APPENDIX 6

BMP Inspection and Maintenance Check List

Permanent Wet Detention Pond Maintenance Guidelines
City of Greensboro, Stormwater Management Division

Introduction

The purpose of this document is to provide owners of permanent wet detention ponds with a set of general guidelines to help maintain these structural stormwater best management practices. For owners to appreciate the need for routine and non-routine maintenance of their wet detention ponds, it is important that they are aware that these ponds provide value to the quality of our surface waters and in many cases can be an amenity to their property. Periodic inspections and maintenance are key factors in preserving the functionality of stormwater wet detention ponds. Wet detention ponds are not self-maintaining systems, and over time the efficiency of these structures to remove pollutants will diminish. Trapped sediments and other pollutants can potentially reduce the volume capacity of the ponds, therefore reducing their potential to treat stormwater runoff. The following guidelines are provided for the benefit of owners of wet detention ponds to help ensure that the pond will continue to meet the objectives for which it was designed. In addition to inspecting and maintaining components that sustain a wet detention pond's water quality functionality, attention must also be paid to the structural components that sustain its hydraulic functionality. Minimizing the risk of hydraulic malfunction (potentially leading to structural failure) is essential, especially for larger impoundment structures such as wet detention ponds. The majority of the wet detention ponds in Greensboro are located in urbanized settings, where structural failure may jeopardize downstream life and property. Maintenance is also important to prevent the decline in the appearance of the wet detention pond. Unhealthy conditions (such as noxious vegetation, stagnant water, etc.) may occur within and around the pond, which may affect the aesthetics and economic value of the surrounding property.

Wet Detention Pond Maintenance

The City of Greensboro's water-supply watershed (Ch. 30) ordinance and the 1999 stormwater management (Ch. 27) ordinance require property owner or owners' associations to meet certain maintenance requirements established for constructed wet detention ponds. The City has the authority to inspect these ponds periodically and require the pond owner to perform maintenance activities, when necessary. The City, as required by the State, will conduct periodic inspections of wet detention ponds implemented for water-supply watershed protection. The City will advise the owner of recommended and/or required maintenance actions needed to maintain the wet detention pond's functionality.

Dam Safety

Preserving the structural integrity of the wet detention pond's dam is important in protecting downstream life and property. There are at least four aspects of the dam that require specific attention: (1) *assessment of hazard potential* due to changes in downstream development; (2) *leakage and seepage*; (3) *dam material problems*; and (4) *vegetation growth* on the dam embankments.

Assessment of Hazard Potential

Before any dam is constructed, the design engineer is responsible for notifying the NC State Dam Safety Office of the proposed dam. If the dam falls under State Dam Safety jurisdiction, the dam must be constructed, maintained, and operated according to their design and construction guidelines. Even if the dam does not fall under the NC Dam Safety Office's jurisdiction, the dam should be designed and constructed in accordance with current proper engineering practices. The City has requirements concerning the maintenance of dams associated with required wet detention ponds. As new development occurs downstream of the pond, the chance of significant property damage or danger to human life may increase if catastrophic failure of the dam occurs. Although the dam may be initially exempt from regulation by the State, the owner is responsible for reporting to the State Dam Safety Office downstream development that may affect the hazard classification of the dam.

Leakage and Seepage

The downstream side of the dam should be inspected regularly for evidence of significant leakage or seepage. Seepage can emerge anywhere below the normal pool elevation, including the downstream slope of earth dams, areas beyond the toe of the dam, and around the spillway or pond outlet conduit. Indications of significant seepage include areas where the soil is saturated or where there is a flowing "spring" or leak. If "sinkholes" in the dam embankment are noticed, or if constant flowing water is noticed on the downstream side of the dam, then seepage has become excessive and professional engineering advice should be sought immediately to avert a major structural problem or a catastrophic failure of the dam.

Dam Material Problems

For earthen dams, pronounced cracks on the embankment surface indicate the first stages of potential dam failure. Transverse cracks (running perpendicular to the embankment face) generally indicating differential settlement of the dam, can provide pathways for excessive seepage. Longitudinal cracks (running parallel to the embankment face) may be due to inadequate compaction of the dam during construction or shrinkage of the clay (desiccation) in the top of the embankment during prolonged dry conditions. These cracks may eventually lead to slope failure, such as sliding or sloughing. For reinforced concrete dams, the concrete should be checked for pronounced cracking, leakage from the joints, and displacement (noticeable leaning or bulging). Also, excessive seepage, leakage, or springs just downstream of the concrete dam could be indicative of potential seepage-related "piping" problems under the dam. If such problems or other structural problems are observed, professional engineering advice should be sought.

