

PDB/BMP OPERATIONS & MAINTENANCE MANUAL

Cherokee Metropolitan District WRF

TDS Reduction Project

El Paso County, Colorado

Prepared for



Cherokee Metropolitan District
6250 Palmer Park Boulevard
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1.0 FACILITY DESCRIPTIONS AND MAINTENANCE CHECKLISTS

Each of the following subsections includes a facility description, illustrated exhibit, and maintenance checklist for common stormwater facilities/components utilized in the Cherokee Water Reclamation Facility (WRF) Total Dissolved Solids (TDS) Reduction Facility.

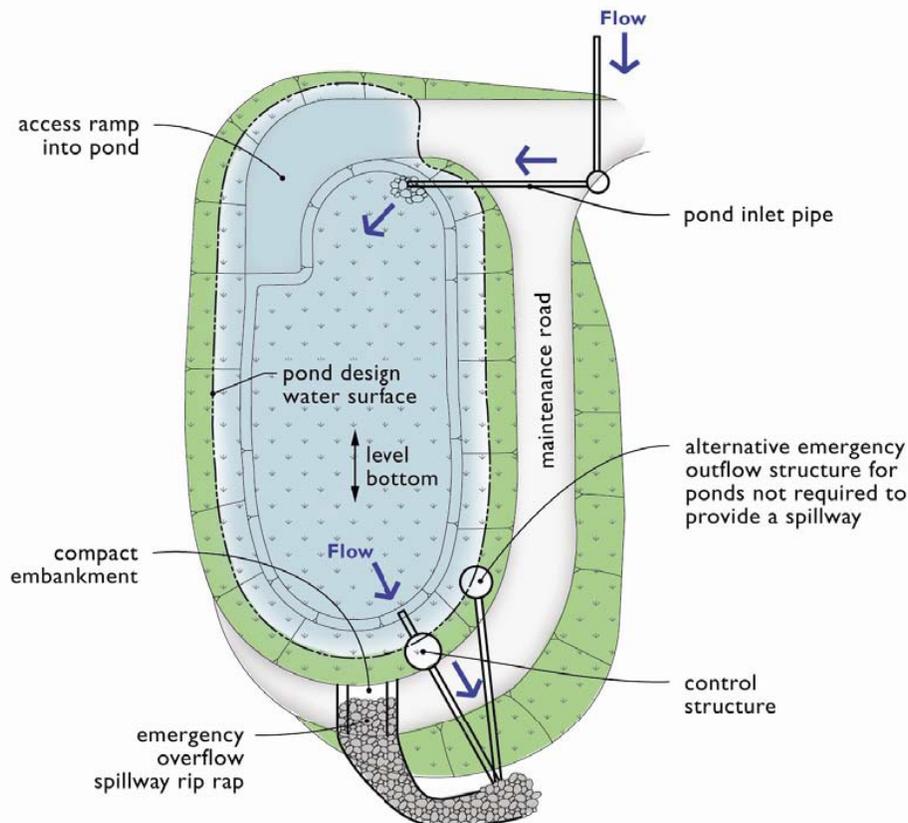
These include:

1. Detention Ponds
2. Control Structure/ Flow Restrictor
7. Energy Dissipators
8. Typical Biofiltration Swale
21. Grounds (Landscaping)

Private stormwater facility owners should print the checklists that apply to their facilities and follow the inspection recommendations and frequencies.

1.1 Detention Ponds

Stormwater detention ponds are open basins built by excavating below existing ground or by constructing above-ground berms (embankments). The detention pond temporarily stores stormwater runoff during rain events and slowly releases it through an outlet (control structure). Components that are typically associated with a detention pond include the following: control structure/flow restrictor, debris barrier (e.g. trash rack), energy dissipaters, access road, and fence.



Detention Ponds Checklist

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
M,S	General					Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
A	General					Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local weed board) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
M,S	General					Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants	No contaminants or pollutants present. (Coordinate removal/cleanup with local water quality response agency).
M	General					Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
M	General					Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
A	General					Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.
A	General					Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).

