plant foliage are excessive
C8. Vegetation requires soil amendment
C9. Evidence of ponded water
D1. Excessive sediment in check dam (see page 9)
D2. Evidence of erosion around check dam (see page 9)
Vegetated Swale Troubleshooting Guide

A1. Trash/debris/sediment in inlet or outlet.

A2. Evidence of erosion or undercutting of riprap in inlet or outlet.

A3. Damaged or plugged pipes of the inlet or outlet.

B1. Evidence of erosion, rills or gullies forming in the side slopes.

C1. Unhealthy or dead grass cover in the swale.

C2. Evidence of minor erosion - soil is exposed in the swale.
C3. Evidence of erosion channels or gullies forming in the swale.


C5. Sediment accumulation in the swale.

C6. Vegetation is cut too short in the swale.

C7. Fallen leaves and debris from deciduous plant foliage are excessive in the swale.

C8. Vegetation requires soil amendment in the swale.

D1. Excessive sediment present in a check dam.

D2. Evidence of erosion around rock check dams.
Vegetated Swale Troubleshooting Guide

Check dams within a grassed swale. (photo courtesy of NCDOT)

A properly functioning roadside grassed swale. (photo courtesy of NCDOT)

Another properly functioning roadside grassed swale. (photo courtesy of NCDOT)

A proper installation of a grassed swale following construction with fiber matting.

Another proper installation of a grassed swale following construction with fiber matting.

Properly functioning rock check dam. (photo courtesy of NCDOT)
# Vegetated Swale Operation & Maintenance Inspection Checklist

SCM: ___________________________  Inspector(s): ___________________________
SCM ID#: ______________________  SCM Locations: _______________________
Installation Name: _______________  Date Installed: _____________________
Inspection Date: __________________

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Vegetated Swale Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet and Outlet</td>
<td>A1.</td>
<td></td>
<td>Trash/debris/sediment present?</td>
</tr>
<tr>
<td></td>
<td>A2.</td>
<td></td>
<td>Evidence of erosion or undercutting of riprap?</td>
</tr>
<tr>
<td></td>
<td>A3.</td>
<td></td>
<td>Damaged or plugged pipes of the inlet or outlet?</td>
</tr>
<tr>
<td>Side Slopes</td>
<td>B1.</td>
<td></td>
<td>Evidence of erosion, rills or gullies forming on side slopes?</td>
</tr>
<tr>
<td></td>
<td>C1.</td>
<td></td>
<td>Unhealthy or dead grass cover present?</td>
</tr>
<tr>
<td></td>
<td>C2.</td>
<td></td>
<td>Evidence of minor erosion - soil is exposed?</td>
</tr>
<tr>
<td></td>
<td>C3.</td>
<td></td>
<td>Evidence of erosion channels or gullies forming in vegetation?</td>
</tr>
<tr>
<td></td>
<td>C4.</td>
<td></td>
<td>Undesirable plant species present?</td>
</tr>
<tr>
<td>Vegetation</td>
<td>C5.</td>
<td></td>
<td>Sediment accumulation present?</td>
</tr>
<tr>
<td></td>
<td>C6.</td>
<td></td>
<td>Vegetation cut too short?</td>
</tr>
<tr>
<td></td>
<td>C7.</td>
<td></td>
<td>Fallen leaves and debris from deciduous plant foliage are excessive?</td>
</tr>
<tr>
<td>Check Dams (if present)</td>
<td>D1.</td>
<td></td>
<td>Trash, debris, undesirable vegetation or excessive sediment is present?</td>
</tr>
<tr>
<td></td>
<td>D2.</td>
<td></td>
<td>Evidence of erosion around the sides of the rock check?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No Action (N) — No action is needed at time of inspection related to respective problem.</td>
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<tr>
<td>MN</td>
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<td>ICA</td>
<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
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</tr>
</tbody>
</table>
Bioretention and filtration basins are structural SCMs designed to temporarily retain storm water runoff, filter and retain pollutants, and reduce peak flows. Inflow to these basins is filtered through engineered media or amended soil. The filtered water typically infiltrates or exits through an underdrain system at the bottom of the filter media. While filtration basins are grassed (mulch, sod or turf grass may be used), bioretention basins use specially selected plants to enhance the pollutant removal capabilities of the basin.

### Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated Labor Hours Per Task (per acre of drainage area)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Vegetation management and debris removal</td>
<td>4</td>
<td>Semi-annually</td>
</tr>
<tr>
<td>3 Till soil</td>
<td>8</td>
<td>Every 4 years</td>
</tr>
<tr>
<td>4 Unclog drain</td>
<td>2</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>5 Replace mulch</td>
<td>4</td>
<td>Every 2 years</td>
</tr>
</tbody>
</table>

### Key Considerations

**Important design criteria**
- Side slopes stabilized with vegetation shall be no steeper than 3:1.
- Ponding depth shall be 12 inches (300 mm) or less; 9 inches (230 mm) is preferred.

**Common maintenance requirements/problems**
- Clogged outlets due to accumulation of debris or sediment.
- Standing water from clogged outlets, for example, can present vegetation management challenges.

### Advantages
- Efficient treatment method for suspended solids, heavy metals, adsorbed pollutants, nitrogen, phosphorus, pathogens, and temperature increases.
- If providing infiltration in appropriate soil conditions it can effectively reduce peak runoff rates for relatively frequent storms, reduce runoff volumes, and recharge groundwater.
- (continued on next page)

### Disadvantages
- Surface soil layer may clog over time (but can be restored).
- Frequent trash removal may be required, especially in high-traffic areas.
- Vigilance in protecting the bioretention area during construction is essential.

(continued on next page)
Advantages (cont’d.)

- Individual units are well suited for use in small areas, and multiple, distributed units can provide treatment in large drainage areas.
- Natural integration into landscaping for urban landscape enhancement.
- Addition of upturned elbow in design can increase nitrogen and phosphorous removal and be added as an inexpensive retrofit.

Disadvantages (cont’d.)

- Single unit only serves a small drainage area (1 acre or less).
- May require frequent maintenance depending on plant selection and other factors.

---

A filtration basin is basically a bioretention basin with a grassed basin instead of the specially selected plants. As with the bioretention basin, the filtration basin uses a filter media (typically sand) to remove pollutants from storm water runoff. It works by temporarily detaining storm water runoff and allowing it to slowly soak into the filter media. As storm water slowly seeps through the filter media, pollutants are absorbed and removed as it makes contact with soil particles. The filtered water then enters the basin’s underdrain system where it exits and flows to the nearest water body.

Cross-section of a typical bioretention basin

Cross-section of a typical filtration basin

(NCDENR, 2012)
1) Mulch and vegetation not shown over underdrain and filter media for clarity.
<table>
<thead>
<tr>
<th>Bioretention or Filtration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Inlet and Outlet | A1. Trash/debris/sediment | • Remove all trash, debris, and sediment.  
• Remove vegetative debris that has the potential to inhibit flow.  
• Pay special attention to inlets and outlets as their clogging will cause the SCM to fail. |
| | A2. Inlet channel, ditch, or outlet shows signs of erosion or invasive vegetation | • Invasive vegetation (woody plants or invasive species) must be removed. Reseed bare soil areas as needed.  
• Remove invasive species as soon as possible or they will be more difficult to remove once they become well-established. |
| | A3. Damaged or plugged pipes, inlet, or outlet | • Repair or replace damaged piping if needed. Consult a design professional if piping within embankment must be replaced.  
• If plugged, remove material and identify and mitigate the source of sediment or debris.  
• See Outlet Control Structure in this attachment for additional inspection and maintenance details. |

Note: Inspect the ground surface above buried pipes/structures for depressions that might indicate pipe breakage or separation.

| Forebay | B1. Sediment accumulation in forebay | • Remove and dispose of sediment offsite if it appears to occupy more than 50% of the forebay's storage capacity. Consult CES/CEIEC on proper disposal of sediment. It may be handled as a hazardous material in some states.  
• If surrounding soil is disturbed during cleanout of the forebay, reseed any areas of bare soil. |
| B2. Invasive species are present in forebay | • Remove invasive species as soon as possible or they will be more difficult to remove once they become well-established. |
| B3. Evidence of erosion or undercutting in erosion protection materials or transition berm | • Replace materials as needed.  
• Repair the transition berm, taking care to maintain the original elevation of the berm.  
• Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional.  
• Cause of erosion must be identified and controlled when native soil is exposed or erosion channels are forming.  
• Check the upstream areas for bank stability and evidence of piping or scour holes. |
<table>
<thead>
<tr>
<th>Bioretention or Filtration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1. Ponding water - water is standing more than 48 to 72 hours after a storm event</td>
<td>Check outlet structure for clogging. If it appears to be a design issue, consult a design professional. If cattails or other wetland vegetation emerge, water is likely remaining in the basin too long. Possible causes include clogged filter media, a high groundwater table, clogged drawdown orifice(s), or localized low areas from heavy equipment or soil compaction.</td>
<td></td>
</tr>
<tr>
<td>C2. Sediment accumulation</td>
<td>Search for the source of the sediment and remedy the problem if possible. Remove the sediment if it is clogging the filter media or if it has reached a depth of 3 inches (75 mm). Dispose of it in a location where it will not cause impacts to streams or the BMP. Revegetate disturbed areas immediately with sod (preferred) or seed protected with securely staked erosion mat.</td>
<td>Removal of accumulated sediment is extremely important. A significant accumulation of sediment impairs the pollutant removal capabilities of the basin by reducing the available storage for the water quality volume and can clog the filter media and cause the basin to fail.</td>
</tr>
<tr>
<td>C3. Trash or debris</td>
<td>Remove all trash and debris.</td>
<td></td>
</tr>
<tr>
<td>C4. Unhealthy or dead plants are present</td>
<td>Replace dead or unhealthy plants using the original design drawings or landscaping plan if necessary.</td>
<td></td>
</tr>
<tr>
<td>C5. Erosion and/or channelization present</td>
<td>If erosion has occurred, reestablish turf grass (seed or sod). Consult a design professional if assistance is needed replacing plant material in a landscaped bioretention basin.</td>
<td>If there is channelization, reestablish the proper grade of the basin bottom by removing sediment and filling in, then reestablishing vegetation. Provide lime and one-time fertilizer application if needed.</td>
</tr>
<tr>
<td>C6. Mulch is breaking down or has floated away</td>
<td>Replenish mulch in void areas. Replace whole mulch layer if necessary according to design plan specifications. Remove the remaining mulch and replace with triple shredded hard wood mulch at a maximum depth of 3 inches (75 mm). Do not replace with pine bark mulch.</td>
<td></td>
</tr>
<tr>
<td>C7. Pruning is needed to maintain optimal plant health</td>
<td>Prune according to best professional practices.</td>
<td>Note: Pruning should not be needed often for native plantings.</td>
</tr>
<tr>
<td>Bioretention or Filtration Basin Component</td>
<td>Problem</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------</td>
<td>------------------</td>
</tr>
</tbody>
</table>
| **Embankment**                           | D1. Shrubs or trees have started to grow on the embankment | • Remove shrubs or trees immediately.  
• Fill/regrade and reestablish ground cover as necessary. |
|                                          | D2. Grass cover is unhealthy or eroding | • Repair eroding areas by filling/regrading and reestablishing ground cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Water and provide lime and one-time fertilizer application if needed.  
• Consult a professional landscaper if needed. |
|                                          | D3. Signs of seepage on the downstream face | • Consult a design professional. This could indicate a serious issue and cause the embankment to fail. |
|                                          | D4. Evidence of animal activity | • Repair all animal burrows.  
• Trap and remove muskrats with a muskrat trap or contact a professional trapper. |
|                                          | D5. Signs of settling, scouring, cracking, or sloughing | • Repair by adding soil and/or re-grade where needed. Compact as indicated in the original design documents, and reestablish vegetation. Consult a design professional if needed and follow any applicable dam safety rules. |
| **Underdrain System**                    | E1. Cleanout caps are missing or damaged | • Replace cleanout caps that are missing, cracked or otherwise damaged. Damaged or missing caps will allow storm water to exit the basin untreated. |
|                                          | E2. Flushing of cleanouts indicates underdrain system is clogged | • If water does not exit freely, the underdrain is likely clogged. A high-pressure hose can be used to flush out the underdrain system by spraying directly into the cleanouts.  
• Repair or replace underdrain systems in accordance with the original design specifications.  
• Consider flushing the underdrain system annually if it appears it has a tendency to plug.  

**Note:** Use a bucket or hose to pour water into cleanout and observe outlet control structure for flow. |
<p>| <strong>Outlet Drainage System and Emergency Spillway</strong> | F1. Outlet drainage system shows signs of erosion or undesirable vegetation | • Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of design professional. |</p>
<table>
<thead>
<tr>
<th>Bioretention or Filtration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outlet Drainage System and Emergency Spillway</td>
<td>F2. Trash, debris or invasive vegetation is present within emergency spillway</td>
<td>• Remove all trash, debris and invasive vegetation.</td>
</tr>
</tbody>
</table>
|                                          | F3. Verify that grass height is maintained between 6 and 12 inches (150 to 300 mm) in emergency spillway | • Grass height should be carefully maintained at a height of 6 to 12 inches (150 to 300 mm).  
  Note: If emergency spillway is not grassed but is constructed of concrete or riprap, repair if in poor condition. |
| Outlet Control Structure                  | G1. Water is not flowing freely to the outlet control structure  
  Note: Standing water above the drawdown orifice indicates that the orifice is blocked. | • If the outlet appears to be clogged or blocked and standing water prevents access to the structure, hip waders or a small boat may be needed to make the necessary repairs. Do not enter the standing water unless you have been trained to do so. Trained contractors can be hired to make needed repairs.  
  • If the water level in the basin is above the orifice, follow proper safety precautions before opening the sluice gate or pumping out the basin.  
  • Remove sediment or debris around trash screen. After the basin has been drained, remove the trash screen to access the orifice. Remember to return the sluice gate to its original position.  
  • Remove sediment and debris blocking the flow into the orifice. Replace the steel orifice plate if there are signs of excessive corrosion. |
|                                          | G2. Trash and debris present in or clogging trash rack, or trash rack is damaged or corroded | • Remove trash and debris from trash rack.  
  • Replace trash rack if it is corroded or damaged. Replace the trash rack according to design specifications for the bioretention basin. |
|                                          | G3. Sluice gate is not operable through intended range of motion | • Remove sediment or debris within and near the sluice gate.  
  • If lubrication is necessary, lubricate with a marine-type grease. For screw-type sluice gates, a PVC cover is recommended for the worm gear to protect it from corrosion.  
  • If the sluice gate is damaged beyond repair, consult a design professional for guidance on replacement. |

Refer to Attachment 2 for outlet control structure diagrams.
A1. Trash, debris, or sediment
A2. Signs of erosion or invasive vegetation
A3. Damaged or plugged pipes
B1. Sediment accumulation
B2. Invasive species
B3. Erosion or undercutting in erosion protection materials or transition berm
C1. Ponding water
C2. Sediment accumulation
C3. Trash or debris
C4. Unhealthy or dead plants
C5. Erosion and/or channelization
C6. Mulch breaking down or has floated away
C7. Pruning is needed
D1. Shrubs or trees are growing on embankment
D2. Grass is unhealthy or eroding
D3. Signs of seepage on downstream face
D4. Evidence of animal activity
D5. Signs of settling, scouring, cracking, or sloughing
E1. Cleanout caps are damaged (see page 12)
E2. Underdrain system is clogged (see page 12)
F1. Outlet drainage system shows signs of erosion or undesirable vegetation
F2. Trash, debris, or invasive vegetation in emergency spillway
F3. Verify grass height is maintained between 6-12 inches in emergency spillway
A1. Trash, debris, or sediment in inlet or outlet.

A2. Inlet channel or ditch or outlet shows signs of erosion or invasive vegetation.

A3. Damaged or plugged inlet or outlet pipes.

B1. Sediment accumulation in forebay.

B2. Invasive species are present in forebay.

B3. Evidence of erosion or undercutting in erosion protection materials or transition berm.
C1. Ponding water - water is standing more than 48 to 72 hours after a storm event.

C2. Sediment accumulation within basin.

C3. Trash or debris within basin.

C4. Unhealthy or dead plants are present within basin.

C5. Erosion and/or channelization present within basin.

C6. Mulch is breaking down or has floated away.
C7. Pruning is needed to maintain optimal plant health.

D1. Shrubs or trees have started to grow on the embankment.

D2. Grass cover is unhealthy or eroding on the embankment.

D3. Signs of seepage on the downstream face.

D4. Evidence of animal activity.

D5. Signs of settling, scouring, cracking, or sloughing.
E1. Cleanout caps are missing or damaged.

E2. Flushing of cleanouts indicates underdrain system is clogged.

F1. Outlet drainage system shows signs of erosion or undesirable vegetation.

F2. Trash, debris or invasive vegetation in emergency spillway.

F3. Verify that grass height is maintained between 6 and 12 inches (150 to 300 mm) in emergency spillway.
A properly functioning filtration basin.

A properly functioning landscaped bioretention basin.

A forebay transition weir from a bioretention basin.

Bioretention basin with sparse vegetation still being established.

Erosion and mulch replacement needed within a bioretention basin.

Properly functioning outlet control structure.

All photos within this Attachment courtesy of NCDOT.
Bioretention & Filtration Basin
Operation & Maintenance Inspection Checklist

SCM: ___________________________ Inspector(s): ___________________________
SCM ID#: ___________________________
SCM Locations: ___________________________
Installation Name: ___________________________
Date Installed: ___________________________ Inspection Date: ___________________________

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Bioretention &amp; Filtration Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet and Outlet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1. Trash/debris/sediment present?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2. Inlet channel, ditch, or outlet shows signs of erosion or invasive vegetation?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3. Damaged or plugged pipes, inlet, or outlet?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forebay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1. Sediment accumulation in forebay?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2. Invasive species are present in forebay?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3. Evidence of erosion or undercutting in erosion protection materials or transition berm?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1. Ponding water present? (Water is standing more than 48 to 72 hours after a storm event)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2. Sediment accumulation present in basin?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3. Trash or debris present in basin?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4. Unhealthy or dead plants are present in basin?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5. Erosion and/or channelization present in basin?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6. Mulch is breaking down or has floated away in basin?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7. Pruning is needed to maintain optimal plant health?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embankment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. Shrubs or trees have started to grow on the embankment?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2. Grass cover is unhealthy or eroding on embankment?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
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<th>Problem</th>
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</thead>
<tbody>
<tr>
<td>Embankment</td>
<td>D3.</td>
<td></td>
<td>Signs of seepage on the downstream face on embankment?</td>
</tr>
<tr>
<td></td>
<td>D4.</td>
<td></td>
<td>Signs of settling, scouring, cracking, or sloughing on embankment?</td>
</tr>
<tr>
<td>Underdrain System</td>
<td>E1.</td>
<td></td>
<td>Cleanout caps are missing or damaged on underdrain system?</td>
</tr>
<tr>
<td></td>
<td>E2.</td>
<td></td>
<td>Flushing of cleanouts indicates underdrain system is clogged?</td>
</tr>
<tr>
<td>Outlet Drainage System and Emergency Spillway</td>
<td>F1.</td>
<td></td>
<td>Outlet drainage system shows signs of erosion or undesirable vegetation?</td>
</tr>
<tr>
<td></td>
<td>F2.</td>
<td></td>
<td>Trash, debris, or invasive vegetation is present within emergency spillway?</td>
</tr>
<tr>
<td></td>
<td>F3.</td>
<td></td>
<td>Verify that grass height is maintained between 6 and 12 inches in emergency spillway?</td>
</tr>
<tr>
<td>Outlet Control Structure</td>
<td>G1.</td>
<td></td>
<td>Water is not flowing freely to the outlet control structure?</td>
</tr>
<tr>
<td></td>
<td>G2.</td>
<td></td>
<td>Trash and debris present in or clogging trash rack or trash rack is damaged or corroded?</td>
</tr>
<tr>
<td></td>
<td>G3.</td>
<td></td>
<td>Sluice gate is not operable through intended range of motion?</td>
</tr>
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<td></td>
</tr>
</tbody>
</table>

Atch 4
(15 of 15)
Level Spreaders, Filter Strip, and Vegetated Buffer Troubleshooting Guide

Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Est. Labor Hours per Task (per 100 ft [30 m] of swale)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Level spreader (LS) inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>2 LS corrective maintenance</td>
<td>8</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>3 Filter strip (FS) inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>4 FS vegetation management</td>
<td>0.5</td>
<td>Quarterly</td>
</tr>
<tr>
<td>5 FS corrective maintenance</td>
<td>8</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>6 Buffer inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>7 Buffer maintenance</td>
<td>4</td>
<td>Every 5 years</td>
</tr>
</tbody>
</table>

Key Considerations

- **Important design criteria**
  - Longitudinal slope should be between 2% and 6%
  - Lateral slope should be less than 1%
  - Length (longitudinal) should be no less than 15 feet (4.5 m)
  - If excessive, the length of the filter strip/buffer may allow storm water to reconcentrate, depending on site conditions, and should be designed with this in mind. An additional level spreader or collection berm/channel may be used to prevent reconcentration of flow.

- **Common maintenance requirements/problems**
  - Level spreader lip damage or blockage immediately downstream
  - Clogging with trash or sediment
  - Erosion in filter strip and/or buffer

Advantages

- Minimal construction effort and change to existing landscape.
- Riparian buffers have additional environmental benefits for wildlife and the receiving water body.

Disadvantages

- Sensitive to erosion and concentrated flow.
- Provide less volume control than most BMPs.

Level spreaders, filter strips, and vegetated buffer systems promote sheet flow over vegetated areas to remove sediment and infiltrate storm water runoff.

