ABSTRACT

A PRACTICUM WITH CLERMONT COUNTY: STORMWATER REGULATIONS

by Samuel Mutiti

Clermont County is located in the southwestern part of Ohio, bordering Kentuck. The Office of Environmental Quality (OEQ) is responsible for monitoring and characterizing the process that impact the environment environmental conditions within Clermont County. I undertook a practicum with OEQ working as a research consultant on a stormwater project from October 2002 to March 2003. The project involved formulating stormwater management programs for areas that were not covered by the Phase I rules and other stormwater regulations. Relevant information from this project was included in Clermont County's Phase II permit application, which was submitted to USEPA. Best management practices (BMPs) were determined by reading literature on stormwater management practices from eclectic sources. This report includes USEPA's requirements for Phase II, my recommendations on what should be included in Clermont County's stormwater program, a summary of ordnances, BMPs that could be implemented and information on programs from other municipalities.

A PRACTICUM WITH CLERMONT COUNTY: STORMWATER REGULATIONS

A Practicum

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Samuel Mutiti
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Advisor: _____

Dr. Avram Primack

Reader_____

Dr. Vincent Hand

Reader_____

Dr. Gene Willeke

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Chapter 1

Introduction

From October 2002 to March 2003, I undertook a project on stormwater management with Clermont County. Clermont County is located in the southwest part of Ohio, boadering Kentucky (Figure 1). The project served as my practicum and fulfilled the research and/or work experience requirement for the Master in Environmental Sciences at Miami University. The practicum involved helping Clermont County to develop a stormwater plan that would meet the requirements of the new USEPA's Phase II stormwater rule (Phase II Rule). I was delighted to undertake this particular practicum because my area of interest is water resource management, and this project involved working as a research consultant on a storm water project.

On December 8, 1999, USEPA published new storm water rules that required operators of Municipal Separate Storm Sewer Systems (MS4s) in both urbanized and rural areas to develop and implement new stormwater management programs. The Phase II Rule required:

> "The operator of a regulated small municipal separate storm sewer system (MS4), to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage because your storm water discharges are considered "point sources" of pollution. MS4s are considered point sources because they discharge storm water into discrete conveyances, including roads with drainage systems and municipal streets. MS4s are publicly owned or operated and are designed or used for collecting or conveying storm water" (USEPA, 2000).

Under this rule, USEPA required all publicly operated storm sewer systems that served 10, 000 or more people to apply for new permits. Small MS4s were also required to reduce discharge of pollutants to the maximum extent practicable (MEP), protect water quality and satisfy water quality requirements of the Clean Water Act. To implement this rule, each MS4 should implement best management practices (BMPs) and achievement goals. The definition of MS4 can be found in Appendix I, "Background and Regulatory Context of the Phase II Rule". Achievement goals are defined by USEPA as "objective markers or milestones that you (and the permitting authority) will use to track the progress and effectiveness of your BMPs in reducing pollutants to the MEP", (USEPA, 2003).

All stormwater management programs were required to address the following six "minimum control measures":

1. Public Education and Outreach
2. Public Participation/Involvement
3. Illicit Discharge Detection and Elimination
4. Construction-Site Runoff Controls
5. Post-Construction Runoff Controls
6. Pollution Prevention and Good House Keeping

During my practicum, I conducted research on stormwater programs and BMPs that Clermont County could implement in order to comply with USEPA's permit application requirements. The BMPs were not only for the permit application process but also for making Clermont County's future stormwater program(s) more effective in improving water quality. Appendix II, "BMP Explanation and Implementation Detail", provides USEPA's detailed explanation of some of the BMPs suggested in this practicum, as requested by Office Environmental Quality (OEQ). After conducting research, I put together information on what should be included in the stormwater programs for the three minimum requirements (illicit discharge and elimination, construction runoff and post construction runoff prevention) that OEQ had asked me to examine. The county was also interested in information on roughly how much it would cost to implement the program. Appendix III contains information on costs of stormwater program elements from USEPA.

Clermont County Office of Environmental Quality

The Office of Environmental Quality is the agency in charge of monitoring environmental conditions and characterizing processes that affect the environment in Clermont County. Their office is located in Batavia, Clermont Ohio (Figure 2). The agency has been conducting water quality and biological monitoring in Clermont County and East Fork Little Miami River Watershed since 1996. Through the Adams-Clermont County Solid Waste District, OEQ is responsible for solid waste management in both Clermont and Adams Counties. The agency is formulating models that can be used to characterize current environmental problems and predict future changes caused by humans with a view to creating a balance between development and natural processes (OEQ, 2003).The agency is headed by Paul Braasch who is the agency's coordinator. Other staff include Mr John McManus (environmental scientist), Jay Dorsey (East Fork Watershed manager) and Carol Bachelier (Information Specialist).

Location

Figure 1: Ohio county map with Clermont County highlighted in red, while the white lines are rivers

Source: http://ohiowatersheds.osu.edu/wgp.php

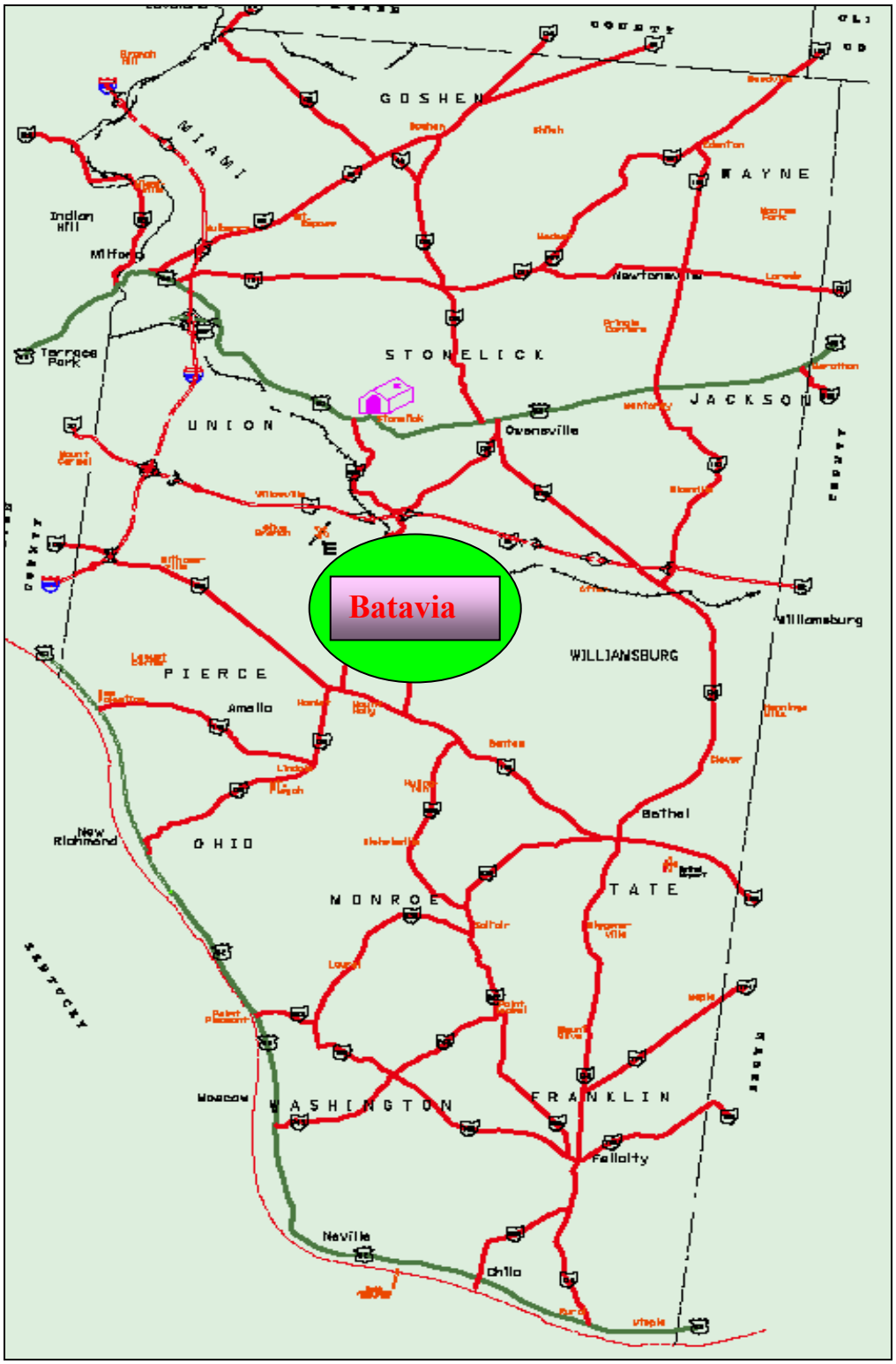

Figure 2 Map of Clermont County showing county boundary, Batavia, main roads, townships and bridges

Source: www.dot.state.oh.us/se/coveredbridges/ clermont/clemap.htm

Literature Review

Stormwater is defined as storm water runoff, snowmelt runoff, and surface runoff and drainage. This definition does not include infiltration and street wash waters (Gallagher et al., 1999). In the USA stormwater regulations can be traced back to the 1972 Clean Water Act (CWA). CWA was amended in 1987 (Section 402(p)) to cover environmental impacts of stormwater (USEPA, 2003, Gallagher et al., 1999). Section 409 identified stormwater discharges from some industrial and municipal activities as point sources that required National Pollutant Discharge and Elimination System (NPDES) permits. This established a two-phase approach to stormwater management, Phase I and Phase II (USEPA, 2000).

The Phase I Rule was promulgated on November 16, 1990 (City of Sacramento, 2003). Under Phase I, USEPA required permits for stormwater discharges from the following:

- Large MS4s for areas with populations greater than 250,000
- Medium MS4s for areas with populations greater than 100, 000
- Construction activity that disturbed 5 or more acres of land
- Eleven categories of industrial activities

The Phase II Rule was promulgated in December 1999 to extend coverage to smaller communities and construction projects (1 to 5 acres).

Stormwater runoff usually contains elevated quantities of constituents that exceed water quality standards (Lee, 2002). Urban stormwater runoff transports pollutants that are similar to those found in rural and agriculture runoff (Bhaduri et al., 2000). The constituents of stormwater runoff come from surfaces over which the water flows before reaching receiving waters (Vassilios et al. 1997). Surfaces include parking lots, gardens, lawns, roads, rooftops, commercial and industrial areas, and other surfaces found in urban areas. Stormwater runoff from urban areas is an important nonpoint source of pollution and is a leading cause of water quality problems in the US (Bhaduri et al., 2000).

Stormwater pollutants include oil, grease, pesticides, pathogens, pesticides, chloride, suspend solids, oxygen demanding organisms (BOD), nutrients (phosphorus and nitrogen), Metals (zinc, lead, copper nickel, chromium) and volatile organic compounds (Bhaduri et al. 2000, USEPA, 2000, Tsihrintzis, 1998, Field, 1994). The pollutants are transported through municipal storm sewer systems before being released into local rivers and streams. Urban stormwater runoff often enters receiving water bodies untreated, resulting in pollutant concentrations that are above the required water quality standards (USEPA, 2000).

Urban stormwater discharges have as much deleterious effects as Combined Sewer overflows (Murray et al. 1999). Urbanization results in pollutant load increase of at least one order of magnitude higher than areas in their natural state. It also increases the intensity and frequency of peak flows in urban streams (Tsihrintzis et al., 1998, Roesner, 1999). This has negative impacts on both the physical, chemical and biological integrity of streams and rivers. Construction and post-construction activities result in increased runoff quantity and reduced water quality. Construction increases impervious surfaces and reduces infiltration capacity of an area (Adoh et al., 1999 and Tracey, 2002).

Storm water runoff is reported to be more harmful in rapidly urbanizing and urbanised areas. Harmful pollutants in stormwater are the cause for poisoning and endocrine disruption of aquatic organisms, eutrophication and decreased water storage capacity in streams and lakes,

(Bhaduri, 2000). The main constituent of runoff from construction sites is suspended sediment, which results in siltation. Construction sites are more susceptible to soil erosion because they are stripped of their vegetation cover (Les et al., 1996). Sediment runoff rates from construction sites are typically 10 to 20 times greater than rates from agriculture lands and 1000 to 2000 times greater than those from forestlands (USEPA, FS 2.6, 2000). One of the best ways of controlling stormwater is by utilizing BMPs (Woelkers, 2002 and Roesner et al.1990). This view also held by other authors, and more importantly by USEPA who have made implementation of BMPs one of the requirements for the Phase II Rule (USEPA, 2000).

Stormwater management can be defined as a set of measures that control stormwater flows, enhance stormwater quality, and mitigate stormwater discharge on receiving waters (Cameron et al., 1999). Measures refer to best management practices. USEPA's suggested method for controlling stormwater pollution is through BMPs that slow, retain and absorb pollutants (Vassilios et al. 1997). An urban stormwater BMP is defined by Woelkers (2002) as a technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of storm water runoff in the most cost–effective way**.** However, BMPs without maintenance and enforcement will be ineffective. USEPA has therefore, included a requirements for ordinances and enforcement procedures in the Phase II Rule (USEPA, 2000). Lee et al. (1996) also assert that public involvement is essential for any storm water program to be effective. It is not surprising therefore, that EPA has included public participation as a requirement in the Phase II rule.

Presentation of Study

Chapter 2 of this report describes the Illicit Discharge Detection and Elimination minimum control measure, USEPA's requirements, program elements suggestions and BMPs. Chapter 3 summarises the Construction Site Runoff Control minimum control measure and its requirements, suggestions on what should be included in the program and BMPs that will be needed. Chapter 4 provides a description of the Post-Construction Runoff minimum control and its requirements, suggested program elements and BMPs. Chapter provides the conclusion of this report.

Chapter 2
Illicit Discharge Detection and Elimination

Background and general recommendations

The Illicit Discharge Detection and Elimination control measure is important because most discharges from MS4s include waste and wastewater from non-storm water sources (USEPA FS 2.5). An Illicit discharge is defined by USEPA as any discharge that is not composed entirely of storm water (Table 1). However, there are some types of discharges that are exempted by USEPA (Table 1). Table 1 one was made based on the lists of regulated and exempted discharges from USEPA's stormwater website (USEPA, 2003)

Table 1: Illegal discharges that are regulated by USEPA and exempted discharges made from USEPA list (USEPA, 2003)

Illegal Discharges	Exempted Discharges
Sanitary wastewater	Fire fighting activities
Septic tank liquid waste	Landscape irrigation
Car wash wastewater	Diverted stream flows
Improper oil disposal	Rising ground water
Radiator flushing disposal	Discharge from potable water sources
Laundry wastewater	Air conditioning condensation
Spills from trucks and tankers	Irrigation water springs
Improper disposal of auto toxic water	Water from crawl space pumps
Industrial process water	Drains of footings
Chlorinated public pool water	Watering lawns
Wash-down from loading areas	Individual residential car washing
Dumping of liquid waste	Flows from riparian habitats

USEPA's Minimum Requirements

USEPA required all MS4s to implement at least the following measures in order to reduce illicit discharges:

1. Create a storm water system map showing all outfalls and known hotspots,
2. Enact an appropriate ordinance with enforcement provisions,
3. Set up a detection and elimination plan,
4. Set up an anti-dumping program,
5. Illicit discharges and anti-dumping information and education campaign,
6. Procedures for tracing the source of an illicit discharge,
7. Procedure for removing the source of the illicit discharge,
8. Procedure for locating priority areas likely to have illicit discharges and
9. Procedure for program evaluation and assessment.