Vegetative Growth
Trees and other woody vegetation are not permitted on the top, slopes, or embankments of earthen dams. Large root systems from woody vegetation can weaken the dam structure and provide seepage pathways. Thick vegetative cover can also provide a haven for burrowing animals such as groundhogs and muskrats. These animals can create a network of burrows in the dam embankments that can significantly weaken the dam, by creating seepage paths, which may eventually lead to dam failure. **Mowing of the dam embankments should occur, at a minimum, once every 6 months to prevent woody vegetation from becoming established.**

Pollution Prevention Activities

To assist the wet detention pond in improving the quality of stormwater runoff, every effort should be made to reduce the pollutant load entering the pond system. The following onsite efforts should be made to reduce pollutants from entering the pond:

- Outside trash dumpsters should be kept covered, and the area around the dumpster should be kept neat and clean.
- Chemicals, petroleum products, and other pollution sources (such as machinery) should be stored in a covered area away from possible stormwater contact. Spent chemicals are to be properly disposed or recycled.
- Fertilizers and pesticides should be used conservatively on the property grounds. Excessive amounts of these chemicals can be washed away with stormwater runoff, increasing the nutrient load to the pond.
- Chemicals such as copper sulfate used to inhibit algal growth in the pond degrade water quality. Since the pond's main function is to enhance water quality, these chemicals should not be used. Rather, reducing the amount of fertilizer application and ensuring that the pond outlets are properly functioning so the pool is flushed periodically will help to deter algal growth.
- Trash and vegetative floatables (grass clippings, leaves, limbs, etc.) should be cleaned from the pond surface and surroundings periodically to promote a healthy, aesthetically pleasing environment, and to prevent blockage of the pond outlets. Studies have shown that people are less likely to litter ponds that are aesthetically pleasing and support wildlife.

Stabilization of Wet Detention Pond Drainage Area

The area draining to the wet detention pond should remain stabilized to prevent excessive sediment from entering the pond. When bare soil is directly exposed to precipitation, the sediment concentration in runoff is much higher than for soil that is covered and stabilized. A stabilized area is covered by impervious surfaces (pavement, buildings), grass cover, landscaping (mulch, pine straw), etc. It is in the best interest of the pond owner to reduce onsite sediment runoff to the pond, as this will reduce the life span of the pond and result in the need for more periodic, expensive dredging.

Embankments

If pond embankments are not kept well vegetated with grasses, erosion may occur. Erosion can be repaired by filling the small channels and gullies with suitable soil, compacting, and seeding. It may be necessary to install temporary erosion control (such as hay bales) along heavily eroded

areas to allow the repaired areas to stabilize. It is especially important to inspect for and immediately repair any erosion on the dam embankments.

Pipe Inlet and Outlet areas

Where erosion causes the undercutting of the downstream end of pipe, the undercut should be stabilized immediately to prevent the end pipe section from "breaking" off. Eroded areas should be filled with good compactable soil and covered with geotextile fabric and rip-rap.

Open Channel Flow

Eroded areas should be seeded/sodded and protected with temporary velocity dissipation (such as excelsior matting, straw bales, etc.). If erosion continues, a more robust lining should be used.

Blockage of Outlets

Wet detention ponds are designed for the water to exit the pond through the low flow orifice(s), the principal spillway, and the emergency spillway.
It is important to check all three outlets for blockage that would impair the pond's water quality and hydraulic functionality.

Low Flow Orifice(s)

Unless an inverted orifice is used, some type of trash guard is to be maintained over the low flow orifice(s) to prevent clogging. When the orifice becomes clogged the water level rises to the principal spillway elevation and the benefits associated with temporary storage and its gradual release are lost. To preserve "extended detention" the low flow orifice should be inspected for blockage **monthly, or after every runoff-producing rainfall event.**

Principal and Emergency Spillway

Principal and emergency spillways are designed to safely convey one-inch rainfall events, and those larger storms that produce runoff which exceed the water quality volume of the wet detention pond. If these spillways are blocked so they do not operate at full capacity, the risk of dam overtopping or other uncontrolled releases may result. To ensure the hydraulic capacity of the spillways, the spillways should be inspected for blockage **monthly, or after every runoff-producing rainfall event.**

If a riser/barrel is used for the principal spillway, a trash rack is to be maintained on the riser. Vegetative growth in the riser should be removed promptly so that the design capacity of the spillway is maintained. The emergency spillway and outlet area where the barrel projects from the fill slope should be clear of woody vegetation, tree limbs, sediment accumulation, etc.