Typical level spreader, filter strip, and vegetated buffer configuration

(NCDENR, 2012)
Typical level spreader, filter strip, and vegetated buffer configuration

Atch 5
(2 of 15)
# Level Spreader, Filter Strip, and Vegetated Buffer Troubleshooting Guide

<table>
<thead>
<tr>
<th>LS, FS, Buffer Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **Inlet, Outlet, and Flow Bypass Structure** | A1. Trash, debris, and sediment | • Remove all trash, debris and sediment.  
• Remove vegetative debris that has the potential to inhibit flow.  
• Pay special attention to inlets and outlets as their failure will cause the BMP to fail. |
| | A2. Evidence of erosion or undercutting of riprap | • Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and rock riprap. If this is a recurring problem, seek guidance of a design professional.  
• Source of erosion damage must be identified and controlled when native soil is exposed or erosion channels are forming.  
• Check the upstream areas for bank stability and evidence of piping or scour holes. |
| | A3. Damaged or plugged inlet or outlet pipes | • Repair or replace damaged piping if needed.  
• If plugged, remove material and identify and mitigate the source of sediment or debris. |
| **Level Spreader Trough, Lip, and Immediate Downslope Area** | B1. Trash, debris, and sediment | • Remove all trash, debris and sediment, especially if it has the potential to inhibit proper flow.  
• Remove major accumulations of sediment in trough and any sediment buildup around the lip that could cause flow to concentrate.  
• Ensure the drainage area is properly stabilized if sediment becomes a common issue. |
| | B2. Erosion/washout in earthen trough and immediately downslope of lip | • Repair by regrading and resodding damaged areas.  
• Use erosion protection materials as needed and repair or replenish any erosion protection materials currently in place.  
• Determine cause of erosion and correct. |
| | B3. Cracks/leaks in concrete trough | • For simple repairs, patch cracks with non-shrink grout.  
• For more difficult repairs, inject chemical grout into cracks. |
| | B4. Damaged level spreader lip | • Repair any damage that could cause flow to concentrate. |
| | B5. Clogged drawdown system | • Clear any sediment or debris and flush the drawdown system if possible. |
| **Vegetated Filter Strip** | C1. Grass mowed too short or allowed to grow too long | • Maintain a minimum grass height of 3 to 5 inches (75 to 125 mm). Communicate proper mowing height to landscapers. Consider adding signs to the area to indicate that a storm water BMP is present and care should be taken to mow at proper height.  
• Mow grass before it exceeds 12 inches (300 mm) in height. Taller grass has a tendency to clump and cause runoff to re-concentrate. It also makes inspection more difficult.  
• Collect grass clippings where possible to further reduce storm water pollution. |
<p>| | C2. Trash/Debris | • Remove all trash and debris. |</p>
<table>
<thead>
<tr>
<th>LS FS Buffer Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Vegetated Filter Strip | C3. Bare areas, or unhealthy or dead grass cover | • Maintain vegetative cover of at least 80%.  
• Reseed and add topsoil to bare areas.  
• Provide lime and one-time fertilizer application if soil testing indicates fertilization is needed.  
• Use matting on eroded areas and steeper slopes as needed.  
• If unusually dry conditions are the cause, water where practical.  
• If compaction is a concern, aerate the soil using a core aerator that collects cores, or collect cores by hand and dispose in an area that will not impact storm water or receiving waters. Aerate only during times of the year when grass is actively growing.  
• If the problem persists, determine the source of the problem (e.g., soils and hydrology).  
• Perform soil testing if needed and carefully apply soil amendments as needed. |
| | C4. Trees, shrubs, invasive species, or other undesirable vegetation has begun to grow | • Remove large woody vegetation that can cause flow to re-concentrate.  
• Remove invasive vegetation that may out-compete other species and compromise ground cover. |
| | C5. Erosion | • Repair eroding areas by filling/regrading and reestablishing ground cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Irrigate and provide lime and one-time fertilizer application if needed. |
| | C6. Sediment accumulation | • Gather and remove sediment with hand tools when possible. Pay special attention to the top and toe of the slope where sediment is likely to gather. Remove sediment from within the filter strip area when it begins to cover and kill grass.  
• Reestablish vegetation and provide lime and one-time fertilizer application if needed.  
• Ensure the drainage area is properly stabilized if sediment becomes a common issue. |
| Pea Gravel Diaphragm | D1. Sediment accumulation | • Remove sediment and replace any lost gravel with new, clean gravel. |
| | D2. Damaged diaphragm | • Repair damaged gravel diaphragm to original design specifications.  
• Supplement gravel if needed.  
• The gravel area may be a deep trench to promote infiltration, or a shallow layer of gravel used to stabilize the top of the slope, help spread flow, and dissipate energy. |
## Level Spreader, Filter Strip, and Vegetated Buffer Troubleshooting Guide

<table>
<thead>
<tr>
<th>LS FS Buffer Component</th>
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<th>Corrective Action</th>
</tr>
</thead>
</table>
| Berm                   | E1. Erosion | • Repair eroding areas by filling/regrading and reestablishing ground cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Irrigate and provide lime and one-time fertilizer application if needed.  
• Restore the berm if necessary to the dimensions and elevations shown on the construction plans (if available); use suitable backfill and compact as indicated on the construction plans/specifications (if available).  If construction plans/specifications are not available for reference, consult with CES/CEIEC to establish appropriate criteria. |
|                        | E2. Sediment accumulating at base of berm | • Gather and remove sediment with hand tools when possible. Pay special attention to the top and toe of the slope where sediment is likely to gather. Remove sediment from within the filter strip area when it begins to cover and kill grass.  
• Reestablish vegetation and provide soil amendments if needed.  
• Ensure the drainage area is properly stabilized if sediment becomes a common issue. |
| Buffer¹                | F1. Vegetation management needed | • Prune or selectively remove plants or trees that are too densely planted, diseased, or undesirable species.  
• Replant where needed to maintain a densely vegetated area. |
|                        | F2. Gullies forming or other erosion evident | • Fill gullies and mulch and replant where needed.  
• Minimize disturbance to the extent possible.  
• Ensure runoff is entering the buffer as sheet flow. Consider installing a level spreader or similar device if none is in place.  
• Reoccurring erosion issues may indicate that runoff exceeds the amount the buffer can accept. Consider installing a flow bypass system to route excess runoff through the buffer in a channel or pipe. |
|                        | F3. Sediment accumulation | • Remove sediment if depths exceed 6 inches (150 mm). |
|                        | F4. Disturbance¹ | • Identify any evidence of activities that have negatively impacted buffer areas (e.g., mowing) and remedy by communicating with responsible parties and identifying buffer boundaries. |

---

1. Buffers are often regulated by environmental regulatory agencies and have specific rules or restrictions for activities within buffers. Typically, regulated buffers should not be developed or disturbed.
A1. Trash, debris, and sediment
A2. Evidence of erosion or undercutting of riprap
A3. Damaged or plugged pipes
B1. Trash, debris, and sediment
B2. Erosion in trough and downslope of lip
B3. Cracks or leaks in concrete trough
B4. Damaged level spreader lip
B5. Clogged drawdown
C1. Grass mowed too short or has grown too long
C2. Trash or debris
C3. Bare or dead grass cover
C4. Trees, shrubs, or invasive species are growing
C5. Erosion
C6. Sediment accumulation
D1. Sediment accumulation
D2. Damaged pea gravel diaphragm
E1. Erosion
E2. Sediment accumulation
F1. Vegetation management needed
F2. Gullies forming or other erosion evident
F3. Sediment accumulation
F4. Disturbance

A2. Evidence of erosion or undercutting of riprap in the inlet, outlet, and flow bypass structure.

A3. Damaged or plugged inlet or outlet pipes, or damaged flow bypass structure.

B1. Trash/debris/sediment in the level spreader trough, lip, and immediate downslope area.

B2. Erosion/washout in level spreader trough and/or immediate downslope area.

B3. Cracks/leaks in trough.
B4. Damaged level spreader lip in the level spreader trough, lip, and immediate downslope area.

B5. Clogged drawdown system.

C1. Grass mowed too short or allowed to grow too long in the vegetated filter strip.

C2. Trash/debris in the vegetated filter strip.

C3. Bare areas or unhealthy or dead grass cover in the vegetated filter strip.

C4. Trees, shrubs, invasive species, or other undesirable vegetation has begun to grow in the vegetated filter strip.
C5. Erosion in the vegetated filter strip.


D1. Sediment in the pea gravel diaphragm.

D2. Damage in pea gravel diaphragm.

E1. Erosion in the berm.

E2. Sediment accumulating at base of berm.
F1. Vegetation management needed in the buffer.

F2. Gullies forming or other erosion evident in the buffer.

F3. Sediment in the buffer.

F4. Disturbance in the buffer.
A newly built level spreader.

A properly functioning level spreader.

Another properly functioning level spreader.

A level spreader with overgrown vegetation and debris obstructing the lip.

A level spreader with erosion downstream of the lip (photo courtesy of NCDOT).

A fallen tree over the level spreader is obstructing flow and will cause flow to be distributed unevenly (photo courtesy of NCDOT).
A level spreader with sand bags in the weir (photo courtesy of NCDOT).

A well-vegetated filter strip.

Roadside filter strip (photo courtesy of NCDOT).

A filter strip prior to vegetation establishment (photo courtesy of NCDOT).

Another view of a filter strip prior to vegetation establishment.

A filter strip, level spreader and part of a buffer.

Atch 5

(12 of 15)
An aerial view of a buffer – see tree line.

A buffer lining the stream bank.
# Level Spreader, Filter Strip, and Vegetated Buffer (LS, FS, Buffer) Operation & Maintenance Inspection Checklist

<table>
<thead>
<tr>
<th>Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet, Outlet, and Flow Bypass Structure</td>
<td>A1.</td>
<td>Trash, debris, and sediment present?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A2.</td>
<td>Evidence of erosion or undercutting of riprap?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A3.</td>
<td>Damaged or plugged inlet or outlet pipes?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B1.</td>
<td>Trash, debris, and sediment present?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B2.</td>
<td>Erosion/washout in earthen trough and immediately downslope of lip?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B3.</td>
<td>Cracks/leaks in concrete trough?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B4.</td>
<td>Damaged level spreader lip?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B5.</td>
<td>Clogged drawdown system?</td>
<td></td>
</tr>
<tr>
<td>Level Spreader Trough, Lip, and Immediate Downslope Area</td>
<td>C1.</td>
<td>Grass mowed too short or allowed to grow too long?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C2.</td>
<td>Trash/debris present in filter strip?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C3.</td>
<td>Bare areas, or unhealthy or dead grass cover present?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C4.</td>
<td>Trees, shrubs, invasive species, or other undesirable vegetation has begun to grow?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C5.</td>
<td>Evidence of erosion?</td>
<td></td>
</tr>
</tbody>
</table>

## Device Ranking

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No Action (N) — No action is needed at time of inspection related to respective problem.</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>Maintenance Needed (MN) - Maintenance is needed to support functionality of the device and to prevent problem from escalating.</td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
<td></td>
</tr>
</tbody>
</table>
## Level Spreader, Filter Strip, and Vegetated Buffer (LS, FS, Buffer) Operation & Maintenance Inspection Checklist - Continued

<table>
<thead>
<tr>
<th>LS, FS, Buffer Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetated Filter Strip</td>
<td>C6</td>
<td></td>
<td>Sediment accumulation present in filter strip?</td>
</tr>
<tr>
<td>Pea Gravel Diaphragm</td>
<td>D1</td>
<td></td>
<td>Sediment accumulation present in pea gravel diaphragm?</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td></td>
<td>Evidence of damaged diaphragm?</td>
</tr>
<tr>
<td>Berm</td>
<td>E1</td>
<td></td>
<td>Evidence of erosion?</td>
</tr>
<tr>
<td></td>
<td>E2</td>
<td></td>
<td>Sediment accumulating at base of berm?</td>
</tr>
<tr>
<td>Buffer</td>
<td>F1</td>
<td></td>
<td>Evidence of vegetation management needed?</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td></td>
<td>Gullies forming or other erosion evident?</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td></td>
<td>Sediment accumulation present?</td>
</tr>
<tr>
<td></td>
<td>F4</td>
<td></td>
<td>Disturbance?</td>
</tr>
</tbody>
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</table>

Complete the form below by indicating the condition of each component. For items marked NM or ICA, indicate when follow-up maintenance was completed.
Wet detention basins (WDB) are storm water controls that maintain a permanent pool of water, reduce peak storm water flows, promote the settling of suspended solids and biological uptake of pollutants, and reduce erosive velocities downstream.

**Operation and Maintenance Tasks**

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours (per acre of drainage area)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Vegetation management and debris removal</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>3 Vector control</td>
<td>4</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>4 Intermittent maintenance</td>
<td>16</td>
<td>Annually</td>
</tr>
<tr>
<td>5 Forebay sediment removal</td>
<td>80</td>
<td>Every 8 years</td>
</tr>
<tr>
<td>6 Basin sediment removal</td>
<td>400</td>
<td>Every 20 years</td>
</tr>
</tbody>
</table>

**Key Considerations**

- Basin side slopes shall be stabilized with vegetation above the permanent pool level.
- Vegetated slopes shall be no steeper than 3:1.
- Discharge rate of the treatment volume is typically designed to drawdown between 2 and 5 days.

**Common Maintenance Requirements/Problems**

- Regular evaluation of the aquatic environment, vegetation, and sediment buildup can prevent significant maintenance problems.

**Advantages**

- Can be aesthetically pleasing and can be sited in both low- and high-visibility areas.
- Can provide wildlife habitat and a focal point for recreation.
- Provides good water quantity control for reducing the frequency of flooding events that cause bank erosion.

**Disadvantages**

- May attract excessive waterfowl. Refer to AFPAM 91-212 for help implementing effective BASH management techniques.
- Nuisance odors, algae blooms, and rotting debris may occur when not properly maintained.
- Local regulations may require fencing around basins to reduce safety hazards.
- May not be appropriate in areas where sensitive aquatic species live as may cause thermal pollution.

(NCDENR, 2012)
# Wet Detention Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Wet Detention Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **Inlet and Outlet**          | A1. Trash/debris/sediment | • Remove all trash and debris.  
• Remove vegetative debris that has the potential to inhibit flow.  
• Pay special attention to inlets and outlets as their failure will cause the BMP to fail. |
|                               | A2. Evidence of erosion or undercutting of riprap | • Repair and replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional.  
• Source of erosion must be identified and controlled when native soil is exposed or erosion channels are forming.  
• Check the upstream areas for bank stability and evidence of piping or scour holes. |
|                               | A3. Inlet channel, ditch, or outlet shows signs of erosion or undesirable vegetation | • Undesirable vegetation (woody plants or invasive species) must be removed. Reseed bare soil areas as needed. |
|                               | A4. Damaged or plugged pipes, inlet, or outlet | • Repair or replace damaged piping if needed. Consult a design professional if piping within embankment must be replaced.  
• If plugged, remove material and identify and remediate source of sedimentation or blockage.  
• See Outlet Control Structure in this attachment for additional inspection and maintenance details.  

Note: Inspect the ground surface above buried pipes/structures for depressions that might indicate pipe breakage or separation. |
| **Forebay**                   | B1. Sediment accumulation in forebay | • Remove and dispose sediment offsite if it appears to occupy more than 50% of the forebay's storage capacity.  
• If surrounding soil is disturbed during cleanout of the forebay, reseed any areas of bare soil. |
|                               | B2. Undesirable species are present in forebay | • Remove invasive species as soon as possible since they will be more difficult to remove once they become well-established. |
|                               | B3. Erosion protection materials no longer intact | • Replace materials as needed.  
• Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional.  
• Source of erosion must be identified and controlled when native soil is exposed or erosion channels are forming.  
• Check the upstream areas for bank stability and evidence of piping or scour holes. |
### Wet Detention Basin Troubleshooting Guide

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</tr>
</thead>
<tbody>
<tr>
<td>Forebay</td>
<td>B4. Transition berm shows signs of erosion</td>
<td>• Repair the transition berm, taking care to maintain the original elevation of the berm.</td>
</tr>
</tbody>
</table>
| Basin                         | C1. The water level appears to be too high given recent weather conditions | • If the outlet appears to be clogged or blocked and standing water prevents access to the structure, trained contractors may be needed to make the necessary repairs. Never attempt to enter the wet basin unless you have been trained to do so.  
  • See F1 under Outlet Control Structure for further details on how to remediate clogged outlet components.  
  Note: The water level should be at or near the invert of the drawdown device except after storm events and during prolonged dry periods. |
|                               | C2. Sediment accumulation                                               | • Remove sediment if it has accumulated to a depth greater than the original design sediment storage depth. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the control. Refer to Attachment 2 for information on measuring sediment in a wet basin.  
  Note: Contact CES/CEIEC if you suspect the sediment to be contaminated |
|                               | C3. Trash and debris                                                    | • Remove all trash and debris.                                                                                                                   |
|                               | C4. Cattails or other invasive species cover 50% or more of the basin surface | • Remove the plants by wiping them with pesticide (do not spray). Remove invasive species by physical removal or by hand-wiping with aquatic glyphosate (wear gloves). Do not spray as the herbicide will kill all vegetation it contacts.  
  Note: Some states require licenses with special endorsements to apply pesticides in an aquatic environment. |
|                               | C5. Algal growth covers more than 50% of the basin                      | • A professional may need to be consulted to develop a management plan to remove and prevent reoccurrence of algal growth.  
  • Physical removal of the algae is an option but reoccurrence is likely.  
  • Chemical control options are available. Consult the state regulatory agency to determine if special requirements exist (e.g., applicators require a commercial license with an aquatic endorsement). |
|                               | C6. Erosion is present in surrounding area                             | • Reestablish grass; fertilize upon reestablishment only if needed according to soil test recommendations. Note that the use of fertilizer may be restricted in some areas. |
## Wet Detention Basin Troubleshooting Guide

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</table>
| Basin                         | C7. Vegetated shelf area has dead, unhealthy, or undesirable plant material | • Replace dead or unhealthy plant material, taking care to determine whether the appropriate vegetation is present. Consult design drawings if necessary to confirm intended plant species are present.  
• Remove undesirable vegetation by hand if possible or by wiping them with pesticide (do not spray pesticide)  

Note: Some states require licenses with special endorsements to apply pesticides in an aquatic environment. |

Note: Some wet detention basins have a vegetated shelf at the perimeter that is planted with wetland vegetation to increase pollutant removal. |

| Embankment | D1. Shrubs or trees have started to grow on the embankment | • Remove shrubs or trees immediately.  
• Fill/regrade and reestablish ground cover as necessary. Use matting on steep slopes as needed when reestablishing ground cover. |
| D2. Grass cover is unhealthy or eroding | • Repair eroding areas by filling/regrading and reestablishing ground cover. Use matting on steep slopes as needed to reestablish grass cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Irrigate and provide lime and one-time fertilizer application if needed. |
| D3. Signs of seepage on the downstream face | • Consult a design professional. This could indicate a serious safety concern as the dam could fail. |
| D4. Evidence of animal activity | • Repair all animal burrows.  
• Contact a professional beaver trapper to assist with beaver removal. Trap and remove muskrats with a muskrat trap or contact a professional trapper. |
| D5. Signs of settling, scouring, cracking, or sloughing | • Repair by adding soil and/or re-grade where needed. Compact as indicated in the original design documents, and reestablish vegetation. Consult a design professional if needed and follow any applicable dam safety rules. |

| Outlet Drainage System and Emergency Spillway | E1. Outlet drainage system shows signs of erosion or undesirable vegetation | • Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of design professional. |
### Wet Detention Basin Troubleshooting Guide

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<th>Corrective Action</th>
</tr>
</thead>
</table>
| Outlet Drainage System and Emergency Spillway | E2. Trash, debris or undesirable vegetation is present within emergency spillway | - Remove all trash, debris and invasive vegetation.  
  
  Note: If emergency spillway is not grassed and is constructed of concrete or riprap, repair if in poor condition. |
|                              | E3. Verify that grass height is maintained between 6 and 12 inches (150 to 300 mm) in emergency spillway | - Grass height should be carefully maintained at a height of 6 to 12 inches (150 to 300 mm).  
  
  Note: If emergency spillway is not grassed and is constructed of concrete or riprap, repair if in poor condition. |

| Outlet Control Structure | F1. Water is not flowing freely to the outlet control structure | - If the outlet appears to be clogged or blocked and standing water prevents access to the structure, a trained contractor may be needed to make the necessary repairs. Never enter standing water unless you have been trained to do so.  
  
  If the water level in the basin is above the orifice, follow proper safety precautions before opening the sluice gate or pumping out the basin.  
  
  Remove sediment or debris around trash screen. After the basin has been drained, remove the trash screen to access the orifice. Remember to return the sluice gate to its original position.  
  
  Remove sediment and debris blocking the flow into the orifice. Replace the steel orifice plate if there are signs of excessive corrosion.  
  
  Note: Standing water above the drawdown orifice indicates that the orifice is blocked. |
|                          | F2. Trash and debris present in or clogging trash rack or trash rack is damaged or corroded | - Remove trash and debris from trash rack.  
  
  Replace trash rack if it is corroded or damaged. Replace the trash rack according to design specifications for the wet detention basin. |
|                          | F3. Sluice gate is not operable through intended range of motion | - Remove sediment or debris within and near the sluice gate.  
  
  If lubrication is necessary, lubricate with a marine-type grease. For screw-type sluice gates, a PVC cover is recommended for the worm gear to protect it from corrosion.  
  
  If the sluice gate is damaged beyond repair, consult a design professional for guidance on replacement. |

Refer to Attachment 2 for outlet control structure diagrams.
A.1. Trash, debris, or sediment
A.2. Evidence of erosion or undercutting of riprap
A.3. Signs of erosion or undesirable vegetation
A.4. Damaged or plugged inlet or outlet pipes
B.1. Sediment accumulation
B.2. Undesirable species are present
B.3. Erosion protection materials are no longer intact
B.4. Signs of erosion
C.1. Water level appears to be too high
C.2. Sediment accumulation
C.3. Trash and debris
C.4. Cattails cover more than 50%
C.5. Algal growth covers more than 50%
C.6. Erosion is present
C.7. Dead, unhealthy, or undesirable plant material
D.1. Shrubs and trees have started to grow
D.2. Grass cover is unhealthy or eroding
D.3. Signs of seepage
D.4. Evidence of animal activity
D.5. Signs of settling, scouring, cracking, or sloughing
E.1. Outlet drainage system shows signs of erosion or undesirable vegetation
E.2. Trash, debris, or undesirable vegetation is present
E.3. Verify that grass height is maintained between 6 and 12 inches in emergency spillway

Grass Height of 6 to 12 inches

Atch 6
(7 of 14)
A1. Trash, debris, or sediment in the inlet or outlet.

A2. Evidence of erosion or undercutting of riprap in the inlet or outlet.

A3. Inlet channel, ditch, or outlet shows signs of erosion or undesirable vegetation.

A4. Damaged or plugged pipes in the inlet outlet.

B1. Sediment accumulation in the forebay.

B2. Undesirable species are present in forebay.

B3. Inlet channel, ditch, or outlet shows signs of erosion or undesirable vegetation.
B3. Erosion protection materials no longer intact in the forebay.

B4. Transition berm shows signs of erosion in the forebay.

C1. The water level appears to be too high given recent weather conditions in the basin.

C2. Sediment accumulation in the basin.

C3. Trash/debris in the basin.

C4. Cattails or other invasive species cover 50% or more of the basin surface.
C5. Algal growth covers more than 50% of the basin.

C6. Erosion is present in surrounding area of the basin.

C7. Vegetated shelf area has dead, unhealthy, or undesirable plant material in the basin.

D1. Shrubs or trees have started to grow on the embankment.

D2. Grass cover is unhealthy or eroding.

D3. Signs of seepage on the downstream face of the embankment.
D4. Evidence of animal activity around the embankment.

D5. Signs of settling, scouring, cracking, or sloughing around the embankment.

E1. Outlet drainage system shows signs of erosion or undesirable vegetation.

E2. Trash, debris or undesirable vegetation is present within emergency spillway.

E3. Verify that grass height is maintained between 6 and 12 inches (150 to 300 mm) in emergency spillway.
A properly functioning wet detention basin.

An outlet control structure with trash rack on a wet detention basin.

An outlet control structure in a drained wet detention basin.

An outlet control structure in a drained wet detention basin.