MS4s are obliged to develop and implement plans for detecting and eliminating illegal discharges to storm sewer systems that include all the above requirements. USEPA recommends the use of BMPs in order to meet these requirements. BMPs should be put in place not only to remove egregious sources of pollution (e.g., oil spills) but also help reduce the subtle and often overlooked sources (e.g., leaking septic tanks). This requires setting up a good illicit discharge detection and elimination program. Most of the elements in the recommendation sections came from the Texas National Council of Governments' program framework and USEPA. However, a significant amount of information came from other sources too.

Recommendations

Clermont County stormwater program should include visual screening of all outfalls during dry weather and testing pollutants as a means locating priority areas. Visual screening should include checking physical characteristics such as floating debris, oil sheen, color, turbidity, algae, opacity, foaming, vegetation, damage to structure and soil stains.

Field test screening should also include water quality indicators that can be tested with field kits either at outfalls or in streams. Indicators include suspended sediments, Secchi depth, pipe corrosion, pH, temperature, nutrients, resistivity, heavy metals and chlorine. Field screening should be limited to those water quality indicators that are most likely to occur in that particular area. Remote sensing Thematic Mapper (TM) images should also be used to check for suspended sediments and temperature pollution. Whenever possible, use field test kits together with colorimeters to avoid subjective observations and to add accuracy to the results. Field screening is an arduous task that requires help from the community. Obtain help through volunteer programs such as dry weather monitoring community program. These programs provide training to members of the community (volunteers) on dry weather testing. Such programs have potential for success if set up as early as possible, i.e., within the first year of program initiation.

Priority areas should be identified for detailed screening of the stormwater systems. This should be based on the likelihood of the existence of illicit connections. Areas where pollutants with unknown sources have been reported should be given the highest priority. To ensure program efficacy, field-based staff should be provided with field kits and water quality observation cards to be filled-out whenever they see any of the following; dry weather flows, illegal dumping, sewage overflows, or anything else unusual.

In order to remove illegal sources, once a problem area or discharge has been found, methods such as dye testing should be employed to identify the sources. Contractors should be required to obtain certificates that show that their buildings have been checked for illicit connections. Other monitoring procedures should include the use of videos in storm sewers located in problem areas.

Ordinances and Permitting

It is imperative that all offenders be identified and warned or punished whenever they break the rules. Therefore a good plan of enforcement should be devised. All offending dischargers should be notified and ordered to correct the problem immediately. The county should utilize escalating enforcement measures to notify operators of violations and to demand corrective action. Escalating enforcement measures are good because they give first time

offenders another chance to operate properly while the perpetual culprits are punished. This could be in the following order:

1. A warning,
2. Notice of violation if the problem persists,
3. Citation,
4. Stop work order,
5. Withhold inspection approvals,
6. Withhold utility connection or
7. Disconnect utility

Registration and permits should be mandatory for activities that produce a lot of wastewater or require connection to a stormwater system (e.g. mobile power washing, mobile carpet cleaning). Permits for such activities should require wastewater disposal at specific locations or by specific methods. All operators of such facilities should show that there are no illegal connections within their facilities. This will force operators to inspect their systems before applying for permits or permit renewals. Registration and permit applications must be reviewed and checked to make sure that all plans include a stormwater pollution prevention plan.

New facilities with potential for discharge of oil and solids should be required to install in-situ oil/water separators because they remove oil floating on top of water. Examples of such facilities include restaurants and carwashes. To ensure that all permitted facilities remain in compliance, each permitted facility should be inspected for illegal connections and proper functioning of all the permitted connections once every year. On the other hand, all non-permitted facilities that have potential for water quality impact (see Table 1 for exempted discharges) should be inspected at least once within the next five years.

Public education

The county should develop a program that includes storm drain curb inlet markers that inform the public about the impacts of dumping into the storm drains. Examples of inlet markers are given in Appendix IV, Storm Drain Marking Program. In addition, businesses should be encouraged to sponsor local water quality education efforts (special events such as stream cleaning days, adopt a creek).

Running in parallel to the educational programs for the general public, the county should develop an industrial stormwater training program for commercial and industrial facilities. This program should be designed to train industrial staff in methods of reducing or minimizing impacts on water quality when performing their usual duties. The county should also develop stormwater training programs specific to activities such as auto repair shops and carwashes. A stormwater quality guide should be provided to all businesses that are likely to impact water quality (City of Sacramento, 2003). The guide should contain on-site stormwater quality control

measures and should target activities such as auto repair, mobile carpet cleaning, restaurants, construction, road repair and maintenance.

Recycling

To further reduce the amount of trash being land filled or illegally dumped into storm drains, a recycling and collection program for pollutants that are likely to be dumped should be established. The program should include organized hazardous waste collection events where oil and other non-hazardous wastes are collected. Used oil recycling programs should also be initiated as part of the recycling program. This will provide operators an alternative to dumping used oil in the stormwater drains. The recycling program should be established as soon as possible, preferably within the first year.

Community involvement

The community should be involved in all storm water projects. There are many ways in which to involve the local people in projects. One is to set up a volunteer program that involves volunteers adopting a creek or a portion of a creek for which they would be responsible. Volunteer responsibilities include keeping the stream clean, putting up signs, monitoring for illicit discharges and performing water sampling (Brenner, 1999). The program can be called "Adopt-A-Creek"

The Adopt-A-Creek program is a creek monitoring and litter abatement program giving county residents the opportunity to become active in reducing the tax dollars spent on cleaning and monitoring streams. As part of Adopt-A-Creek, an organization or individuals agree to periodically remove trash and conduct dry weather monitoring from a single, mile-long stretch of creek. The responsible group will be actively involved in the coordination and promotion of this program by helping to develop community interest and involvement. The clubs, civic groups or businesses can help keep Clermont County beautiful by joining county officials in keeping the creeks clean. To be involved in the program the following could be used as requirements for participation:

a. Select someone 21 or older to be your coordinator.

b. Identify the one-mile section you want to adopt.

c. Call or visit specified locations to receive an application form and more information

d. Organize a certain number of clean-ups within a 12-month period.

e. Attend a safety training session before initial clean up.

f. Submit a release of liability; parental consent forms, organization roster and other paperwork.

g. Participants should be 11 or older.

Communication

A local illegal dumping hotline with immediate relay to stormwater personnel or fire dispatch should be established for people to report violations. To supplement this hotline a website link for reporting illegal, or suspected illegal discharges should be added to the county's website. The website should also provide a link to information about the local stormwater program. Montgomery County, MA, has a program called "Pipe Detectives" that uses volunteer monitoring and community hotlines to identify suspicious discharges (USEPA, 2002). Through this program three illicit connections were detected and removed, including a source for paint from paintbrushes. The hotlines should be used for reporting illegal (or suspected) connections to storm water systems as well as intentional and accidental spills.

To ensure effectiveness and avoid backlogs, all complaints must be acted upon immediately. The next available stormwater personnel should be charged with the task of investigating the complaint or observation. All complaints need to be logged. The county should also train pre-treatment staff and building inspectors to perform stormwater inspections while conducting their regular jobs (City of Sacramento 2003). In addition, cooperative inspection with the fire and police departments should be established in order to identify hazardous material stored at industrial facilities.

Information storage

The need for a long-term program necessitates the requirement of a water quality-tracking database. The database should be developed to track complaints, inspections, enforcements, and dry weather sampling. The tracking database should be in the form of a GIS (ArcGIS and ArcView 3.2) layer where maps for all existing and planned outfalls will be stored. GIS enables quick and efficient storage, access, processing and output of spatial data (Meiner, 1996). GIS data on all planned and existing sewer lines should also be collected and stored so as to enable planners to easily identify potential sources of illicit discharge.

Chapter 3
Construction Site Runoff Control Measure

Background Information

The motivation for the Construction Site Runoff minimum control measure stems from the fact that rapidly urbanizing regions have rapid increases in impermeable surfaces and stormwater runoff (Adoh et al., 2000). Increased runoff results in frequent flooding and escalating water pollution problems. Another problem associated with rapidly developing areas is increased construction activities, which facilitate mobilization of sediments. Dislodged sediments are carried into streams and lakes by runoff from rainfall. Large amounts of sediments carried by runoff from urban construction sites have adverse effects on water quality. Impacts of sediments on water quality include clogging of drains and fish gills, increased water temperature, and transportation of sediment-attached pollutants (such as non-soluble phosphorus) to streams and rivers.

USEPA's Minimum Requirements

According to USEPA (2002) Phase II Storm Water programs must include the development and implementation, at a minimum, of:

1. An ordinance or other regulatory mechanism that requires erosion and sediment controls on construction sites,
2. Sanctions to ensure compliance, to the extent allowable under state, tribal, or local law,
3. A requirement for construction site operators to implement appropriate Erosion and Sediment Control (ESC) Best Management Practices,
4. A requirement for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the site and
5. Set up procedures for site plan review, which incorporate consideration of potential water quality impacts.

Recommendations

Ordinances and procedures for site plan review and construction inspection

The county already has existing regulations for construction site runoff control. Some adjustments might be necessary depending on what the county decides to implement under this control measure. USEPA requires municipalities to review all construction site plans so as to ensure compliance with county's landscaping and building codes, and engineering standards. A review program that obliges contractors to submit all construction plans for sites above a specified size should be established. Plans should either be submitted for review prior to permit application or included in the permit application. The plans should be detailed and critically reviewed by the appropriate agencies before commencement of construction activity.

In light of the plan review requirement, the county should identify specific departments or agencies that will be responsible for issuing permits for different construction activities. The identification of departments and agencies should be completed within the first year. As an alternative to a multi-agency review system, a special review committee that comprises experts from different departments should be established. This committee should be responsible for reviewing construction plans. The committee should also be responsible for arranging pre-construction meetings with the concerned parties to discuss plans, specifications, schedules, erosion and sediment control plans, and other construction details. Responsible agencies should review the detailed site plans before permits are issued. More than one agency should conduct the review of construction plans to ensure that all specifications are met.

An inspection program is essential to ensure compliance with all the specifications and regulations. Inspection is also important in ensuring that actual construction work conforms to approved plans. The program should define ways in which all permitted sites are to be inspected, both during and after construction. This requirement necessitates the establishment of an inspection team. The team could be a separate group or the plan review committee. It should include building, electrical, mechanical and plumbing inspectors to ensure that all aspects of construction meet the required standards. Inspectors for construction projects should be required to be at the sites on a daily basis. If there is a shortage of manpower, consulting firms should be contracted to oversee some of the projects. The number of people and agencies in charge of this program should be determined within the first year (from March 2003 to March 2004).

Waste control and procedure for information response

The following are some of the practices that builders should be enjoined to follow:

1. All construction sites that are greater than or equal to 1 acre should have on-site litter and other disposal bins
2. All trash should be thrown in proper litter bins and transported to appropriate disposal sites
3. All truck and vehicle washout wastes should be connected to stormwater systems that drain into sanitary sewers or detention/treatment ponds. This will require obtaining a connection permit from the county
4. All construction sites should have bins for all recyclable solid waste

In order to facilitate public participation in violations reporting, a hotline and a website link should be established. The hotline and website link should be advertised to the public via radio, television, newspaper and newsletter announcements. The police department, environmental services division and other agencies should be requested to cooperatively respond to calls. All reported cases should be checked within 24 hours, and violators given a warning, fine, or a stop work order, depending on the severity and duration of the violation. Escalating enforcement measures should also be utilized as an enforcement procedure for this control measure.

Best Management Practices

A manual of BMPs that includes implementation specifications (abiotic and biotic) should be produced and made available to all operators and the general public by March 2005.

Construction site BMPs can put into four broad classes given in Table 2. The table also provides examples from each class. A list of brief descriptions of some construction site BMPs is also provided after Table 2. More detailed explanations of the BMPs have been included in Appendix II.

Table 2: General classes of Construction site stormwater BMPs and some examples are given in this table. The bold words are the general classes and the normal texts are example under each class

Runoff Control	Vegetated buffer
Land grading	Construction sequencing
Permanent diversions	Dust control
Preserving natural vegetation	**Sediment Control**
Construction entrances	Temporary diversion dikes
Check dams	Wind fences and sand fences
Filter berms	Brush barrier
Grass-lined channels	Silt fence
Riprap	Sediment basins and rock dams
Erosion Control	Sediment filters and sediment chambers
Chemical stabilization	Sediment trap
Mulching	Storm drain inlet protection
Permanent seeding	**Good Housekeeping**
Sodding	General construction site waste management
Soil roughening	Spill prevention and control plan
Geotextiles	Vehicle maintenance and washing areas
Gradient terraces	Contractor certification and inspector training
Soil retention	Construction reviewer
Temporary slope drain	BMP inspection and maintenance
Temporary stream crossings	Model ordinances

Source: USEPA

Brief descriptions of construction site BMPs

1. Operators should be required to install sediment traps early in the construction process to increase surface area for infiltration and sediment settling. Sediment traps should be installed in places where runoff from erosion surfaces can be directed into the traps. To increase the effectiveness of sediment traps, diversion pathways should be designed to accommodate sediment trap overflows due to excess stormwater runoff. According to Smolen et al. (1998) the approximate storage capacity of a trap should be at least 1800 square feet. According to USEPA sediment traps have a useful life of approximately 24 months. They have an average removal rate for total suspended solids of 60% (USEPA

2002). Traps also have an efficiency rate of about 75% for most coastal plain and piedmont soils (Smolen et al. 1998).

2. All operators should use silt fence controls around construction sites. Silt fences are a length of fabric supported by anchoring posts that are installed around the perimeter of the site. The fabric should be entrenched in the ground between the poles and should be inspected regularly. Silt fences are applicable in areas with shallow flow and a slope length above the fence of not more than 100 feet. However, silt fences should not be installed in areas with severe winds, frequent excessive runoff, and where uniform anchoring of fence poles is difficult. Fences should not be installed across ditches, waterways and streams. According to USEPA (2002) estimates, the effectiveness of properly installed silt fences should be: 70% for average total suspended solids, 80 – 90% for sand, 50 – 80% for silty-loam and 0-20% for silty-clay.

3. Unpaved channels should be lined with grass (roughened pavement for paved drains) to reduce the velocity of water. These should be installed in areas with highly erodable soils such that erosion resistant conveyance is required. The costs for grassed channels vary depending on the depth, width and length of the channel. (USEPA, 2002, Appendix III).

4. Create detention/retention ponds for sediment settling on all subdivisions and big sites before runoff is released to the main storm drains. Use reasonable quantities of water for dust control.

5. All vehicles leaving construction sites should be washed before they get on the streets. Vehicles leaving sediments/silt on the road should be cited and the construction site responsible fined. Contractors should be encouraged to use gravel on entrances to reduce compaction of soils and mud on cars leaving the site.

6. All construction sites should be required to establish specific areas on the site where vehicles and equipment should be washed. The water from these areas should go to a detention ponds or some kind of treatment area.

7. Encourage tree planting and avoid cutting trees on the edge of construction sites.

8. Construct temporary runoff channels and diversion dikes to direct water around the site to detention ponds during construction
9. Cover stock piles and excavated soil with secured tarps or plastic sheeting

10. Operators should be required to schedule most of the construction work for dry weather and stop all grading during rain.

Chapter 4
Post –Construction Runoff Minimum Control Measure

Background Information

Construction site runoff is not the only overland flow that is of concern to water quality managers. Post-construction runoff is equally important. Runoff from completed construction sites can be deleterious to aquatic and human life, especially when it contains elements such as arsenics, chromium, copper, lead, zinc, organic toxins and bacteria. Construction results in increased impervious surfaces, which increase amounts and rates of runoff. This results in larger quantities of water reaching receiving water bodies more rapidly during and after storm events. This impacts the integrity of receiving waters causing bank scouring, erosion and flooding. Together with the pollutants and sediments carried in runoff, this can be very harmful to aquatic organisms.