Sediment Accumulation

To preserve the wet detention pond's pollutant removal capability, sediment must be removed in areas where the capacity of the design sediment storage volume has been exceeded. The pond forebay helps to improve the removal efficiency of the pond system by trapping the majority of coarser suspended solids behind a rock baffle. When sediment deposition in the forebay exceeds the designed sediment storage capacity for the forebay, the forebay must be dredged. Typically, forebays will need to be dredged every 5 to 10 years. Depth measurements relative to the normal surface elevation (bottom of water quality orifice) should be taken at several locations around the pond. The sediment is to be removed when the measured depth is less than the design permanent water depth. Most wet detention ponds are designed for a three to four foot permanent water depth. As sediment accumulates in the pond, the permanent water depth is reduced along with the pond's ability to treat pollutants in the runoff. If a forebay is used at the inlet area of the pond and is regularly dredged, the frequency of dredging the entire pond could be greatly reduced. Check water depth at various points in the pond **semi-annually**. If depth is reduced to 75 % of the original design depth, sediment must be removed to at least the original design depth.

Sediment from most sources is usually not hazardous or contaminated, however, it is very "soupy" and is difficult to manage. It is good idea to provide a storage area near the wet detention pond to place sediment once it is dredged to allow it to dry. If desired, sediment may be land applied and seeded, while following all pertinent soil and erosion control regulations. If land applied on-site, it should be within the drainage area to the pond so sediment that runs off can be recaptured.

Wet Detention Pond Maintenance

Routine Maintenance

Routine maintenance shall include minor upkeep such as mowing; trash and debris removal; minor slope repair and stabilization; periodic structural inspections of the valves, gates, dam, etc.; and tree and brush removal from the dam, spillway, inlet(s), and outlet. These maintenance items may be performed by the owner without review of a Professional Engineer.

Non-Routine Maintenance

Non-routine maintenance shall include such items as sediment clean-out (dredging); channel stabilization; and problems regarding the principal spillway conduits, emergency spillway, dam failure, and seepage. These items require a Registered Professional Engineer to prepare a plan and/or details and to certify completion of the maintenance. All revisions and repairs to permanent runoff control structures shall be done in accordance with City of Greensboro guidelines and specifications.

Maintenance Schedule: estimated schedule - certain ponds may require more or less frequent attention.

I. **Monthly**, or after every runoff-producing rainfall event.
A. Remove trash and debris from the trash rack.
B. Check and clear the orifice of any obstructions.

C. Check the pond side slopes for erosion and remove trash from around the pond.
D. Inspect principal and emergency spillways for blockage.

II. **Quarterly**, or after major storm events (more than 2 inches of rain).
A. Inspect the collection system (e.g. catch basins, piping, grassed swales) for proper functioning. Clear accumulated trash from basin grates and basin bottoms, and check piping for obstructions.
B. Check pond inlet pipes for undercutting, replace rip-rap that is choked with sediment, and repair broken pipes.
C. Check the operation of the gate valve. All valves should be operated from the fully closed to the fully open position.
D. Remove woody vegetation (trees and brush) from dam embankment surfaces and spillway(s).

III. **Semi-Annually**
A. Remove accumulated sediment from the bottom of the outlet structure.
B. Check for presence of rip-rap at inlet pipes and replace if necessary.
C. Check pond depth at various points in the pond. If mean depth is reduced to 75 % of the original design depth, sediment will be removed to at least the original design depth.
D. Check riser and barrel for improper alignment, elongation and displacement of joints, cracks, leaks, loss of protective coating, corrosion, and blockage - repair as necessary.

IV. **General**
A. Mow side slopes according to the season. Maximum grass height should be nine (9) inches.
B. Riparian and aquatic vegetation (willows, alders, cattails, etc.) are encouraged along the perimeter of the pond at the water's edge. However, the dam, emergency spillway, inlet(s), and water control structure should be kept clear of all woody vegetation.
C. In case the ownership of the pond should change, the current owner should, within thirty (30) days of transfer of ownership, notify the City of Greensboro, Stormwater Management Division of such ownership transfer.
D. Excessive plant growth, algae blooms, odors, discoloration, perceived animal pests, etc. should be addressed with the Stormwater Management Division on an as-needed basis. Solutions to these problems should be non-chemical and deemed safe to our drinking water supply.

<u>Annual Inspections</u>
Annual maintenance inspections will be performed by the Stormwater Management Division. The owner of the pond will be notified of the results of the inspections and any maintenance that may be recommended or required.

* for additional information, please consult:

City of Greensboro, Stormwater Management Division. 2000. Stormwater Management Manual. First Edition.