A wet detention basin with a vegetated shelf.
# Wet Detention Basin Operation & Maintenance Inspection Checklist

<table>
<thead>
<tr>
<th>Wet Detention Basin Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inlet and Outlet</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.</td>
<td>N</td>
<td></td>
<td>Trash/debris/sediment present?</td>
</tr>
<tr>
<td>A2.</td>
<td>MN</td>
<td></td>
<td>Evidence of erosion or undercutting of riprap?</td>
</tr>
<tr>
<td>A3.</td>
<td>MN</td>
<td></td>
<td>Inlet channel, ditch, or outlet shows signs of erosion or undesirable vegetation?</td>
</tr>
<tr>
<td>A4.</td>
<td>ICA</td>
<td></td>
<td>Damaged or plugged pipes, inlet, or outlet?</td>
</tr>
<tr>
<td><strong>Forebay</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1.</td>
<td>N</td>
<td></td>
<td>Sediment accumulation in forebay?</td>
</tr>
<tr>
<td>B2.</td>
<td>MN</td>
<td></td>
<td>Undesirable species are present in forebay?</td>
</tr>
<tr>
<td>B3.</td>
<td>MN</td>
<td></td>
<td>Erosion protection materials no longer intact?</td>
</tr>
<tr>
<td>B4.</td>
<td>MN</td>
<td></td>
<td>Transition berm shows signs of erosion?</td>
</tr>
<tr>
<td><strong>Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1.</td>
<td>N</td>
<td></td>
<td>The water level appears to be too high given recent weather conditions?</td>
</tr>
<tr>
<td>C2.</td>
<td>N</td>
<td></td>
<td>Sediment accumulation present?</td>
</tr>
<tr>
<td>C3.</td>
<td>N</td>
<td></td>
<td>Trash and debris present?</td>
</tr>
<tr>
<td>C4.</td>
<td>N</td>
<td></td>
<td>Cattails or other invasive species cover 50% or more of the basin surface?</td>
</tr>
<tr>
<td>C5.</td>
<td>N</td>
<td></td>
<td>Algal growth covers more than 50% of the basin?</td>
</tr>
<tr>
<td>C6.</td>
<td>N</td>
<td></td>
<td>Erosion is present in surrounding area?</td>
</tr>
</tbody>
</table>

## Device Ranking

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken:</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No Action (N) — No action is needed at time of inspection related to respective problem.</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>Maintenance Needed (MN) - Maintenance is needed to support functionality of the device and to prevent problem from escalating.</td>
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<tr>
<td>ICA</td>
<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
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</tr>
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</table>
Wet Detention Basin Operation & Maintenance Inspection Checklist - Continued

SCM: ____________________________ Inspector(s): ____________________________
SCM ID#: ________________________________________________________________
SCM Locations: ___________________________________________________________
Installation Name: __________________________________________________________
Date Installed: ____________________________________________________________
Inspection Date: ___________________________________________________________

Complete the form below by indicating the condition of each component. For items marked NM or ICA, indicate when follow-up maintenance was completed.

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<tbody>
<tr>
<td>Basin</td>
<td>C7.</td>
<td></td>
<td>Vegetated shelf area has dead, unhealthy, or undesirable plant material?</td>
</tr>
<tr>
<td>Embankment</td>
<td>D1.</td>
<td></td>
<td>Shrubs or trees have started to grow on the embankment?</td>
</tr>
<tr>
<td></td>
<td>D2.</td>
<td></td>
<td>Grass cover is unhealthy or eroding?</td>
</tr>
<tr>
<td></td>
<td>D3.</td>
<td></td>
<td>Signs of seepage on the downstream face?</td>
</tr>
<tr>
<td></td>
<td>D4.</td>
<td></td>
<td>Evidence of animal activity?</td>
</tr>
<tr>
<td></td>
<td>D5.</td>
<td></td>
<td>Signs of settling, scouring, cracking or sloughing?</td>
</tr>
<tr>
<td>Outlet Drainage System and Emergency Spillway</td>
<td>E1.</td>
<td></td>
<td>Outlet drainage system shows signs of erosion or undesirable vegetation?</td>
</tr>
<tr>
<td></td>
<td>E2.</td>
<td></td>
<td>Trash, debris or undesirable vegetation is present within emergency spillway?</td>
</tr>
<tr>
<td></td>
<td>E3.</td>
<td></td>
<td>Verify that grass height is maintained between 6 and 12 inches in emergency spillway?</td>
</tr>
<tr>
<td>Outlet Control Structure</td>
<td>F1.</td>
<td></td>
<td>Water is not flowing freely to the outlet control structure?</td>
</tr>
<tr>
<td></td>
<td>F2.</td>
<td></td>
<td>Trash and debris present in or clogging trash rack or trash rack is damaged or corroded?</td>
</tr>
<tr>
<td></td>
<td>F3.</td>
<td></td>
<td>Sluice gate is not operable through intended range of motion?</td>
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Comments/Recommendations/Other Actions Taken:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

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Dry Detention Basin Troubleshooting Guide

**Operation and Maintenance Tasks**

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours (per acre of drainage area)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Vegetation management and debris removal</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>3 Vector control</td>
<td>4</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>4 Forebay sediment control</td>
<td>12</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>5 Sediment removal</td>
<td>88</td>
<td>Every 10 years</td>
</tr>
<tr>
<td>6 Intermittent maintenance</td>
<td>16</td>
<td>Annually</td>
</tr>
</tbody>
</table>

**Key Considerations**

**Important Design Criteria**
- Basin side slopes should be 3:1 or less.
- Maximum contributing drainage area should not exceed 75 acres.
- Basin volume should not exceed 10 acre-feet.

**Common Maintenance Requirements/Problems**
- Clogged outlets due to accumulation of debris or sediment.
- Standing water can present vegetation management challenges.

**Advantages**
- Can effectively control peak runoff discharge rates from both small and large drainage areas.
- Moderately effective at removing suspended solids and particulate matter.
- May allow for recreational and other open-space uses between storms.
- Presents fewer BASH issues due to lack of permanent pool of water.

**Disadvantages**
- Limited effectiveness in removing dissolved substances.
- Tends to develop a soggy bottom or standing water, which hinders facility maintenance and the growth of effective vegetative cover, as well as becoming a perceived eyesore.
- Debris can accumulate and not only be an eyesore but also clog the outlets and cause overflows during heavy rainfall events.

Dry detention basins reduce peak storm water flows, promote the settling of suspended pollutants, and minimize erosive velocities downstream of the outlet structure. Dry detention basins may also be called dry extended detention basin, extended detention basin, dry detention ponds, or detention basin.

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(NCDENR, 2012)
Typical dry detention basin configuration
## Dry Detention Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Dry Detention Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet and Outlet</td>
<td>A1. Trash, debris, or sediment</td>
<td>• Remove all trash and debris.&lt;br&gt;• Remove vegetative debris that has the potential to inhibit flow.&lt;br&gt;• Pay special attention to inlets and outlets as their failure will cause the BMP to fail.</td>
</tr>
<tr>
<td>A2. Evidence of erosion or undercutting of riprap</td>
<td>• Repair and replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional.&lt;br&gt;• Source of erosion must be identified and controlled when native soil is exposed or erosion channels are forming.&lt;br&gt;• Check the upstream areas for bank stability and evidence of piping or scour holes.</td>
<td></td>
</tr>
<tr>
<td>A3. Inlet channel, ditch, or outlet shows signs of erosion or undesirable vegetation</td>
<td>• Undesirable vegetation (woody plants or invasive species) must be removed. Reseed bare soil areas as needed.</td>
<td></td>
</tr>
<tr>
<td>A4. Damaged or plugged pipes, inlet, or outlet</td>
<td>• Repair or replace damaged piping if needed. Consult a design professional if piping within embankment must be replaced.&lt;br&gt;• If plugged, remove material and identify and remediate source of sedimentation or blockage.&lt;br&gt;• See Outlet Control Structure in this attachment for additional inspection and maintenance details.</td>
<td></td>
</tr>
<tr>
<td>Perimeter of Basin</td>
<td>B1. Area of bare soil and/or erosive gullies have formed</td>
<td>• Regrade the soil if necessary to remove the gully and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application if vegetation does not establish as intended.</td>
</tr>
<tr>
<td>Forebay</td>
<td>C1. Sediment accumulation in forebay</td>
<td>• Remove and dispose of sediment offsite if it appears to occupy more than 50% of the forebay's storage capacity.&lt;br&gt;• If surrounding soil is disturbed during cleanout of the forebay, reseed any areas of bare soil.</td>
</tr>
<tr>
<td></td>
<td>C2. Undesirable species are present in forebay</td>
<td>• Remove invasive species as soon as possible since they will be more difficult to remove once they become well-established.</td>
</tr>
</tbody>
</table>
# Dry Detention Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Dry Detention Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forebay</td>
<td>C3. Erosion protection materials no longer intact</td>
<td>Replace materials as needed.</td>
</tr>
<tr>
<td></td>
<td>C4. Transition berm shows signs of erosion</td>
<td>Repair or reshape the transition berm, taking care to maintain the original elevation of the berm. Repair, supplement, or replace erosion protection materials as needed.</td>
</tr>
<tr>
<td>Basin</td>
<td>D1. Water is standing more than five days after a storm event</td>
<td>Check outlet structure for clogging. If it appears to be a design issue, consult a design professional. If cattails or other wetland vegetation are present, water is likely remaining in the basin too long. Possible causes include a high groundwater table, clogged drawdown orifice(s), or localized low areas from heavy equipment or soil compaction.</td>
</tr>
<tr>
<td></td>
<td>D2. Sediment accumulation</td>
<td>Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose in an approved location where it will not cause impacts to streams or the BMP. Revegetate disturbed areas immediately with sod (preferred) or seed protected with securely staked erosion mat. Removal of accumulated sediment is extremely important. A significant accumulation of sediment impairs the pollutant-removal capabilities of the basin by reducing the available storage for the water quality volume.</td>
</tr>
<tr>
<td></td>
<td>D3. Trash and debris</td>
<td>Remove all trash and debris.</td>
</tr>
<tr>
<td></td>
<td>D4. Vegetation not withstanding soggy conditions</td>
<td>Dry detention basins may have soggy bottoms, making mowing costly and difficult. The use of water-tolerant, hardy, and slow-growing grass is recommended for the bottom of these basins. Consult a landscape professional to determine ideal species for the site conditions and replant to maintain dense vegetation cover.</td>
</tr>
<tr>
<td></td>
<td>D5. Erosion and/or channelization present</td>
<td>If erosion has occurred, reestablish turfgrass (seed or sod). Consult a design professional if assistance is needed replacing plant material in a landscaped dry detention basin. If there is channelization, reestablish the proper grade of the basin bottom by removing sediment and filling in, then reestablishing vegetation. Provide lime and one-time fertilizer application if needed.</td>
</tr>
<tr>
<td>Embankment</td>
<td>E1. Shrubs or trees have started to grow on the embankment</td>
<td>Remove shrubs or trees immediately by root. Fill/regrade and reestablish ground cover as necessary.</td>
</tr>
</tbody>
</table>
## Dry Detention Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Dry Detention Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **Embankment**               | E2. Grass cover is unhealthy or eroding | • Repair eroding areas by filling/regrading and reestablishing ground cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Irrigate and provide lime and one-time fertilizer application if needed.  
• Consult a professional if needed. |
| E3. Signs of seepage on the downstream face | | • Consult a design professional. This could indicate a serious safety concern as the dam could fail. |
| E4. Evidence of animal activity | | • Repair all animal burrows.  
• Trap and remove muskrats with a muskrat trap or contact a professional trapper. |
| **Outlet Drainage System and Emergency Spillway** | F1. Outlet drainage system shows signs of erosion or undesirable vegetation | • Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional. |
| F2. Trash, debris, or undesirable vegetation is present within emergency spillway | | • Remove all trash, debris, and undesirable vegetation. |
| F3. Grass height is not between 6 and 12 inches (150 to 300 mm) in emergency spillway | | • Grass height should be carefully maintained at a height of 6 to 12 inches (150 to 300 mm).  
Note: If emergency spillway is not grassed and is constructed of concrete or riprap, repair if in poor condition. |
### Dry Detention Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>DDB Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outlet Control Structure</td>
<td>G1. Water is not flowing freely to the outlet control structure&lt;br&gt;Note: Standing water above the drawdown orifice indicates that the orifice is blocked.</td>
<td>• If the outlet appears to be clogged or blocked and standing water prevents access to the structure, a trained contractor may be needed to make the necessary repairs. Never enter standing water unless you have been trained to do so.&lt;br&gt;• If the water level in the basin is above the orifice, follow proper safety precautions before opening the sluice gate or pumping out the basin.&lt;br&gt;• Remove sediment or debris around trash screen. After the basin has been drained, remove the trash screen to access the orifice. Remember to return the sluice gate to its original position.&lt;br&gt;• Remove sediment and debris blocking the flow into the orifice. Replace the steel orifice plate if there are signs of excessive corrosion.</td>
</tr>
<tr>
<td></td>
<td>G2. Trash and debris present in or clogging trash rack or trash rack is damaged or corroded</td>
<td>• Remove trash and debris from trash rack.&lt;br&gt;• Replace trash rack if corroded or damaged. Replace the trash rack according to design specifications for the wet detention basin.</td>
</tr>
<tr>
<td></td>
<td>G3. Sluice gate is not operable through intended range of motion</td>
<td>• Remove sediment or debris within and near the sluice gate.&lt;br&gt;• If lubrication is necessary, lubricate with a marine-type grease. For screw-type sluice gates, a PVC cover is recommended for the worm gear to protect it from corrosion.&lt;br&gt;• If the sluice gate is damaged beyond repair, consult a design professional for guidance on replacement.</td>
</tr>
</tbody>
</table>

Note: An underdrain system may be present on larger dry detention basins. Refer to Attachment 4 for maintenance details. Refer to Attachment 2 for outlet control structure diagrams.
A1. Trash, debris, or sediment
A2. Evidence of erosion or undercutting of riprap
A3. Signs of erosion or undesirable vegetation
A4. Damaged or plugged inlet or outlet pipes
B1. Bare soil and/or erosive gullies have formed
C1. Sediment in forebay
C2. Undesirable species
C3. Erosion protection materials not intact
C4. Erosion is present
D1. Standing water 5 days after a storm event
D2. Sediment accumulation
D3. Trash and debris
D4. Vegetation not withstanding soggy conditions
D5. Erosion present
E1. Shrubs and trees have started to grow
E2. Grass cover is unhealthy or eroding
E3. Signs of seepage
E4. Evidence of animal activity
F1. Outlet drainage systems show signs of erosion or undesirable vegetation
F2. Trash, debris, or undesirable vegetation is present
F3. Verify that grass height is maintained between 6 and 12 inches in emergency spillway
Dry Detention Basin Troubleshooting Guide

A1. Trash, debris, or sediment in the inlet or outlet.

A2. Evidence of erosion or undercutting of riprap in the inlet or outlet.

A3. Inlet channel, ditch, or outlet shows signs of erosion or undesirable vegetation.

A4. Damaged or plugged pipes in the inlet outlet.

B1. Areas of bare soil and/or erosive gullies have formed around the perimeter of the basin.

C1. Sediment accumulation in forebay.
C2. Undesirable species are present in forebay.

C3. Erosion protection materials no longer intact.

C4. Transition berm shows signs of erosion.

D1. Water is standing more than five days after a storm event.

D2. Sediment accumulation in basin.

D3. Trash/debris in basin.
D4. Vegetation not withstands soggy conditions.

D5. Erosion and/or channelization present in the basin.

E1. Shrubs or trees have started to grow on the embankment.

E2. Grass cover is unhealthy or eroding on the embankment.

E3. Signs of seepage on the downstream face of the embankment.

E4. Evidence of animal activity around the embankment.
F1. Outlet drainage system shows signs of erosion or undesirable vegetation.

F2. Trash, debris, or undesirable vegetation is present within emergency spillway.

F3. Grass height is not maintained between 6 and 12 inches (150 to 300 mm) in emergency spillway.
Dry Detention Basin Troubleshooting Guide

A well-maintained dry detention basin.

Standing water at the outlet control structure of a dry detention basin.

An outlet control structure of a dry detention basin.

The onset of erosion on the left-hand slope of a dry detention basin.

The inlet drainage system of a dry detention basin.

Atch 7
(12 of 14)
Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

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<td></td>
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</tr>
<tr>
<td>Perimeter of Basin</td>
<td>B1.</td>
<td></td>
<td>Area of bare soil and/or erosive gullies have formed?</td>
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<td>Forebay</td>
<td>C1.</td>
<td></td>
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<td>C2.</td>
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<td>Trash and debris present?</td>
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<td>D4.</td>
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<td>D5.</td>
<td></td>
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**Device Ranking**

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**Comments/Recommendations/Other Actions Taken:**

Atch 7
(13 of 14)
**Dry Detention Basin Operation & Maintenance Inspection Checklist - Continued**

| SCM: | Inspector(s): |
| SCM ID#: |  |
| SCM Locations: |  |
| Installation Name: |  |
| Date Installed: | Inspection Date: |

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

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<thead>
<tr>
<th>Dry Detention Basin Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embankment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1.</td>
<td><strong>Shrubs or trees have started to grow on the embankment?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E2.</td>
<td><strong>Grass cover is unhealthy or eroding?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3.</td>
<td><strong>Signs of seepage on the downstream face?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E4.</td>
<td><strong>Evidence of animal activity?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outlet Drainage System and Emergency Spillway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1.</td>
<td><strong>Outlet drainage system shows signs of erosion or undesirable vegetation?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2.</td>
<td><strong>Trash, debris or undesirable vegetation is present within emergency spillway?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F3.</td>
<td><strong>Grass height is not between 6 and 12 inches in emergency spillway?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outlet Control Structure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G1.</td>
<td><strong>Water is not flowing freely to the outlet control structure?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2.</td>
<td><strong>Trash and debris present in or clogging trash rack or trash rack is damaged or corroded?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3.</td>
<td><strong>Sluice gate is not operable through intended range of motion?</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken:</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td><strong>No Action (N)</strong> —No action is needed at time of inspection related to respective problem.</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td><strong>Maintenance Needed (MN)</strong> — Maintenance is needed to support functionality of the device and to prevent problem from escalating.</td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td><strong>Immediate Corrective Action (ICA)</strong> — Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
<td></td>
</tr>
</tbody>
</table>

Atch 7
(14 of 14)
An infiltration basin is a water impoundment in permeable soils that detains and infiltrates storm water runoff. Infiltration basins do not have underdrain systems and are located in areas where the hydraulic conductivity of the site soils is adequate for infiltration. Infiltration trenches and dry wells are discussed in Attachment 8b.

### Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annual</td>
</tr>
<tr>
<td>2 Vegetation Management, Trash and Debris Removal</td>
<td>4</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>3 Till Soil</td>
<td>8</td>
<td>Every 4 years</td>
</tr>
</tbody>
</table>

### Key Considerations

#### Important Design Criteria
- Pretreatment devices must be provided to prevent clogging.
- The bottom shall be a minimum of 2 feet (0.6 m) above underlying impervious soil horizon or bedrock and seasonal high water table, if applicable.

#### Common Maintenance Requirements/Problems
- The drainage area must be carefully managed to reduce the sediment load to the infiltration basin to prevent reduction in the basin’s infiltrative capacity.

### Advantages
- Reduce frequency of flooding by reducing the amount of water flowing to surface waters
- Help recharge groundwater, which supports dry-weather flows in streams
- Particulate pollutant removal efficiencies generally as good as other BMPs
- Help meet EISA 438 requirements
- Reduce erosion potential downstream

### Disadvantages
- Often fail relatively quickly compared to other types of BMPs if not maintained
- Restricted to areas with permeable soils
- May cause undesirable groundwater seepage into basements and foundations if not properly sited
- Infiltration of contaminated storm water may contaminate groundwater

(NCDENR, 2012)
Infiltration Basin Troubleshooting Guide

Typical infiltration basin configuration

Atch 8a
(2 of 11)
<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Inlet and Outlet            | A1. Trash/debris/sediment                                               | • Remove all trash, debris, and accumulated sediment.  
• Remove vegetative debris that has the potential to inhibit flow.                                                                                                                                               |
|                             | A2. Evidence of erosion or undercutting of riprap                       | Note: Infiltration basins are particularly susceptible to sedimentation. Inspect the area draining to the basin carefully for bare soil.  
• Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance from a design professional.  
• Source of erosion must be identified and controlled when soil is exposed or erosion channels are forming.  
• Check the upstream areas for bank stability and evidence of piping or scour holes. |
|                             | A3. Inlet channel, ditch, or outlet - undesirable vegetation present.    | • Undesirable vegetation (woody plants or invasive species) must be removed by the root. Reseed bare soil areas as needed.                                                                                                             |
|                             | A4. Damaged or plugged pipes, inlet, or outlet                          | • Repair or replace damaged piping if needed. Consult a design professional if piping within embankment must be replaced.  
• If plugged, remove material, identify and remediate source of sedimentation or blockage.  
Refer to the end of this section for guidance on emergency spillways and outlet control structures and see Attachment 2, General Storm Water Infrastructure O&M Guide, for additional inspection and maintenance details on these components. |
| Perimeter of Basin          | B1. Areas of bare soil and/or erosive gullies have formed                | • Regrade the soil if necessary to remove the gully. Plant a perennial ground cover and water until it is established.                                                                                           |
## Infiltration Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forebay</td>
<td>C1. Sediment accumulation in forebay</td>
<td>• Remove and dispose sediment offsite if it appears to occupy more than 50% of the forebay's storage capacity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If surrounding soil is disturbed during cleanout of the forebay, reseed any areas of bare soil.</td>
</tr>
<tr>
<td></td>
<td>C2. Invasive species are present in forebay</td>
<td>• Remove invasive species as soon as possible since they will be more difficult to remove once they become well-established.</td>
</tr>
<tr>
<td></td>
<td>C3. Evidence of erosion or undercutting in erosion protection materials or</td>
<td>• Replace materials as needed.</td>
</tr>
<tr>
<td></td>
<td>transition berm</td>
<td>• Repair the transition berm, taking care to maintain the original elevation of the berm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cause of erosion must be identified and controlled when native soil is exposed or erosion channels are forming.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check the upstream areas for bank stability and evidence of piping or scour holes.</td>
</tr>
<tr>
<td>Flow Bypass System</td>
<td>D1. Trash/debris/sediment/undesirable vegetation</td>
<td>• Remove all trash, debris, accumulated sediment, and undesirable or invasive vegetation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Consult CES/CEIEC on proper disposal of sediment. It may be handled as a hazardous material in some states.</td>
</tr>
<tr>
<td></td>
<td>D2. Evidence of erosion in flow bypass system</td>
<td>• Repair areas affected by erosion or channelization. Restore grass to dense cover for optimum removal of pollutants. Reestablish turf grass using seed or sod and water until reestablished.</td>
</tr>
<tr>
<td></td>
<td>D3. Materials in system are damaged</td>
<td>• Repair any cracks and/or holes, replace components as necessary, and replace or repair any materials (e.g., riprap, permanent soil reinforcement matting [PSRM]) used to protect the outlet of the bypass structure.</td>
</tr>
<tr>
<td></td>
<td>D4. Grass height in filter strip not between recommended 6 and 12 inches (150 to 300 mm)</td>
<td>• Verify that grass in filter strip is being mowed at the proper frequency.</td>
</tr>
</tbody>
</table>

Note: There may be a filter strip or swale attached to the flow bypass structure. Inspect these areas if present.
# Infiltration Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin</td>
<td>E1. Standing water more than five days after a storm event</td>
<td>• Drain the basin and replace the top few inches of soil and see if this corrects the standing water problem. If so, revegetate immediately. If not, consult an appropriate professional for a more extensive repair.</td>
</tr>
</tbody>
</table>
|                             | E2. Sediment accumulation | • Remove sediment to avoid clogging in the basin.  
• Consult CES/CEIEC on proper disposal of sediment. It may be handled as a hazardous material in some states.  
• Removal of accumulated sediment is extremely important. A significant accumulation of sediment impairs the pollutant-removal capabilities of the basin by reducing the infiltration rate. Reestablish groundcover according to original design specifications if needed. |
|                             | E3. Trash/debris/undesirable vegetation | • Remove all trash and debris. Remove undesirable vegetation by the root. |
|                             | E4. Erosion and/or channelization is occurring | • Reestablish turf grass where erosion is occurring using seed or sod. Water until grass is reestablished.  
• If there is channelization, reestablish the proper grade of the basin bottom by removing sediment and filling in, then reestablishing vegetation if applicable.  