USEPA's Minimum Requirements

Under this control measure all MS4s are supposed to implement the following:

1. Development and implementation strategies, which include a combination of structural best management practices, ensuring adequate long term operations and maintenance of controls,
2. Formulate and implement an ordinance or regulatory mechanism requiring the implementation of post-construction runoff controls to the extent allowable under state law,
3. Determine the appropriate best management practices and measuring goals for the minimum control measure (USEPA, 2000).

Recommendations

Ordinance or Regulatory Mechanism

The most cost effective way of controlling post-construction runoff is by planning and designing ways to minimize pollutants in post-construction runoff prior to construction (USEPA, 2000). Therefore, the county should require that all permit applications include a plan for post-construction BMP implementation. Clermont County should also formulate an ordinance for post-construction runoff to meet USEPA's requirements.

To reduce the total impervious surfaces in the county, street parking should be limited to one side of the street. The number of parking lots should be lowered and parking lot sharing among adjacent facilities should be encouraged. Another way of reducing impervious surfaces is by reducing parking lot development in proximity to public transportation.

Two other important factors that should be considered are topography and drainage patterns. Plans should be checked or modified so that the natural topography and drainage patterns of the land are maintained. An example of such topographical consideration is incorporating sunken landscape islands in the middle of cul-de-sac turnarounds. Builders should be encouraged to reduce rooftops by constructing multiple level structures wherever feasible. In

order to protect streams, wetlands, floodplains and other ecological valuables all buildings should be located away from them.

Inspection and Enforcement

To ensure that inspection and enforcement form an integral part of the stormwater program, all public and private stormwater management facilities in the county should be inspected once every year. Whenever inspections uncover violations, responsible parties should be held accountable. First time offenders should be given a warning and instructed to correct the situation immediately. If violations persist, the operator should be fined for every day that the facility has been in violation. In cases where the violation is critical, local governments should step in and correct the situation and all money spent on the project should be recovered from the offender.

Post-construction flows should be as close as possible to pre-construction flows. The operator and an inspector should measure pre-construction flows. Post-construction flows should also be measured and compared with pre-construction conditions. County officials should inspect control plans once every year on stormwater facilities. The county officials should also inspect any BMPs that have been implemented by each operator.

Strategies for structural and non-structural BMPs

The county should create a manual for BMPs that are suitable to the physical conditions in Clermont County. The manual should be made available to the public and be updated regularly to ensure that all suitable BMPs are included and/or improved on. County officials should check all operations and controls for effectiveness to ensure that adequate long-term operations are put in place and all faulty facilities are repaired. When selecting BMPs to implement, preference should be given to the non-structural BMPs in the manual and those known to developers. Non-structural BMPs are BMPs that do not require and structural installation or land disturbance. It is important to note here that incentives for non-structural BMP implementation, such as lower land tax assessment, will be required for this to work. Potential BMPs that the county should consider are listed in Table 3.

Table 4 is a summary of effectiveness of selected BMPs in improving water quality. It can be inferred from the table that extended detention basins and media filters are, to some extent, effective in removing bacteria from storm water. Therefore proper implementation of the two BMPs together should lead to a significant reduction in bacteria concentration in the waters. Implementing either extended detention basin, vegetated swales, filter strips or media filters BMPs on their own should result in significant reduction of suspended solids and metals. A combination of any of these BMPs should lead to an improvement in the water quality in the county. These BMPs together with other good practices lead to a significant improvement in the water quality.

Table 3: BMPs for Post-Construction storm water management obtained from USEPA (2003)

Ponds	**Experimental practices**
Dry extended detention ponds	Alum injection
Wet ponds	**On-lot Treatment**
Infiltration practices	On-Lot treatment
Infiltration basin	
Infiltration trench	**Better site design**
Porous pavement	Buffer zones
	Open space design
Filtration practices	Urban forestry
Bioretention	Conservation easements
Sand and organic filters	Infrastructure planning
Vegetative practices	Narrower residential streets
Storm water wetland	Eliminating curbs and gutters
Grassed swales	Green parking
Grassed filter strip	Alternative turnarounds
Runoff pretreatment practices	Alternative pavers
Catch basins/Catch basin insert	BMP inspection and maintenance
In-line storage	Ordinances for post-construction runoff
Manufactured products for storm water inlets	Zoning

Table 4: Percentage reduction in storm BMPs for solids, nutrients, pesticides, metals and bacteria (Lee, 2002)

Percentage Reduction in Storm water Load by BMP					
Runoff Control	Solids	Nutrients	Pesticides	Metals	Bacteria
Drain Inlet Insert	10	5	5	5	5
Extended Detention Basin	75	25	25	50	40
Vegetated Swales	70	30	30	50	0
Filter Strips	85	40	40	63	0
Media Filters	85	40	40	70	55

Chapter 5
Conclusion

This report has provided general information about the stormwater Phase II Rule and some specific information for Clermont County. The report has summarised the requirements for the Phase II Rule with regards to illicit discharge detection and elimination, construction site runoff control and post-construction site runoff control.

The Phase II Rule has potential to improve the overall water quality in the US if properly implemented and enforced. The Phase II Rule allows for a different way of managing stormwater by requiring both quality and quantity stormwater controls. Traditionally stormwater management concentrated on improving drainage pipes and other conveyance conduits, which resulted in down stream flooding. This new approach focuses on both flood control and system integrity.

The suggestions made in this practicum were given to the county for review and use in their Phase II permit application. My suggestions were made with the expectation that the county would analyse them and determine what was relevant to their needs. The suggestions are eclectic in that an array of sources had to be consulted in order to make them. A lot of the information was derived from personal experience as a geologist and environmental scientist, work experience in the geo-technical consulting profession, USEPA, NCTCG, discussions with professionals in the field, consultation with Mr John McManus of Clermont County and IES course work.

The courses that I found particularly useful to this practicum included Environmental Law, Watershed Management, Environmental Policy Making and Administration, Environmental Methodology, GIS and Agriculture & Ecology. This practicum offered me the opportunity to apply the same methodology I used in my oral exam on a real and practical issue. I have also had a chance to learn more about storm water management and public education. The knowledge I have gained from this practicum will be invaluable when doing my doctoral research. However, I was disappointed by the lack of IES involvement in arranging and organising the practicum. I recommend that for such projects, IES, the client and the student should all meet and agree on the objectives and minimum requirements of the practicum.

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Appendices

Appendix I:	Phase II Rule
Appendix II:	Best Management Practices
Appendix III:	Curb and Drain inlet program (Fort Worth Texas
Appendix IV:	Butler County program with Cost estimates
Appendix V:	Sample Ordinances

APPENDIX I
Background and Regulatory Context of the Phase II Rule
(From USEPA)

REGULATORY REQUIREMENTS AND APPLICABLE STANDARDS

The Storm Water Phase II Final Rule requires you, the operator of a regulated small municipal separate storm sewer system (MS4), to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage because your storm water discharges are considered "point sources" of pollution. MS4s are considered point sources because they discharge storm water into discrete conveyances, including roads with drainage systems and municipal streets. MS4s are publicly owned or operated and are designed or used for collecting or conveying storm water.

According to 40 CFR 122.26(b)(8), "municipal separate storm sewer means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

- Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States.
- Designed or used for collecting or conveying storm water;
- Which is not a combined sewer; and
- Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

MS4 Definitions

EPA categorizes MS4s as either "small," "medium," or "large." The Phase I Storm Water Rule covers medium and large MS4s. A medium MS4 is an MS4 located in an incorporated place or county with a population of 100,000–249,999 (according to the 1990 Census). A large MS4 is an MS4 located in an incorporated place or county with a population of at least 250,000.

A small MS4 is one that is not already defined as medium or large. The Phase II Storm Water Rule covers a subset of small MS4s that are called "regulated small MS4s." Regulated small MS4s are automatically designated if they are located in "urbanized areas" (as defined by

the Bureau of the Census). Other small MS4s located outside urbanized areas may be designated on a case-by-case basis by the NPDES permitting authority. EPA has published two fact sheets that provide more information about designation of regulated small MS4s and the definition of urbanized areas.

NPDES Permits

NPDES storm water permits are issued by an NPDES permitting authority, which may be a NPDES-authorized State or EPA in non-authorized States. A list of EPA and State storm water contacts is provided on EPA's web site. Once you submit a permit application and permit coverage is obtained, you must satisfy the conditions of the permit and submit periodic reports on the status and effectiveness of the program at reducing pollutants to the MEP.

Requirements for Regulated Small MS4s

As a Phase II regulated small MS4, you are required to submit a permit application and obtain coverage under an NPDES storm water permit. Under the permit, you will be required to develop and implement a storm water management program that includes the 6 minimum control measures, evaluation/assessment and reporting efforts, and recordkeeping, as described below. You must design a storm water management program that:

- Reduces the discharge of pollutants to the "maximum extent practicable" (MEP);
- Protects water quality; and
- Satisfies the appropriate water quality requirements of the Clean Water Act.

MEP is a standard that establishes the level of pollutant reductions that MS4 operators must achieve through implementation of a storm water management program. The strategies used to reduce pollutants to the MEP may be different for each small MS4 because of unique local hydrologic, geologic, and water quality concerns in different areas. EPA envisions that permittees will determine what the MEP is on a location-by-location basis and consider such factors as conditions of receiving waters, specific local concerns, and other aspects of a comprehensive watershed plan.

Because so many diverse factors can dictate the specifics of a storm water management program, you should determine appropriate BMPs to satisfy each of the minimum control measures through an evaluative process. The definition of "MEP" should adapt continually to both current conditions and BMP effectiveness, but ultimately, successive iterations of the mix of BMPs and measurable goals should be made to achieve the objective of meeting water quality standards. If, after implementing the minimum control measures, there is still water quality impairment associated with discharges from the MS4, you will need to expand or better tailor your BMPs.
NPDES permitting authorities will review the identified BMPs and measurable goals and determine if they are likely to reduce pollutants to the MEP, protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act. If the permitting authority does not think that you are reducing pollutants to the MEP, they can request that you revise your mix of BMPs and measurable goals.

Storm Water Management Programs

The Phase II Rule defines a storm water management program for a small MS4 as a program composed of six elements that, when implemented together, are expected to reduce pollutants discharged into receiving waterbodies to the MEP. These six program elements, or minimum control measures, are

- Public Education and Outreach on Storm Water Impacts;
- Public Involvement/Participation;
- Illicit Discharge Detection and Elimination;
- Construction Site Runoff Control;
- Post-Construction Storm Water Management in New Development and Redevelopment;
- Pollution Prevention/Good Housekeeping for Municipal Operations.

For each minimum control measure, you will select and implement BMPs and measurable goals that comprehensively address the specific storm water problems in your area. The process for developing a storm water management program is described in Part 4 of this guidance, and examples of BMPs and measurable goals are presented in Part 3.

Notice of Intent

To apply for coverage under a general permit, you must fill out a Notice of Intent (NOI) application form. You will be asked for the following information:

- Best management practices (BMPs) for each of the six minimum control measures;
- Measurable goals for each of the BMPs (i.e., narrative or numeric standards used to gauge program effectiveness);
- A timeline for implementation of each measure (estimate months and years to implement each measure, including interim milestones and frequency); and
- Specify the individual(s) or group(s) responsible for implementing or coordinating the storm water program.

Deadlines

General Permit Timeline	
Storm Water Phase II Final Rule	December 1999
Draft general permits developed	January–June 2002
Draft NOI available	January–June 2002
Final general permit available	December 2002
NOI Due	March 2003

OPTIONS FOR PERMIT COVERAGE

There are a number of implementation options for regulated small MS4 operators. They include obtaining coverage under a general permit, participating in the implementation of an existing Phase I MS4's storm water program as a co-permittee (including sharing responsibility for program development with a nearby-regulated small MS4), or applying for an individual permit. These options are described in detail below. The deadline for applying for permit coverage is March 10, 2003. Check with your state or EPA regional NPDES permitting authority to learn more about permitting in your area.

Option 1. General Permits

- Once a general permit is issued, submit a Notice of Intent (NOI) application form to the NPDES permitting authority to apply for permit coverage under the general permit conditions.

- In completing the NOI, you need to include a description of your storm water management program, including best management practices (BMPs) and measurable goals for each of the 6 minimum control measures.

- Although general permits have a set of requirements determined by the permitting authority, they still provide the flexibility to develop an individualized storm water program that addresses the particular characteristics of your water quality problems and the needs of your system.

Option 2. Co-Permittee Option

Other Phase II MS4s:

- Partnering with neighboring Phase II MS4s allows you to capitalize on existing resources in meeting Phase II requirements.

- This option also provides you the opportunity to forge a link between your storm water program and a regional or watershed management plan.

- Check with your State or EPA permitting authority for more information about submitting a joint NOI with one or more small MS4s in your area.

Larger Phase I MS4s:

- Partnering with a Phase I (larger) MS4 offers an attractive option for you because you could participate in an existing storm water management program. This can be accomplished by you and your neighboring MS4 jointly seeking a modification of their Phase I MS4 permit.

- As a limited Phase I co-permittee, you would be responsible for compliance with the permit's conditions that are applicable to your jurisdiction, which would be the applicable terms of the modified Phase I individual permit rather than the minimum control measures in the Phase II Final Rule.

Option 3. Individual Permits

- You may seek coverage under an individual NPDES permit, which is tailored for an individual MS4.

- Upon submitting the appropriate application(s), the NPDES permitting authority develops a permit for that particular applicant based on the information submitted.

- The draft permit is then published for public comment before being finalized and issued.

- This option may take additional time and involve additional documentation, public notice, and comment than either the general permit or co-permittee options.

APPENDIX II

This appendix contains detailed explanation of some BMPs for illicit discharge detection and elimination, Construction site runoff control and post-construction runoff control from USEPA.

Appendix II.A. Inspection and Maintenance

Description

To maintain the effectiveness of construction site storm water control best management practices (BMPs), regular inspection of control measures is essential. Generally, inspection and maintenance of BMPs can be categorized into two groups--expected routine maintenance and nonroutine (repair) maintenance. Routine maintenance refers to checks performed on a regular basis to keep the BMP in good working order and aesthetically pleasing. In addition, routine inspection and maintenance is an efficient way to prevent potential nuisance situations (odors, mosquitoes, weeds, etc.), reduce the need for repair maintenance, and reduce the chance of polluting storm water runoff by finding and correcting problems before the next rain.

Routine inspection should occur for all storm water and erosion and sediment control (ESC) measures implemented at a site. These measures may include, but are not limited to, grass-covered areas, seeded areas, mulched areas, areas stabilized with geotextiles or sod, silt fences, earth dikes, brush barriers, vegetated swales, sediment traps, sediment basins, subsurface drains, pipe slope drains, level spreaders, storm drain drop inlet protection measures, gabions, rain barrels, and road and site entrance stabilization measures. Nonroutine maintenance refers to any activity that is not performed on a regular basis. This type of maintenance could include major repairs after a violent storm or extended rainfall, or replacement and redesign of existing control structures.

In addition to maintaining the effectiveness of storm water BMPs and reducing the incidence of pests, proper inspection and maintenance is essential to avoid the health and safety threats inherent in BMP neglect (Skupien, 1995). The failure of structural storm water BMPs can lead to downstream flooding, causing property damage, injury, and even death.

Applicability

All storm water BMPs should be inspected for continued effectiveness and structural integrity on a regular basis for the life of the construction project. Generally, all BMPs should be checked after each storm event in addition to the regularly scheduled inspections. Scheduled inspections vary between BMPs. Structural BMPs like storm drain drop inlet protection might require more frequent inspection than other BMPs to ensure proper operation. Inspection and maintenance of BMPs should continue until all construction activities have ended and all areas of a site have been permanently stabilized. During each inspection, the inspector should document whether the BMP is performing correctly, any damage to the BMP since the last inspection, and what should be done to repair the BMP if damage has occurred.