Detention Ponds Checklist (Continued)

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
							trees are not interfering with access or maintenance, do not remove	
A	General						If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Remove hazard Trees
M	Side Slopes of Pond					Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
M,S	Side Slopes of Pond						Any erosion observed on a compacted berm embankment.	If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
M	Storage Area					Sediment	Accumulated sediment that exceeds 10% (typically 6" to 12") of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
M	Storage Area					Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
A	Pond Berms (Dikes)					Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
A	Pond Berms (Dikes)					Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.

Detention Ponds Checklist (Continued)

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
A	Emergency Overflow/ Spillway					Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
A	Emergency Overflow/ Spillway					Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.

Key:

(M) Monthly from November through April.

(A) Once in late summer (preferably September)

(S) After any major storm (use 1-inch in 24 hours as a guideline).

Extended detention basins have low to moderate maintenance requirements. Routine and nonroutine maintenance is necessary to assure performance, enhance aesthetics, and protect structural integrity. The dry basins can result in nuisance complaints if not properly designed or maintained. Bio-degradable pesticides may be required to limit insect problems. Frequent debris removal and grass-mowing can reduce aesthetic complaints. If a shallow wetland or marshy area is included, mosquito breeding and nuisance odors could occur if the water becomes stagnant. Access to critical elements of the pond (inlet, outlet, spillway, and sediment collection areas) must be provided. The basic elements of the maintenance requirements are presented in the following table.

Required Action	Maintenance Objective	Frequency of Action
Lawn Mowing & Lawn Care	Occasional mowing to limit unwanted vegetation. Maintain irrigated turf grass as 2 to 4 inches tall and nonirrigated native turf grasses at 4 to 6 inches.	Routine – Depending on aesthetic requirements.
Debris & Litter Removal	Remove debris and litter from the entire pond to minimize outlet clogging and improve aesthetics.	Routine – Including just before annual storm seasons (that is, April and May) and following significant rainfall events.
Erosion & Sediment Control	Repair and revegetate eroded areas in the basin and channels.	Nonroutine – Periodic and repair as necessary based on inspection.
Structural	Repair pond inlets, outlets, forebays, low flow channel liners, and energy dissipators whenever damage is discovered.	Nonroutine – Repair as needed based on regular inspections.

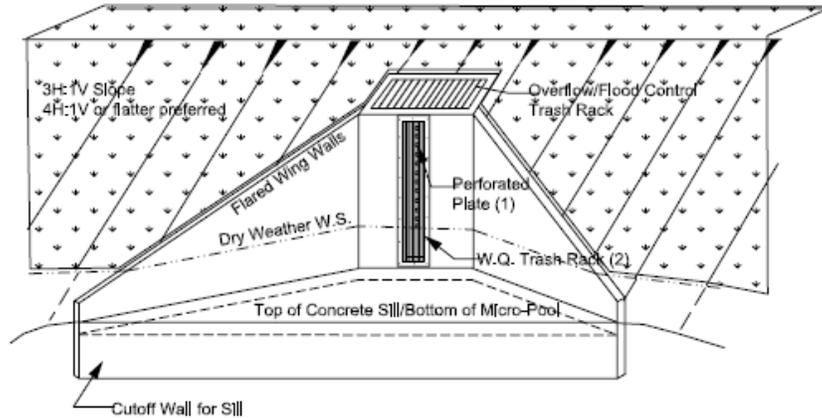
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Required Action	Maintenance Objective	Frequency of Action
Inspections	Inspect basins to insure that the basin continues to function as initially intended. Examine the outlet for clogging, erosion, slumping, excessive sedimentation levels, overgrowth, embankment and spillway integrity, and damage to any structural element.	Routine – Annual inspection of hydraulic and structural facilities. Also check for obvious problems during routine maintenance visits, especially for plugging of outlets.
Nuisance Control	Address odor, insects, and overgrowth issues associated with stagnant or standing water in the bottom zone.	Nonroutine – Handle as necessary per inspection or local complaints.
Sediment Removal	Remove accumulated sediment from the forebay, micro-pool, and the bottom of the basin.	<p>Nonroutine – Performed when sediment accumulation occupies 20 percent of the WQCV. This may vary considerably, but expect to do this every 10 to 20 years, as necessary per inspection if no construction activities take place in the tributary watershed. More often if they do.</p> <p>The forebay and the micro-pool will require more frequent cleanout than other areas of the basin, approximately every 3 to 6 months until the concrete liners are constructed. After each concrete liner is constructed, slightly less frequent cleanout will be required, approximately every 1 or 2 years.</p>