Note: The bottom of the basin may be vegetated with grass or covered with a layer of sand. If sand is used, it should form a uniform cover of at least 4 inches (100 mm). |
| Embankment                  | F1. Shrubs or trees have started to grow on the embankment | • Remove shrubs or trees immediately by root.  
• Fill/regrade and reestablish ground cover as necessary. |
|                             | F2. Grass cover is unhealthy or eroding | • Repair eroding areas by filling/regrading and reestablishing ground cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Water until grass is reestablished. |
|                             | F3. Evidence of animal activity | • Repair all animal burrows.  
• Contact a professional beaver trapper to assist with beaver removal. Trap and remove muskrats with a muskrat trap or contact a professional trapper. |

Note: The permeability of the soil beneath the basin must be maintained or the infiltration basin will fail. Do not operate vehicles or construction equipment within the basin.
# Infiltration Basin Troubleshooting Guide

<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embankment</td>
<td>F4. Signs of settling, scouring, cracking, or sloughing</td>
<td>• Repair by adding soil and/or regrade where needed. Compact as indicated in the original design documents, and reestablish vegetation. Consult a design professional if needed.</td>
</tr>
<tr>
<td>Emergency Spillway</td>
<td>G1. Trash/debris/undesirable vegetation is present within emergency spillway</td>
<td>• Remove all trash, debris, and undesirable vegetation.</td>
</tr>
</tbody>
</table>
|                              | G2. Grass height is not between 6 and 12 inches (150 to 300 mm) in emergency spillway | • Grass height should be carefully maintained within a range of 6 to 12 inches (150 to 300 mm).  
  Note: If emergency spillway is not grassed and is constructed of concrete or riprap, repair if in poor condition. Inspect emergency spillway after significant rainfall as riprap may become displaced. |
| Outlet Control Structure     | H1. Outlet is clogged                                                  | • If the outlet appears to be clogged or blocked and standing water prevents access to the structure, hip waders or a small boat may be needed to make the necessary repairs. Do not enter the standing water unless you have been trained to do so. Portable pumps can often be used to dewater the basin. Trained contractors can be hired to make needed repairs.  
  • Remove sediment or debris around outlet pipe or sluice gate. |
|                              | H2. Trash and debris present in or clogging trash rack or trash rack is damaged or corroded | • Remove trash and debris from trash rack.  
  • Replace trash rack if it is corroded or damaged. Replace the trash rack according to design specifications for the basin.  
  • If trash rack is hinged, exercise hinge and lubricate with a marine-type lubricant as necessary. |
|                              | H3. Sluice gate is not operable through intended range of motion        | • Remove sediment or debris within and near the sluice gate.  
  • If lubrication is necessary, lubricate with a marine-type grease. For screw-type sluice gates, a PVC cover is recommended for the worm gear to protect it from corrosion.  
  • If the sluice gate is damaged beyond repair, consult a design professional for guidance on replacement.  
  • Periodically exercise sluice gate to prevent gate from freezing shut. |

An emergency spillway may be present in place of the outlet control structure. Refer to Attachment 7 for emergency spillway graphics.

Refer to Attachment 2 for outlet control structure diagrams.
A1. Trash, debris, or sediment
A2. Evidence of erosion or undercutting of riprap
A3. Undesirable vegetation present in inlet channel, ditch, or outlet
A4. Damaged or plugged pipes, inlet, or outlet
B1. Areas of bare soil and/or erosive gullies have formed
C1. Sediment accumulation
C2. Invasive species present
C3. Evidence of erosion or undercutting in protection materials or transition berm
D1. Trash, debris, sediment, or undesirable vegetation
D2. Evidence of erosion
D3. Materials in structure are damaged
D4. Grass height not between 6 and 12 inches
E1. Standing water more than five days after a storm event
E2. Sediment accumulation
E3. Trash, debris, or undesirable vegetation
E4. Erosion and/or channelization is occurring
F1. Shrubs or trees have started to grow on the embankment
F2. Grass cover is unhealthy or eroding
F3. Evidence of animal activity
F4. Signs of settling, scouring, cracking, or sloughing
G1. Trash, debris, or undesirable vegetation is present (Not shown)
G2. Grass height is not between 6 and 12 inches (Not shown)
Infiltration Basin Troubleshooting Guide

A1. Trash, debris, or sediment at inlet or outlet.
A2. Evidence of erosion or undercutting of riprap at inlet or outlet.
A3. Undesirable vegetation present in inlet channel, ditch, or outlet.
A4. Damaged or plugged pipes, inlet, or outlet.
B1. Areas of bare soil and/or erosive gullies have formed at perimeter of basin.
C1. Sediment accumulation in forebay.
C2. Invasive species are present in forebay.

C3. Evidence of erosion or undercutting in erosion protection materials or transition berm.

D1. Trash, debris, sediment, or undesirable vegetation within flow bypass system.

D2. Evidence of erosion within flow bypass system.

D3. Materials in flow bypass structure are damaged.

D4. Grass height in flow bypass filter strip is not between recommended 6 and 12 inches (150 to 300 mm).

Grass Height of 6 to 12 inches
E1. Standing water in basin more than five days after a storm event.

E2. Sediment accumulation in basin.

E3. Trash, debris, or undesirable vegetation in basin.

E4. Erosion and/or channelization is occurring in basin.

F1. Shrubs or trees have started to grow on the embankment.

F2. Grass cover on embankment is unhealthy or eroding.
F3. Evidence of animal activity on the embankment.

F4. Signs of settling, scouring, cracking, or sloughing on the embankment.

G1. Trash, debris, or undesirable vegetation is present within emergency spillway.

G2. Grass height is not between 6 and 12 inches (150 to 300 mm) in emergency spillway.
Infiltration Trench and Dry Well

Infiltration Trench
Infiltration trenches are filled with large, crushed stone or other media to create storage for the storm water in the voids between the media. Other designs use precast concrete vaults with open bottoms to provide a large storage volume to hold storm water for infiltration into the soil. Infiltration trenches are most often used to manage the runoff from parking lots and buildings.

Key Considerations for Infiltration Trenches and Dry Wells

Important Design Criteria
- Ensure that the soils onsite are appropriate for infiltration and that the design minimizes the potential for groundwater contamination; there should be at least 2 feet (0.6 m) from the bottom of the device to the seasonally high groundwater table.
- Infiltration trenches should be placed on flat ground, but the slopes of the site draining to the device can be as steep as 15 percent.
- Overflow from a trench or dry well should be directed to a vegetated swale or other conveyance that prevents erosion.

Common Maintenance Requirements and Problems
- Infiltration trenches should be applied to relatively small sites (less than 5 acres), with relatively high impervious cover. Application to larger sites generally causes clogging, resulting in a high maintenance burden.
Dry Well

A dry well (also known as a French drain or seepage pit) is a variation on an infiltration trench that is designed to temporarily store and infiltrate rooftop runoff. Mesh or screen filters at the top of the downspout are usually sufficient pretreatment for these devices.

Advantages

- Infiltration trenches and dry wells reduce storm water runoff volume (a main objective of EISA 438), typically most of the runoff volume from small storms.
- They reduce peak discharge rates by retaining the first flush of storm water runoff and creating longer flow paths for runoff.
- Infiltration devices are moderately expensive to construct and can help to reduce the size of downstream storm water control measures.

Disadvantages

- Infiltration trenches and dry wells cannot receive untreated (i.e., unfiltered) runoff, as untreated runoff typically contains fine sediment that will clog these devices.
- As with infiltration basins, these devices are restricted to areas with permeable soils.
- May cause undesirable groundwater seepage into basements and foundations if not properly sited.
- Failed devices cannot be repaired and require complete reconstruction.

Atch 8b
(2 of 3)
<table>
<thead>
<tr>
<th>Maintenance Task</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Check test/observation wells following 72 hours of dry weather. If no test well is present, check for ponded water. Failure to percolate within this time period indicates clogging.</td>
<td>Semi-annually</td>
</tr>
<tr>
<td>• If ponding occurs on the surface of an infiltration trench, remove and replace the topsoil or first layer of stone and the top layer of filter fabric.</td>
<td></td>
</tr>
<tr>
<td>• Inspect pretreatment devices and diversion structures for structural damage.</td>
<td>Annually</td>
</tr>
<tr>
<td>• Remove sediment and oil/grease from pretreatment devices and overflow structures.</td>
<td>Monthly</td>
</tr>
<tr>
<td>• Regularly clean out gutters and check connections leading to dry well; may be able to decrease inspection frequency based on rate of sediment/debris accumulation.</td>
<td></td>
</tr>
<tr>
<td>• If bypass capability is available, provide an extended dry period for the trench or dry well by temporarily bypassing; this may improve the infiltration rate.</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>• Upon failure, the trench or dry well will likely need complete reconstruction to maintain storage capacity within two-thirds of the design treatment volume and 72-hour infiltration rate.</td>
<td>Upon failure</td>
</tr>
<tr>
<td>• Trench walls should be excavated to expose clean soil.</td>
<td></td>
</tr>
</tbody>
</table>
Infiltration Basin, Trench and Dry Well Troubleshooting Guide

A well maintained, shallow infiltration basin with no emergency outlet structure (i.e., the basin is designed to overflow during large storms).

An infiltration basin that is becoming overgrown and will soon be difficult to access and inspect.

A newly established infiltration basin.

A newly established infiltration basin that requires additional vegetative cover.

An elongated infiltration basin that receives runoff from the roadway and resembles a swale or infiltration trench.

An elongated infiltration basin that receives runoff from the roadway and resembles a swale or infiltration trench.

(Photos on this page courtesy of NCDOT)
An infiltration basin that receives parking lot runoff (currently contains snow).

An elongated infiltration basin that receives parking lot runoff.

Construction of a dry well (1 of 3) (photo courtesy of Earth Stone and Water, LLC)

Construction of a dry well (2 of 3) (photo courtesy of Earth Stone and Water, LLC)

Construction of a dry well (3 of 3) (photo courtesy of Earth Stone and Water, LLC)

Atch 8a-b (2 of 2)
# Infiltration Basin Operation & Maintenance Inspection Checklist

**SCM:** __________________________  **Inspector(s):** __________________________  
**SCM ID#:** __________________________  
**SCM Locations:** __________________________  
**Installation Name:** __________________________  
**Date Installed:** __________________________  
**Inspection Date:** __________________________

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1.</td>
<td>Trash/debris/sediment present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2.</td>
<td>Evidence of erosion or undercutting of riprap?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3.</td>
<td>Inlet channel, ditch, or outlet - undesirable vegetation present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4.</td>
<td>Damaged or plugged pipes, inlet, or outlet?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1.</td>
<td>Areas of bare soil and/or erosive gullies have formed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1.</td>
<td>Sediment accumulation in forebay?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2.</td>
<td>Invasive species are present in forebay?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3.</td>
<td>Evidence of erosion or undercutting in erosion protection materials or transition berm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1.</td>
<td>Trash/debris/sediment/undesirable vegetation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2.</td>
<td>Evidence of erosion in flow bypass system?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3.</td>
<td>Materials in system are damaged?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4.</td>
<td>Grass height in filter strip not between recommended 6 and 12 inches?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1.</td>
<td>Standing water more than five days after a storm event?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E2.</td>
<td>Sediment accumulation present?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Device Ranking**

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No Action (N) — No action is needed at time of inspection related to respective problem.</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>Maintenance Needed (MN) - Maintenance is needed to support functionality of the device and to prevent problem from escalating.</td>
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<tr>
<td>ICA</td>
<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
<td></td>
</tr>
</tbody>
</table>

Atch 8c  
(1 of 3)
Infiltration Basin Operation & Maintenance Inspection Checklist - Continued

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin</td>
<td>E3.</td>
<td></td>
<td>Trash/debris/undesirable vegetation present?</td>
</tr>
<tr>
<td></td>
<td>E4.</td>
<td></td>
<td>Erosion and/or channelization is occurring?</td>
</tr>
<tr>
<td>Embankment</td>
<td>F1.</td>
<td></td>
<td>Shrubs or trees have started to grow on the embankment?</td>
</tr>
<tr>
<td></td>
<td>F2.</td>
<td></td>
<td>Grass cover is unhealthy or eroding?</td>
</tr>
<tr>
<td></td>
<td>F3.</td>
<td></td>
<td>Evidence of animal activity?</td>
</tr>
<tr>
<td></td>
<td>F4.</td>
<td></td>
<td>Signs of settling, scouring, cracking, or sloughing?</td>
</tr>
<tr>
<td>Emergency Spillway</td>
<td>G1.</td>
<td></td>
<td>Trash/debris/undesirable vegetation is present within emergency spillway?</td>
</tr>
<tr>
<td></td>
<td>G2.</td>
<td></td>
<td>Grass height is not between 6 and 12 inches in emergency spillway?</td>
</tr>
<tr>
<td>Outlet Control Structure</td>
<td>H1.</td>
<td></td>
<td>Outlet is clogged?</td>
</tr>
<tr>
<td></td>
<td>H2.</td>
<td></td>
<td>Trash and debris present in or clogging trash rack or trash rack is damaged or corroded</td>
</tr>
<tr>
<td></td>
<td>H3.</td>
<td></td>
<td>Sluice gate is not operable through intended range of motion?</td>
</tr>
</tbody>
</table>

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<tr>
<th>Device Ranking</th>
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<tbody>
<tr>
<td>N</td>
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</tr>
<tr>
<td>MN</td>
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<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
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</tbody>
</table>
# Infiltration Trench and Dry Well
## Operation & Maintenance Inspection Checklist

<table>
<thead>
<tr>
<th>Storm Water SCM:</th>
<th>Inspector(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM ID#:</td>
<td></td>
</tr>
<tr>
<td>SCM Locations:</td>
<td></td>
</tr>
<tr>
<td>Installation Name:</td>
<td></td>
</tr>
<tr>
<td>Date Installed:</td>
<td>Inspection Date:</td>
</tr>
</tbody>
</table>

Complete the form below by indicating the condition of each component.

<table>
<thead>
<tr>
<th>Infiltration Basin Component</th>
<th>Condition (A, B, or C)</th>
<th>Date Maintenance Performed</th>
<th>Maintenance Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
<td></td>
<td></td>
<td>Remove sediment and oil/grease from pretreatment devices and overflow structures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Regularly clean out gutters and check connections leading to dry well; may be able to decrease inspection frequency based on rate of sediment/debris accumulation.</td>
</tr>
<tr>
<td>Semi-annually</td>
<td></td>
<td></td>
<td>Check test/observation wells following 72 hours of dry weather. If no test well is present, check for ponded water. Failure to percolate within this time period indicates clogging.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If ponding occurs on the surface of an infiltration trench, remove and replace the topsoil or first layer of stone and the top layer of filter fabric.</td>
</tr>
<tr>
<td>Annually</td>
<td></td>
<td></td>
<td>Inspect pretreatment devices and diversion structures for structural damage.</td>
</tr>
<tr>
<td>Every 5 Years</td>
<td></td>
<td></td>
<td>If bypass capability is available, provide an extended dry period for the trench or dry well by temporarily bypassing; this may improve the infiltration rate.</td>
</tr>
<tr>
<td>Upon Failure</td>
<td></td>
<td></td>
<td>Upon failure, the trench or dry well will likely need complete reconstruction to maintain storage capacity within 2/3 of the design treatment volume and 72-hour infiltration rate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Some aging and wear has occurred, but no structural deterioration or maintenance needs were found. Device is functioning properly.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Minor structural deterioration and/or maintenance needs were found, but function of the device has not been affected.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Moderate structural deterioration and/or maintenance needs were found, but function of the device has not been significantly affected.</td>
<td></td>
</tr>
</tbody>
</table>
Storm Water Wetland Troubleshooting Guide

Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours (per acre of drainage area)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Vegetation Management and Debris Removal</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>3 Vector Control</td>
<td>2</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>4 Intermittent Maintenance</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>5 Forebay Sediment Removal</td>
<td>16</td>
<td>Every 8 years</td>
</tr>
<tr>
<td>6 Wetland Sediment Removal</td>
<td>40</td>
<td>Every 20 years</td>
</tr>
</tbody>
</table>

Key Considerations

Important Design Criteria
- Side slopes stabilized with vegetation shall be no steeper than 3:1.
- The shallow land areas must drawdown in 2 to 5 days.
- Flow through the wetland shall not be short-circuited and shall be made as lengthy as possible.

Common Maintenance Requirements/Problems
- Wetlands should be inspected twice per year for the first three years after construction during a growing and non-growing season. Monitor vegetative establishment and compare against landscaping design. After three years, if wetland is in good condition, inspect annually. (VADCR, 2013)

Advantages
- Excellent storm water control for maximum total suspended solids, nitrogen, and phosphorus removal while also providing storm water volume control.
- Aesthetically pleasing when properly maintained and can be sited in both low- and high-visibility areas.
- Provides a shallow matrix of sediment, plants, water, and detritus that collectively removes multiple pollutants through a series of complementary physical, chemical, and biological processes.

Disadvantages
- Occupies more land than other storm water controls such as detention basins.
- Needs to meet critical water balance requirements to stay healthy and properly functioning.
- Poorly maintained storm water wetlands can be colonized by invasive species that out-compete native wetland plants.
- Removal of invasive plants is difficult and labor intensive and may need to be done repeatedly.
- Provides habitat for wildlife and waterfowl, which can be a hazard for Air Force installations. (NCDENR, 2012)

Storm water wetlands are constructed SCMs that mimic natural wetlands and have multiple treatment zones of different water depths. Each treatment zone supports a diverse aquatic ecosystem. The primary treatment zones are deep pools, shallow water, and shallow land.

Typical storm water wetland configuration

Photo courtesy of NCDOT
Typical storm water wetland configuration
<table>
<thead>
<tr>
<th>Wetland Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
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</table>
| Inlet and Outlet   | A1. Trash/debris/sediment | • Remove all trash, debris and sediment.  
• Remove vegetative debris that has the potential to inhibit flow.  
• Pay special attention to inlets and outlets as their clogging will cause the BMP to fail. |
|                   | A2. Inlet channel, ditch, or outlet shows signs of erosion or invasive vegetation | • Invasive vegetation (woody plants or invasive species) must be removed. Reseed bare soil areas as needed.  
• Remove invasive species as soon as possible or they will be more difficult to remove once they become well established. |
|                   | A3. Damaged or plugged pipes at inlet or outlet | • Repair or replace damaged piping if needed. Consult a design professional if piping within embankment must be replaced.  
• If plugged, remove material and identify and mitigate the source of sediment or debris.  
• Inspect the ground surface above buried pipes/structures for depressions that might indicate pipe breakage or separation.  
• See outlet control structure guidance in Attachment 2 for additional inspection and maintenance details. |
| Forebay           | B1. Sediment has accumulated in forebay to greater than 50% of the forebay storage capacity | • Remove and dispose of sediment offsite if it appears to occupy more than 50% of the forebay's storage capacity. Consult CES/CEIEC on proper disposal of sediment. It may be handled as a hazardous material in some states. Replace riprap as needed.  
• If surrounding soil is disturbed during cleanout of the forebay, reseed any areas of bare soil.  
Note: Sediment is typically removed with a backhoe or track hoe. The water level in the wetland can be lowered if necessary to remove sediment from the forebay. Research indicates that sediment will need to be removed from storm water wetland forebays every 5 to 10 years (NCSU-BAE, 2006). |
|                   | B2. Invasive species are present in forebay | • Remove invasive species as soon as possible or they will be more difficult to remove once they become well-established.  
Note: Forebays are **not** designed to support vegetation. |
<table>
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<tr>
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| Forebay           | B3. Evidence of erosion or undercutting in erosion protection materials or transition berm | • Replace materials as needed.  
• Repair the transition berm, taking care to maintain the original elevation of the berm.  
• Repair and re-sod or replace riprap. If this is a recurring problem, seek guidance of a design professional.  
• Cause of erosion must be identified and controlled when native soil is exposed or erosion channels are forming.  
• Check the upstream areas for bank stability and evidence of piping or scour holes. |
| Basin             | C1. Inadequate aquatic plant density compared to what was implemented (refer to planting plan) | • Consult a design professional for vegetation reestablishment and provide them with the original planting plan. Note that the use of fertilizer is restricted in some locations. |
|                   | C2. Sediment accumulation                                               | • Unlike most other storm water controls, sediment or solids cannot be removed from a storm water wetland by dredging. Dredging of the wetland negatively impacts the vegetative cover. Solids should be removed from the wetland only if it is deemed critical to the functioning of the wetland. Note: if dredging is unavoidable, take care to spread the top layer of dredged material over the wetland to aid in reestablishing vegetation.  
• Sediment will likely need to be removed when it accumulates to the point of reducing the original design depth by 75% or more. Refer to Attachment 2 for guidance on measuring sediment in wet basins.  
Note: Proper maintenance of the forebay should prevent costly and potentially detrimental dredging of the wetland basin. |
|                   | C3. Trash/debris                                                        | • Remove all trash and debris as often as needed as accumulated trash/debris can clog the outlet. |
|                   | C4. Unhealthy or dead plants are present                                | • Replace dead or unhealthy plants using the original design drawings or landscaping plan if necessary.  
• Determine the source of the problem, e.g., soils, hydrology, disease. Remedy the problem before replacing plants. |
|                   | C5. Algae covers more than 50% of the wetland                           | • Consult a pond management professional for assistance developing and implementing a management plan. |
## Storm Water Wetland Troubleshooting Guide

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| **Basin**         | C6. Cattails or other invasive species cover 50% or more of the deep pool or shallow water areas | • Remove invasive species by physical removal or by hand-wiping with aquatic glyphosate (wear gloves). Do not spray as the herbicide will kill all vegetation it contacts.  
• Monitor the wetland for cattails twice per year during the first two years after it is constructed and annually thereafter. |
|                   | C7. Geese or other waterfowl have taken residence in the wetland | • Refer to AFPAM 91-212 for guidance on bird removal. |
| **Embankment**    | D1. Shrubs or trees have started to grow on the embankment | • Remove shrubs or trees immediately.  
• Fill/regrade and reestablish ground cover as necessary. |
|                   | D2. Grass cover is unhealthy or eroding | • Repair eroding areas by filling/regrading and reestablishing ground cover.  
• Use sod where possible and provide adequate erosion protection until repaired areas are well stabilized.  
• Consult a professional landscaper if needed. |
|                   | D3. Signs of seepage on the downstream face | • Consult a design professional. This could indicate a serious issue and cause the embankment to fail. |
|                   | D4. Evidence of animal activity | • Repair all animal burrows.  
• Contact a professional beaver trapper to remove beavers.  
• Use a muskrat trap to trap and remove muskrats, or contact a professional trapper. |
|                   | D5. Signs of settling, scouring, cracking, or sloughing | • Repair by adding soil and/or re-grade where needed. Compact as indicated in the original design documents, and reestablish vegetation. Consult a design professional if needed and follow any applicable dam safety rules. |
| **Outlet Drainage Systems and Emergency Spillway** | E1. Outlet drainage system shows signs of erosion or undesirable vegetation | • Repair and re-sod or replace riprap. Restore compacted fill, filter fabric, and riprap. If this is a recurring problem, seek guidance of a design professional. |
|                   | E2. Trash, debris, or invasive vegetation is present within emergency spillway | • Remove all trash, debris, and invasive vegetation.  
• Remove trash as often as possible as it can clog the outlet. |
### Storm Water Wetland Troubleshooting Guide

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</table>
| Outlet Drainage Systems and Emergency Spillway                                    | E3. Verify that grass height is maintained between 6 and 15 inches (150 to 300 mm) in emergency spillway | • Grass height should be carefully maintained at a height of 6 to 15 inches (150 to 300 mm).  
  Note: If emergency spillway is not grassed but is constructed of concrete or riprap, repair if in poor condition. |

| Outlet Control Structure                                                          | F1. Water is not flowing freely to the outlet control structure         | • If the outlet appears to be clogged or blocked and standing water prevents access to the structure, hip waders or a small boat may be needed to make the necessary repairs. Do not enter the standing water unless you have been trained to do so. Trained contractors can be hired to make needed repairs.  
  • If the water level in the deep pool is above the orifice, follow proper safety precautions before opening the sluice gate or pumping out the pool.  
  • Remove sediment or debris around the trash screen. After the deep pool has been drained, remove the trash screen to access the orifice. Remember to return the sluice gate to its original position.  
  • Remove sediment and debris blocking the flow into the orifice. Replace the steel orifice plate if there are signs of excessive corrosion. |

|                                                                                   | F2. Trash and debris present in or clogging trash rack or trash rack is damaged or corroded | • Remove trash and debris from trash rack.  
  • Replace trash rack if it is corroded or damaged. Replace the trash rack according to design specifications for the constructed wetland.  
  • If trash rack is hinged, exercise periodically and lubricate with marine-type grease as necessary. |

|                                                                                   | F3. Sluice gate is not operable through intended range of motion          | • Remove sediment or debris within and near the sluice gate.  
  • If lubrication is necessary, lubricate with a marine-type grease. For screw-type sluice gates, a PVC cover is recommended for the worm gear to protect it from corrosion.  
  • If the sluice gate is damaged beyond repair, consult a design professional for guidance on replacement.  
  • Exercise sluice gate periodically to prevent gate from freezing shut. |

Refer to Attachment 2 for outlet control structure diagrams.
Storm Water Wetland Troubleshooting Guide

A1. Trash, debris, or sediment
A2. Signs of erosion or invasive vegetation
A3. Damaged or plugged inlet or outlet pipes
B1. Sediment has accumulated greater than 50%
B2. Invasive species present
B3. Evidence of erosion or undercutting in protection materials or berm
C1. Inadequate aquatic plant density
C2. Sediment accumulation
C3. Trash or debris
C4. Unhealthy or dead plants are present
C5. Algae covers more than 50% of the wetland
C6. Cattails or other invasive species cover more than 50%
C7. Geese or waterfowl have taken residence
D1. Shrubs or trees have started to grow on the embankment
D2. Grass cover is unhealthy or eroding
D3. Signs of seepage on the downstream face
D4. Evidence of animal activity
D5. Signs of settling, scouring, cracking, or sloughing
E1. Outlet drainage system shows signs of erosion or undesirable vegetation
E2. Trash, debris or invasive vegetation present
E3. Verify that grass height is maintained between 6 and 12 inches

Atch 9
(7 of 14)
Storm Water Wetland Troubleshooting Guide

A1. Trash/debris/sediment at inlet or outlet.
A2. Inlet channel, ditch, or outlet shows signs of erosion or invasive vegetation.
A3. Damaged or plugged pipes at inlet or outlet.

