A-7. SCM Operation & Maintenance

Chapter Contents

The Importance of Maintaining SCMs

SCMs are crucial in protecting water quality from the impacts of development. However, no matter how well they are designed and constructed, SCMs will not function correctly nor remain attractive unless they are properly operated and maintained. Maintenance problems with SCMs are also less costly to correct when they are caught early.

Regular inspection and maintenance is an ongoing regulatory responsibility for most required SCMs– These responsibilities typically include regular inspections throughout the year, maintaining inspection records, and often annual inspections and reporting. A qualified professional should conduct SCM inspections. NC State University offers a SCM Inspection and Maintenance Certification Program: http://www.bae.ncsu.edu/topic/bmp-im/ There are also many companies in NC that specialize specifically in SCM inspection and maintenance.

This chapter will discuss the logistical issues associated with SCM operation and maintenance as well as provide an overview of some of the typical tasks associated with maintaining most SCMs. Each of the individual SCM chapters in this manual also include a table explaining specific inspection and maintenance activities required for a particular SCM to ensure its proper functioning.

Access and Maintenance Easements

SCMs on private property should have access and maintenance easements to provide the legal authority for inspections and maintenance activities. The location and configuration of easements should be established during the design phase and be clearly shown on the design drawings. The entire footprint of the SCM system should be included in the access and maintenance easement, plus an additional ten or more feet around the SCM to provide enough room for the equipment and activities necessary to complete maintenance tasks. This SCM system includes components such as the side slopes, forebay, riser structure, SCM device, and basin outlet, dam embankment, outlet, and emergency spillway.

Access and maintenance easements should be designed and constructed considering the maintenance tasks that may be needed. If heavy equipment will be necessary to perform maintenance tasks (such as for devices with a forebay that will require sediment clean-out), typically a roadway with a minimum width of ten feet to the SCM needs to be available. Easements are usually held by the person responsible for the SCM facility, whether an individual, a corporation, or a government. Easements for SCMs that are not publicly maintained require provisions that allow the permitting entity access for inspection and maintenance.

Inspection & Maintenance Agreements

SCM facilities are typically built, owned and maintained by non-governmental entities. To insure proper long-term maintenance, an Inspection and Maintenance Agreement should be part of the design plans for any SCM. For regulatory purposes, authorities may require that these agreements be signed and notarized. An Inspection and Maintenance Agreement will typically include the following:

- The frequency of inspections that are needed (based on the type of SCM proposed).
- The components of the SCM that need to be inspected.
- The types of problems that may be observed with each SCM component.
- The appropriate remedy for any problems that may occur.

Sample Inspection and Maintenance Agreement provisions are included at the end of each SCM chapter. The most effective Inspection and Maintenance Agreements are site- specific for the SCM components that are used on the site as well as any conditions that are unique to the site (for example, the presence of steep slopes that should be inspected for soil stability).

Table 1: Required Inspection Frequency for SCMs

Inspection Frequency	SCM
Monthly and within 24 hours after every water quality storm (greater than 1.5 inches in Coastal Counties and greater than 1.0 inch elsewhere)	Stormwater Wetlands Wet Detention Basins Bioretention Cells
Quarterly and within 24 hours after every water quality storm (greater than 1.5 inches in Coastal Counties and greater than 1.0 inch elsewhere)	Level Spreaders Infiltration Devices Sand Filters Extended Dry Detention Basins Permeable Pavement Rooftop Runoff Management Filter Strips * Grassed Swales * Restored Riparian Buffers *
*Although these devices require quarterly inspection, mowing will usually be done at more frequent intervals during the growing season.	

To summarize Table 1, devices that include vegetation in a highly engineered system require inspection monthly and after large storm events to catch any problems with flow conveyance or vegetative health before they become serious. All other SCMs should be inspected at least quarterly and after large storm events.

When required, signed and notarized Inspection and Maintenance Agreements should be recorded with the appropriate Register of Deeds. The responsible party should keep a copy of the Inspection and Maintenance Agreement along with a current set of SCM plans at a known set location. It is also crucial that these documents be passed on when responsibility for maintenance is transferred to a different party.