1.2 Control Structure/Flow Restrictor

Control structures/flow restrictors are located on the outlet pipe of a detention system. The control structure is typically a concrete catch basin with a riser. The control structure reduces the discharge rate of stormwater from a detention facility. The flow is regulated by a combination of orifices (holes with specifically sized diameters) and weirs (plates with rectangular or vee shaped notch).

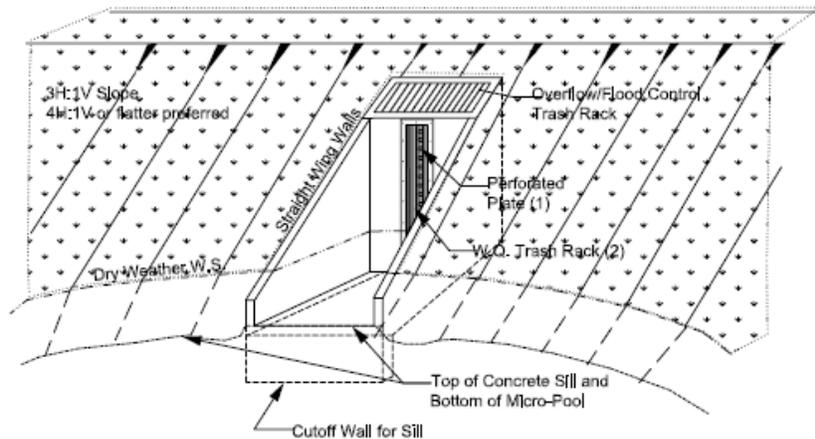
Lack of maintenance of the control structure can result in the plugging of an orifice. This can result in flooding of the stormwater system and/or an increase in the rate of discharge from the site potentially damaging downstream property.



Notes:

- (1) Mounted to the back of the headwall
- (2) Mounted to the front of the headwall

Perspective View of a Standardized Water Quality Outlet with Flared Wing Walls



Notes:

- (1) Mounted to the back of the headwall
- (2) Mounted to the front of the headwall

Perspective View of a Standardized Water Quality Outlet with Straight Wing Walls

Control Structure/Flow Restrictor Checklist

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
M	General					Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
A	General					Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
A	General					Structural Damage	Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
A	General					Structural Damage	Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
A	General					Structural Damage	Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
A	Cleanout Gate					Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
A	Cleanout Gate					Damaged or Missing	Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
A	Cleanout Gate					Damaged or Missing	Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
A	Cleanout Gate					Damaged or Missing	Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
A	Orifice Plate					Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
M,S	Orifice Plate					Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
	Overflow Pipe					Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
A	Manhole					Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.

Control Structure/Flow Restrictor Checklist (Continued)

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
A	Manhole					Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
A	Manhole					Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
A	Manhole					Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.

Key:

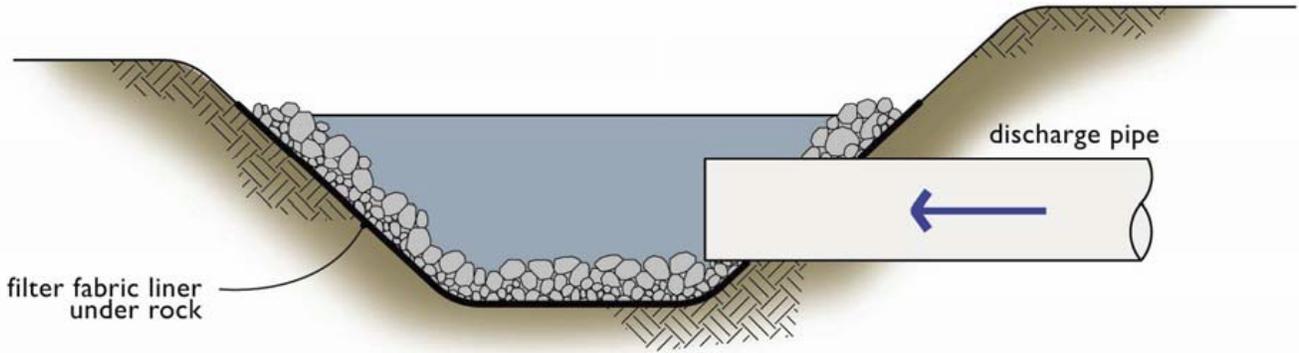
(M) Monthly from November through April.

(A) Once in late summer (preferably September)

(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.4 Energy Dissipaters

Energy dissipaters are provided on the inlet and outlet to a closed pipe system to prevent erosion at these locations. Design of an energy dissipater can vary significantly from highly engineered systems (concrete or rock gabion structures) to the more commonly used rock pad. The rock pad is typically constructed of 4- to 12-inch diameter rocks a minimum of 12 inches thick and is often lined with filter fabric. The rock pad should extend above the top of the pipe a minimum of 1 foot.



3.7 Energy Dissipaters Checklist

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
External:								
MONTHLY	Rock Pad					Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
MONTHLY	Rock Pad					Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.

Key:

(M) Monthly from November through April.

(A) Once in late summer (preferably September)

(S) After any major storm (use 1-inch in 24 hours as a guideline).

1.4 Typical Grass Swale

Grass swales are engineered grass-lined open channels with moderate centerline slope similar in appearance to typical ditches. The following check list gives some general guidance for grass swale management.

3.8 Typical Biofiltration Swale Checklist

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
MONTHLY	General					Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
MONTHLY	General					Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
MONTHLY	General					Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
MONTHLY	General					Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
MONTHLY	General					Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
MONTHLY	General					Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.

Typical Biofiltration Swale Checklist (Continued)

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
MONTHLY	General					Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
MONTHLY	General					Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
MONTHLY	General					Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
MONTHLY	General					Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Key:

(M) Monthly from November through April.

(A) Once in late summer (preferably September)

(S) After any major storm (use 1-inch in 24 hours as a guideline).

1.5 Grounds (Landscaping)

Landscaping is an essential component of stormwater management. Bare soil areas generate higher levels of stormwater runoff and sedimentation in stormwater facilities. The following check list gives some general guidance for landscape management.

Grounds (Landscaping) Checklist

Frequency	Drainage System Feature	Date				Problem	Conditions to Check For	Conditions That Should Exist
		✓	✓	✓	✓			
M	General					Weeds (nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
M	General					Insect hazard or poisonous vegetation	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
M,S	General					Trash or litter	See Ponds Checklist.	See Ponds Checklist.
M,S	General					Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
A	Trees and shrubs					Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
M	Trees and shrubs					Damage	Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A	Trees and shrubs					Damage	Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.

Key:

(M) Monthly from November through April.

(A) Once in late summer (preferably September)

(S) After any major storm (use 1-inch in 24 hours as a guideline).

2.0 DEVELOPING A MAINTENANCE PROGRAM

A stormwater maintenance program is essential to ensure that the facilities continue to function as designed to prevent possible flooding and property damage. The maintenance program consists of inspections and repairs.

Stormwater management facilities are not intended to replace good housekeeping procedures. Good housekeeping includes educating facility users of proper storage and disposal of chemicals and potential pollutants, procedures for spill cleanup, proper use of fertilizers and other lawn care products, and maintenance of equipment to prevent release of pollutants to the stormwater system. Guidelines for establishing good housekeeping procedures can be found in the Stormwater Management Plan (SWMP) developed for this project.