Siting and Design Considerations

In the case of vegetative or other infiltration BMPs, inspection of storm water management practices following a storm event should occur after the expected drawdown period for a given BMP. This approach allows the inspector to see whether detention and infiltration devices are draining correctly. Inspection checklists should be developed for use by BMP inspectors. The checklists might include each BMP's minimum performance expectations, design criteria, structural specifications, date of implementation, and expected life span. In addition, the maintenance requirements for each BMP should be listed on the inspection checklist. This checklist will aid the inspector in determining whether a BMP's maintenance schedule is adequate or needs revision. Also, a checklist will help the inspector determine renovation or repair needs.

Limitations

Routine maintenance materials such as shovels, lawn mowers, and fertilizer can be obtained on short notice with little effort. Unfortunately, not all materials that might be needed for emergency structural repairs are obtained with such ease. Thought should be given to stockpiling essential materials in case immediate repairs must be made to safeguard against property loss and to protect human health.

Maintenance Considerations

When considering a maintenance schedule for BMPs to control storm water runoff from construction activities, care should be taken to factor in increased erosion and sedimentation rates for construction sites. Clearing, grading, or otherwise altering the landscape at a construction site can increase the erosion rate by as much as 1,000 times the preconstruction rate for a given site (USEPA, 1992). Depending on the relative amount of disturbed area at a site, routine maintenance might have to occur on a more frequent basis.

It is important that routine maintenance and nonroutine repair of storm water and erosion control BMPs be done according to schedule or as soon as a problem is discovered. Because many BMPs are rendered ineffective for storm water runoff control if not installed and maintained properly, it is essential that maintenance schedules are maintained and repairs are performed promptly. In fact, in some cases BMP neglect can have detrimental effects on the landscape and increase the potential for erosion. However, "routine" maintenance such as mowing grass should be flexible enough to accommodate varying need based on weather conditions. For example, more harm than good might be caused by mowing during a drought or immediately after a storm event.

Effectiveness

The effectiveness of BMP inspection is a function of the familiarity of the inspector with each particular BMP's location, design specifications, maintenance procedures, and performance expectations. Documentation should be kept regarding the dates of inspection, findings, and maintenance and repairs that result from the findings of an inspector. Such records are helpful in

maintaining an efficient inspection and maintenance schedule and provide evidence of ongoing inspection and maintenance.
Because maintenance work for storm water BMPs (mowing, removal of sediment, etc.) is usually not technically complicated, workers can be drawn from a large labor pool. As structural BMPs increase in their sophistication, however, more specialized maintenance training might be needed to sustain BMP effectiveness.

Cost Considerations

Mowing of vegetated and grassed areas may be the costliest routine maintenance consideration (WEF, 1998). Management practices using relatively weak materials (such as filter fabric and wooden posts) may mean more frequent replacement and therefore increased costs. The use of more sturdy materials (such as metal posts) where applicable may increase the life of certain BMPs and reduce replacement cost. However, the disposal requirements of all materials should be investigated before BMP implementation to ensure proper handling after the BMP has become ineffective or when it needs to be disposed of after the site has reached final stabilization.

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Appendix II.B: Sediment Trap

Sediment traps are used to collect sediment-laden runoff from disturbed areas on construction sites

Description

Sediment traps are small impoundments that allow sediment to settle out of runoff water. They are usually installed in a drainageway or other point of discharge from a disturbed area. Temporary diversions can be used to direct runoff to the sediment trap (USEPA, 1993). Sediment traps are used to detain sediments in storm water runoff and trap the sediment to protect receiving streams, lakes, drainage systems, and the surrounding area.

Sediment traps are formed by excavating an area or by placing an earthen embankment across a low area or drainage swale. An outlet or spillway is often constructed using large stones or aggregate to slow the release of runoff (USEPA, 1992).

Applicability

Sediment traps are generally temporary control measures to slow concentrated runoff velocity and catch sediment, and they can be used with other temporary storm water control measures. They are commonly used at the outlets of storm water diversion structures, channels, slope drains, construction site entrance wash racks, or any other runoff conveyance that discharges waters containing erosion sediment and debris. Sediment traps can also be used as part of a storm water drop intake protection system when the inlet is located below a disturbed area and will receive runoff with large amounts of sediment.

Siting and Design Considerations

Sediment traps can simplify the storm water control plan design process by trapping sediment at specific spots at a construction site (USEPA, 1992). Therefore, they should be installed as early in the construction process as possible. Natural drainage patterns should be noted, and sites where runoff from potential erosion can be directed into the traps should be selected. Sediment traps should not be located in areas where their failure due to storm water runoff excess can lead to further erosive damage of the landscape. Alternative diversion pathways should be designed to accommodate these potential overflows.

A sediment trap should be designed to maximize surface area for infiltration and sediment settling. This will increase the effectiveness of the trap and decrease the likelihood of backup during and after periods of high runoff intensity. Although site conditions will dictate specific design criteria, the approximate storage capacity of each trap should be at least 1,800 ft^3 per acre of total drainage area (Smolen et al., 1988). The volume of a natural sedimentation trap can be approximated by the following equation (Smolen et al., 1988):

Volume (ft^3) = 0.4 x surface area (ft^2) x maximum pool depth (ft)

Care should be taken in the siting and design phase to situate sediment traps for easy access by maintenance crews. This will allow for proper inspection and maintenance on a periodic basis. When excavating an area for sediment trap implementation, side slopes should not be steeper than 2:1 and embankment height should not exceed 5 feet from the original ground surface. All embankments should be machine compacted to ensure stability. To reduce flow rate from the trap, the outlet should be lined with well-graded stone.

The spillway weir for each temporary sediment trap should be at least 4 feet long for a 1-acre drainage area and increase by 2 feet for each additional drainage acre added, up to a maximum drainage area of 5 acres.

Limitations

Sediment traps should not be used for drainage areas greater than 5 acres (USEPA, 1993). The effective life span of these temporary structures is usually limited to 24 months (Smolen et al., 1988). Although sediment traps allow for settling of eroded soils, because of their short detention periods for storm water they typically do not remove fine particles such as silts and clays.

Maintenance Considerations

The primary maintenance consideration for temporary sediment traps is the removal of accumulated sediment from the basin. This must be done periodically to ensure the continued effectiveness of the sediment trap. Sediments should be removed when the basin reaches approximately 50 percent sediment capacity. A sediment trap should be inspected after each rainfall event to ensure that the trap is draining properly. Inspectors should also check the structure for damage from erosion. The depth of the spillway should be checked and maintained at a minimum of 1.5 feet below the low point of the trap embankment.

Effectiveness

Sediment trapping efficiency is a function of surface area, inflow rate, and the sediment properties (Smolen et al., 1988). Those traps that provide pools with large length-to-width ratios have a greater chance of success. Sediment traps have a useful life of approximately 18 to 24 months (USEPA, 1993), although ultimately effectiveness depends on the amount and intensity of rainfall and erosion, and proper maintenance. USEPA (1993) estimates an average total suspended solids removal rate of 60 percent. An efficiency rate of 75 percent can be obtained for most Coastal Plain and Piedmont soils by using the following equation (Barfield and Clar, in Smolen et al., 1988):

Surface area at design flow (acres) = (0.01) peak inflow rate (cfs)

Cost Considerations

The cost of installing temporary sediment traps ranges from $0.20 to $2.00 per cubic foot of storage (about $1,100 per acre of drainage). The average cost is approximately $0.60 per cubic foot of storage (USEPA, 1993).

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Appendix II. C: Grass-Lined Channels

A grass-lined channel can be used to filter and convey runoff

Description

Grass-lined channels convey storm water runoff through a stable conduit. Vegetation lining the channel reduces the flow velocity of concentrated runoff. Grassed channels usually are not designed to control peak runoff loads by themselves and are often used in combination with other BMPs, such as subsurface drains and riprap stabilization.

Where moderately steep slopes require drainage, grassed channels can include excavated depressions or check dams to enhance runoff storage, decrease flow rates, and enhance pollutant removal. Peak discharges can be reduced through temporary detention in the channel. Pollutants can be removed from storm water by filtration through vegetation, by deposition, or in some cases by infiltration of soluble nutrients into the soil. The degree of pollutant removal in a channel depends on the residence time of water in the channel and the amount of contact with vegetation and the soil surface. As a result, removal efficiency is highly dependent on local conditions.

Applicability

Grassed channels should be used in areas where erosion-resistant conveyances are needed, including areas with highly erodible soils and moderately steep slopes (although less than 5 percent). They should only be installed where space is available for a relatively large cross section. Grassed channels have a limited ability to control runoff from large storms and should not be used in areas where flow rates exceed 5 feet per second.

Siting and Design Considerations

Grass-lined channels should be sited in accordance with the natural drainage system and should not cross ridges. The channel design should not have sharp curves or significant changes in slope. The channel should not receive direct sedimentation from disturbed areas and should be sited only on the perimeter of a construction site to convey relatively clean storm water runoff. Channels should be separated from disturbed areas by a vegetated buffer or other BMP to reduce sediment loads.

Basic design recommendations for grassed channels include the following:

- Construction and vegetation of the channel should occur before grading and paving activities begin.
- Design velocities should be less than 5 feet per second.
- Geotextiles can be used to stabilize vegetation until it is fully established.

- Covering the bare soil with sod, mulches with netting, or geotextiles can provide reinforced storm water conveyance immediately.
- Triangular-shaped channels are used with low velocities and small quantities of runoff; parabolic grass channels are used for larger flows and where space is available; trapezoidal channels are used with large flows of low velocity (low slope).
- Outlet stabilization structures should be installed if the runoff volume or velocity has the potential to exceed the capacity of the receiving area.
- Channels should be designed to convey runoff from a 10-year storm without erosion.
- The sides of the channel should be sloped less than 2:1, and triangular-shaped channels along roads should be sloped 2:1 or less for safety.
- All trees, brushes, stumps, and other debris should be removed during construction.

Effectiveness

Grass-lined channels can effectively transport storm water from construction areas if they are designed for expected flow rates and velocities and if they do not receive sediment directly from disturbed areas.

Limitations

Grassed channels, if improperly installed, can alter the natural flow of surface water and have adverse impacts on downstream waters. Additionally, if the design capacity is exceeded by a large storm event, the vegetation might not be sufficient to prevent erosion and the channel might be destroyed. Clogging with sediment and debris reduces the effectiveness of grass-lined channels for storm water conveyance.

Maintenance Considerations

Maintenance requirements for grass channels are relatively minimal. During the vegetation establishment period, the channels should be inspected after every rainfall. Other maintenance activities that should be carried out after vegetation is established are mowing, litter removal, and spot vegetation repair. The most important objective in the maintenance of grassed channels is the maintaining of a dense and vigorous growth of turf. Periodic cleaning of vegetation and soil buildup in curb cuts is required so that water flow into the channel is unobstructed. During the growing season, channel grass should be cut no shorter than the level of design flow.

Cost Considerations

Costs of grassed channels range according to depth, with a 1.5-foot-deep, 10-foot-wide grassed channel estimated between $6,395 and $17,075 per trench, while a 3.0-foot-deep, 21-foot-wide grassed channel is estimated at $12,909 to $33,404 per trench (SWRPC, 1991). Grassed channels can be left in place permanently after the construction site is stabilized to contribute to long-term storm water management. The channels, in combination with other practices that detain, filter,

and infiltrate runoff, can substantially reduce the size of permanent detention facilities such as storm water ponds and wetlands, thereby reducing the overall cost of storm water management.

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Appendix II.D: Silt Fence

Silt fences prevent the offsite transport of sediment

Description

Silt fences are used as temporary perimeter controls around sites where there will be soil disturbance due to construction activities. They consist of a length of filter fabric stretched between anchoring posts spaced at regular intervals along the site perimeter. The filter fabric should be entrenched in the ground between the support posts. When installed correctly and inspected frequently, silt fences can be an effective barrier to sediment leaving the site in storm water runoff.

Applicability

Silt fences are generally applicable to construction sites with relatively small drainage areas. They are appropriate in areas where runoff will be occurring as low-level shallow flow, not exceeding 0.5 cfs. The drainage area for silt fences generally should not exceed 0.25 acre per 100-foot fence length. Slope length above the fence should not exceed 100 feet (NAHB, 1995).

Siting and Design Considerations

Material for silt fences should be a pervious sheet of synthetic fabric such as polypropylene, nylon, polyester, or polyethylene yarn, chosen based on minimum synthetic fabric requirements, as shown in Table 1.

Table 1. Minimum requirements for silt fence construction (Sources: USEPA, 1992; VDCR, 1995)

Physical Property	**Requirements**
Filtering Efficiency	75 - 85% (minimum): highly dependent on local conditions
Tensile Strength at 20% (maximum) Elongation	Standard Strength: 30 lbs/linear inch (minimum) Extra Strength: 50 lbs/linear inch (minimum)
Ultraviolet Radiation	90% (minimum)
Slurry Flow Rate	0.3 gal/ft2/min (minimum)

If a standard strength fabric is used, it can be reinforced with wire mesh behind the filter fabric. This can increase the effective life of the fence. In any case, the maximum life expectancy for

synthetic fabric silt fences is approximately 6 months, depending on the amount of rainfall and runoff for a given area. Burlap fences have a much shorter useful life span, usually only up to 2 months.

Stakes used to anchor the filter fabric should be either wooden or metal. Wooden stakes should be at least 5 feet long and have a minimum diameter of 2 inches if a hardwood such as oak is used. Softer woods such as pine should be at least 4 inches in diameter. When using metal post in place of wooden stakes, they should have a minimum weight of 1.00 to 1.33 lb/linear foot. If metal posts are used, attachment points are needed for fastening the filter fabric using wire ties.

A silt fence should be erected in a continuous fashion from a single roll of fabric to eliminate unwanted gaps in the fence. If a continuous roll of fabric is not available, the fabric should overlap from both directions only at stakes or posts with a minimum overlap of 6 inches. A trench should be excavated to bury the bottom of the fabric fence at least 6 inches below the ground surface. This will help prevent gaps from forming near the ground surface that would render the fencing useless as a sediment barrier.

The height of the fence posts should be between 16 and 34 inches above the original ground surface. If standard strength fabric is used in combination with wire mesh, the posts should be spaced no more than 10 feet apart. If extra-strength fabric is used without wire mesh reinforcement, the support posts should be spaced no more than 6 feet apart (VDCR, 1995).

The fence should be designed to withstand the runoff from a 10-year peak storm event, and once installed should remain in place until all areas up-slope have been permanently stabilized by vegetation or other means.

Limitations

Silt fences should not be installed along areas where rocks or other hard surfaces will prevent uniform anchoring of fence posts and entrenching of the filter fabric. This will greatly reduce the effectiveness of silt fencing and can create runoff channels leading off site. Silt fences are not suitable for areas where large amounts of concentrated runoff are likely. In addition, open areas where wind velocity is high may present a maintenance challenge, as high winds may accelerate deterioration of the filter fabric. Silt fences should not be installed across streams, ditches, or waterways (Smolen et al., 1988).

When the pores of the fence fabric become clogged with sediment, pools of water are likely to form on the uphill side of fence. Siting and design of the silt fence should account for this and care should be taken to avoid unnecessary diversion of storm water from these pools that might cause further erosion damage.