Inspection & Maintenance Record Keeping

All inspection and maintenance activities should be recorded. One easy way to do this is to create an Inspection and Maintenance checklist based on the Inspection and Maintenance Agreement. The checklist, at a minimum, should include the following:

- Date of inspection.
- Condition of each of the SCM elements.
- Any maintenance work that was performed (as well as who performed the work).
- Any issues noted for future maintenance (sediment accumulating, vegetation needing pruning or replacement, etc.).

Each SCM should have its own maintenance record. Records should be kept in a log in a known set location. Any deficient SCM elements noted in the inspection should be corrected, repaired or replaced in a timely manner. Some deficiencies can affect the integrity of structures, safety of the public, and the function of the SCM.

Major repairs or maintenance work should include the same level of inspection and documentation as original installations. Inspection checklists and record logs should be kept in a known set location.

Maintenance Responsibilities

As stated in the section above, maintenance is usually the responsibility of the owner, which in most cases is a private individual, corporation, or home owner's association. Simple maintenance items such as minor landscaping tasks, litter removal, and mowing can be done by the owner, or can be incorporated in conventional grounds maintenance contracts for the overall property.

Although a non-professional can undertake many maintenance tasks effectively, a professional should be consulted periodically to ensure that all needs of the SCM facility are met. Some elements that would benefit from professional judgment include structures, outlets, embankments, and dams by a professional engineer, as well as plant system health by an appropriate plant professional. Some developing problems may not be obvious to the untrained eye.

In addition, it is advisable to have professionals do the more difficult or specialized work. Filling eroded areas and soil-disturbing activities, such as re-sodding or replanting vegetation, are tasks that are best assigned to a professional landscaping firm. If the work is not done properly the first time, not only will the effort have been wasted, but also the facility may have been damaged by excessive erosion. Grading and sediment removal are best left to professional contractors. Appropriate professionals (e.g. SCM maintenance specialists, professional engineers, aquatic plant specialists, etc.) should be hired for specialized tasks such as inspections of vegetation and structures.

Providing for Maintenance Expenses

The expenses associated with maintaining a SCM are highly dependent on the SCM type and design. However, the most important factor that determines the cost of SCM maintenance is the condition of the drainage area upstream of the SCM. If a drainage area conveys a high load of sediment and other pollutants to a SCM, the cost of maintaining the SCM will increase dramatically. Preventing pollution in the drainage area as much as possible will reduce the cost of SCM maintenance.

A funding mechanism should be created and maintained at a level that provides adequate funding to pay for the maintenance expenses over the lifetime of the SCM. One option is to

establish an escrow account, which can be spent solely for sediment removal, structural, biological or vegetative replacement, major repair, or reconstruction of the SCMs. In the case of a residential subdivision, the escrow account could be funded by a combination of an initial payment by the developer and regular contributions by the homeowners' association. For an example of how to legally structure such an account, please see the Phase II model stormwater ordinance at the Stormwater Program web site. Routine maintenance costs may be relatively easy to estimate, and include the expenses associated with the following activities:

- Conducting SCM inspections at the intervals shown in Table 1.
- Maintaining site safety, including any perimeter fences and other access inhibitors (trash racks or pipe grates).
- Removing trash.
- Removing sediment that has accumulated in any components of the SCM.
- For infiltration-type systems, maintaining the filtering media and cleaning or replacing it when necessary.
- Restoring soils to assure performance.
- Mowing turf grasses or maintaining other types of ground covers
- Controlling weeds and other invasive plants
- Pruning woody vegetation.
- Thinning desired vegetation
- Replacing dead vegetation.
- Stabilizing any eroding side slopes.
- Repairing damaged or eroded outlet devices and conveyance systems.
- Repairing embankments, dams, and channels due to erosion or rodents.

Emergency maintenance costs are more difficult to estimate. They depend on the frequency of occurrence and the nature of the problem, which could vary from storm erosion repairs to complete failure of a structure.

Emergency Maintenance

Maintenance after floods and other emergencies requires immediate mobilization. It can include replanting and repairs to structures. Living systems are likely to need at least minor repairs after emergencies. Following an emergency such as a flood, standing water may pose health risks because of mosquitoes. Mosquito control should be considered if this becomes a problem.