B1. Sediment has accumulated in forebay to greater than 50% of the forebay’s storage capacity.
B2. Invasive species are present in forebay.
B3. Evidence of erosion or undercutting in erosion protection materials or transition berm.

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(8 of 14)
C1. Inadequate aquatic plant density within basin compared to what was implemented.

C2. Sediment accumulation within basin.

C3. Trash or debris within basin.

C4. Unhealthy or dead plants are present within basin.

C5. Algae covers more than 50% of the wetland.

C6. Cattails or other invasive species cover 50% or more of the deep pool or shallow water areas.
C7. Geese or other waterfowl have taken residence in the wetland.

D1. Shrubs or trees have started to grow on the embankment.

D2. Grass cover is unhealthy or eroding on the embankment.

D3. Signs of seepage on the downstream face of the embankment.

D4. Evidence of animal activity on the embankment.

D5. Signs of settling, scouring, cracking, or sloughing on the embankment.
E1. Outlet drainage system shows signs of erosion or undesirable vegetation.

E2. Trash, debris, or invasive vegetation is present within emergency spillway.

E3. Verify that grass height is maintained between 6 to 15 inches (150 to 300 mm) in the emergency spillway.
A well-maintained storm water wetland.

A storm water wetland with low water and signs of erosion, possibly indicating a problem with the outlet control structure.

A newly established storm water wetland.

The same storm water wetland (left) after vegetation is fully established.

A storm water wetland that has become overgrown with invasive species that inhibit the SCM’s ability to provide a diverse ecosystem and may promote mosquito breeding.

All photos courtesy of NCDOT
# Storm Water Wetland Operation & Maintenance Inspection Checklist

| SCM: | Inspector(s): |
| SCM ID#: | |
| SCM Locations: | |
| Installation Name: | |
| Date Installed: | Inspection Date: |

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Storm Water Wetland Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet and Outlet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.</td>
<td>Trash/debris/sediment present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2.</td>
<td>Inlet channel, ditch, or outlet shows signs of erosion or invasive vegetation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3.</td>
<td>Damaged or plugged pipes at inlet or outlet?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forebay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1.</td>
<td>Sediment has accumulated in forebay to greater than 50% of the forebay’s storage capacity?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2.</td>
<td>Invasive species are present in forebay?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3.</td>
<td>Evidence of erosion or undercutting in erosion protection materials or transition berm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1.</td>
<td>Inadequate aquatic plant density compared to what was implemented? (Refer to planting plan)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2.</td>
<td>Sediment accumulation present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3.</td>
<td>Trash/debris present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4.</td>
<td>Unhealthy or dead plants are present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5.</td>
<td>Algae covers more than 50% of the wetland?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6.</td>
<td>Cattails or other invasive species cover 50% or more of the deep pool or shallow water areas?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7.</td>
<td>Geese or other waterfowl have taken residence in the wetland?</td>
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## Storm Water Wetland
### Operation & Maintenance Inspection Checklist - Continued

**SCM:** __________________________  **Inspector(s):** __________________________

**SCM ID#:** __________________________  **SCM Locations: [ ]** __________________________

**Installation Name:** __________________________  **Date Installed:** __________________________

**Inspection Date:** __________________________

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Storm Water Wetland Component</th>
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<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1. Embankment</td>
<td></td>
<td></td>
<td>Shrubs or trees have started to grow on the embankment?</td>
</tr>
<tr>
<td>D2.</td>
<td></td>
<td></td>
<td>Grass cover is unhealthy or eroding?</td>
</tr>
<tr>
<td>D3.</td>
<td></td>
<td></td>
<td>Signs of seepage on the downstream face?</td>
</tr>
<tr>
<td>D4.</td>
<td></td>
<td></td>
<td>Evidence of animal activity?</td>
</tr>
<tr>
<td>D5.</td>
<td></td>
<td></td>
<td>Signs of settling, scouring, cracking, or sloughing?</td>
</tr>
<tr>
<td>E1. Outlet Drainage Systems and Emergency Spillway</td>
<td></td>
<td></td>
<td>Outlet drainage system shows signs of erosion or undesirable vegetation?</td>
</tr>
<tr>
<td>E2.</td>
<td></td>
<td></td>
<td>Trash, debris, or invasive vegetation is present within emergency spillway?</td>
</tr>
<tr>
<td>E3.</td>
<td></td>
<td></td>
<td>Verify that grass height is maintained between 6 and 15 inches in emergency spillway?</td>
</tr>
<tr>
<td>F1. Outlet Control Structure</td>
<td></td>
<td></td>
<td>Water is not flowing freely to the outlet control structure?</td>
</tr>
<tr>
<td>F2.</td>
<td></td>
<td></td>
<td>Trash and debris present in or clogging trash rack or trash rack is damaged or corroded?</td>
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Atch 9
(14 of 14)
Rainwater harvesting practices can vary greatly. In the context of this attachment, rainwater harvesting refers to capturing and storing storm water from rooftops for non-potable uses. Rainwater harvesting is considered a good low impact development (LID) / green infrastructure (GI) practice because it reduces total runoff volume.

### Key Considerations

#### Important Design Criteria
- Gutter guards and screen should be provided upstream of the tank to prevent debris from clogging the system.
- Connections should be sealed and downspouts should have screens to prevent mosquito breeding.
- Select materials suitable to the service conditions. Considerations should be made for temperature extremes and UV damage.
- Signage designating approved uses should be provided.

#### Common Maintenance Requirements/Problems
- Collection system and pretreatment components clogged by debris.
- Debris buildup in storage tank.

### Advantages
- Minimal maintenance for the most common rainwater harvesting systems.
- GI/LID practice that reduces storm water volume.
- Reduces potable water consumption and associated cost.

### Disadvantages
- Complex systems can require frequent maintenance and water quality testing, depending on uses.
- Can be mistaken for potable water and accidentally consumed.
- In dry regions there may be laws against rainwater harvesting to protect water rights.

---

<table>
<thead>
<tr>
<th>Operation and Maintenance Tasks</th>
<th>Labor Hours (per system)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Routine maintenance (e.g., cleaning gutters and screens)</td>
<td>8</td>
<td>Semi-annually</td>
</tr>
<tr>
<td>3 Tank inspection and disinfection</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>4 Intermittent maintenance (e.g., debris removal from tank)</td>
<td>6</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>5 Pump replacement</td>
<td>6</td>
<td>Every 5 years</td>
</tr>
</tbody>
</table>
Rainwater Harvesting Troubleshooting Guide

Typical rainwater barrel configuration

Typical rainwater cistern configuration
<table>
<thead>
<tr>
<th>Rainwater Harvesting Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment Area</td>
<td>A1. Trash/debris</td>
<td>• Remove all trash and debris.</td>
</tr>
<tr>
<td></td>
<td>A2. Excessive vegetation</td>
<td>• Trim, prune, or otherwise remove excessive vegetation located over the catchment area if it is creating excessive debris.</td>
</tr>
</tbody>
</table>
| Collection and Conveyance System | B1. Leaves and other debris are present | • Leaves and other debris should be regularly removed on an as-needed basis, especially in the fall.  
• Gutters and downspouts should be kept clear.  
• Consider installing gutter guards.  

Note: Follow proper safety procedures when working on roofs and ladders. |
| | B2. Leaks or damaged components | • Seal leaks and replace damaged components. |
| Pretreatment System/Components | C1. First-flush diversion device not functioning | • First-flush diverters capture a small volume of initial runoff that has higher pollutant concentrations due to debris, bird droppings, etc., that have accumulated between storm events.  
• Clear debris from the first-flush diversion device regularly and check for damage or leaks. |
| | C2. Debris on screens and in sediment traps or other pretreatment devices | • Remove all debris from these devices. |
| | C3. Damaged screens, sediment traps, or other pretreatment devices | • Seal any leaks and repair/replace damaged components.  
• Replace screens if holes are present. |
| Storage Tank | D1. Debris or sediment buildup in tank | • Flush the tank or manually remove debris.  
• Scrub with a long-handled brush if needed.  
• Vinegar can be used as a cleaning agent.  
• Avoid entering the tank or follow proper confined space procedures.  
• A more thorough cleaning using a disinfectant may be required for systems used for toilet flushing. |

Note: For complex systems, an O&M manual should be provided by the designer or manufacturer of the system with detailed instructions tailored to the specific application. Use the system-specific manual as the primary guide and the guidance in this ETL as a secondary reference.
### Rainwater Harvesting Troubleshooting Guide

<table>
<thead>
<tr>
<th>Rainwater Harvesting Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| **D2. Algal growth in tank**  | • Algal growth usually only occurs when sunlight reaches the interior of the tank.  
• Tanks can be painted, moved to shaded areas, or shaded by other means. |

| **Storage Tank** (Continued)  | **D3. Cracks or other damage**  | • Inspect for sun damage and cracking for plastic tanks and replace if needed.  
• Inspect for other damage and make repairs.  
• Seal any leaks. |
| **D4. Mosquitos breeding in tank** | • Check all inlets to ensure they are properly sealed. Use caulking for small seams or window screen for larger gaps.  
• Check that screens are present at all vents and inlets and replace any screens that have holes.  
• For persistent problems, a tablespoon of vegetable oil may be used in rain barrel-sized tanks.  
• Products containing *Bacillus thuringiensis* can also be used to control mosquitos. |
| **D5. Clogged or damaged vents** | • Clear debris from vents and replace any damaged components.  
• Ensure screens are present. |
| **D6. Freezing** | • Drain tank and take offline during the winter months if freezing is a concern. |

| **Distribution System** | **E1. Leaks or damaged components** | • Repair leaks and replace damaged components. |
| **E2. Damaged or missing labels/signage** | • Replace any signage or pipe markings that are missing, faded, or illegible. |
| **E3. Inoperable pump(s)** | • Check control panel for warning indicators and tripped circuit breakers.  
• Perform troubleshooting and maintenance according to manufacturer’s recommendations. |
| **E4. Poor water quality** | • Check the point of use and determine if the water has any strange color or odors.  
• If water quality is a concern for the designated use, clean filters and pretreatment components.  
• Clean the entire system and disinfect if warranted. |
| **E5. Improper use** | • Check to make sure the spigot (if applicable) is kept closed so rain water from storms will be stored.  
Spigots may be left open in the winter if necessary to prevent water from building up and freezing.  
• Rain water should be used between storm events when possible to maximize runoff reduction. |
| **E6. Freezing** | • The distribution system should be drained in the winter months if it is susceptible to freezing.  
• Slope hoses to prevent water from building up and freezing. |
<table>
<thead>
<tr>
<th>Rainwater Harvesting Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overflow</td>
<td>F1. Inappropriate discharge location</td>
<td>• Flow from the overflow system should be directed away from the storage tank and building to prevent settling and damage to the building’s foundation.</td>
</tr>
<tr>
<td></td>
<td>F2. Erosion occurring at the outlet</td>
<td>• Repair eroded area, stabilize, and provide adequate erosion protection materials. • If there is evidence that flow through the overflow system is excessive, check inlets and overflow system for debris and correct any issues. Also, ensure that the stored water is actually being used between storm events. The goal should be to empty the tank before the next storm event.</td>
</tr>
<tr>
<td>Potable Water Makeup Line</td>
<td>G1. Inappropriate cross-connection/malfunctioning backflow preventer</td>
<td>• If there is a connection to the potable water system to fill the tank during dry periods, it should have a built-in air gap or backflow preventer to prevent water in the rain barrel from getting into the potable water supply.</td>
</tr>
</tbody>
</table>
A1. Trash/debris
A2. Excessive vegetation
B1. Leaves and other debris present (shown on page 7)
B2. Leaks and damaged components (shown on page 7)
C1. First-flush diversion device not functioning
C2. Debris on screens, sediment traps, or other pretreatment devices (shown on page 7)
C3. Damaged screens, sediment traps, or other pretreatment devices (shown on page 7)
D1. Debris or buildup present in tank
D2. Algal growth in tank
D3. Cracks or other damage (shown on page 7)
D4. Mosquitoes breeding in tank
D5. Clogged or damaged vents (not shown)
D6. Freezing (not shown)
E1. Leaks or damaged components
E2. Damaged or missing labels or signage (shown on page 7)
E3. Inoperable pump(s)
E4. Poor water quality (shown on page 7)
E5. Improper use (not shown)
E6. Freezing (not shown)
F1. Inappropriate discharge location (not shown)
F2. Erosion at outlet
G1. Inappropriate cross-connection/malfunctioning backflow preventer
A1. Trash/debris (shown on page 6)
A2. Excessive vegetation (shown on page 6)
B1. Leaves and other debris present
B2. Leaks and damaged components
C1. First-flush diversion device not functioning (shown on page 6)
C2. Debris on screens, sediment traps, or other pretreatment devices
C3. Damaged screens, sediment traps, or other pretreatment devices
D1. Debris or buildup present in tank (shown on page 6)
D2. Algal growth in tank (shown on page 6)
D3. Cracks or other damage
D4. Mosquitoes breeding in tank (shown on page 6)
D5. Clogged or damaged vents (not shown)
D6. Freezing (not shown)
E1. Leaks or damaged components (shown on page 6)
E2. Damaged or missing labels or signage
E3. Inoperable pump(s) (shown on page 6)
E4. Poor water quality
E5. Improper use (not shown)
E6. Freezing (not shown)
F1. Inappropriate discharge location (not shown)
F2. Erosion at outlet (shown on page 6)
G1. Inappropriate cross-connection/malfunctioning backflow preventer (shown on page 6)
Rainwater Harvesting Troubleshooting Guide


A2. Excessive vegetation over catchment area.

B1. Leaves and other debris present in collection and conveyance system.

B2. Leaks or damaged components present in collection and conveyance system.

C1. First-flush diversion device not functioning.

C2. Debris on screens and in sediment traps or other pretreatment devices.

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C3. Damaged screens, sediment traps, or other pretreatment devices.

D1. Debris or sediment buildup in storage tank.

D2. Algal growth in storage tank.

D3. Cracks or other damage to storage tank.

D4. Mosquitos breeding in storage tank.

E1. Leaks or damaged components in distribution system.
E2. Damaged or missing labels/signage
E3. Inoperable distribution system pump(s).
E4. Poor water quality.

F2. Erosion occurring at the overflow outlet.
G1. Cross-connection with inadequate backflow protection at potable water makeup line.
Rainwater Harvesting Troubleshooting Guide

A simple rain barrel system.

A rain barrel system with a diversion/overflow device.

Example of a diversion/overflow device.

Rain barrel inlet screen.

A simple cistern system.

Example of a common cistern.

Common Rainwater Harvesting Systems

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Rainwater Harvesting Troubleshooting Guide

A cistern and collection and conveyance system.

Pretreatment and overflow systems.

Cistern inlet screen with debris buildup.

Cistern irrigation system control panel.

Common Rainwater Harvesting Systems

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Rainwater Harvesting Operation & Maintenance Annual Inspection Checklist

| SCM: | Inspector(s): |
| SCM ID#: | |
| SCM Locations: | |
| Installation Name: | |
| Date Installed: | Inspection Date: |

Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Rainwater Harvesting Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.</td>
<td>Trash/debris present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2.</td>
<td>Excessive vegetation growth over catchment area?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection and Conveyance System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1.</td>
<td>Leaves and other debris present?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2.</td>
<td>Leaks or damaged components?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretreatment System/Components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1.</td>
<td>First-flush diversion device malfunctioning or damaged?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2.</td>
<td>Screens/pretreatment devices clogged/full of sediment or debris?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3.</td>
<td>Damaged screens, traps, or other pretreatment devices?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Tank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1.</td>
<td>Sediment/debris buildup in storage tank?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2.</td>
<td>Algal growth in tank?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3.</td>
<td>Cracks or other structural damage?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4.</td>
<td>Mosquitos breeding in tank?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5.</td>
<td>Clogged or damaged vent(s)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6.</td>
<td>Winter freeze problems?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken:</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No Action (N) — No action is needed at time of inspection related to respective problem.</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>Maintenance Needed (MN) — Maintenance is needed to support functionality of the device and to prevent problem from escalating.</td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>Immediate Corrective Action (ICA) — Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
<td></td>
</tr>
</tbody>
</table>
### Rainwater Harvesting Operation & Maintenance Inspection Checklist - Continued

**SCM:** 

**Inspector(s):** 

**SCM ID#:** 

**SCM Locations:** 

**Installation Name:** 

**Date Installed:**  

**Inspection Date:** 

Complete the form below by indicating the condition of each component. For items marks MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Rainwater Harvesting Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution System</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1.</td>
<td></td>
<td></td>
<td>Leaks or damaged components?</td>
</tr>
<tr>
<td>E2.</td>
<td></td>
<td></td>
<td>Damaged or missing labels and signage?</td>
</tr>
<tr>
<td>E3.</td>
<td></td>
<td></td>
<td>Inoperable pump(s)?</td>
</tr>
<tr>
<td>E4.</td>
<td></td>
<td></td>
<td>Poor water quality?</td>
</tr>
<tr>
<td>E5.</td>
<td></td>
<td></td>
<td>Improper use (e.g., spigots left open or water not used between storm events)?</td>
</tr>
<tr>
<td>E6.</td>
<td></td>
<td></td>
<td>Winter freeze problems?</td>
</tr>
<tr>
<td><strong>Overflow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1.</td>
<td></td>
<td></td>
<td>Inappropriate discharge location (e.g., too close to building foundation)?</td>
</tr>
<tr>
<td>F2.</td>
<td></td>
<td></td>
<td>Erosion occurring at outlet?</td>
</tr>
<tr>
<td><strong>Potable Water Makeup Line</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G1.</td>
<td></td>
<td></td>
<td>Inappropriate cross-connection or malfunctioning backflow preventer?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken:</th>
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<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
<td></td>
</tr>
</tbody>
</table>

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**Atch 10**

*(14 of 14)*
Permeable pavement is an alternative to conventional concrete and asphalt paving materials that allows for infiltration of storm water into void spaces that provide temporary storage. (NCDENR, 2012)

Research studies have shown that permeable pavements significantly reduce runoff volumes, limit peak flows, and sequester (trap) many types of pollutants. Many permeable pavements improve ground water recharge, reduce runoff temperature, and improve aesthetics. Permeable pavements do this by allowing water to pass through the surface layer and temporarily collect in underlying aggregate storage layers. This water then: 1) is released back to the storm drain system through underdrains; and/or 2) infiltrates into the underlying soil. (NCSU-BAE, 2011)

Three types of permeable pavement are discussed in this attachment, including pervious concrete, porous asphalt, and permeable interlocking concrete pavement (also referred to as pavers).

### Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours (per 20,000 ft² [1850 m²] of permeable pavement)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspections</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Trash/debris removal</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>3 Sweeping</td>
<td>1</td>
<td>Annually</td>
</tr>
</tbody>
</table>

### Key Considerations

#### Important Design Criteria
- Use construction techniques that minimize the compaction of subsurface soils
- Systems should have a designed overflow system
- System should not be used at gas stations or where other hazardous materials are loaded, unloaded, or stored

#### Common Maintenance Requirements/Problems
- The most prevalent maintenance concern is the potential clogging of the pervious pavement pores. (EPA, 2013)

### Advantages

- Replaces impervious areas with materials that infiltrate or detain storm water.
- Eliminates standing water on pavement.
- Reduces the pollutant loading, runoff rate, and volume associated with storm water runoff.
- Reduces land consumption by using treatment area for parking/driving.
- A useful BMP for heavily developed sites with limited space.

### Disadvantages

- Without proper maintenance it can become clogged by sediment, compromising its effectiveness.
- Not applicable for all site conditions.
- Pavement installation costs are higher than conventional pavements. However, overall costs may be comparable or lower when considering the cost savings from reduced need for storm water piping and land for BMPs.