Maintenance Considerations

Silt fences should be inspected regularly and frequently as well as after each rainfall event to ensure that they are intact and that there are no gaps at the fence-ground interface or tears along the length of the fence. If gaps or tears are found, they should be repaired or the fabric should be replaced immediately. Accumulated sediments should be removed from the fence base when the sediment reaches one-third to one-half the height of the fence. Sediment removal should occur

more frequently if accumulated sediment is creating noticeable strain on the fabric and there is the possibility of the fence failing from a sudden storm event. When the silt fence is removed, the accumulated sediment also should be removed.

Effectiveness

USEPA (1993) reports the following effectiveness ranges for silt fences constructed of filter fabric that are properly installed and well maintained: average total suspended solids removal of 70 percent, sand removal of 80 to 90 percent, silt-loam removal of 50 to 80 percent, and silt-clay-loam removal of 0 to 20 percent. Removal rates are highly dependent on local conditions and installation.

Cost Considerations

Installation costs for silt fences are approximately $6.00 per linear foot (USEPA, 1992). SWRPC estimates unit costs between $2.30 and $4.50 per linear foot (SWRPC, 1991).

References

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Appendix II. E: Vegetated Buffer

Buffers at the perimeters of construction sites are similar to agricultural buffers in that they trap sediments and remove pollutants in runoff from exposed areas (Source: Nova Scotia Department of Agriculture and Fisheries, 2000)

Description

Vegetated buffers are areas of either natural or established vegetation that are maintained to protect the water quality of neighboring areas. Buffer zones reduce the velocity of storm water runoff, provide an area for the runoff to permeate the soil, contribute to ground water recharge, and act as filters to catch sediment. The reduction in velocity also helps to prevent soil erosion.

Applicability

Vegetated buffers can be used in any area that is able to support vegetation but they are most effective and beneficial on floodplains, near wetlands, along streambanks, and on steep, unstable slopes. They are also effective in separating land use areas that are not compatible and in protecting wetlands or waterbodies by displacing activities that might be potential sources of nonpoint source pollution.

Siting and Design Considerations

To establish an effective vegetative buffer, the following guidelines should be followed:

- Soils should not be compacted.
- Slopes should be less than 5 percent.
- Buffer widths should be determined after careful consideration of slope, vegetation, soils, depth to impermeable layers, runoff sediment characteristics, type and quantity of storm water pollutants, and annual rainfall.
- Buffer widths should increase as slope increases.
- Zones of vegetation (native vegetation in particular), including grasses, deciduous and evergreen shrubs, and understory and overstory trees, should be intermixed.
- In areas where flows are concentrated and velocities are high, buffer zones should be combined with other structural or nonstructural BMPs as a pretreatment.

Limitations

Vegetated buffers require plant growth before they can be effective, and land on which to plant the vegetation must be available. If the cost of the land is very high, buffer zones might not be cost-effective. Although vegetated buffers help to protect water quality, they usually do not effectively counteract concentrated storm water flows to neighboring or downstream wetlands.

Maintenance Considerations

Keeping vegetation healthy in vegetated buffers requires routine maintenance, which (depending on species, soil types, and climatic conditions) can include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning. Inspection and maintenance are most important when buffer areas are first installed. Once established, vegetated buffers do not require much maintenance beyond the routine procedures listed earlier and periodic inspections of the areas, especially after any heavy rainfall and at least once a year. Inspections should focus on encroachment, gully erosion, density of vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If there is more than 6 inches of sediment in one place, it should be removed.

Effectiveness

Several researchers have measured greater than 90 percent reductions in sediment and nitrate concentrations. Buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).

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Appendix II.F. Sodding

Grass sod is laid on exposed soil to stabilize the soil and to reduce the velocity of storm water runoff (Source: Landscape USA, no date)

Description

Sodding is a permanent erosion control practice that involves laying a continuous cover of grass sod on exposed soils. In addition to stabilizing soils, sodding can reduce the velocity of storm water runoff. Sodding can provide immediate vegetative cover for critical areas and stabilize areas that cannot be vegetated by seed. It also can stabilize channels or swales that convey concentrated flows and can reduce flow velocities.

Applicability

Sodding is appropriate for any graded or cleared area that might erode, requiring immediate vegetative cover. Locations particularly well-suited to sod stabilization are:

- Residential or commercial lawns and golf courses where prompt use and aesthetics are important
- Steeply-sloped areas
- Waterways and channels carrying intermittent flow
- Areas around drop inlets that require stabilization.

Siting and Design Considerations

Sodding eliminates the need for seeding and mulching and produces more reliable results with less maintenance. Sod can be laid during times of the year when seeded grasses are likely to fail. The sod must be watered frequently within the first few weeks of installation. The type of sod selected should be composed of plants adapted to site conditions. Sod composition should reflect environmental conditions as well as the function of the area where the sod will be laid. The sod should be of known genetic origin and be free of noxious weeds, diseases, and insects. The sod should be machine cut at a uniform soil thickness of 15 to 25 mm at the time of establishment (this does not include top growth or thatch).

Soil preparation and additions of lime and fertilizer may be needed; soils should be tested to determine if amendments are needed. Sod should be laid in strips perpendicular to the direction of waterflow and staggered in a brick-like pattern. The corners and middle of each strip should be stapled firmly. Jute or plastic netting may be pegged over the sod for further protection against washout during establishment. Areas to be sodded should be cleared of trash, debris, roots, branches, stones and clods larger than 2 inches in diameter. Sod should be harvested, delivered, and installed within a period of 36 hours. Sod not transplanted within this period should be inspected and approved prior to its installation.

Limitations

Compared to seed, sod is more expensive and more difficult to obtain, transport, and store. Care must be taken to prepare the soil and provide adequate moisture before, during, and after installation to ensure successful establishment. If sod is laid on poorly prepared soil or unsuitable surface, the grass will die quickly because it is unable to root. Sod that is not adequately irrigated after installation may cause root dieback because grass does not root rapidly and is subject to drying out.

Maintenance Considerations

Watering is very important to maintain adequate moisture in the root zone and to prevent dormancy, especially within the first few weeks of installation, until it is fully rooted. Mowing should not result in the removal of more than one-third of the shoot. Grass height should be maintained between 2 and 3 inches. After the first growing season, sod might require additional fertilization or liming. Permanent, fine turf areas require yearly maintenance fertilization. Warm-season grass should be fertilized in late spring to early summer, and cool-season grass, in late winter and again in early fall.

Effectiveness

Sod has been shown to remove up to 99 percent of total suspended solids in runoff. It is therefore a highly effective management practice for erosion and sediment control, but its trapping efficiency is highly variable depending on hydrologic, hydraulic, vegetation, and sediment characteristics.

Cost Considerations

Average construction costs of sod average $0.20 per square foot and range from $0.10 to $1.10 per square foot; maintenance costs are approximately 5 percent of installation costs (USEPA, 1993).

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Appendix II.G: Construction Entrances

Stabilized construction entrances allow dirt to be removed from tire treads and collected as trucks leave construction sites

Description

The purpose of stabilizing entrances to a construction site is to minimize the amount of sediment leaving the area as mud and sediment attached to motorized vehicles. Installing a pad of gravel over filter cloth where construction traffic leaves a site can help stabilize a construction entrance. As a vehicle drives over the gravel pad, mud and sediment are removed from the vehicle's wheels and offsite transport of soil is reduced. The gravel pad also reduces erosion and rutting on the soil beneath the stabilization structure. The filter fabric separates the gravel from the soil below, preventing the gravel from being ground into the soil. The fabric also reduces the amount of rutting caused by vehicle tires by spreading the vehicle's weight over a larger soil area than just the tire width.

In addition to removal of sediment by simple friction of vehicle tires on the gravel pad, a vehicle washing station can be established at the site entrance. Wash stations, if used on a routine basis, remove a substantial amount of sediment from vehicles before they leave the site. Diverting runoff from vehicle washing stations into a sediment trap helps ensure that sediment removed from vehicles is kept on-site and disposed of properly.

Applicability

Typically, stabilized construction entrances are installed at locations where construction traffic leaves or enters an existing paved road. However, the applicability of site entrance stabilization should be extended to any roadway or entrance where vehicles will access or leave the site. From a public relations point of view, stabilizing construction site entrances can be a worthwhile exercise. If the site entrance is the most publicly noticeable part of a construction site, stabilized entrances can improve the appearance to passersby and improve public perception of the construction project.

Siting and Design Considerations

All entrances to a site should be stabilized before construction and further disturbance of the site area begins. The stabilized site entrances should be long and wide enough so that the largest construction vehicle that will enter the site will fit in the entrance with room to spare. If many vehicles are expected to use an entrance in any one day, the site entrance should be wide enough for the passage of two vehicles at the same time with room on either side of each vehicle. If a site entrance leads to a paved road, the end of the entrance should be "flared" (made wider as in the shape of a funnel) so that long vehicles do not leave the stabilized area when turning onto or off of the paved roadway. If a construction site entrance crosses a stream, swale, or other depression, a bridge or culvert should be provided to prevent erosion from unprotected banks. Stone and gravel used to stabilize the construction site entrance should be large enough so that they are not carried off site with vehicle traffic. In addition, sharp-edged stone should be avoided to reduce

the possibility of puncturing vehicle tires. Stone or gravel should be installed at a depth of at least 6 inches for the entire length and width of the stabilized construction entrance.

Limitations

Although stabilizing a construction entrance is a good way to help reduce the amount of sediment leaving a site, some soil may still be deposited from vehicle tires onto paved surfaces. To further reduce the chance of these sediments polluting storm water runoff, sweeping of the paved area adjacent to the stabilized site entrance is recommended. For sites using wash stations, a reliable water source to wash vehicles before leaving the site might not be initially available. In this case, water may have to be trucked to the site at additional cost.

Maintenance Considerations

Stabilization of site entrances should be maintained until the remainder of the construction site has been fully stabilized. Stone and gravel might need to be periodically added to each stabilized construction site entrance to keep the entrance effective. Soil that is tracked offsite should be swept up immediately for proper disposal. For sites with wash racks at each site entrance, sediment traps will have to be constructed and maintained for the life of the project. Maintenance will entail the periodic removal of sediment from the traps to ensure their continued effectiveness.

Effectiveness

Stabilizing construction entrances to prevent sediment transport off-site is effective only if all entrances to the site are stabilized and maintained. Also, stabilization of construction site entrances may not be very effective unless a wash rack is installed and routinely used (Corish, 1995). This can be problematic for sites with multiple entrances and high vehicle traffic.

Cost Considerations

Without a wash rack, construction site entrance stabilization costs range from $1,000 to $4,000. On average, the initial construction cost is around $2,000 per entrance. Including maintenance costs for a 2-year period, the average total annual cost is approximately $1,500. If a wash rack is included in the construction site entrance stabilization, the initial construction costs range from $1,000 to $5,000, with an average initial cost of $3,000 per entrance. The total cost, including maintenance for an estimated 2-year life span, is approximately $2,200 per year (USEPA, 1993).

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Appendix II.H: Industrial/Business Connections

A common source of pollution from businesses is a floor drain that is improperly connected to a storm drain (Source: Petro-Marine Company, Inc., no date)

Description

This management practice involves the identification and elimination of illegal or inappropriate connections of industrial and business wastewater sources to the storm drain system. Illicit connection detection and elimination programs attempt to prevent contamination of ground and surface water supplies by regulation, inspection, and removal of these connections. Any industrial discharge not composed entirely of storm water that is conveyed to the storm drainage system or a water body is considered to be an illicit discharge. These discharges may contain a variety of pollutants that can affect both public safety and the aquatic environment.

Many of these discharges are a result of connections to the storm drain that are unknown to the business owner and may not be evident in architectural plans. The large amount of storm and sanitary sewer pipes in a community creates a complex and often confusing system of utilities, so it is not unusual for improper connections to occur. For example, nearly 10 percent of all businesses in Wayne County, Michigan, had illicit connections, with an average of 2.6 found at each detected business (Johnson, 1998). A 1986 study found a 38-percent rate of illicit connections for businesses in Washtenaw County, Michigan, mostly in automobile-related and manufacturing businesses (Schmidt and Spencer, 1986).

Applicability

Illicit industrial connections can arise in a number of ways, including cross connections with sanitary sewers and floor drains improperly attached to storm drainage pipes. These connections may be accidental or planned, and may occur in new developments as well as in existing developments. For new businesses, preventative practices such as thorough inspection and verification during the entire construction phase can avoid the need for more extensive detection techniques and disconnection. For existing industries, improper connections are located by using field screening procedures, source testing protocols, and visual inspection.

Design Considerations

Discharges from industry and business may come from a variety of sources including process wastewater, wash waters, and sanitary wastewater. The following methods are often used for identifying improper industrial discharges to the storm drain system:

- *Field Testing of Dry Weather Discharges*. Storm drain outfalls are monitored to identify those areas where discharges are occurring that exceed water quality standards. This monitoring includes both visual inspection and chemical analysis to aid in identifying potential discharge sources.
- *Visual Inspection*. A physical examination of piping connections or analysis by closed circuit camera is used to identify possible illicit connection sites.

- *Piping Schematic Review*. Architectural plans and plumbing details are examined for potential sites where improper connections have occurred.
- *Smoke Testing*. Smoke testing is used to locate connections by injecting a non-toxic vapor (smoke) into the system and following its path of travel.
- *Dye Testing*. Colored dye is added to the drain water in suspect piping. Dyed water appearing in the storm drain system indicates an illegal connection, possibly between the sanitary sewer system and the storm drain.

Facilities that receive NPDES storm water permits are usually required to include documentation that the storm water collection system has been tested or evaluated for the presence of non-storm water discharges. To ensure that only storm water is being discharged into the storm drain system from an industry, communities may wish to institute a program that includes the following:

- Locating of industrial discharges to the municipal storm sewer system or local waters using storm drain monitoring, visual observation, and pipeline schematics
- Locating and evaluating the on-site industrial storm sewer system using field screening techniques, dye tests, smoke tests, and closed circuit television
- Developing plans to eliminate improper connections and exploring alternative disposal options for discharges that cannot be sent to the storm sewer system, such as using the sanitary sewer system or collecting and disposing of discharges off-site at an approved disposal facility
- Documenting the testing and eliminating of industrial/business illicit connections, including recording the location of the connection, the date of testing, and the method used to remove the connection
- Establishing a citizen complaint hotline to report incidences of illicit discharges

A program for the field screening of dry weather flows at storm drain outfalls can aid in identifying possible locations of industrial illicit connections. These field screening programs monitor for certain chemical and visual tracers that indicate potential sources of non-ground water illegal discharges. The use of these tracers provides a method for prioritizing sections of the storm drain system that require more intensive analysis to accurately pinpoint the specific sources contributing contaminated discharges. The reference section at the end of this fact sheet provides two excellent resources on the methodology for investigating inappropriate discharges and for selecting tracers to identify sources of contamination in dry weather flows.

Limitations

There are a number of factors affecting the ability of detection and elimination programs to remove illicit industry and business connections to the storm drainage system. The first is cost. Illegal connection location techniques are often labor intensive and can require a large commitment of staff to carry out detection tests. If a community hotline is used, staff will be necessary to record complaints. Training will be required for performing field screening tests,

and a variety of equipment is necessary for performing the various detection tests. Resource sharing between several departments may help offset equipment costs.

Another limitation to industrial illicit connection control is the issue of access to private property for inspection purposes. An ordinance that ensures "right of entry" is vital in locating potential sources of illegal industrial discharges. Several cities have enacted sewer use ordinances that include language for permitting the entrance of municipal staff onto commercial and industrial sites for detection purposes. An example of a sewer use ordinance for the city of St. Louis, Missouri, is available for review at the Center for Watershed Protection web page at *http://www.cwp.org*.