For all installations, obstructions and debris deposited during storm events should be removed immediately. Exceptions include debris that provides habitat and does not damage vegetation or divert currents to, from, or in the SCM. In fact, because of the high quality habitat that can be found in woody debris, careful re-positioning rather than complete removal may be desirable. There may be instances where debris is even added. Such locations should be noted so that this debris is not accidentally removed. Educating adjacent property owners about the habitat benefits of debris and vegetation can decrease requests for removal.

Debris & Litter Removal

Regularly removing debris and litter is well worth the effort and can be expected to help in the following ways:

- Reduce the chance of clogging in outlet structures, trash racks, and other facility components.
- Prevent damage to vegetated areas.
- Reduce mosquito breeding habitats.
- Maintain facility appearance.
- Reduce conditions for excessive surface algae.
- Reduce the likelihood of stagnant pool formation.

Special attention should be given to removing floating debris, which can clog outlet devices and risers.

Sediment Removal & Disposal

Sediment gradually accumulates in many SCMs. For most SCMs, accumulated sediment must eventually be removed. However, removal intervals vary so dramatically among facilities that no "rules of thumb" are applicable. The specific setting of a SCM is important in determining how often sediment must be removed. Important factors that determine rates of sedimentation include the current and future land uses upstream and the presence of other sediment-trapping SCMs upstream.

Before installing a SCM, designers should estimate the lifetime sediment accumulation that the SCM will have to handle. Several time periods may be considered, representing expected changes in land use in the watershed. To estimate sediment accumulation, first, an estimate of the long term sediment load from upstream is needed, then an estimate of SCM sediment removal efficiency (see Sections 3.0 and 4.0). The analysis of watershed sediment loss and SCM efficiency can be expedited by using a sediment delivery computer model.

The frequency of sediment removal is then based on the sediment accumulation rate described above versus the amount of sediment storage volume that is inherently provided in the SCM without affecting treatment efficiency or stormwater storage volume. Again, the frequency of sediment removal is SCM and site specific, and could be as frequent as every couple years, or longer than 15-25 years. The volume of sediment needing to be removed and disposed of per dredging cycle is the volume calculated above multiplied by any density or dewatering factors, as appropriate.

Wet sediment is more difficult and expensive to remove than dry sediment. Ideally, the entire facility can be drained and allowed to dry sufficiently so that heavy equipment can operate on the bottom. Provisions for draining permanent pools should be incorporated in the design of water impoundments where feasible. Also, low flow channels and outlets should be included in all SCMs to bypass stormwater flow during maintenance. However, in many impoundments, periodic rainfall keeps the sediment soft, preventing access by heavy equipment. In these

cases, sediment may have to be removed from the shoreline by using backhoes, grade-alls, or similar equipment.

Proper disposal of the sediment removed from a SCM must be considered. It is least expensive if an onsite area or a nearby site has been set aside for the sediment. This area should be located outside of the floodplain to prevent migration of the sediment if flooding occurs prior to stabilization. If such a disposal area is not set aside, transportation and landfill tipping fees can greatly increase the cost of maintaining the SCM, especially where disposal of wet sediment is not allowed in the local landfill., Often, the material must be dewatered before disposal, which again adds more cost and requires land area where wet material can be temporarily placed to dry.

Sediment removal is usually the largest single cost of maintaining a SCM facility so the necessary funds should be allocated in advance. Since sediment removal costs are so site specific and dependent on disposal plans, it is difficult to provide good estimates. Actual estimates should be obtained during the design phase of the SCM from sediment removal contractors based on the planned situation. The estimates should include: mobilization expenses, sediment removal expenses, material transport expenses (if applicable), and disposal expenses (if applicable).

Stability & Erosion Control

The best way to promote soil stability and erosion control is to maintain a healthy ground cover in and around SCMs. Areas of bare soil quickly erode, potentially clogging the facility with sediment and threatening its integrity. Therefore, bare areas must be re- stabilized as quickly as possible. Newly seeded areas should be protected with mulch and/or an erosion mat that is securely staked. For SCM's that rely on filtration, such as bioretention facilities, it is critical that adjacent soils do not contaminate the selected media during or after construction. If the site is not permanently stabilized with vegetation when the filter media is installed, the best design practice is to specify sod or other robust erosion control practices for all slopes in and immediately around the SCM.