(NCDENR, 2012)
Pervious concrete (PC), also known as porous, gap-graded, or enhanced porosity concrete, is concrete with reduced sand or fines and allows water to drain through it. (Photo courtesy of NCSU-BAE)

Porous asphalt (PA), also known as pervious, permeable, "popcorn," or open-graded asphalt, is standard hot-mix asphalt with reduced sand or fines, which allows water to drain through it. (Photo courtesy of NCSU-BAE)

Permeable interlocking concrete pavement (PICP) consists of manufactured concrete units that reduce storm water runoff volume, rate, and pollutants. The impervious units are designed with small openings between permeable joints. (Photo courtesy of NCSU-BAE)
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(3 of 8)
# Permeable Pavement Troubleshooting Guide

<table>
<thead>
<tr>
<th>Permeable Pavement Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter of Permeable Pavement</td>
<td>A1. Areas of bare soil and/or erosive gullies have formed</td>
<td>• Regrade the soil if necessary to remove the gully. Plant a ground cover and water until it is established.</td>
</tr>
<tr>
<td></td>
<td>A2. A vegetated area drains toward the pavement</td>
<td>• Regrade the area so that it drains away from the pavement then plant ground cover and water until established.</td>
</tr>
<tr>
<td>Surface of Permeable Pavement</td>
<td>B1. Trash or debris is present</td>
<td>• Remove all trash and debris</td>
</tr>
<tr>
<td></td>
<td>B2. Sediment is present</td>
<td>• Vacuum or mechanically sweep the pavement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Note:</strong> Vacuum sweepers are powerful and, if not carefully operated, can suction too much aggregate from the gaps and beneath the pavers. Care must be taken to verify that the amount of suction provided by the vacuum sweeper is not removing portions of the gravel base layer. (NSCU-BAE, 2011)</td>
</tr>
</tbody>
</table>
|                              | B3. Cracking, rutting, or damaged surface                               | • Cracked areas shall be repaired using the same materials as the original permeable pavement or, in the case of PC and PA, small areas can be replaced with standard (impermeable) materials. The impervious repaired area shall not exceed 5% of the total surface area. (NCDENR, 2012)  
• If large areas are damaged or rutted, contact a design professional. |
|                              | B4. Weeds                                                               | • Do not pull the weeds (may pull out media as well). Spray them with a systemic herbicide such as Glyphosate and then return within the week to remove them by hand. (NCDENR, 2012) |
|                              | B5. Surface appears to be clogged                                       | • Perform a simple infiltration test by pouring a gallon of water onto the surface and noting whether water infiltrates immediately, very slowly, or not at all.  
• If pavement is clogged and is constructed of PA or PC, 0.5-inch (12 mm) holes can be drilled through the pavement surface every few feet to allow storm water to drain to the aggregate base. (EPA, 2013)  
• If pavers are clogged, vacuum sweep. If this does not restore permeability, the aggregate between pavers likely needs to be replaced. (EPA, 2013) |
|                              | B6. Gaps between pavers                                                 | • Replace aggregate with material used at time of construction. Use a push broom to spread gravel into gaps. |

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(4 of 8)
<table>
<thead>
<tr>
<th>Permeable Pavement Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Observation Well             | C1. Observation well needs to be inspected  
Note: Periodically inspect well based on criteria provided. | - Follow these steps to inspect the observation wells:  
  - Wait five days after a rainfall exceeding 1 to 1.5 inches (25 to 38 mm). If no additional rain occurs during the five days, open each observation well.  
  - Visually assess whether water is present. If visual assessment is not possible, use a yard stick or other water-level measurement method.  
  - If water is present more than five days after a rain event, the subgrade soil is clogged and/or underdrains are not functioning. Clean out clogged underdrain pipes by flushing with water. If subgrade soil appears to be clogged, consult a design professional. (NCDENR, 2013) |
| Educational Sign             | D1. Sign is missing or damaged  
Note: No photo shown for this problem. | - Replace or repair sign.  
- For common language that should be on an educational sign, see figure on page 3. |
A1. Areas of bare soil and/or erosive gullies have formed.

A2. A vegetated area (plus construction) drains toward the pavement. (Photo courtesy of NCSU-BAE)

B1. Trash or debris is present on surface. (Photo courtesy of NCSU-BAE)

B2. Sediment is present on surface. (Photo courtesy of NCSU-BAE)

B3. Cracking, rutting, or damaged surface.

B4. Weeds are present on surface.

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B5. Surface appears to be clogged as water runs off during infiltration test. (Photo courtesy of NCSU-BAE)

B6. Gaps between pavers. (Photo courtesy of NCSU-BAE)

C1. Observation well needs to be inspected.
Complete the form below by indicating the condition of each component. For items marked MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Permeable Pavement Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter of Permeable Pavement</td>
<td>A1.</td>
<td></td>
<td>Areas of bare soil and/or erosive gullies have formed?</td>
</tr>
<tr>
<td></td>
<td>A2.</td>
<td></td>
<td>A vegetated area drains toward the pavement?</td>
</tr>
<tr>
<td></td>
<td>B1.</td>
<td></td>
<td>Trash or debris is present?</td>
</tr>
<tr>
<td></td>
<td>B2.</td>
<td></td>
<td>Sediment is present?</td>
</tr>
<tr>
<td></td>
<td>B3.</td>
<td></td>
<td>Cracking, rutting, or damaged surface?</td>
</tr>
<tr>
<td></td>
<td>B4.</td>
<td></td>
<td>Weeds present?</td>
</tr>
<tr>
<td></td>
<td>B5.</td>
<td></td>
<td>Surface appears to be clogged?</td>
</tr>
<tr>
<td></td>
<td>B6.</td>
<td></td>
<td>Gaps between pavers?</td>
</tr>
<tr>
<td>Observation Well</td>
<td>C1.</td>
<td></td>
<td>Observation well needs to be inspected. Note: Periodically inspect well based on criteria provided.</td>
</tr>
<tr>
<td>Educational Sign</td>
<td>D1.</td>
<td></td>
<td>Sign is missing or damaged?</td>
</tr>
</tbody>
</table>

**Device Ranking**

<table>
<thead>
<tr>
<th>Device Ranking</th>
<th>Ranking Description</th>
<th>Comments/Recommendations/Other Actions Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No Action (N) — No action is needed at time of inspection related to respective problem.</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>Maintenance Needed (MN) - Maintenance is needed to support functionality of the device and to prevent problem from escalating.</td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>Immediate Corrective Action (ICA) - Functionality of the device is compromised due to the respective problem and action should be taken immediately.</td>
<td></td>
</tr>
</tbody>
</table>
Reforestation Troubleshooting Guide

### Operation and Maintenance Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours (per system)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>2 Vegetation management and debris removal</td>
<td>4</td>
<td>Annually</td>
</tr>
<tr>
<td>3 Corrective maintenance</td>
<td>4</td>
<td>Every 2 years</td>
</tr>
</tbody>
</table>

### Key Considerations

**Important Design Criteria**
- A variety of species are selected that are best suited for the region and take into account storm water management considerations.
- Soils should be properly prepared and amended prior to planting.
- Invasive species removal prior to reforestation will greatly increase survivability of planted species by reducing competition.
- Saplings are planted at a spacing that assumes an appropriate mortality rate.
- It is preferred that upgradient areas provide sheet flow to avoid eroding the forested area.
- Slopes of less than 5% are preferred to avoid concentration of runoff.

**Areas of disturbance in regions where canopy forests grow naturally can be enhanced for storm water treatment through reforestation. In forested areas, root networks help to stabilize soil and increase infiltration. Evapotranspiration is also increased in reforested areas which in turn reduces runoff. Reforested areas provide valuable habitat for wildlife and moderate runoff temperature.**

Varying species of shrubs and trees are planted at prescribed spacing to encourage the growth of a forested ecosystem. The most important period of maintenance is before the forest matures (i.e., canopy closure) (PA DEP, 2006). Some maintenance is likely necessary in the first three to five years after planting to control competing species and other pests and to correct other issues.

**Common Maintenance Requirements/Problems**
- Weeds and invasives competing against desirable species.
- Insect infestations and other pests.
- Erosion in the reforested area.
- Pruning and selective removal of trees.

**Advantages**
- Requires very little maintenance after the system matures (three to five years after initial planting).
- Restores the area to natural hydrology.
- Provides wildlife habitat and shade.
- Aesthetically more appealing than some storm water controls.

**Disadvantages**
- Requires a clear area that is not needed for development.

---

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(1 of 4)
<table>
<thead>
<tr>
<th>Reforestation Component</th>
<th>Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| Upgradient Area        | A1. Bare soil or areas that are eroding | • Repair eroded areas by filling in and regrading; add erosion protection materials if needed.  
• Seed, mulch, sod, and/or add topsoil or compost. |
| B1. Concentrated flow and erosion | • Concentrated flow should be minimized so infiltration and other storm water benefits are maximized.  
• Where concentrated flow is unavoidable, the channel should be stabilized with the appropriate vegetation and/or erosion protection materials.  
• Repair eroded areas. |
| B2. Vehicle, pedestrian, or other disturbance | • Minimize disturbances where possible.  
• If disturbances are unavoidable, establish a path or driveway so traffic is contained to the designated path/driveway. Provide measures to prevent erosion of the path/driveway.  
• If necessary, post signage to minimize traffic, undesired landscaping activities, and other disturbances. |
| B3. Excessive growth of weeds or invasive species | • There are many weed-control strategies, each with associated advantages and disadvantages. Mulch, weed control fabric, mowing, and herbicide are some of the options.  
• The use of herbicides is often discouraged due to concerns that they may negatively impact receiving waters. Only herbicides designated as suitable for riparian and wetland areas should be used.  
• Invasive species should be removed early and often as they are much more difficult to control after they become well established. If left unattended, invasives can smother and kill young trees. |
| B4. Dead or unhealthy vegetation | • Some die-off is expected and taken into account during design. Replace trees and shrubs only as needed.  
• Check tree density and diversity. There should be a good variety of shrub, understory, and canopy species.  
• Selective tree removal and pruning may be necessary to maintain a healthy system.  
• Trees that present a safety hazard to people, equipment, structures, etc., should be removed.  
• The growth of certain species over others may be desired, depending on location and pollutant concerns. For example, many hardwoods intake excess nutrients (Palone, R.S. and Todd, A.H. ed., 1997).  
• Check for evidence of insect, disease, or pest infestation. Consult a forestry specialist if action is needed.  
• Irrigation may be needed if drought conditions are experienced in the early stages of reforestation. Planting in the fall decreases the need for watering and increases survivability. |

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(2 of 4)
Reforestation Troubleshooting Guide

A1. Bare soil and areas of erosion can contribute excessive sediment to reforested areas. Steep slopes can lead to erosion within the reforested areas.

B1. Erosion and sedimentation in a mature forest.

B2. Example signage used to minimize disturbances in reforested areas.

B3. Vegetative debris generated during selective tree removal is being used to control growth of weeds and invasive species.

B4. Selective removal of saplings to meet ideal tree density and encourage healthy growth.

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Reforestation Operation & Maintenance Inspection Checklist

SCM: ___________________________________________________________________________
SCM ID#: _________________________________________________________________________
SCM Locations: ___________________________________________________________________
Installation Name: __________________________________________________________________
Date Installed: _____________________________________________________________________
Inspection Date: ____________________________________________________________________

Complete the form below by indicating the condition of each component. For items marks MN or ICA, indicate when follow-up maintenance was completed.

<table>
<thead>
<tr>
<th>Reforestation Component</th>
<th>Condition (N, MN, or ICA)</th>
<th>Date Maintenance Performed</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgradient Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.</td>
<td></td>
<td></td>
<td>Bare or eroded areas present?</td>
</tr>
<tr>
<td>B1.</td>
<td></td>
<td></td>
<td>Evidence of concentrated flow or erosion?</td>
</tr>
<tr>
<td>B2.</td>
<td></td>
<td></td>
<td>Evidence of vehicle, pedestrian, or other disturbance?</td>
</tr>
<tr>
<td>B3.</td>
<td></td>
<td></td>
<td>Excessive growth of weeds or invasive species?</td>
</tr>
<tr>
<td>B4.</td>
<td></td>
<td></td>
<td>Dead or unhealthy vegetation?</td>
</tr>
<tr>
<td>Reforested Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4.</td>
<td></td>
<td></td>
<td></td>
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Device Ranking | Ranking Description                                                                 | Comments/Recommendations/Other Actions Taken: |
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STORM WATER CONSTRUCTION PERMIT DECLARATION LANGUAGE

All Air Force construction projects must affirm by declaration that the project does or does not require an NPDES construction storm water permit and must provide a thorough explanation of the circumstances. This determination needs to be made early in the project development—preferably during the project definition phase—and should also be covered during the Environmental Impact Analysis Process (EIAP). The following is suggested language to include on applicable contract or project documents and can be written to show intent during early project development but must indicate completion before project groundbreaking. The declaration should include the following or equivalent content:

1. The Air Force has determined that this project involves the disturbance, breakage and/or movement of earth on land at a construction site encompassing a total aggregate site area of ________ acre(s).

2. 
   a. This construction site area is less than one acre and does not require an NPDES storm water construction permit. The activities taking place at this site (will be/have been) evaluated for their potential to generate or contaminate storm water. Best management practices and pollution prevention practices appropriate for this size and type project will be implemented during project construction.

   Or

   b. This construction site area involves the repair and maintenance of a facility that does not change the original line and grade, hydraulic capacity, or purpose of the facility site and therefore does not require an NPDES storm water construction permit.

   Or

   c. This construction site area is greater than one acre or is less than one acre but is judged to be part of a larger common plan of development exceeding one acre and requires coverage under an NPDES storm water construction permit.

      (1) This project comes under the jurisdiction of construction general permit #___________________. A Notice of Intent (NOI) to comply with the provisions of this general construction permit will be/was issued ____(date)__, ____(days)__ before groundbreaking of this project commences.

3. Activity at this construction site (will be/was) completed (by) on ____(date)__ , and a Notice of Termination (will be/was) issued ____(date)__ .
SWPP CONTENT OUTLINE

SWPPP SECTION 1: RESPONSIBLE PARTIES

1.1 Operator(s)/Subcontractor(s)
   - Identify the operator(s) who will be engaged in construction activities at the site. Indicate respective responsibilities, where appropriate. Also include the 24-hour emergency contact.
   - List subcontractors expected to work on-site. Notify subcontractors of storm water requirements applicable to their work.
   - Consider using Subcontractor Agreements that document storm water compliance.

1.2 Storm Water Team
   - Identify the staff members (by name or position) that comprise the project's storm water team as well as their individual responsibilities. At a minimum, the storm water team is comprised of individuals who are responsible for overseeing the development of the SWPPP, any later modifications to it, and for compliance with the requirements in this permit (i.e., installing and maintaining storm water controls, conducting site inspections, and taking corrective actions where required).
   - Each member of the storm water team must have ready access to either an electronic or paper copy of the permit and SWPPP.

SWPPP SECTION 2: SITE EVALUATION, ASSESSMENT, AND PLANNING

2.1 Project/Site Information
   - Compile basic site information that will be helpful when the NOI is filed.
     o Project name and address
     o Latitude and longitude
     o Site identification (see http://cfpub.epa.gov/surf/locate/index.cfm)
       - Watershed name
       - 8-digit hydrologic unit code (HUC)
       - Permit references (e.g., ID number, type, and NOI after these items become available)
     o Site information (Note: Most of this information can be referenced from customary design documents, but should be summarized in the storm water control site plan.)
       - Soil type
       - Native vegetation type
       - Discharge locations (existing and planned)
       - Drainage patterns
       - Slope and terrain (before and after grading)
       - Total construction site area (acres)
       - Total site area disturbed (acres)
       - Total construction cost ($000)
     o Non-impervious/impervious site areas (before and after)
       - Paved and unpaved road area
       - Paved and unpaved parking area
- Aquatic area (on-site or nearby)
  - BMPs selected
    - Descriptive name
    - Drainage area served
    - Estimated control efficiency
    - Estimated cost of implementing selected practice
  - Construction cost
    - Total cost of construction
    - Estimated cost to implement storm water control site plan
  - Run-off information (optional)
    - Average run-off coefficient (before and after)
    - Design storm (frequency, intensity)

2.2 Discharge Information
- Include information relating to project site’s discharge. This information corresponds to the “Discharge Information” section of the NOI form.
- List the name of the first surface water that receives discharges from the site. If the site has discharges to multiple surface waters, indicate the names of all such waters.
- If any of the surface waters receiving discharge are listed as impaired by the applicable state or tribe, provide specified information about pollutants causing the impairment and whether or not a total maximum daily load (TMDL) has been completed for the surface water.
- Indicate whether any of the surface waters receiving discharge from the site are high-quality waters.

2.3 Nature of Construction Activities
- Provide a general description of the nature of the construction activities for the project.
- Describe the size of the property (in acres) and the total area expected to be disturbed by the construction activities (in acres), construction support activities (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas), and the maximum area expected to be disturbed at any one time.

2.4 Sequence and Estimated Dates of Construction Activities
- Describe the intended construction sequence and timing of major activities.
- For each phase of construction, include the following information:
  - Installation of storm water controls, and when they will be made operational;
  - Commencement and duration of earth-disturbing activities, including clearing and grubbing, mass grading, site preparation (i.e., excavating, cutting and filling), final grading, and creation of soil and vegetation stockpiles requiring stabilization;
  - Cessation, temporarily or permanently, of construction activities on the site or in designated portions of the site;
Final or temporary stabilization of areas of exposed soil. The dates for stabilization must reflect the applicable deadlines to which you are subject; and

- Removal of temporary storm water conveyances/channels and other storm water control measures, removal of construction equipment and vehicles, and cessation of any pollutant-generating activities.

- The construction sequence must reflect the following requirements:
  - Area of disturbance;
  - Installation of storm water controls; and
  - Stabilization deadlines

### 2.5 Allowable Non-Storm Water Discharges

#### • Identify all allowable sources of non-storm water discharges. The allowable non-storm water discharges include:

- Discharges from emergency fire-fighting activities;
- Fire hydrant flushings;
- Landscape irrigation;
- Waters used to wash vehicles and equipment, provided that there is no discharge of soaps, solvents, or detergents used for such purposes;
- Water used to control dust;
- Potable water, including uncontaminated water line flushings;
- Routine external building washdown that does not use detergents;
- Pavement wash waters provided spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and detergents are not used (It is prohibited to direct pavement was waters directly into any surface water, storm drain inlet, or storm water conveyance unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control.);
- Uncontaminated air conditioning or compressor condensate;
- Uncontaminated, non-turbid discharges of ground water or spring water;
- Foundation or footing drains where flows are not contaminated with process materials such as solvents or contaminated ground water; and
- Construction dewatering water that has been treated by an appropriate control.

### 2.6 Site Maps

- Attach site maps. For most projects, a series of site maps is necessary and recommended. The first map should show the undeveloped site and its current features. An additional map or maps should be created to show the developed site or, for more complicated sites, show the major phases of development.
- These maps should include the following features:
  - Boundaries of the property and of the locations where construction will occur, including:
    - Locations where earth-disturbing activities will occur, noting any phasing of construction activities;

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- Approximate slopes before and after major grading activities. Note areas of steep slopes;
- Locations where sediment, soil, or other construction materials will be stockpiled;
- Locations of any crossings of surface waters;
- Designated points on the site where vehicles will exit onto paved roads;
- Locations of structures and other impervious surfaces upon completion of construction; and
- Locations of construction support activity areas covered by the permit.
  - Locations of all surface waters, including wetlands, that exist on or near the site. Indicate which water bodies are listed as impaired and which are identified by your state, tribe, or EPA as outstanding water quality.
  - The boundary lines of any natural buffer areas.
  - Areas of federally listed critical habitat for endangered or threatened species.
  - Topography of the site, existing vegetative cover (e.g., forest, pasture, pavement, structures), and drainage pattern(s) of storm water and allowable non-storm water flow onto, over, and from the site property before and after major grading activities.
  - Storm water and allowable non-storm water discharge locations, including:
    - Locations of any storm drain inlets on the site and in the immediate vicinity of the site; and
    - Locations where storm water or allowable non-storm water will be discharged to surface waters (including wetlands).
  - Locations of all potential pollutant-generating activities.
  - Locations of storm water control measures.
  - Locations where polymers, flocculants, or other treatment chemicals will be used and stored.

**SWPPP SECTION 3: DOCUMENTATION OF COMPLIANCE WITH OTHER FEDERAL REQUIREMENTS**

3.1 Endangered Species Protection
- Determine if the construction activity will have any impacts with respect to the protection of endangered species.

3.2 Historic Preservation
- Determine whether the installation of subsurface earth-disturbing storm water controls will have an effect on historic properties.

3.3 Safe Drinking Water Act Underground Injection Control Requirements
- If using any of the identified controls in this section, include documentation of contact between the permittee and the applicable state agency or EPA regional office responsible for implementing the requirements for underground
injection wells in the Safe Drinking Water Act and EPA’s implementing regulations at 40 CFR Parts 144–147.

- Infiltration trenches (if storm water is directed to any bored, drilled, driven shaft, or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system).
- Commercially manufactured pre-cast or pre-built proprietary subsurface detention vaults, chambers, or other devices designed to capture and infiltrate storm water flow.
- Drywells, seepage pits, or improved sinkholes (if storm water is directed to any bored, drilled, driven shaft, or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system).

3.4 Section 438 of the Energy Independence and Security Act (EISA 438)

- EISA 438 requires GI/LID site planning, design, construction, and maintenance strategies to maintain predevelopment hydrology for federal development projects with footprints exceeding 5,000 square feet (464 square meters).

SWPPP SECTION 4: EROSION AND SEDIMENT CONTROLS

4.1 Natural Buffers or Equivalent Sediment Controls

- This section only applies if surface water is located within 50 feet (15.2 meters) of the construction activities.
- Describe the compliance alternative that was chosen to meet the buffer requirements and include any required documentation supporting the selected alternative. The compliance alternative selected must be maintained throughout the duration of permit coverage. However, if you select a different compliance alternative during the period of permit coverage, modify the SWPPP to reflect this change.
- If eligible for one of the exceptions, include documentation related to the site’s qualification for such exceptions.

Buffer Compliance Alternatives

- Provide and maintain a 50-foot (15.2 meters) undisturbed natural buffer; or
- Provide and maintain an undisturbed natural buffer that is less than 50 feet (15.2 meters) and is supplemented by additional erosion and sediment controls, which in combination achieves the sediment load reduction equivalent to a 50-foot (15.2 meters) undisturbed natural buffer.
- If infeasible to provide and maintain an undisturbed natural buffer of any size, implement erosion and sediment controls that achieve the sediment load reduction equivalent to a 50-foot (15.2 meters) undisturbed natural buffer.
- Qualify for one of the exceptions.
Buffer Exceptions

- There is no discharge of storm water to the surface water that is located 50 feet (15.2 meters) from my construction disturbances.
- No natural buffer exists due to preexisting development disturbances that occurred prior to the initiation of planning for this project.
- For a “linear project’s” site constraints (e.g., limited right-of-way), make it infeasible to meet compliance alternatives.
- The project qualifies as “small residential lot” construction.
- Buffer disturbances are authorized under a CWA Section 404 permit.
- Buffer disturbances will occur for the construction of a water-dependent structure or water access area (e.g., pier, boat ramp, and trail).

4.2 Green Infrastructure/ Low Impact Development

- Describe techniques or controls that minimize velocities and impound construction site runoff and promote infiltration; include controls that use organic materials from offsite or from the project site to minimize erodible surfaces and promote infiltration.

4.3 Perimeter Controls

- Describe sediment controls that will be used (e.g., silt fences, filter berms, temporary diversion dikes, or fiber rolls) to meet the requirement to “install sediment controls along those perimeter areas of the site that will receive storm water from earth-disturbing activities.”
- For linear projects where it is determined that the use of perimeter controls in portions of the site is impracticable, document why this is to be the case.

4.4 Sediment Track-Out

- Describe storm water controls that will be used to “minimize the track-out of sediment onto off-site streets, other paved areas, and sidewalks from vehicles exiting the construction site.”
- Describe location(s) of vehicle exit(s), procedures to remove accumulated sediment off-site (e.g., vehicle tracking), and stabilization practices (e.g., stone pads or wash racks or both) to minimize off-site vehicle tracking of sediment. Also include the design, installation, and maintenance specifications for each control.

4.5 Stockpiled Sediment or Soil

- Describe storm water controls and other measures taken to minimize the discharge of sediment or soil particles from stockpiled sediment or soil. Include a description of structural practices (e.g., diversions, berms, ditches, storage basins), including design, installation, and maintenance specifications, used to divert flows from stockpiled sediment or soil, retain or detain flows, or otherwise limit exposure and the discharge of pollutants from stockpiled sediment or soil.
- Describe any controls or procedures used to minimize exposure resulting from adding to or removing materials from the pile.
4.6 Minimize Dust
- Describe controls and procedures used at the project/site to minimize the generation of dust.

4.7 Minimize the Disturbance of Steep Slopes
- Describe how to minimize the disturbance to steep slopes.
- Describe controls (e.g., erosion control blankets, tackifiers), including design, installation and maintenance specifications, that will be implemented to minimize sediment discharges from slope disturbances.

4.8 Topsoil
- Describe how topsoil will be preserved and identify these areas and associated control measures on site map(s).
- If it is infeasible to preserve topsoil on the site, provide an explanation.

4.9 Soil Compaction
- In areas where final vegetative stabilization will occur or where infiltration practices will be installed, describe the controls, including design, installation, and maintenance specifications that will be used to restrict vehicle or equipment access or condition the soil for seeding or planting.