2.1 Who Should Perform Maintenance Duties?

Private stormwater facility owners are responsible for ensuring that the facilities are maintained and continue to function as designed. Some activities such as litter removal and mowing can be effectively undertaken by facility owners, however, it is usually worth the cost to have a professional do the more difficult tasks. Filling eroded areas and soil disturbing activities, such as reseeded or re-planting vegetation are tasks that a professional landscaping firm should manage. If these tasks are not performed properly, erosion may occur resulting in accelerated sedimentation of stormwater facilities. Grading and sediment removal are tasks that are best left to professional contractors with the equipment and experience to safely perform the task and who are also able to identify potential problems early when it is most cost effective to make repairs or alterations.

2.2 Working with Maintenance Contractors

Selecting and working with a maintenance contractor can be an intimidating process for many private facility owners. The following is a guideline for researching and choosing a qualified contractor to meet your maintenance needs.

Start your search for a contractor the right way - be informed. The information provided below will help you in your search for the right contractor for your job.

- Landscape maintenance contractors are typically capable of providing most routine maintenance for stormwater facilities. Special, non-routine maintenance may require an earthwork contractor or factor company. Recently, several contractors have started specializing in stormwater facility maintenance. Private owners can choose to hire contractors when individual maintenance needs arise or enter into annual maintenance agreements where the contractor monitors and provides routine maintenance throughout the year as needed.
- Develop a list of potential contractors. Look in the Yellow Pages and/or ask friends, neighbors, relatives, and coworkers who they have used. Find out if their experiences were good or bad and why. Ask if they would use the contractor again.
- Ask contractors for references. Call your potential contractors and ask for a list of their customers or locations of completed jobs. Call references and ask whether they were satisfied with the job done, if the contractor kept to the agreed upon schedule, and whether they would hire the same contractor again.
- Ask to which trade associations the contractor belongs. Membership in a professional association is one sign the contractor recognizes the responsibilities of being a professional.
- Make sure to obtain and evaluate bids. Ask for a free written estimate of the work you want done. Be sure everyone is bidding on the same exact scope of work and including the exact materials you want. Be sure all quotes include everything you want and that there is a clear understanding of work to be performed by owner and work to be performed by contractor.

- Remember "you get what you pay for." A higher bid may be worth the price for better workmanship and contractor reliability.
- Make sure you understand the different types of bids you may receive. Be careful about hiring a contractor on an hourly time-and-materials, or costplus basis. Although the price may seem high at first, a fixed-price bid may give you the best protection and price. Also beware of "special deals, demonstration projects," or "a great deal from a friend of a friend." Completely review and understand the contract prior to authorizing work.

2.3 How much will it Cost to Maintain a Stormwater Management System?

Specific maintenance costs depend on the characteristics of the facility, the site, and the area that contributes runoff to the facility. The general rule of thumb is that annual maintenance costs will be 5 to 10% of the facility's total capital cost. Routine, scheduled maintenance can help keep overall costs down by addressing problems before they require major attention.

Most of the routine maintenance measures recommended in the checklists (excluding major repair and replacement) are estimated to have an annual cost of \$200 to \$600 per acre of facility, above current landscape maintenance costs. Costs can vary depending on the types and level of maintenance practices used.

The cost and intensity of maintenance activities are usually higher during the two-year plant establishment period than after the facility has "settled in" after those first two years. You need to determine how you will finance your maintenance needs. A healthy reserve should be put into place for both capital maintenance procedures (e.g., facility replacement and non-routine maintenance such as sediment removal, facility component repair or replacement, major replanting, or safety structure construction) and operating maintenance procedures (routine activities such as facility inspection, debris removal, and vegetation management).

The best recommendation is to establish a facility maintenance fund. The fund should include:

- Ten percent of the facility's capital cost for annual routine maintenance per year.
- A percentage of the non-routine maintenance costs per year (i.e. for sediment removal, vegetation replacement) based on the frequency of removal. For example, if the facility needs mechanical sediment removal every 10 years, 10 percent of the total cost should be put aside each year.
- An additional 3 to 5% of the facility's capital cost per year for eventual facility replacement, based on the facility's life expectancy. Most of these facilities have a life expectancy of 25 to 50 years.