Despite the difficulty identifying these connections due to budget and staff restraints, it is important to understand that these connections are illegal and should be identified and reported regardless of cost. Jurisdictions can offset some of these costs by encouraging the reporting of illicit discharges by public and municipal employees, thereby saving expense on inspectors and directing resources more efficiently.

Effectiveness

Industrial storm water discharges due to improper connections to the storm sewer system can have considerable impacts on storm water and receiving waters. These discharges may contain heavy metals, oil and grease, nutrients, or raw sewage that pose serious environmental risks. Bacteria from the presence of untreated human waste may contaminate drinking water supplies and lead to outbreaks of disease. Toxic pollutants and heavy metals can destroy habitat and affect aquatic organisms, impacting economic and public health. The detection and correction of illicit discharges can result in significant reductions of these contaminants, improving water quality and meeting effluent requirements.

Illicit connection programs often do not concentrate solely on businesses and industries, so effectiveness data on actual pollutant removal are difficult to locate. However, there are data that demonstrate the effectiveness of illicit connection correction programs at improving water quality. Two examples show how illicit connection elimination can reduce pollutant levels and remove fecal coliform from streams. The first is the Huron River Pollution Abatement Project, in Washtenaw County, Michigan. This program was active from 1987 to 1992 and dye tested over 3,800 facilities. Improper connections to the storm sewer were found in 450 facilities, of which 328 were verified as being removed. As a result, fecal coliform levels in the Huron River dropped approximately 75 percent between 1987 and 1990. The City of Tulsa, Oklahoma, along with several state agencies, has also sought to control the impacts of illicit discharges. Through inspection of possible illicit discharges, dry weather field screening, repairs to storm sewer and sanitary sewer lines, and community involvement, the city was able to demonstrate an improvement in water quality from pre-program levels. The city compared the average event mean concentration of selected parameters from pre-program levels to results after 4 years of implementation (1994–1998) to show how much reductions had occurred. The results are listed in Table 1.

Table 1. Water quality improvements 1994–1998 in Tulsa, Oklahoma (Source: NRDC, 1999)

Parameter	Average EMC after program implementation (mg/l)	Pre-program average EMC (mg/l)	Percent reduction
Copper	0.013	0.030	56
Zinc	0.097	0.215	55
BOD[a]	7.7	9.4	18
COD[a]	66.5	70.2	5
TP[a]	0.270	0.325	17
TKN[a]	1.354	1.660	18
TSS[a]	117.5	135	13

[a]BOD=biological oxygen demand; COD=chemical oxygen demand; TP=total phosphorus; TKN=total Kjeldhal nitrogen; TSS=total suspended solids

Cost Considerations

The cost for instituting an illicit connection detection and elimination program will vary greatly based on the intensity of the effort. Identification of illicit connections using visual inspections of dry weather flows has an estimated cost of $1,250 to $1,750 per square mile (Claytor and Brown, 1996). Many programs offset some of their cost by encouraging the reporting of illicit discharges by public and municipal employees, thereby saving expense on inspectors and directing resources more efficiently. Programs have also saved money by using student interns to locate and map dry weather flows from outfalls, or contracting with academic institutions to perform outfall monitoring.

Some programs have used funds available from "environmental fees" or special assessment districts to fund their illicit connection elimination programs. The Huron River Pollution Abatement Project used annual assessments of the city of Ann Arbor, Michigan, and a per parcel basis for the rest of the district to fund the costs of illicit connection removal efforts. The project provided Washtenaw County with a total of $1.7 million over the life of the program to finance their efforts. Fort Worth, Texas, charges an "environmental fee" to local residents and businesses to fund storm water-related efforts, including illicit connection detection. Approximately $2.5 million dollars a year is raised through these fees.

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Appendix II.I: Illicit Discharge Detection and Elimination

Illegal Dumping

Description

Illegal dumping is disposal of waste in an unpermitted area, such as a back area of a yard, a stream bank, or some other off-road area. Illegal dumping can also be the pouring of liquid wastes or disposing of trash down storm drains. It is often called "open dumping," "fly dumping," and "midnight dumping" because materials are often dumped in open areas, from vehicles along roadsides, and late at night. Illegally dumped wastes are primarily non-hazardous materials that are dumped to avoid paying disposal fees or expending the time and effort required for proper disposal (USEPA Region 5, 1998).

A "No Dumping" sign discourages illegal dumping by threatening arrest (Source: @Home WebSpace, Neuskool, 2000)

Applicability

Illegally dumping wastes down storm drains and creating illegal dumps can impair water quality. Runoff from dumpsites containing chemicals can contaminate wells and surface water used as sources of drinking water. Substances disposed of directly into storm drains can also lead to water quality impairment. In systems that flow directly to water bodies, those illegally disposed-of substances are introduced untreated to the natural environment. For example, the state of Oklahoma has 2,446 illegal dumps, which will cost $3,922,000 to clean up. As part of its pollution prevention efforts, the Oklahoma State University's Cooperative Extension Service has developed a series of posters and other displays to promote awareness of the problems that result from illegal dumping.

Implementation

Municipalities and organizations all over the United States have implemented programs to stop the illegal dumping of trash and used materials. The most important method of implementing such programs is public education. To ensure their effectiveness, some programs allow for citizen reporting of illegal dumpers, who can then be fined, sentenced to jail, or be required to perform community service. Some clues can help citizens identify illegal dumpers (Fairfax County, 2000):

- Illegal dumping often occurs late at night and before dawn.
- There is often no company name on the construction vehicles or equipment.
- The construction activity occurs on a site with no company advertising sign.
- There is no construction entrance adjacent to the roadway (an area of large stone and gravel placed to keep mud off streets).

In 1993 the North Central Texas Council of Governments (NCTCOG) initiated a public outreach program called *Our Water—Take It Personally*. The campaign includes storm water stenciling that reads "Don't Dump—Protect Our Water." In 1993 NCTCOG won the Keep Texas Beautiful

President's Award for its efforts to address illegal dumping. Tarrant County, Texas, has initiated an aggressive public reporting program to stop illegal dumping. Work with public and private entities to develop a manual, *Storm Water Quality Best Management Practices for Industrial Activities—North Central Texas*, has also been successful (NCTCOG, 2000a, 2000b).

The Dallas County Illegal Dumping Hotline (1-888-335-DUMP) is a 24-hour hotline for citizens to report illegal dumping in Collin, Dallas, Denton, Ellis, Erath, Hood, Hunt, Johnson, Kaufman, Navarro, Palo Pinto, Parker, Rockwell, Somervell, Tarrant, and Wise counties. Citizens are asked to leave as much information as possible—city and county of the incident, specific street location, license plate number and description of vehicle, personal description of violator, type of waste dumped, caller's name and telephone number, date of violation. As an incentive to report illegal dumping, a $50 reward is given to reporting individuals if their information leads to an arrest (the City Web, 1998). Earthwater Stencils, Inc., supports storm water pollution prevention by providing materials such as posters, stencils, and brochures to community-based storm drain stenciling and related programs in local watersheds. Their web site (*www.earthwater-stencils.com*) offers information on how and where to stencil and how to obtain stenciling materials.

Clean Ocean Action, a nonprofit organization that focuses on the New Jersey/New York coast, has designated 2 weeks of the year as "Storm Drain Stencil Week." They offer free storm drain stenciling kits to teachers and also have available a variety of lesson plans and activities about storm drains.

Effectiveness

Illegal dumping regulations must be enforced. In Chicago, Illinois, penalties for dumping without a permit can include fines up to $2,000, 6 months in jail, and up to 200 hours of community service. Violators are liable for up to three times the cost of cleaning up a site, and city contracts can be terminated. Vehicles are subject to seizure and impoundment, with the owner of record liable for a $500 fine in addition to towing and storage fees. Finally, owners or occupants of any unimproved parcel of real estate must remove any abandoned or derelict motor vehicle, garbage, debris, refuse, litter, or miscellaneous waste. Violations can result in fines of $200 to $1,000 per day. These regulations are promulgated under Ordinances 7-28-440 and 7-28-450, Municipal Code, City of Chicago (USEPA Region 5, 1998). Hawaii has instituted a similar program. In 1998 Governor Cayetano enacted a law that imposes fines and jail time on individuals or groups that operate or use illegal dumps. Open dumps throughout the state have been found to lead to groundwater and surface water pollution, as well as odor problems and fires of hazardous materials. The sites are often at least 5 acres and are not visible from public roads because they are on private property or behind closed gates (HDOH, 1998).

Local police department or other public entities can play a major role in catching illegal dumpers. The Central Oklahoma Trash Cop Program, which consists of environmental officers hired to catch and prosecute litterers and illegal dumpers in four counties, was begun with $160,000 obtained through fundraising efforts by a local community group, Oklahoma City Beautiful. The program will be sustained by fines collected from offenders (USEPA Region 5, 1998).

Reliance on public reporting is an important factor in the effectiveness of anti-illegal dumping programs. Municipalities can develop citizen reporting hotlines or web site forms. Program administrators must ensure that these reports are followed up and that the reporter receives a notice of the results. Otherwise, the incentive for reporting could be lost. San Diego County (California) has a toll-free telephone number and a web site reporting form (*www.co.san-diego.ca.us/cnty/cntydepts/landuse/env_health/stormwater/sw_report_dumping.html*) for reporting illegal dumping. Citizens are encouraged to report anyone seen dumping anything onto street surfaces or into the storm drains in the county.

In some cases, citizens have been rewarded for helping clean up illegal dumpsites. PhilaPride, a nonprofit group in Philadelphia, Pennsylvania, promotes neighborhood participation in cleanup and enforcement activities. The program is funded primarily by corporations that have had dumping problems on their properties, such as the Conrail Corporation, which contributes up to $25,000 each year (USEPA Region 5, 1998). A community group in Detroit, Michigan, uses a county grant to pay residents to bring illegally dumped tires to drop-off locations. A local waste hauler donates services to transport the tires to a tire shredder, which shreds them at no charge. A local bank donates money to cover disposal costs (USEPA Region 5, 1998).

Design Considerations

Illegal dumping programs might also include monitoring of roads that have often been used for trash disposal. Other methods are as simple as public education, such as storm drain stenciling (See Storm Drain Stenciling fact sheet). Both programs depend on citizen reporting of illegal dumpers.

Storm drain stenciling is an effective method of raising public awareness of the impacts of storm water runoff on water quality. Stenciling neighborhood storm drains reminds car owners not to dump their motor oil down the drain. It helps all neighbors realize that throwing their trash down the storm drain could have negative effects on their local river. Storm drain stenciling programs can be started by any local group, such as the Boy Scouts, a school class, or a neighborhood association. It is an activity that is quick, easy, and fun.

Limitations

Determining which storm drains to stencil is a vital step. Groups must ensure they have the proper authority's permission to paint storm drains. In terms of reporting illegal dumpers, citizens must be assured that their efforts to contact reporting agencies will result in action by authorities. The city of Jacksonville, Florida, has a citizen complaint form on its web page. Some of the categories of complaints are "discharge of pollutants to storm drains, ditches, rivers or creeks," "overflowing manholes or pump stations," "uncontrolled erosion from land clearing activities," and "pumping of muddy water into creeks, storm drains, or ditches." City staff have established a goal of contacting complaint submitters within 24 hours (City of Jacksonville, 2000).

Maintenance

Municipalities should set goals for reducing the number of illegal dumping acts. The city of Sacramento, California, has set a goal of stenciling 45,000 storm drains throughout the city.

Citizen participation and reporting are important steps in maintaining an anti-illegal dumping program. Furthermore, proper enforcement must be implemented to discourage others from performing these illegal acts.

Cost Considerations

Costs for implementing illegal dumping programs vary. Storm drain stenciling by volunteers is inexpensive because there are only small costs for the stencils and paints. Cash incentives like the $50 reward offered in Dallas County are likely to be minimal costs, because the rewards would not be granted until after a conviction. Actual monitoring by local police or another authority can be more expensive and would require funding in the locality's budget.

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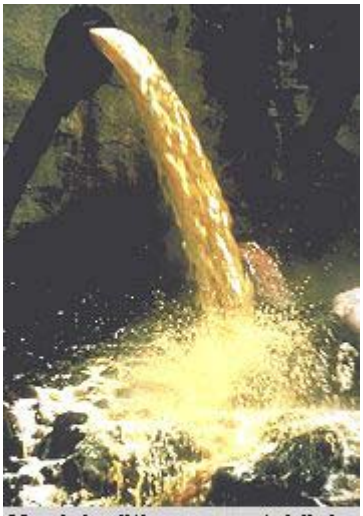
Appendix II.J: Wastewater Connections to the Storm Drain System



Municipalities can establish a program to inspect storm drain systems for connections to the sanitary sewer system to prevent discharge of untreated wastewater to waterbodies

Description

An illicit discharge is considered to be a discharge composed of non-storm water that enters the storm drain system through an unwarranted connection. Storm sewer systems are sometimes employed as an inexpensive or convenient alternative to proper disposal of wastewater to treatment plants. These illegal wastewater discharges can occur as illicit connections from commercial or business establishments or illegal dumping into storm drain inlets. Illicit connection detection and elimination programs seek to prevent contamination of ground and surface water supplies by regulation, inspection, and removal of these illegal sources of wastewater discharge.

Pollutants that may be found in these untreated wastewater discharges include raw sewage, heavy metals, oil and grease, solids, detergents, chlorine, potassium, ammonia and nutrients. These pollutants can have implications for both human health and the aquatic environment. Bacterial contamination from raw sewage can spread disease and close waters to fishing and swimming, and heavy metals are known to be toxic to aquatic organisms. Excessive nutrient loads can lead to eutrophication in lakes, reducing oxygen levels, and affecting aquatic species.

An example of an illicit wastewater connection is a cross-connect of a shop drain to the storm sewer. This type of improper connection often occurs in automobile-related facilities (garage/repair, tire stores, service stations, muffler/transmission shops, car washes, and auto dealerships). The Wayne County, Michigan, illicit connection investigation program found that the majority of illicit connections in nonresidential facilities were drains connected to storm sewers (Johnson, 1998). Many times the connection of the shop drain to the storm drain system is unknown to the business owner, and may not be evident in architectural plans. Shop drains that may potentially be connected to the storm sewer include floor drains, wash sinks, sump pumps and solvent sinks.

Applicability

Illicit connection programs tend to concentrate their efforts on areas where nonresidential facilities are located. The USEPA has estimated that approximately 60 percent of the businesses known to use or store petroleum products were improperly connected to the storm sewers systems (USEPA, 1991, as referenced by the Rouge River National Wet Weather Demonstration Project).

These improper connections often happen during new construction activities. Inadequate mapping of the internal plumbing connections for a building can lead to wastewater being discharged incorrectly to storm drains. Sewer maps may also be incorrect, leading to cross

connections between the sanitary sewer lines and the storm sewer system. Thorough inspection and verification by monitoring during the entire construction phase can prevent the illegal connection of wastewater sources during new construction. For existing facilities, the location of improper connections will require the use of field screening procedures, source testing protocols, and visual inspection.

Design Considerations

Programs that address illicit connections, including wastewater connections, typically use a combination of monitoring, inspection, and public outreach to achieve the goal of eliminating improper discharges to the storm drainage system. With many communities facing limited budgets and resources, it is important that investment in an illicit detection program have the greatest return possible.

Field monitoring is an essential component of an illicit detection program and is very valuable for creation of a cost-effective program. Monitoring drains that have dry weather flows will allow program mangers to focus their illicit detection investigations on those outfalls that do not meet water quality standards. Once an outfall is identified as having a high priority through visual inspection, there are a few ways to find the source of the problem. Using closed circuit television testing may reveal a connection that is discharging suspicious material. Spot testing at storm drain manholes upstream of the outfall may aid in isolating an area where the problem discharge is coming from. Infrared and thermal photography have also been used to identify suspect discharges.