4.10 Storm Drain Inlets
- Describe controls (e.g., inserts, rock-filled bags, or block and gravel), including design, installation, and maintenance specifications, that will be implemented to protect all inlets that will receive storm water from the construction activities.

4.11 Constructed Storm Water Conveyance Channels
- If installing a storm water conveyance channel, describe control practices (e.g., velocity dissipation devices), including design specifications and details (volume, dimensions, outlet structure) that will be implemented at the construction site.

4.12 Sediment Basins
- If a sediment basin will be installed, include design specifications and other details (volume, dimensions, outlet structure) that will be implemented.
- At a minimum, sediment ponds must provide storage for either (1) the calculated volume of runoff from the two-year, 24-hour storm; or (2) 3,600 cubic feet (101.9 cubic meters) per acre drained.
- Sediment ponds must also utilize outlet structures that withdraw water from the surface, unless infeasible.

4.13 Chemical Treatment
- If using treatment chemicals at the site, provide details for each of the items below:
Soil types
Treatment chemicals
Special controls for cationic treatment chemicals

4.14 Dewatering Practices
• If discharging storm water removed from excavations, trenches, foundations, vaults, or other similar points of accumulation, include design specifications and details of all dewatering practices that are installed and maintained.

4.15 Other Storm Water Controls
• Describe any other storm water controls that do not fit into the above categories.

4.16 Site Stabilization
• Immediately initiate stabilization when work in an area of the site has permanently or temporarily stopped, and to complete certain stabilization activities within prescribed deadlines. Stabilization measures meet certain minimum criteria for the site’s geographic location. Include the following:
  o Describe the specific vegetative and/or non-vegetative practices that will be used to stabilize exposed soils where construction activities have temporarily or permanently ceased. Avoid using impervious surfaces for stabilization whenever possible.
  o Once you begin construction, use a grading/stabilization activities log to document compliance with stabilization requirements.

SWPPP SECTION 5: PERMANENT CONSTRUCTION BMPs

5.1 Strategic Use of Permanent Construction BMPs
• Incorporate at planning process
• Utilize LID/GI practices that promote infiltration, evapotranspiration, and water reuse
• Incorporate in conjunction with E&SC measures and transition to permanent storm water measures during the site-stabilization phase
• Make sure to reference section on post-construction controls

SWPPP SECTION 6: POLLUTION PREVENTION STANDARDS

6.1 Potential Sources of Pollution
• Identify and describe all pollutant-generating activities at the site (e.g., paving operations; concrete, paint, and stucco washout and waste disposal; solid waste storage and disposal).
• For each pollutant-generating activity, include an inventory of pollutants or pollutant constituents associated with that activity (e.g., sediment, fertilizers, and/or pesticides, paints, solvents, fuels) that could be exposed to rainfall or snowmelt and could be discharged from the construction site. Take into
account where potential spills and leaks could occur that contribute pollutants to storm water discharges.

6.2 Spill Prevention and Response
- Describe procedures to prevent and respond to leaks, spills, and other releases. Implement the following, at a minimum:
  - Procedures for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases. Identify the name or title of the employee(s) responsible for detection and response of spills or leaks; and
  - Procedures for notification of appropriate facility personnel, emergency response agencies, and regulatory agencies where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity consistent with Part 2.3.3.4c of the Construction General Permit and established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302 occurs during a 24-hour period. Contact information must be in locations that are readily accessible and available.
- Some projects/site may be required to develop a spill prevention control and countermeasure (SPCC) plan under a separate regulatory program (40 CFR 112). If you are required to develop an SPCC plan, or you already have one, you should include references to the relevant requirements from your plan.

6.3 Fueling and Maintenance of Equipment or Vehicles
- Describe equipment/vehicle fueling and maintenance practices that will be implemented to eliminate the discharge of spilled or leaked chemicals, e.g., providing secondary containment examples: spill berms, decks, spill containment pallets and cover where appropriate, and/or having spill kits readily available.

6.4 Washing Equipment and Vehicles
- Describe equipment/vehicle washing practices that will be used to minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other types of washing (e.g., locating activities away from surface waters and storm water inlets or conveyances and directing wash waters to a sediment basin or sediment trap, using filtration devices such as filter bags or sand filters or using other similarly effective controls).
- Describe how to prevent the discharge of soaps, detergents, or solvents by providing either (1) cover (examples: plastic sheeting or temporary roofs) to prevent these detergents from coming into contact with rainwater, or (2) a similarly effective means designed to prevent the discharge of pollutants from these areas.
6.5 Storage, Handling, and Disposal of Construction Products, Materials, and Wastes
  • For any of the types of construction products, materials, and wastes below that are expected to be used or stored on-site, provide information on compliance and the specific practices that will be employed.
    o Building products
    o Pesticides, herbicides, insecticides, fertilizers, and landscape materials
    o Diesel fuel, oil, hydraulic fluids, other petroleum products, and other chemicals
    o Hazardous or toxic waste
    o Construction and domestic waste
    o Sanitary waste

6.6 Washing Applicators and Containers used for Paint, Concrete, or Other Materials
  • Describe compliance with the requirement to “provide an effective means of eliminating the discharge of water from the washout and cleanout of stucco, paint, concrete, form release oils, curing compounds, and other construction materials.”

6.7 Fertilizers
  • Describe compliance with the requirement to “minimize discharges of fertilizers containing nitrogen or phosphorus.”

6.8 Other Pollution Prevention Practices
  • Describe any additional pollution prevention practices that do not fit into the above categories.

SWPPP SECTION 7: INSPECTION AND CORRECTIVE ACTION

Inspections are typically required: (1) once every seven calendar days; or (2) once every 14 calendar days and within 24 hours of a storm event 0.25 inch (6.4 millimeters) or greater. Required SWPPP content is summarized below. Detailed information regarding inspection and corrective actions requirements as well as a troubleshooting guide and checklist are provided in Attachment 1.

7.1 Inspection Personnel and Procedures
  • Define personnel responsible for inspection
  • Define inspection frequency
  • Attach inspection report form

7.2 Corrective Action
  • Outline the procedures for taking corrective action

7.3 Delegation of Authority
  • Identify the individual(s) or positions within the installation that have been delegated authority to sign inspection reports
• Attach a copy of the signed delegation of authority

**SWPPP SECTION 8: TRAINING**

8.1 Minimum Training
- Personnel responsible for the design, installation, maintenance, and/or repair of storm water controls (including pollution prevention measures);
- Personnel responsible for the application and storage of treatment chemicals (if applicable);
- Personnel responsible for conducting inspections;
- Personnel responsible for taking corrective actions.

8.2 Required Training Based on Scope of Job Duties
- The location of all storm water controls on the site required by this permit and how they are to be maintained;
- The proper procedures to follow with respect to the permit’s pollution prevention requirements; and
- When and how to conduct inspections, record applicable findings, and take corrective actions.

**SWPPP SECTION 9: CERTIFICATION AND NOTIFICATION**

- Certification statement must be signed and dated by a person who meets the requirements of an operator
- Certification must be re-signed in the event of a SWPPP modification.

**SWPPP SECTION 10: OPERATIONS AND MAINTENANCE OF PERMANENT SW CONTROLS**

- Certify as-built plans
- Implement O&M program
- Document and certify with annual inspections
PREVENTIVE MAINTENANCE WORKSHEETS

The following preventive maintenance (PM) worksheets are provided to assist in developing a PM program for storm water control measures (SCMs). Maintenance tasks, associated costs, and labor hours may be adjusted based on location and varying SCM configurations. A cost assumptions worksheet is provided for each PM worksheet to further assist in developing a PM program. These worksheets give a breakdown of costs and associated assumptions. They also list the references used to develop the costs as well as additional resources that can be used if needed.
## Maintenance Action Sheet (MAS) Source: WERF, 2009

### Equipment Type: Storm Water System

#### Component: Swale

<table>
<thead>
<tr>
<th>PM Components (Task Description)</th>
<th>Labor-hrs</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual Inspection</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2 Routine Maintenance (mowing, trash removal, etc.)</td>
<td>8</td>
<td>Monthly</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>3 Corrective Maintenance</td>
<td>32</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MAS Cost Summary - Annualized

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>106.000</td>
<td>$25.00</td>
<td>$3,180.00</td>
<td>$3,000.00</td>
<td>$6,205.00</td>
</tr>
</tbody>
</table>

### MAS Cost Summary - Annualized for All Items of this Type on Base

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Notes:
1. Costs assume a 100 ft long, 10 ft wide swale.
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly.
## Swale

### Labor Hour Summary (per 100 ft of swale)

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Routine Maintenance (Mowing, etc.)</td>
<td>8</td>
<td>Monthly</td>
</tr>
<tr>
<td>Corrective Maintenance</td>
<td>32</td>
<td>Every 4 years</td>
</tr>
</tbody>
</table>

### Assumptions
1. 2 ac DA, 40% Impervious (WERF, 2009)
2. 1200 SF of swale per acre of impervious drainage area (IDA)
3. 2 ac x 40% = 0.8 ac IDA x 1200 SF = 960 SF
4. Assuming 10 ft wide swale, swale length is appr. 100 ft

### O&M Costs per 100 ft of Swale

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$40</td>
<td>$80</td>
<td>$30</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Vegetation Management, Trash and Debris Removal</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$2,880</td>
<td>$60</td>
<td>$2,880</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Corrective Maintenance</td>
<td>48</td>
<td>8</td>
<td>4</td>
<td>$30</td>
<td>$240</td>
<td>$60</td>
<td>$120</td>
<td>$100</td>
<td>$25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,200</strong></td>
<td><strong>3,060</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pro-rated Avg Labor Rate</strong></td>
<td><strong>$30</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Adapted from WERF, 2009
Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
## Equipment Type: Storm Water System

<table>
<thead>
<tr>
<th>Component: Bioretention Basin</th>
<th>Task Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM Components (Task Description)</strong></td>
<td><strong>Labor-hrs</strong></td>
</tr>
<tr>
<td>1 Annual Inspection</td>
<td>2</td>
</tr>
<tr>
<td>2 Vegetation Management and Debris Removal</td>
<td>4</td>
</tr>
<tr>
<td>3 Till Soil</td>
<td>8</td>
</tr>
<tr>
<td>4 Unclog Drain</td>
<td>2</td>
</tr>
<tr>
<td>5 Replace Mulch</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
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<td>10</td>
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</tr>
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<td>11</td>
<td></td>
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<tr>
<td>12</td>
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<tr>
<td>25</td>
<td></td>
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<tr>
<td>26</td>
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</table>

### MAS Cost Summary - Annualized

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Costs</td>
<td>15,000</td>
<td>$1,000.00</td>
<td>$525.00</td>
<td>$50.00</td>
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</table>

### MAS Cost Summary - Annualized for All Items of this Type on Base

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Costs assume a 2,500 SF bioretention basin
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly

Atch 15
(4 of 21)
## Bioretention Basin

### Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Routine Maintenance (Mowing)</td>
<td>4</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Till Soil</td>
<td>8</td>
<td>Every 4 years</td>
</tr>
<tr>
<td>Unclog Drain</td>
<td>2</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>Replace Mulch</td>
<td>4</td>
<td>Every 2 years</td>
</tr>
</tbody>
</table>

### Assumptions

1. 1 ac DA, 80% Impervious (Source: WERF, 2009)
2. Bioretention surface area = 7% of effective drainage area (Source: WERF, 2009)
3. 2,500 SF bioretention basin

### O&M Costs per Bioretention Basis

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$65</td>
<td>$130</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Vegetation Management, Trash and Debris Removal</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>$31</td>
<td>$248</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Till Soil</td>
<td>48</td>
<td>4</td>
<td>2</td>
<td>$31</td>
<td>$62</td>
<td>$50</td>
<td>$50</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>4 Unclog Drain</td>
<td>24</td>
<td>2</td>
<td>1</td>
<td>$30</td>
<td>$30</td>
<td>$0</td>
<td>$0</td>
<td>$100</td>
<td>$50</td>
</tr>
<tr>
<td>5 Replace Mulch ($0.75/SF)</td>
<td>24</td>
<td>2</td>
<td>2</td>
<td>$31</td>
<td>$62</td>
<td>$0</td>
<td>$0</td>
<td>$1,875</td>
<td>$938</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>$532</td>
<td>$50</td>
<td></td>
<td></td>
<td>$988</td>
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</tr>
</tbody>
</table>

### Notes:

- Adapted from WERF, 2009
- Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
## Storm Water System

<table>
<thead>
<tr>
<th>Component: Level Spreader, Filter Strip, and/or Buffer</th>
<th>Task Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM Components (Task Description)</td>
<td>Labor-hrs</td>
</tr>
<tr>
<td>Level Spreader - Annual Inspection</td>
<td>1</td>
</tr>
<tr>
<td>Level Spreader - Corrective Maintenance</td>
<td>8</td>
</tr>
<tr>
<td>Filter Strip - Annual Inspection</td>
<td>1</td>
</tr>
<tr>
<td>Filter Strip - Vegetation Management</td>
<td>0.5</td>
</tr>
<tr>
<td>Filter Strip - Corrective Maintenance</td>
<td>8</td>
</tr>
<tr>
<td>Buffer - Annual Inspection</td>
<td>1</td>
</tr>
<tr>
<td>Buffer - Remove Debris, Veg Mgmt/Maintenance</td>
<td>4</td>
</tr>
</tbody>
</table>

### MAS Cost Summary - Annualized

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.400</td>
<td>$50.00</td>
<td>$376.20</td>
<td>$250.00</td>
<td>$676.20</td>
</tr>
</tbody>
</table>

### MAS Cost Summary - Annualized for All Items of this Type on Base

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to:</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Costs assume a 100 ft level spreader, 100x30 ft filter strip, and 100x50 ft buffer
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
## Level Spreader, Filter Strip, and/or Buffer

### Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Spreader - Inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>Level Spreader - Corrective Maintenance</td>
<td>8</td>
<td>Every 2 Years</td>
</tr>
<tr>
<td>Filter Strip - Inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>Filter Strip - Vegetation Management</td>
<td>0.5</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Filter Strip - Corrective Maintenance</td>
<td>8</td>
<td>Every 5 Years</td>
</tr>
<tr>
<td>Buffer - Inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>Buffer - Debris Removal, Vegetation</td>
<td>4</td>
<td>Every 5 Years</td>
</tr>
</tbody>
</table>

### Assumptions
1. Level spreader is 100 ft long
2. Filter strip is 100 ft X 30 ft
3. Buffer is 100 ft X 50 ft
4. Filter strip maintenance = $0.07/SF assuming a 3,000 SF filter strip, $150/yr for mowing, and $50/yr for seeding (Source: LID Center, 2005)

### O&M Costs per Level Spreader, Filter Strip, and Buffer

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Level Spreader - Inspection</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>$40</td>
<td>$40</td>
<td>$30</td>
<td>$30</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Level Spreader - Corrective Maintenance</td>
<td>24</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$120</td>
<td>$30</td>
<td>$60</td>
<td>$100</td>
<td>$50</td>
</tr>
<tr>
<td>3 Filter Strip - Inspection</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>$40</td>
<td>$40</td>
<td>$30</td>
<td>$30</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>4 Filter Strip - Vegetation Management</td>
<td>3</td>
<td>0.5</td>
<td>1</td>
<td>$30</td>
<td>$60</td>
<td>$30</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>5 Filter Strip - Corrective Maintenance</td>
<td>60</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$48</td>
<td>$30</td>
<td>$24</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>6 Buffer - Inspection</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>$40</td>
<td>$40</td>
<td>$30</td>
<td>$30</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>7 Buffer - Debris Removal, Vegetation</td>
<td>60</td>
<td>2</td>
<td>2</td>
<td>$30</td>
<td>$24</td>
<td>$30</td>
<td>$12</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

| Total Pro-rated Avg Labor Rate | $372 | $246 | $50 |

Notes:
- Filter strip costs were adapted from WERF, 2009
- Level spreader and buffer costs are based on engineering estimates
- Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly

Atch 15
(7 of 21)
### Equipment Type: Storm Water System

#### Component: Wet Detention Basin

<table>
<thead>
<tr>
<th>PM Components (Task Description)</th>
<th>Labor-hrs</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual Inspection</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2 Vegetation Management and Debris Removal</td>
<td>8</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3 Vector Control</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Intermittent Maintenance</td>
<td>16</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5 Forebay Sediment Removal</td>
<td>80</td>
<td>8</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6 Pond Sediment Removal</td>
<td>400</td>
<td>20</td>
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</tr>
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</table>

### MAS Cost Summary - Annualized

<table>
<thead>
<tr>
<th></th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
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<tbody>
<tr>
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<td>$2,064.00</td>
<td>$2,500.00</td>
<td>$5,164.00</td>
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</table>

### MAS Cost Summary - Annualized for All Items of this Type on Base

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Notes:
1. Costs assume a basin with a 90,000 CF permanent pool and WQv.
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly.
Wet Detention Basin

**Labor Hour Summary**

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Vegetation Management and Debris Removal</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>Vector Control</td>
<td>4</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>Intermittent Maintenance</td>
<td>16</td>
<td>Annually</td>
</tr>
<tr>
<td>Forebay Sediment Removal</td>
<td>80</td>
<td>Every 8 years</td>
</tr>
<tr>
<td>Basin Sediment Removal</td>
<td>400</td>
<td>Every 20 years</td>
</tr>
</tbody>
</table>

**Assumptions**

1. Assumes 50 ac DA, 40% Impervious (Source: WERF, 2009)
2. Results in a WQv of 90,750 CF, and a permanent pool of 90,750 CF (Source: WERF, 2009)
3. Total capacity is approximately 4 ac-ft
4. Forebay is 10% of WQv (Source: Assumption based on multiple sources)

**O&M Costs per Wet Detention Basin (with an appr. 4 ac-ft capacity)**

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection/Reporting</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$40</td>
<td>$80</td>
<td>$30</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Vegetation management/debris removal</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$240</td>
<td>$60</td>
<td>$240</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Vector Control</td>
<td>36</td>
<td>4</td>
<td>1</td>
<td>$40</td>
<td>$53</td>
<td>$200</td>
<td>$267</td>
<td>$200</td>
<td>$67</td>
</tr>
<tr>
<td>4 Intermittent Maintenance</td>
<td>12</td>
<td>8</td>
<td>2</td>
<td>$30</td>
<td>$480</td>
<td>$60</td>
<td>$480</td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>5 Forebay Sediment Removal</td>
<td>96</td>
<td>16</td>
<td>5</td>
<td>$40</td>
<td>$400</td>
<td>$250</td>
<td>$500</td>
<td>$1,200</td>
<td>$150</td>
</tr>
<tr>
<td>6 Pond Sediment Removal</td>
<td>240</td>
<td>80</td>
<td>5</td>
<td>$40</td>
<td>$800</td>
<td>$250</td>
<td>$1,000</td>
<td>$5,000</td>
<td>$250</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>2,053</strong></td>
<td></td>
<td><strong>2,547</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>567</strong></td>
<td></td>
</tr>
<tr>
<td>Pro-rated Avg Labor Rate</td>
<td></td>
<td><strong>$2,053</strong></td>
<td></td>
<td><strong>$2,547</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$567</strong></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Adapted from WERF, 2009 ($50/CY for sediment removal)

**Sediment Removal Assumptions**

1. Remove sediment from pond when 25% full (840 CY)
2. Remove sediment from forebay when 50% full (168 CY)
3. $20/CY for labor
4. $24/CY for equipment
5. $6/CY for sediment disposal (included in material cost)
6. Riprap replacement in forebay requires 4 CY of riprap at $50/CY

Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly

Atch 15
(9 of 21)
<table>
<thead>
<tr>
<th>Component</th>
<th>PM Components (Task Description)</th>
<th>Labor-hrs</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Annual Inspection</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2</td>
<td>Vegetation Management and Debris Removal</td>
<td>8</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3</td>
<td>Vector Control</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Intermittent Maintenance</td>
<td>16</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5</td>
<td>Forebay Sediment Removal</td>
<td>12</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pond Sediment Removal</td>
<td>88</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized**

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.533</td>
<td>$300.00</td>
<td>$1,271.60</td>
<td>$1,500.00</td>
<td>$3,071.60</td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized for All Items of this Type on Base**

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

Notes:
1. Costs assume an 18,000 CF basin
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
Dry Detention Basin

### Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Vegetation Management, Trash and Debris Removal</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>Vector Control</td>
<td>4</td>
<td>Every 3 Years</td>
</tr>
<tr>
<td>Other Intermittent Facility Maintenance</td>
<td>16</td>
<td>Annually</td>
</tr>
<tr>
<td>Forebay Sediment Removal</td>
<td>12</td>
<td>Every 5 Years</td>
</tr>
<tr>
<td>Pond Sediment Removal</td>
<td>88</td>
<td>Every 10 Years</td>
</tr>
</tbody>
</table>

### Assumptions
1. 10 ac DA, 40% Impervious (Source: WERF, 2009)
2. Results in a WQv of 18,150 CF (Source: WERF, 2009)
3. Forebay is 10% of WQv (1,800 CF) (Source: Assumption based on multiple sources)

### O&M Costs per Dry Detention Basin

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$40</td>
<td>$80</td>
<td>$30</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Vegetation Management, Trash and Debris Removal</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$240</td>
<td>$60</td>
<td>$240</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Vector Control</td>
<td>36</td>
<td>4</td>
<td>1</td>
<td>$40</td>
<td>$53</td>
<td>$200</td>
<td>$267</td>
<td>$200</td>
<td>$67</td>
</tr>
<tr>
<td>4 Other Intermittent Facility Maintenance</td>
<td>12</td>
<td>8</td>
<td>2</td>
<td>$30</td>
<td>$480</td>
<td>$60</td>
<td>$480</td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>5 Forebay Sediment Removal</td>
<td>60</td>
<td>6</td>
<td>2</td>
<td>$30</td>
<td>$72</td>
<td>$70</td>
<td>$84</td>
<td>$100</td>
<td>$20</td>
</tr>
<tr>
<td>6 Pond Sediment Removal</td>
<td>120</td>
<td>22</td>
<td>4</td>
<td>$40</td>
<td>$352</td>
<td>$180</td>
<td>$396</td>
<td>$1,000</td>
<td>$100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,277</strong></td>
<td><strong>1,527</strong></td>
<td><strong>287</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pro-rated Avg Labor Rate</strong></td>
<td><strong>$33</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Adapted from WERF, 2009 ($50/CY for sediment removal)

### Sediment Removal Assumptions
1. Remove sediment when 25% full (pond = 170 CY; forebay = 17 CY)
2. $20/CY for labor
3. $24/CY for equipment
4. $6/CY for sediment disposal (listed as a material cost)
5. Riprap replacement in forebay requires 2 CY of riprap at $50/CY

Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly

Atch 15
(11 of 21)
<table>
<thead>
<tr>
<th>PM Components (Task Description)</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Inspection</td>
<td>Annually</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetation Management and Debris Removal</td>
<td>Semi-Annually</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Till Soil</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MAS Cost Summary - Annualized

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,000</td>
<td>$50.00</td>
<td>$444.00</td>
<td>$50.00</td>
<td>$544.00</td>
</tr>
</tbody>
</table>

### MAS Cost Summary - Annualized for All Items of this Type on Base

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Costs assume a 2,500 SF infiltration basin
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
### Infiltration Basin

#### Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Vegetation Management, Trash and Debris Removal</td>
<td>4</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Till Soil</td>
<td>8</td>
<td>Every 4 Years</td>
</tr>
</tbody>
</table>

#### Assumptions
1. 1 ac DA, 80% Impervious (Source: WERF, 2009 for bioretention)
2. Infiltration basin surface area is 7% of effective drainage area (Source: WERF, 2009 for bioretention)
3. Results in a 2,500 SF infiltration basin