Erosion more often occurs in or around the inlet and outlet of SCM facilities and should be repaired as soon as possible.

The roots of woody growth such as young trees and bushes in embankments are destabilizing and may result in premature failure if unchecked. Consistent mowing of the embankment controls stray seedlings that take root. Woody growth, such as trees and bushes, further away from the embankment should not pose a threat to the stability of the embankment and can provide important runoff filtering benefits. Trees and bushes may be planted outside maintenance and access areas.

Animal burrows also diminish the structural integrity of an embankment. Muskrats, in particular, burrow tunnels up to 6 inches in diameter. Efforts should be made to control animal burrowing. Burrows should be filled as soon as possible.

Maintenance of Mechanical Components

SCMs may incorporate mechanical components that need periodic attention. For example, valves, sluice gates, fence gates, locks, and access hatches should be functional at all times. The routine inspection, exercising, and preventive maintenance on such mechanical components should be included on a routine inspection and maintenance checklist.

Vegetation Maintenance

Vegetation maintenance is an important component of any maintenance program. The grasses and plants in all SCMs, but particularly in vegetative SCMs such as filter strips, grass swales, restored riparian buffers, bioretention facilities, and stormwater wetlands, require regular attention. The development of distressed vegetation, bare spots, and rills indicates that a SCM is not functioning properly. Problems can have many sources, such as:

- Excessive sediment accumulation, which clogs the soil pores and produces anaerobic conditions.
- Nutrient deficiencies or imbalances, including pH and potassium.
- Water-logged conditions caused by reduced soil drainage or high seasonal water table.
- Competition from invasive weeds.
- Animal grazing

The soil in vegetated areas should be tested every other year and adjustments made to sustain vigorous plant growth with deep, well-developed root systems. Aeration of soils is recommended for filter strips and grassed swales where sediment accumulation rates are high. Ideally, vegetative covers should be mown infrequently, allowing them to develop thick stands of tall grass and other plant vegetation. Also, trampling from pedestrian traffic should be prevented.

Areas immediately up and downstream of some SCM plant installations are more likely to experience increased erosion. Properly designed, located, and transitioned installations experience may reduce accelerated erosion. All erosion should be repaired immediately to prevent spreading.

Table 2 below describes some typical vegetation maintenance. It is important to note that specific requirements related to some management practices, such as those performed within buffers, must be followed. In addition, any vegetation that poses threats to human safety, buildings, fences, and other important structures should be addressed. Finally, vegetation maintenance activities typically change as the project ages.

Table 2: Vegetation Maintenance for SCMs

Maintenance Activity	Instructions
Replacement of Dead Plants	All dead plants should be removed and disposed of. Before vegetation that has failed on a large scale is replaced, the cause of such failure should be investigated. If the cause can be determined, it should be eliminated before any reinstallation.
Fertilization	The objective of fertilizing at a SCM is to secure optimum vegetative growth rather than yield (often the objective with other activities such as farming). Infertile soils should be amended before installation and then fertilized periodically thereafter. Fertilizer can be composed of minerals, organic matter (manure), compost, green crops, or other materials.
Irrigation/ Watering	Watering of the vegetation can often be required during the germination and establishment of the vegetation, as well as occasionally to preserve the vegetation through drought conditions. This can typically be accomplished by pumping water retained in the SCM or from the stream, installing a permanent irrigation system or frost-proof hose bib, or using portable water trucks.
Mulching	Mulching should be used to maintain soil temperature and moisture, as well as site aesthetics. A half-inch layer is typically adequate. Ideally, mulch should be removed before winter to prevent an infestation of rodents.
Weeding	Weeding is often necessary in the first growing season, particularly if herbaceous grasses are out-competing the young woody vegetation growth. The need for weeding may be largely eliminated by minimizing the amount of seed used for temporary erosion control. Weeding may also be required if, over time, invasive or undesirable species are entering the site and out-competing plants that are specifically involved in the treatment of the stormwater.
Cultivating/ Hoeing	Hoeing is often required to loosen overly compacted soil and eliminate weeds that compete with the desirable vegetation.
Pruning	Pruning is used to trim to shape and remove dead wood. It can force single-shoot shrubs and trees to assume a bushier configuration.