Once an area is identified as requiring further investigation, a letter should be sent to facility owners or operators in that area to that alert them that their facility has been selected for an illicit connection inspection. An inspection appointment is made, and field crew determines the location of storm and sanitary sewer manholes and the locations of all plumbing fixtures in the facility. Using either a trace dye or smoke test, the facility is monitored for any illicit connection. If the dye is seen in the storm sewers or smoke is seen in the facility, an inspection team identifies the likely source of the illicit connection.

If a plumbing fixture is found to be connected to the storm sewer, or discharging to either surface water or the ground, the facility is informed of the violation. The facility is given a time frame in which to respond to the violation. Following this period, the fixtures are retested. If the connection has not been corrected, further disciplinary action may be taken if the business or property owner has not provided a description of the corrective actions that were taken.

The general housekeeping practices of a facility should also be examined during an inspection. Issues such as proper storage of hazardous materials and where wastewater from cleaning equipment is emptied should be reviewed with facility operators. This check will help eliminate potential sources of pollutants entering the storm sewers system.

An inspection program of existing septic systems to identify failing systems will also prevent wastewater discharges to storm drains or receiving waters. Requiring inspection of on-site wastewater systems at the time of property transfer and developing a database that tracks septic system pumpouts can help this effort. This process could be done in cooperation with the local health department.

Limitations

A number of limitations might occur during the establishment and operation of an illicit connection program. One is the time and effort it takes to inspect each individual site if program managers plan to inspect all the facilities within their community. Many times illicit connection programs are just one aspect of a public works' or environmental department's mission, so the ability to monitor and inspect nonresidential facilities may be limited by staff availability. In some instances, agencies primarily use citizen complaints to identify potential sources of illicit connections due to staff requirements. Citizens can play an important role in monitoring and inspecting the system to save the municipality money. Louisville and Jefferson counties in Kentucky employ students in the summer to conduct dry weather sampling and system inspections. Monterey, California, has trained citizen volunteers to help with outfall sampling (NRDC, 1999).

Another limitation is the issue of public access to private property. Inspectors responsible for illicit discharge detection and elimination must have access to private property to identify and remove the connections that are the source of illegal non-storm water discharges. An ordinance guaranteeing "right of entry" to private property is critical to allowing inspectors to identify and take corrective actions on individual sources of illicit discharges.

A final limitation is the intermittent nature of illicit discharges. Because wastewater discharges from illicit connections do not necessarily happen on a consistent basis, it is difficult to identify areas where these connections exist unless constant monitoring occurs.

Maintenance Considerations

Two-person teams should be capable of performing field investigations and inspections. The number of teams required in a program will be based on the size of the community, the number of nonresidential facilities to be inspected, and the number of storm drain outfalls to be monitored.

Effectiveness

The effectiveness of illicit discharge programs at removing pollutants from storm water has not received extensive study at this time. Some program managers have estimated the amount of pollutants they believe to have been removed by their programs (see the fact sheet on Industrial Connections, as well as below), but percentage estimates for individual pollutant removal effectiveness are currently difficult to locate. Table 1 from the Wayne County Illicit Connection Control Program shows the estimated reduction in pounds of pollutants due to illicit connection elimination for the years 1991−1994.

Table 1. Estimated pounds of pollutants removed by illicit connection control program, 1991−1994 (Source: Wayne County Dept. of Public Health Illicit Connection Investigation Program Quarterly Report)

Pollutant	Pounds Removed
Ammonia	
Chlorine	165
Potassium	54
Total Phosphorus	34
Biological Oxygen Demand	148
Chemical Oxygen Demand	2,010
Flow, Storm Water to Sanitary System	5,800
Surfactants as MBAs?	850,000 (gallons/year)
Suspended Solids	2,554
Total Solids	2,010
Volatile Solids	6,790
	2,800

Illicit connection elimination programs have been identified by the USEPA as an important tool in protecting urban water quality. EPA's Nationwide Urban Runoff Program (NURP) recognized the importance of addressing pollutants from inappropriate entries to the urban storm drain system (Lalor and Pitt, 1999). A recent example from the state of Virginia further illustrates the need for such programs. In 1998, sanitary sewer lines from nine condos inside a large housing complex were found to have been inadvertently connected to a roof drain that drained to storm sewer pipes. This cross-connection into the storm drainage system went undetected by authorities (despite periodic odor complaints by local residents) for more than 27 years. While this problem has been fixed, more than 6 million gallons of raw sewage were estimated to have been discharged into the Four Mile Run stream over the course of that 27 years (NVRC, 2001).

Examples such as these demonstrate the need for illicit connection elimination programs. By preventing wastewater discharges to the storm drain system, these programs reduce pollutant loads and protect water quality and the aquatic environment from the effects of these non-storm water discharges.

Cost Considerations

The costs of illicit connection detection and elimination programs vary with the intensity of effort and the amount of staff dedicated to the program. Wayne County, Michigan, has an average annual cost of $187,000 for their program. This budget pays for a full-time, two-person field crew and one part-time field crew and allows them to perform 325 to 350 site inspections annually.

Some programs have offset the cost of field monitoring by using volunteers to adopt outfalls and monitor stream quality. Citizen hotlines broaden the involvement of the public in illicit discharge surveillance. These measures help identify areas where inspection crews can focus their efforts.

Another way to save staff time and money is by establishing a certification program. This program could identify properties that have checked their buildings and found no illicit connections. If inspectors know what buildings have been evaluated, time could be saved when tracking down contamination.

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Appendix II. K: Illicit Discharge Detection & Elimination

Many marinas provide pumpout stations for safe disposal of bilge (Source: Oregon State Marine Board, no date)

Recreational Sewage

Description

Recreational sewage management measures seek to regulate wastewater generated from outdoor activities such as boating or camping by providing alternative methods to waste disposal in place of illegal overboard discharge. Under federal law, it is illegal to discharge marine sewage from boats in navigable U.S. waters, including coastal waters up to 3 miles offshore. The law also specifies that there be "no discharge" by boats operated in lakes and reservoirs or in rivers not capable of interstate navigation. Boats with installed toilets must have an operable Coast Guard approved marine sanitation device (MSD) that either holds sewage for pumpout ashore or for discharge in the ocean beyond the 3-mile limit, or that treats the sewage to Federal standards prior to discharge.

The proper disposal of recreational waste is necessary to avoid the impacts that these activities and their associated developments (i.e., marinas and campgrounds) can have on aquatic environments. Marina and recreational boat sewage can have substantial impact on water quality by introducing bacteria, nutrients, and hazardous chemicals into waterways. It has been reported that a single overboard discharge of human waste can be detected in up to a 1-square-mile area of shallow enclosed water (FL DEP, no date). These human wastes can include *Streptococci*, fecal coliform, and other bacteria which contribute to incidences of human disease, shellfish bed closures, alerts on eating fish, and algal blooms. Boats can be a significant source of fecal coliform bacteria in areas with high boating densities and low hydrologic flushing, and fecal coliform levels become elevated near boats during periods of high occupancy and usage (USEPA, 1993). Holding tanks on boats also concentrate pollutants and use increased levels of oxygen during decomposition. Table 1 shows a comparison of the biological oxygen demand required to break down sewage held by MSD's versus untreated and treated municipal sewage (FL DEP, no date).

Table 1. BOD concentrations according to sewage type

Applicability

Sewage	BOD concentration
Boat Sewage	1,700–3,500 mg/l
Raw Municipal Sewage	110–400 mg/l
Treated Municipal Sewage	5–100 mg/l

Implementing proper disposal practices and providing services for removal of recreational wastes can alleviate the effects that this source of pollutants has on water quality.

Best management practices dealing with recreational sewage sources are most often applied in coastal areas and freshwater bodies of water where boating activity occurs. Physical factors involving the siting of marinas can affect the release of sewage to surface water due to flushing times and circulation patterns. In addition, the use of inadequate marine sanitation devices on boats can cause unintended sewage discharges. Climatic factors such as rainfall and wind also influence the circulation and flushing times for marinas. The proper siting of marina basins and adequate planning for the disposal of boater sewage are important considerations in addressing this form of illicit discharge. The same basic techniques regarding siting and pumpout provision are applicable for sewage generated at campgrounds.

Implementation

Several management practices can reduce the discharge of sewage from vessels at marinas. These practices range from installation of pumpout systems to public education to inspection of marine sanitation devices. The use of the following practices is encouraged to help reduce the incidence of improper discharges from vessels:

Pumpout Installation and Operation—Pumpout stations are an efficient method to control sanitary discharges from boating activities. Pumpout facilities collect waste from on-board MSDs, which are recommended for vessels over 25 feet. EPA Region 1 determined that, in general, one pumpout facility per 300−600 boats with holding tanks (type III MSDs) should be sufficient to meet the demand for pumpout services in most harbor areas (USEPA, 1991b). EPA Region 4 suggested one facility for every 200 to 250 boats with holding tanks (USEPA, 1985a). The State of Michigan has instituted a no-discharge policy and mandates one pumpout facility for every 100 boats with holding tanks (USEPA, 1993).

There are three types of pumpout stations: a fixed collection system, a mobile/portable system, or a slipside system. All three types of systems provide for the removal of sanitary waste by connecting a flexible hose to the wastewater fitting in the hull of the boat, and pumping or vacuuming the wastewater to an onshore holding tank, sanitary sewer system, or an approved disposal facility. However, there are differences in the cost, location, and use of each of the three collection system types. *Fixed systems* include one or more centrally located sewage pumpout stations. These stations are often located at the end of a pier, typically near fueling docks, so that fueling and pumpout operations are easily accessible. *Portable/mobile collection systems* are similar to fixed-point systems, but are capable of being moved around a marina to provide pumpout services in various locations. This collection system is connected to the deck fitting on the vessel, and wastewater is pumped from the vessel's holding tank to the pumping unit's storage tank. The contents of the storage tank are then discharged into a municipal sewage system or a holding tank for removal by a septic tank pumpout service. Another form of portable pumpout is the radio-dispatched pumpout boat. The pumpout boat goes to a vessel in response to a radio-transmitted request, and eliminates the inconvenience of lines, docking, and maneuvering vessels in high-traffic areas. (USEPA, 1993). *Slipside or remote systems* provide direct hookup and continuous wastewater collection at a slip. EPA recommends that slipside pumpout should be provided to live-aboard vessels (USEPA, 1993). Marina slips designed to serve transient boating populations can be served by either fixed or mobile pumpout systems.

According to a 1989 American Red Cross Boating Survey, there were approximately 19 million recreational boats in the United States (USCG, 1991). About 95 percent of these boats were less than 26 feet in length. On-board marine sanitation devices are not regularly used on vessels less than 26 feet long. These boats often use only small portable (removable) toilets, requiring planning for sewage disposal for these smaller vessels. A satisfactory disposal facility for this type of device could be a dump station, possibly located at the end of a pier. Given the large percentage of smaller boats, facilities for the dumping of portable toilet waste should be provided at marinas that service significant numbers of these boats (USEPA, 1993).

The operation of pumpout facilities should be tied to times when customers are most likely to use the service. Having services available on weekend mornings and evenings when demand is high will encourage pumpout use. Fees for pumpout use should also be kept at reasonable rates to encourage use. A willingness to-pay-survey conducted by the EPA found that boaters would accept a fee of between $3 and $7 dollars for pumpout service (RI Sea Grant, 1992). Some marinas offer free pumpout service, and build the cost into slip fees or environmental surcharges. Routine inspection of pumpout facilities is also necessary to ensure that the equipment is functioning properly.

No-discharge area designations—No-discharge areas are zones where it is illegal to discharge sanitary waste from vessels, whether it is treated or untreated. Once a specific area has adequate pumpout facilities, states can apply for this designation. The only type of marine sanitation device that can be legally used in these areas are Type III MSDs (holding tanks). The benefit of the no-discharge areas is that they can significantly reduce the amount of bacterial contamination from illegal discharges of vessel waste. In Rhode Island, water quality studies indicate that levels of fecal coliform have declined during the boating season since the establishment of a no-discharge designation (RI Sea Grant, 1992).

Education—Pumpout facilities are of little use if boaters do not use the service. Many boaters are unaware of state and federal regulations requiring the use of marine sanitation devices, or of the location of pumpout services. Like most forms of educational outreach, the use of pamphlets, newsletters, bill inserts, and meetings are often used to inform users of available pumpout services. Offering free inspections of customer MSDs through the Coast Guard Auxiliary Boating Safety Program is another way to control illegal wastewater discharges. Sources can be identified through a number of methods—public complaints, visual screening, water sampling from manholes, outfalls during dry weather, and use of infrared and thermal photograph (USEPA, 2000a).

Enforcement—In some states, laws have been passed granting local harbormasters the authority to enforce MSD requirements and fine violators. Ensuring that local and state laws are passed granting enforcement authority will allow for the inspection and identification of MSDs that are not operating properly. One method that has been used to enforce illegal discharge controls is by placing dye tablets in holding tanks to discourage illegal disposal. This practice was employed in Avalon Harbor, California, to identify fecal coliform bacteria sources. Upon a vessel entering the harbor, a harbor patrol officer boards and places dye tablets in all sanitary devices. The devices are then flushed to ensure that the holding tanks do not leak. During the first 3 years of implementation, this practice detected 135 violations of the no-discharge policy and was

extremely successful at reducing pollution levels (USEPA, 1993). One tablet in approximately 60 gallons of water will give a visible dye concentration of one part per million. The cost of the tablets is approximately $30 per 200 tablets (Forestry Suppliers, 1992, as cited in USEPA, 1993).

Signage—Signs marking pumpout station locations and hours of operation should be placed in prominent places where marina tenants tend to gather. If the pumpout station serves an entire harbor, then signs should be placed in neighboring marinas and mooring areas to direct boaters to the station. Self-service pumpout stations need to include a sign that provides operating guidance. Pumpout signs may be available through either state or federal programs, and marina owners should be encouraged to place these signs near each pumpout station.

Limitations

The management practices for controlling recreational sewage are limited mostly by a lack of pumpout facilities and the need for boater education programs that stress techniques to prevent wastewater discharges. These two factors have been called the most important in successfully preventing sewage discharge (USEPA, 1991b). The cost of pumpout facilities has also been cited as a limitation, but this may be due to a lack of awareness about federal and state grant programs to aid in pumpout station installation.

Maintenance Considerations

In general, marina pumpouts are fairly inexpensive to operate and maintain. Maintenance considerations can include scheduling of inspection and replacement of pumpout equipment, cleaning of hoses and pumpout connections, and hiring of a service to remove sewage that is not discharged into the sanitary sewer.

Effectiveness

Limited data are available on the effectiveness of management practices to reduce water quality impacts from illegal wastewater discharges in marinas. The water quality effects of improper sewage discharges include elevated fecal coliform bacteria levels and reduced oxygen levels in the water. A single weekend boater flushing untreated sewage into our waters produces the same amount of bacterial pollution as 10,000 people whose sewage passes through a treatment plant (CA DBW).

Marine sanitation devices can also introduce harmful chemicals into the aquatic environment. These chemicals are used to disinfect and deodorize the waste, and they include formaldehyde, paraformaldehyde, quaternary ammonium chloride, and zinc sulfate. Some of these chemicals are known carcinogens and have adverse impacts on aquatic organisms.

Cost Considerations

Costs associated with pumpouts vary according to the size of the marina and the type of pumpout system. Table 2 presents EPA cost information for three marina sizes and two types of pumpout systems (USEPA, 1993). The average cost for pumpout installation has been estimated to be $5,323 (RI Sea Grant, 1992). Portable pumpout facilities are believed to be the most logistically

feasible, convenient, accessible, and economically affordable way to ensure proper disposal of boat sewage (Natchez, 1991).
Depending on the type of pumpout system installed, maintenance costs can range between $36 and $200 per slip per year. Table 2 contains operation and maintenance figures for three types of sewage pumpout collection system. As the table shows, operation and maintenance is more expensive for marina-wide and portable systems than for slipside systems. This extra expense is balanced by the lower capital cost for system installation for both marina-wide and portable systems.