#### O&M Costs per Infiltration Basin

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection (modified)</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$65</td>
<td>$130</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Vegetation Management, Trash and Debris Removal</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>$31</td>
<td>$248</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Till Soil</td>
<td>48</td>
<td>4</td>
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<td>$31</td>
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<td>$50</td>
<td>$50</td>
<td>$0</td>
<td>$50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
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<td></td>
<td>$440</td>
<td>$50</td>
<td>$50</td>
<td>$100</td>
<td>$100</td>
</tr>
</tbody>
</table>

**Pro-rated Avg Labor Rate** $37

Notes:
Adapted from WERF, 2009 costs for bioretention basins
Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
<table>
<thead>
<tr>
<th>PM Components (Task Description)</th>
<th>Labor-hrs</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual Inspection</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2 Vegetation Management and Debris Removal</td>
<td>8</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3 Vector Control</td>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Intermittent Maintenance</td>
<td>8</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5 Forebay Sediment Removal</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>6 Wetland Sediment Removal</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized**

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Costs</td>
<td>22.667</td>
<td>$225.00</td>
<td>$748.00</td>
<td>$875.00</td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized for All Items of this Type on Base**

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Costs assume a wetland with an 18,000 CF permanent pool and WQv.
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly.
## Storm Water Wetland

### Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Vegetation Management and Debris Removal</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>Vector Control</td>
<td>2</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>Intermittent Maintenance</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>Forebay Sediment Removal</td>
<td>16</td>
<td>Every 8 years</td>
</tr>
<tr>
<td>Wetland Sediment Removal</td>
<td>40</td>
<td>Every 20 years</td>
</tr>
</tbody>
</table>

### Assumptions

1. Assumes 10 ac DA, 40% Impervious (Source: WERF, 2009)
2. Results in a WQv of 18,000 CF, and a permanent pool of 18,000 CF (Source: WERF, 2009)
3. Forebay is 10% of WQv (1,800 CF) (Source: Assumption based on multiple sources)

### O&M Costs per Storm Water Wetland

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection / Reporting</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$40</td>
<td>$80.00</td>
<td>$30</td>
<td>$60.00</td>
<td>$0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2 Vegetation Management / Debris Removal</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$240.00</td>
<td>$60</td>
<td>$240.00</td>
<td>$0</td>
<td>$0.00</td>
</tr>
<tr>
<td>3 Vector Control</td>
<td>36</td>
<td>2</td>
<td>1</td>
<td>$40</td>
<td>$26.67</td>
<td>$200</td>
<td>$133.33</td>
<td>$200</td>
<td>$66.67</td>
</tr>
<tr>
<td>4 Intermittent Maintenance</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$24.00</td>
<td>$60</td>
<td>$240.00</td>
<td>$100</td>
<td>$100.00</td>
</tr>
<tr>
<td>5 Forebay Sediment Removal</td>
<td>96</td>
<td>8</td>
<td>2</td>
<td>$40</td>
<td>$80.00</td>
<td>$100</td>
<td>$100.00</td>
<td>$300</td>
<td>$37.50</td>
</tr>
<tr>
<td>6 Wetland Sediment Removal</td>
<td>240</td>
<td>20</td>
<td>2</td>
<td>$40.00</td>
<td>$80.00</td>
<td>$100</td>
<td>$100.00</td>
<td>$400</td>
<td>$20.00</td>
</tr>
</tbody>
</table>

Total $747.67 $873.33 $224.17

Pro-rated Avg Labor Rate $33

Notes:
Adapted from WERF, 2009 costs for wet detention basins ($50/CY for sediment removal)

### Sediment Removal Assumptions

1. Remove sediment from pond when 10% full (70 CY)
2. Remove sediment from forebay when 50% full (35 CY)
3. $20/CY for labor
4. $24/CY for equipment
5. $6/CY for sediment disposal (included in material cost)
6. Riprap replacement in forebay requires 2 CY of riprap at $50/CY

Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly.
### Equipment Type: Storm Water System

**Component:** Rainwater Harvesting - Cistern

<table>
<thead>
<tr>
<th>PM Components (Task Description)</th>
<th>Labor-Hrs</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2 Routine Maintenance (e.g., cleaning gutters and screens)</td>
<td>8</td>
<td>Semi-Annually</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3 Tank Inspection and Disinfection</td>
<td>8</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>4 Intermittent Maintenance (e.g., debris removal from tank)</td>
<td>6</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Pump Replacement</td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized**

<table>
<thead>
<tr>
<th></th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Costs</td>
<td>29.200</td>
<td>$ 140.00</td>
<td>$ 1,051.20</td>
<td>$ 0</td>
<td>$ 1,191.20</td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized for All Items of this Type on Base**

<table>
<thead>
<tr>
<th></th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Items on Base the MAS applies to:</td>
<td>0.000</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Costs assume a 6,300 gal system that requires a pump
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
## Rainwater Harvesting

### Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Routine Maintenance (e.g., cleaning gutters and screens)</td>
<td>8</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Tank Inspection and Disinfection</td>
<td>8</td>
<td>Annually</td>
</tr>
<tr>
<td>Intermittent Maintenance (e.g., debris removal from tank)</td>
<td>6</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>Pump Replacement</td>
<td>6</td>
<td>Every 5 years</td>
</tr>
</tbody>
</table>

### Assumptions
1. 5,000 sq ft impervious drainage area (usually roof area) (Source: WERF, 2009)
2. Cistern sized for 2" rain event (6,300 gallons) (Source: WERF, 2009)
3. System requires a pump and is used for toilet flushing

### O&M Costs per Rainwater Harvesting System (6,300-gallon Cistern)

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inspection</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$65</td>
<td>$130</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Routine Maintenance (e.g., cleaning gutters and screens)</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$480</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Tank Inspection and Disinfection</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>$30</td>
<td>$240</td>
<td>$0</td>
<td>$0</td>
<td>$20</td>
<td>$20</td>
</tr>
<tr>
<td>4 Intermittent Maintenance (e.g., debris removal from tank)</td>
<td>36</td>
<td>3</td>
<td>2</td>
<td>$65</td>
<td>$130</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>5 Pump Replacement</td>
<td>60</td>
<td>3</td>
<td>2</td>
<td>$65</td>
<td>$78</td>
<td>$0</td>
<td>$0</td>
<td>$600</td>
<td>$120</td>
</tr>
</tbody>
</table>

Total: $1,058 | $0 | $0 | $600 | $140

Pro-rated Avg Labor Rate: $36

Notes:
Adapted from WERF, 2009
Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
### Equipment Type
Storm Water System

### Component
Permeable Pavement

#### Task Frequency

<table>
<thead>
<tr>
<th>PM Components (Task Description)</th>
<th>Labor-hrs</th>
<th>Frequency (yrs if not indicated)</th>
<th>W</th>
<th>M</th>
<th>Q</th>
<th>S</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual Inspection</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2 Trash/Debris Removal</td>
<td>2</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3 Sweeping</td>
<td>1</td>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized**

<table>
<thead>
<tr>
<th></th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Costs</td>
<td>5.000</td>
<td>$ 0</td>
<td>$ 160.0</td>
<td>$ 180.00</td>
<td>$ 340.00</td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized for All Items of this Type on Base**

<table>
<thead>
<tr>
<th></th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Costs assume 20,000 SF of pavement
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
Permeable Pavement

Labor Hour Summary

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Inspection</td>
<td>2</td>
<td>Annually</td>
</tr>
<tr>
<td>Trash/Debris Removal</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>Sweeping</td>
<td>1</td>
<td>Annually</td>
</tr>
</tbody>
</table>

Assumptions
1. 20,000 SF of permeable pavement

O&M Costs per 20,000 SF of Permeable Pavement

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Annual Inspection</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$40</td>
<td>$80</td>
<td>$30</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>2 Trash/Debris Removal</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>$30</td>
<td>$60</td>
<td>$30</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>3 Sweeping</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>$20</td>
<td>$20</td>
<td>$60</td>
<td>$60</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total</td>
<td>$160</td>
<td>$180</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pro-rated Avg Labor Rate: $32

Notes:
Costs are from WERF, 2009
Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly
<table>
<thead>
<tr>
<th>Component:</th>
<th>Storm Water System</th>
<th>Equipment Type:</th>
<th>Shop Labor Rate:</th>
<th>34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component:</td>
<td>Reforested Area</td>
<td>Task Frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM Components (Task Description)</td>
<td>Labor-hrs</td>
<td>Frequency (yrs if not indicated)</td>
<td>W</td>
<td>M</td>
</tr>
<tr>
<td>Annual Inspection</td>
<td>1</td>
<td>Annually</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Vegetation Management</td>
<td>4</td>
<td>Annually</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Corrective Maintenance</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized**

<table>
<thead>
<tr>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Costs</td>
<td>$150.00</td>
<td>$238.00</td>
<td>$90.00</td>
<td>$478.00</td>
</tr>
</tbody>
</table>

**MAS Cost Summary - Annualized for All Items of this Type on Base**

<table>
<thead>
<tr>
<th>Number of Items on Base the MAS applies to:</th>
<th>Labor Hrs</th>
<th>Material</th>
<th>Labor</th>
<th>Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes:**
1. Preventive maintenance requirement will likely decrease as the forest matures (after 3-5 years).
2. Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly.
Reforested Area

**Labor Hour Summary**

<table>
<thead>
<tr>
<th>Task</th>
<th>Labor Hours</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Inspection</td>
<td>1</td>
<td>Annually</td>
</tr>
<tr>
<td>Vegetation Maintenance</td>
<td>4</td>
<td>Annually</td>
</tr>
<tr>
<td>Corrective Maintenance</td>
<td>4</td>
<td>Every 2 Years</td>
</tr>
</tbody>
</table>

**Assumptions**

1. Costs are estimated per each contiguous reforested area assumed to be between 1-5 acres.

**O&M Costs per Reforested Area**

<table>
<thead>
<tr>
<th>Task</th>
<th>Freq (months)</th>
<th>Labor Hours</th>
<th>Crew Size</th>
<th>Labor Rate</th>
<th>Labor Annual</th>
<th>Equipment Rate</th>
<th>Equip Annually</th>
<th>Material</th>
<th>Material Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Annual Inspection</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>$ 40</td>
<td>$ 40</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 0</td>
</tr>
<tr>
<td>2  Vegetation Maintenance</td>
<td>12</td>
<td>2</td>
<td>2</td>
<td>$ 30</td>
<td>$ 120</td>
<td>$ 30</td>
<td>$ 60</td>
<td>$ 100</td>
<td>$ 100</td>
</tr>
<tr>
<td>3  Corrective Maintenance</td>
<td>24</td>
<td>2</td>
<td>2</td>
<td>$ 40</td>
<td>$ 80</td>
<td>$ 30</td>
<td>$ 30</td>
<td>$ 100</td>
<td>$ 50</td>
</tr>
</tbody>
</table>

**Total**  
$ 240  
$ 90  
$ 150

**Pro-rated Avg Labor Rate**  
$ 34

**Notes:**

From engineering estimate based on values from WERF, 2009 for similar work

*Costs will vary depending on location and configuration of the SCM and should be adjusted accordingly*
STATE STORM WATER CONTACTS

This attachment provides a list of continental U.S. environmental regulatory agencies and contacts that can provide assistance with implementation and O&M of construction and post-construction SCMs.

**Alabama**

Alabama Department of Environmental Management, Water Division

Street Address:
1400 Coliseum Boulevard
Montgomery, Alabama 36110

Mailing Address:
PO Box 301463
1400 Coliseum Blvd
Montgomery, AL 36130-1463


Email: cswmail@adem.state.al.us
Phone: (334) 271-7700
Fax: (334) 279-3051

**Alaska**

Division of Water – Alaska Department of Environmental Conservation

Street Address:
555 Cordova Street
Anchorage, AK 99501


Email: jim.rypkema@alaska.gov
Phone: 907-334-2288
Fax: 907-334-2415

**Arizona**

Arizona Department of Environmental Quality, Water Quality Division, Stormwater General Permits

Street Address:
1110 West Washington St.
Phoenix, AZ 85007

Mailing Address:
1110 West Washington St.
Mail Code: 5415A-1
Phoenix, AZ 85007

Arkansas

Arkansas Department of Environmental Quality

Street Address:
5301 Northshore Drive
North Little Rock, AR 72118-5317


Email: jamal@adeq.state.ar.us
Phone: (501) 682-0620

California

California Environmental Protection Agency, State Water Resources Control Board, Storm Water Program

Street Address:
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Mailing Address:
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100


E-Mail: stormwater@waterboards.ca.gov
Phone: 1-866-563-3107
Fax: (916) 341-5543

Colorado

Colorado Department of Public Health & Environment / Water Quality Control Division

Street and Mailing Address:
4300 Cherry Creek Drive South
WQCD-WQPS-B2
Denver, CO 80246-1530


E-Mail: comments.wqcd@state.co.us
Phone: (303) 692-3500
Fax: (303) 782-0390

Nathan Moore, Construction, MS4, and Pretreatment Unit Manager
Phone: (303) 692-3555
E-Mail: nathan.moore@state.co.us

**Connecticut**

Connecticut Department of Environmental Protection / Bureau of Water Management / Permitting and Enforcement Division

Street Address:
79 Elm St.
Hartford, CT 06106-5127


Email: chris.stone@po.state.ct.us
Phone: (860) 424-3850

**Delaware**

DNREC Division of Watershed Stewardship

Street Address:
89 Kings Highway
Dover, DE 19901

Webpage: [http://www.dnrec.delaware.gov/swc/Pages/SedimentStormwater.aspx](http://www.dnrec.delaware.gov/swc/Pages/SedimentStormwater.aspx)

Email: Jamie.Rutherford@state.de.us
Phone: 302-739-9921
Fax: 302-739-6724

**District of Columbia**

DDOE Stormwater Management Division

Street Address:
1200 First Street NE
Washington, DC 20002


Email: ddoe@dc.gov
Phone: (202) 741-2136

**Florida**

Florida Department of Environmental Protection, NPDES Stormwater Section

Street and Mailing Address:
Georgia Environmental Protection Division / Water Protection Branch

Street Address:
4220 International Pkwy, Suite 101
Atlanta, GA 30354

Webpage: http://www.gaepd.org/Documents/index_water.html

Email: jan.sammons@dnr.state.ga.us
Phone: (404) 675-6240
Fax: (404) 675-6245

Hawaii Department of Health / Clean Water Branch

Street Address:
919 Ala Moana Blvd., Room 301
Honolulu, HI 96814-4920

Mailing Address:
P.O. Box 3378
Honolulu, HI 96801-3378

Webpage: http://health.hawaii.gov/cwb/

Email: CleanWaterBranch@doh.hawaii.gov
Phone: (808) 586-4309
Fax: (808) 586-4352

Idaho DEQ State Office, Water Quality Division

Street Address:
1410 N. Hilton
Boise, ID 83706


Email: miranda.adams@deq.idaho.gov
Phone: (208) 373-0574
Illinois

Illinois Environmental Protection Agency / Division of Water Pollution Control

Street Address:
1021 North Grand Avenue East
Springfield, IL 62794-9891

Mailing Address:
1021 North Grand Avenue East
Post Office Box 19276
Springfield, IL 62794-9891

Webpage: [http://www.epa.state.il.us/water/permits/storm-water/index.html](http://www.epa.state.il.us/water/permits/storm-water/index.html)

Email: Terri.LeMasters@illinois.gov
Phone: 217-782-0610

Indiana

Indiana Department of Environmental Management
Office of Water Quality Surface Water, Operations & Enforcement Branch
Wetlands and Storm Water Section - Storm Water Program

Street Address:
100 North Senate Avenue MC 65-42, Room 1255
Indianapolis, Indiana 46204

Webpage: [http://www.in.gov/idem/5422.htm](http://www.in.gov/idem/5422.htm)

Email: rbraun@idem.in.gov
Phone: (317) 234-3980
Fax: (317) 232-8637

Iowa

Iowa Department of Natural Resources

Street Address:
502 E 9th St
Des Moines, IA 50319-0034


Phone: 515-281-7017
Fax: (515) 281-8895
Kansas

Kansas Department of Health & Environment / Bureau of Water

Street Address:
1000 SW Jackson St
Suite 420
Topeka, KS 66612-1367


Email: stormwater@kdheks.gov
Phone: (785) 296-5549
Fax: (785) 296-5509

Kentucky

Kentucky Department for Environmental Protection / Division of Water

Street Address:
200 Fair Oaks Lane, 4th Floor
Frankfort, KY 40601

Webpage: http://water.ky.gov/wet_weather/Pages/default.aspx

Email: abigail.rains@ky.gov
Phone: (502) 564-3410

Louisiana

Louisiana Department of Environmental Quality / Water Permits Division

Street Address:
602 N. Fifth Street
Baton Rouge, LA 70802

Mailing Address:
PO Box 4313
Baton Rouge, LA 70821-4313

Webpage:

Email: webmaster-deq@la.gov
Phone: (225) 219-9371
Fax: (225) 219-3309

Maine

Maine Department of Environmental Protection

Street Address:
17 State House Station
Augusta, ME 04333

Email: david.ladd@maine.gov
Phone: (207) 287-5404

**Maryland**

Maryland Department of the Environment / Water Management Administration / Program Review Division

Street Address:
1800 Washington Blvd
Baltimore, MD 21230-1708

Webpage: [http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SedimentandStormwaterHome/Pages/Programs/WaterPrograms/SedimentandStormwater/home/index.aspx](http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SedimentandStormwaterHome/Pages/Programs/WaterPrograms/SedimentandStormwater/home/index.aspx)

Email: bcleveenger@mde.state.md.us
Phone: (410) 537-3543

**Massachusetts**

Massachusetts Department of Environmental Protection

Street Address:
One Winter St.
Boston, MA 02108


Email: Frederick.Civian@state.ma.us
Phone: 617-292-5821

**Michigan**

Michigan Department of Environmental Quality / Water Resource Division

Street Address:
525 W. Allegan (Constitution Hall, 4th Floor, North)
Lansing, MI 48909-7742

Mailing Address:
PO Box 30273
Lansing, MI 48909-7773

Webpage: [http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3716---,00.html](http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3716---,00.html)

Email: ploehnk@michigan.gov
Phone: 517-335-4137
**Minnesota**

Minnesota Pollution Control Agency / Stormwater Program

Street Address:
520 Lafayette Rd N  
St. Paul, MN 55155


Email: lisa.woog@state.mn.us  
Phone: 218-316-3891

**Mississippi**

Mississippi Department of Environmental Quality / Office of Pollution Control

Street Address:
515 East Amite St.  
Jackson, MS 39201

Mailing Address:
P. O. Box 2261  
Jackson, MS 39225


Phone: 601-961-5169  
Fax: (601) 961-5703

**Missouri**

Missouri Department of Natural Resources

Street Address:
1101 Riverside Drive  
Jefferson City, MO 65102-0176

Mailing Address:
PO Box 176  
Jefferson City, MO 65102-0176


Email: cleanwater@dnr.mo.gov  
Phone: 573-751-1300
Montana
Montana Department of Environmental Quality
Street Address:
1520 E 6th Ave
Helena, MT 59620-0901
Webpage: [http://deq.mt.gov/pcd/WPB/default.mcpx](http://deq.mt.gov/pcd/WPB/default.mcpx)
Email: jpetaja@mt.gov
Phone: (406) 444-3080
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• HQ AFCESA Preventive Maintenance Example Checklist, September 2012
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A17.4. Army:
• U.S. Army Nationwide Permit Information, http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/NationwidePermits.aspx. This site identifies stream, culvert, and associated structure activities that may be applicable to Nationwide Section 404 Clean Water Act permits.

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ACRONYMS AND GLOSSARY

A18.1. Acronyms.

ac - acre
ac-ft - acre-foot
AFCEC - Air Force Civil Engineer Center
AFI - Air Force instruction
AFPAM - Air Force pamphlet
AFPD - Air Force policy directive
BASH - bird aircraft strike hazard
BMP - best management practice
CCTV - closed-circuit television
CES - civil engineer squadron
CES/CEIEC - civil engineer squadron, environmental
CES/CEOHP - civil engineer squadron, horizontal shop
CES/CEOIU - civil engineer squadron, utilities shop
CES/CEPT - civil engineer squadron, GeoBase
CF - cubic foot
CFR - Code of Federal Regulations
CGP - construction general permit
CWA - Clean Water Act
CY - cubic yard
DoD - Department of Defense
DODI - Department of Defense Instruction
E&S - erosion and sediment
E&SC - erosion and sediment control
EISA - Energy Independence and Security Act
EPA - Environmental Protection Agency
ETL - Engineering Technical Letter
FGS - Final Governing Standards
FS - filter strip
ft - foot
gal - gallon
GI - green infrastructure
GIS - Geographic Information System
GPS - Global Positioning System
ID - identification
IDA - impervious drainage area
LID - low impact development
LS - level spreader
m - meter
MAJCOM - major command
MAS - Maintenance Action Sheet
MDEQ - Mississippi Department of Environmental Quality
mm - millimeter
MS4 - municipal separate storm sewer system
NCDENR - North Carolina Department of Environment and Natural Resources
NCDOT - North Carolina Department of Transportation
NO - Notice of Intent
NPDES - National Pollutant Discharge Elimination System
O&M - operation and maintenance
OEBGD - Overseas Environmental Baseline Guidance Document
P.L. - Public Law
A18.2. Glossary.

A18.2.1. Affected Construction Area. For the purpose of determining requirements for storm water control, the affected construction area is the site perimeter encompassing all areas disturbed during project construction and delineated on a site map, and may consist of natural boundaries, physical boundaries (e.g., curbs, gutters, catchments), or any other chosen line of demarcation to encompass the site. It also includes any off-site storage and control areas dedicated to the project. Note that EPA’s 2012 Construction General Permit uses the term “Area of Disturbance.”

A18.2.2. Qualified Storm Water Professional. A qualified storm water professional is a person who by experience and training is knowledgeable in the principles and practices of construction-related erosion and sediment controls (E&SC) and construction site pollution prevention. Credentials cited in the site log of the storm water control site plan, or storm water pollution prevention plan (SWPPP) designate the qualified storm water professional.

A18.2.3. Best Management Practice (BMP). Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the U.S. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. (Source: Appendix A of EPA’s 2003 Construction General Permit; also 40 CFR 122.2). BMPs are also commonly referred to as storm water control measures (SCM).

A18.2.4. Construction Controls. Temporary measures taken during construction activities to prevent the discharge of pollutants to waters of the U.S. through storm water runoff. Often referred to as E&SCs. (Source: Modified from Appendix A of EPA’s 2003 Construction General Permit; also 40 CFR 122.2)

A18.2.5. Construction Storm Water Pollution Prevention Plan (SWPPP). A plan that documents the construction site operator’s activities to prevent storm water contamination, control sedimentation and erosion, and comply with the requirements of the CWA. (Source: EPA 833-R-06-004, Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites)
A18.2.6. **Green Infrastructure (GI).** A storm water management approach that mimics natural processes to mitigate the impacts of urbanization and maintain predevelopment hydrology. Often soils, vegetation, and other natural features (green infrastructure) are used in lieu of impervious surfaces, inlets, and conveyance pipes (often referred to as gray infrastructure). (Source: State University of New York, College of Environmental Science and Forestry, Green Infrastructure Initiative)

A18.2.7. **Low Impact Development (LID).** A stormwater management strategy designed to maintain site hydrology and mitigate the adverse impacts of stormwater runoff and nonpoint source pollution. (Source: UFC 3-210-10, *Low Impact Development*)

A18.2.8. **Post-Construction Controls.** Permanent structural controls that remain in place following construction (e.g., rain gardens, infiltration basins).
DISTRIBUTION LIST

SPECIAL INTEREST ORGANIZATIONS

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