Thinning	Thinning dense vegetation may be necessary to thrive, to maintain open areas of water as well as aesthetics, increase the vigor of individual specimens, to reduce flow obstructions, and to increase the ability of maintenance staff to access the entire SCM. Tall maturing trees, for the most part, have no place in a SCM (except for buffers) and should be removed as soon as possible.
Staking	Saplings of tall trees planted in or near the SCM may require staking. Care should be taken not to damage the tree's roots with stakes. Stakes should be kept in place for 6 to 18 months, and the condition of stakes and ties should be checked periodically.
Wound Dressing	The wounds on any trees found broken off or damaged should be dressed following recommendations from a trained arborist.
Disease Control	Based on monitoring observations, either insecticides or (preferably) organic means of pest and fungal control should be used.
Protection from Animal & Human Foot Traffic	Fencing and signage should be installed to warn pedestrians and to prevent damage due to trampling. These measures are often most necessary during early phases of installation but may be required at any time. Measures for controlling human foot traffic include signs, fencing, floating log barriers, impenetrable bushes, ditches, paths, and piled brush. Wildlife damage is caused by the animals browsing, grazing, and rubbing the plants. The use of chemical wildlife repellents should be avoided. Fences and meshes can be used to deter entry to the SCM. Tree tubes can be used to prevent damage to individual specimens.
Mowing	Mowing of perennial herbaceous grasses and wildflowers, especially once seed heads have set, promotes redistribution of seed for this self-sustaining system. Mowing should be carefully controlled, however, especially when performed for aesthetics. As adjacent property owners and customers in general learn more about SCMs, their vision of what is aesthetically pleasing can change. Grasses, in healthy herbaceous stands, should never be mown more than once per year.

Maintenance of the Aquatic Environment

An important yet often overlooked aspect of SCMs that maintain a permanent pool is the need to regularly monitor and manage conditions to promote a healthy aquatic environment. An indicator of excess nutrients (a common problem) is excessive algae growth in the permanent pool of water. Often, these problems can be addressed by encouraging the growth of more desirable aquatic and semi-aquatic vegetation in and around the permanent pool. The plants selected should be tolerant of varying water levels and have a high capacity to incorporate the specific nutrients associated with the problem. Unchecked algae growth may result in aesthetic and odor problems and algae-laden water can be washed downstream during rain contributing to nuisance odors and stresses in downstream aquatic habitat.

Insect Control

Under the right conditions, ponded water can become a breeding ground for mosquitoes. Many mosquito problems can be minimized through proper design and maintenance. The best control technique for SCMs that maintain a permanent pool of water is to ensure that the design discourages mosquito breeding habitat and encourages mosquito predators. Research at NC State University has shown that Mosquitofish (Gambusia holbrooki) can be effective in the control of mosquito populations in SCMs. This may include establishing combinations of deep and shallow areas that encourage Mosquitofish as well as avoiding overhanging trees and other vegetation that creates shade conducive to mosquito breeding and discourages dragonflies, birds, bats, and other desirable predators. In larger basins, fish, which feed on mosquito larvae, can be stocked. Additionally, splash aerators can be employed to prevent stagnant water, however, this requires electricity at the site, increases maintenance costs and must be properly designed so as to not decrease the settling efficiency of the SCM. Where feasible, SCMs may incorporate a source of steady dry weather flow to reduce stagnant water.

Maintenance of Other Project Features

All other devices and features associated with the SCM should be monitored and maintained appropriately. These additional items could affect the safety or aesthetics of the facility, which can be as important if not more important than the operational efficiency of the facility. Such items could include:

- Fences
- Access roads
- Trails
- Lighting
- Signage (e.g. no trespassing, emergency notification contact information, etc.)
- Nest boxes
- Platforms
- Watering system