Also available on the internet at:
www.ci.greensboro.nc.us/stormwater/Planning/TechnicalDocuments/SWM_update.pdf

BIORETENTION MAINTENANCE PLAN*

Routine and Non-Routine Maintenance of Bioretention Areas:

Paved Area Sweeping Program

A paved area sweeping program should be implemented for all properties that utilize bioretention areas. Sweeping paved areas on a periodic basis will help extend the life of this best management practice (BMP) by reducing the pollutant load and debris that enters it.

Mowing/Landscaping Activities

Mowing/landscaping activities on the property should to be conducted in such a way to prevent lawn and plant clippings as well as eroded sediment from entering the bioretention area. One way to prevent clippings from entering the cell is to use a mulching mower or bag, and remove clippings. This is especially important in areas that drain to the BMP.

Minimum Inspection and Maintenance Requirements

The following inspection/maintenance activities should be conducted on a **quarterly** (i.e., 4 times per year) basis, unless noted otherwise:
* This information is provided as a typical maintenance plan for bioretention areas in Greensboro. You may find that the specific maintenance needs or timeframe for maintenance of your bioretention area may be slightly different due to site-specific characteristics of your property and stormwater treatment device. For more information, please refer to the City of Greensboro's *Stormwater Management Manual (2000)*.

Overall bioretention area

(a) Remove accumulated litter and debris should be removed from the bioretention area.
The bioretention area should remain clear of trash and debris to preserve the draw down rate and stormwater treatment function of the cell. The type of debris removed should be noted and their possible sources identified. Efforts should be made to reduce the amount of debris entering the bioretention area.

(b) Observe the filtration performance of the cell (every six months at a minimum).
After a storm event the bioretention area should hold several inches of standing water, but this water should drain within one to two days. If not, corrective maintenance to restore proper drawdown time and stormwater treatment performance of the filter bed should be performed in the following order:

1. Clean out the underdrain system.
2. Remove mulch and top few inches of planting soil and replace. The clogged material should be replaced with new material of the original specifications. Contaminated soil should be removed and disposed of at an approved site (landfill). Instead of replacing the top layer of planting soil, it may be possible to aerate or cultivate the first few inches to restore the draw down capacity of the cell.
3. If appropriate draw down time cannot be restored the owner will be required to remove and replace the filter bed and underdrain system.

Pretreatment Area

(a) Inspect energy dissipators for proper functionality.

Energy dissipators (rip-rap pads, check dams, etc) that are used to slow down and spread the runoff before it enters the bioretention area should be inspected for proper functionality. Sediment build-up should be removed. Once the voids become substantially filled with sediment, the rock must be removed, cleaned (away from bioretention area) and placed back in its original location. Larger rock or other measures may be required if the rock is being carried away by high flows.

(b) Inspect filter strips and channels for bare areas, rill or channel erosion.

A healthy stand of grass or similar ground cover for the pretreatment areas must be maintained. Bare areas and eroded areas should be stabilized, and seeded or sodded immediately.

Plantings

(a) Replace plantings that are dead, diseased, or otherwise have failed to establish.

If replacing plantings frequently, the planting soil may need to be tested. Make sure that the plantings used are to able withstand the bioretention environment (e.g. frequent inundation and drying).

(b) Prune and weed as needed or desired.

Make sure that all loose vegetation is removed from the bioretention cell so as not to interfere with the functionality of the cell.

Mulch Layer

(a) Inspect the cell for proper mulch cover.

Mulch needs to be reapplied in areas where erosion has displaced the mulch (mulch just may need spreading out). It will be necessary to replace the mulch layer once a year as the mulch decays. The thickness of mulch should be approximately 3-4 inches.

Soil Media

(a) Test the pH of the soil (annually).

To keep plantings healthy, the planting soil should be tested once a year to determine if the pH is in the acceptable range (5.5-6.5). Contact the Guilford County Cooperative Extension Service for advice on testing your soil and adjusting the pH.

(b) Test the toxicity of the soil (as needed, approximately once every 5 years).
After several years of service, the quantity of heavy metals and other pollutants that are collected by the cell may reach toxic levels, which may impair plant growth and the effectiveness of the cell. If the toxic levels are too high, the soil media must be replaced.

Outlet

(a) Verify that there is discharge from the drain pipe after storm events.
If there is no discharge from the outlet drain pipe, the underdrain system or soil media may be clogged. If so, corrective maintenance is needed immediately to restore the functionality of the bioretention area.
(b) Inspect the overflow grate and pipe to ensure it is not blocked with debris.
(c) Maintain access to the outlet pipe for inspection.
(d) *Inspect for and repair erosion problems at the outlet areas.*
The discharge area at the outlet pipe should be inspected to ensure there is no erosion. A rip-rap energy dissipator, if not already in place, may be needed if erosion continues to occur.

*The design engineer and/or developer should initially be responsible for providing pond owners with inspection and maintenance guidelines.