Table 2. Annual per slip pumpout costs for three collection systems (Source: USEPA 1985 as cited in USEPA, 1993)

Factor	Marina-Wide	Portable/Mobile System	Slipside System
Small Marina (200 slips)			
Capital Cost	15[a]	15[b]	102[a]
O&M Cost	110	200	50
Total Cost (slip/year)	125	215	152
Medium Marina(500 slips)			
Capital Cost	17	10	101
O&M Cost	90	160	40
Total Cost (slip/year)	107	170	141
Large Marina(2,000 slips)			
Capital Cost	16	10	113
O&M Cost	80	140	36
Total Cost (slip/year)	96	150	149
[a]Based on 12% interest, 15 years amortization [b]12% interest, 15 years on piping, 12% interest, 15 years on portable units			

Case studies of best management practices for nonpoint-source pollution related to boating were performed by the University of Rhode Island Sea Grant. The three case studies in Table 3 examined various public education techniques for their cost, educational value, and cost effectiveness. While these public education case studies did not focus exclusively on boat sewage practices, the results can be used as an indicator of expected cost and performance for recreational sewage BMPs.

Table 3. A review of three BMP case studies for marinas (Source: RI Sea Grant, 1992)

BMP	Cost	Educational Value	Cost Effectiveness
Conducting Workshops	Low cost ($16 per facility) but requires considerable investment of time	Ranked last among customer choices for receiving information Low turnout Only 31% of attendees have used BMP's	Low unless attendance is tied to a more popular marina event
Distributing Literature	$52.80 per marina for distribution through display rack ($45 for rack and $7.80 for copies) $45.36 if done through monthly mailing	Ranked as the second most popular way of receiving information 75% reported reading fact sheets and 91% of these readers indicated that they began using practices learned	High if monthly mailing method is used
Posting Signs	$105	Ranked first as the most popular way of receiving information	Very cost effective since signs can be used for several years.

Federal aid is available to states for the construction, renovation, operation, and maintenance of pumpout and dump stations to improve water quality. The Clean Vessel Act Grant Program also provides funds for educational programs about disposing of human waste in an environmentally safe manner. The federal share of any project cannot exceed 75 percent of the total cost, and marina operators agree to the following conditions:

Pumpout facilities will be operated, maintained, and accessible to all recreation vessels for the full period of their useful life
The national pumpout symbol shall be installed and must be clearly visible to boaters.
An informational sign shall be installed at pumpout stations and will specify fees, restrictions, hours of operation, operating instructions, and a contact name and telephone number to call if the facility is inoperable.

The maximum user fee that can be charged for pumpout use is $5 unless a written proposal for a higher fee is submitted. For further information about the Clean Vessel grants program, consult *http://fa.r9.fws.gov/cva/cva.html*.

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APPENDIX III
Storm Water Quality
Environmental Management Department

(http://www.fortworthgov.org/DEM/fishsign.htm)

Storm Drain Marking Program

Storm drain curb inlet markers have proven to be an effective means of providing a pollution prevention message to citizens of Fort Worth. These markers inform citizens that anything dumped into a curb inlet will pollute a local waterway. The city began its curb-marking program in 1989 using spray painted stencils. In 1994 our staff designed an aluminum plaque to replace the stencils.

The plaques are more attractive and eye catching, quicker to install, and more durable than the stenciled messages. More recently, we have added plastic markers produced by das Manufacturing Inc. to our arsenal. In 1999 the Texas Department of Transportation Fort Worth District (a co-permittee of the city's NPDES Storm Water Permit) provided us with about 2000 of these markers, and we purchased a slightly different design from the North Central Texas Council of Governments.

As one requirement of the City's NPDES Storm Water Permit, we place a minimum of 250 plaques/markers each year. Typically, we target heavily trafficked locations with high visibility potential, areas with a past history of dumping or reported illicit discharge problems, and locations requested by citizens. We primarily use city staff to apply the markers but we also supply them to interested citizen groups such as neighborhood associations and scout troops. By increasing public awareness of the consequences of disposing of materials into a storm drain, curb inlet markers are helping us maintain or improve water quality in Fort Worth's creeks and lakes.

Read the "Plaque Installation SOP"

The City of Fort Worth uses these curb markers to get the message out:

This 4x8 inch aluminum plaque was designed by Fort Worth Environmental Management Department staff.

This curb marker was purchased from the North Central Texas Council of Governments (COG), and was designed by a COG ad hoc committee. The curb marker is four inches in diameter.

This curb marker was given to the City by the Texas Department of Transportation (TXDOT). The curb marker is four inches in diameter.

APPENDIX IV
Butler County Storm Water Study

Minimum Control Measure (MCM) Permit Requirements and Best Management Practices (BMP's) with cost estimation

Introduction

Ohio EPA's Draft NPDES Permit states, in detail, the requirements for permit application. The purpose of this issue paper is to list the requirements (in blue) and a plan for the Butler County Storm Water District to address each requirement with BMP's or other means of compliance (in green). In general, operators of small municipal separate storm sewer systems (MS4s) are required to develop, implement, and enforce a storm water management program (SWMP) designed to reduce the discharge of pollutants from the MS4 to the waters of the State. The SWMP should reduce pollutant levels to the maximum extent practicable (MEP) to protect water quality and to comply with the Ohio Revised Code and the Clean Water Act. The SWMP should include management practices, control techniques, system design, and engineering methods. Each MCM should include BMP's, measurable goals, person(s) or departments responsible, and rationale and decision process documentation.

The six MCMs, with estimated costs, are as follows:

1. Public Education and Outreach on Storm Water Impacts

1.1 Implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of storm water discharges on water bodies and the steps that the public can take to reduce pollutants in storm water runoff.

1.1.1 To distribute educational materials to the community, the Butler County Storm Water District will annually develop and distribute a media awareness packet to local media outlets (TV, Radio, Regional and Neighborhood Newspapers).

1.1.2 To distribute educational materials and inform the public through an outreach program, the Butler County Storm Water District will *coordinate an education and curriculum program with local school districts, provide and distribute educational materials for the program, train educators about the water program*, and establish a Butler County Storm Water District website.

1.1.3 To inform the public on the impacts pollutants can have on water bodies and to reduce pollutants in storm water runoff, the Butler County Storm Water District will implement a storm drain stenciling program including purchasing and coordinating installation of 1,000 stencils per year, *until all storm water facilities are labeled, with local governments, watershed groups, and civic groups. Labeling practices shall also be included in all future storm water facility construction, both public and private.*

1.2 Document the decision process for the development of a storm water public education and outreach program. The decision process documentation must include the overall public education program, individual BMP's, measurable goals, and persons responsible for the program. The statement must include at a minimum:

1.2a A plan to inform individuals and households about the steps they can take to reduce storm water pollution.

1.2b A plan to inform individuals and groups on how to become involved in the storm water program, including activities.

1.2c Identify the target audiences for your education program who are likely to have significant storm water impacts (including industrial, commercial, and institutional entities) and why those target audiences were selected.

1.2d Identify the target pollutant sources your public education program is designed to address.

1.2e Identify the outreach strategy, including the mechanisms (e.g., printed brochures, newspapers, media, workshops, etc.) you will use to reach your target audiences, and how many people you expect to reach by your outreach strategy over the permit term.

1.2f Identify the person or department that is responsible for overall management and implementation of your storm water public education and outreach program and individual BMP's.

1.2g Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

1.2.1 The Public Information Specialist will be responsible for the overall management and implementation of the Public Education and Outreach program (1.2f). The Public Information Specialist will create and document requirements 1.2a and 1.2b by implementing BMP's 1.1.1, 1.1.2, and 1.1.3. The Public Information Specialist will identify target audiences (1.2c) and develop an outreach strategy, through BMP 1.1.1, to reach them (1.2e). The Public Information Specialist will work with the Engineer to determine target pollutant sources to address (1.2d). The Public Information Specialist will work closely with the Senior Engineer to evaluate the success of the Public Education MCM and BMP's and document the achievement of the measurable goals (1.2g).

		MCM #1: Estimated Cost				
BMP	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1.1.1	**Media Packet**	$ 4,300	$ 3,000	$ 3,000	$ 3,100	$ 3,200
1.1.2	**School Education**	$ 7,900	$ 2,500	$ 2,500	$ 2,600	$ 2,600
1.1.3	**Stencils**	$ 13,100	$ 10,300	$ 9,000	$ 9,100	$ 9,200
1.2.1	**Documentation**	$ 6,900	$ 5,600	$ 5,800	$ 5,900	$ 6,100
Total		$ 32,200	$ 21,400	$ 20,300	$ 20,700	$ 21,100

Public Involvement/Participation

2.

2.1 Comply with State and local public notice requirements when implementing a public involvement/participation program.

2.1.1 To comply with State and local public notice requirements, the Butler County Storm Water District will *hold public meetings and/or citizen discussion panels until the plan is fully implemented*, throughout the county, targeting diverse groups.

2.2 Document the decision process for the development of a storm water public involvement/participation program. The decision process documentation must include the overall public involvement/participation program, individual BMP's, measurable goals, and persons responsible for the program. The statement must include at a minimum:

2.2a Identify how you involved the public in the development and submittal of your Notice of Intent (NOI) and SWMP description.

2.2b State the plan to actively involve the public in the development and implementation program.

2.2c Identify the target audiences for the public involvement program, including a description of the types of ethnic and economic groups engaged. You are encouraged to actively involve all potentially affected stakeholder groups, including commercial and industrial businesses, trade associations, environmental groups, homeowners associations, and educational groups, among others.

2.2d Identify the types of public involvement activities included in the program. Where appropriate, consider the following types of public involvement activities:

- Citizen representatives on a storm water management panel
- Public hearings
- Working with citizen volunteers willing to educate others about the program
- Volunteer monitoring or stream clean-up activities

2.2e Identify the person or department that is responsible for overall management and implementation of your storm water public involvement/participation program and individual BMP's.

2.2f Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

2.2.1 The Public Information Specialist will be responsible for the overall management and implementation of the Public Involvement/Participation program (1.2e). Requirements 2.2a, 2.2b, and 2.2c will be addressed by the Public Information Specialist through creating, implementing, and documenting the process of BMP 2.1.1. The Public Information Specialist will work closely with the Senior Engineer to evaluate the success of the Public Education MCM and BMP's and document achievement of the measurable goals (2.2f). To get the community actively involved in the program (2.2d), the Butler County Storm Water District will implement the following BMP's:

2.2.2 Facilitate and oversee volunteer stream clean-up and monitoring programs.

2.2.3 Establish and maintain a community storm water hotline. *The hotline will be used to develop a database of complaints, use as an investigation tool for the complaints, and used as a means of enforcement.*

		MCM #2 Public Involvement: Estimated Cost				
BMP	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
2.1.1	**Public Meetings**	$ 4,300	$ 8,300	$ 8,500	$ 8,700	$ 9,000
2.2.1	**Documentation**	$ 10,700	$ 8,600	$ 8,800	$ 9,000	$ 9,300
2.2.2	**Stream Clean-up**	$ 13,200	$ 10,700	$ 10,900	$ 11,200	$ 11,500
2.2.3	**Hotline**	$ 41,900	$ 38,900	$ 39,900	$ 40,900	$ 42,000
Total		$ 70,100	$ 66,500	$ 68,100	$ 69,800	$ 71,800

3. Illicit Discharge Detection and Elimination

3.1 Develop, implement, and enforce a program to detect and eliminate illicit discharges into your small MS4.

3.1.1 The Butler County Storm Water District's plan to detect and eliminate illicit discharges will entail preparation of a storm sewer system map (3.2.1), preparation of a Home Sewage Treatment System (HSTS) database (3.3.1), development and implementation of an illicit discharge ordinance, location of problem areas (BMP 3.1.1.1), and other means listed below.

3.2 Develop a storm sewer system map, showing the location of all outfalls and the names and location of all surface waters of the State that receive discharges from those outfalls.

3.2.1 The Butler County Storm Water District will employ a GIS Manager to be charged with the task of creating the storm sewer system map using Butler County GIS data. The GIS Manager will also coordinate, with the Inspectors, field verification of the system map.

3.3 Within three years of when your coverage under this general permit was granted, you must submit the following to the Ohio EPA:

3.3a A list of all on-site sewage disposal systems (Home Sewage Treatment Systems, HSTS's) connected to discharge to your MS4 with addresses;

3.3b A storm sewer map showing the location of all HSTS's connected to your MS4. The map shall include details on the type and size of conduits/ditches in your MS4 that receive discharges from the HSTS's, as well as water bodies receiving the discharges from your MS4.

3.3.1 The Butler County Storm Water District, in conjunction with the County Board of Health and the Department of Environmental Services, will develop a list of on-

site sewage disposal systems. The Engineer, Inspectors, and GIS Manager will be charged with collecting the data, establishing a database, and creating a map.

3.4 To the extent allowable under State or local law, effectively prohibit, through ordinance, or other regulatory mechanism, illicit discharges into your storm sewer system and implement appropriate enforcement procedures and actions.

3.4.1 The Storm Water Engineer will draft the illicit discharge detection and elimination ordinance, including enforcement procedures, for the Butler County Storm Water District. The Engineer will meet with participating local governments to coordinate enactment and implementation of the ordinance.

3.5 Develop and implement a plan to detect and eliminate non-storm water discharges, including illegal dumping into your system.

3.5.1 The Engineer will develop the draft Plan to detect and eliminate non-storm water discharges including illegal dumping by:

3.5.1.1 Performing Dry weather screening

3.5.1.2 Conducting Chemical field tests (see 3.9d) and

3.5.1.3 Meeting with each participating local government to coordinate adoption of the Illicit Discharge Plan.

3.6 Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

3.6.1 The Storm Water Engineer and/or Public Information Specialist will meet with local government employees, business groups, and the public to inform them of the hazards by preparing brochures (3.6.1.1) and a news release (3.6.1.2) about the hazards. This requirement will also be addressed through the Public Education MCM as well as in the Pollution Prevention/Good Housekeeping MCM.

3.7 Address the following categories of illicit discharges only if they are identified as significant contributors of pollutants: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltrations, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash water, and discharges from fire fighting activities.

3.7.1 The Storm Water Engineer will monitor the effectiveness of BMP's *and address adverse affects of the above stated illicit discharges and the water quality and pollutant levels.*

3.8 Create a list of other similar occasional incidental non-storm water discharges that will not be addressed. You must document in the SWMP any local controls or conditions on the discharges. You must include a provision prohibiting any individual non-storm water discharge that is determined to be contributing significant amounts of pollutants to your MS4.

3.8.1 The Storm Water Engineer will create a list of non-storm water discharges and include provisions for restrictions in the Illicit Discharge Ordinance.

3.9 Document the decision process for the development of a storm water illicit discharge detection and elimination program. The decision process documentation must include the overall illicit discharge detection and elimination program, individual BMP's, measurable goals, and persons responsible for the program. The statement must include at a minimum:

3.9a How the storm sewer map will be developed showing the location of all outfalls and the names and locations of all receiving waters. Describe the sources of information for the maps with a description of a plan to verify the outfall locations with field surveys. Also, describe how the plan will be regularly updated.

3.9b The ordinance you will use to effectively prohibit illicit discharges into the MS4. A plan and schedule to create this ordinance shall also be included.

3.9c A plan to ensure through appropriate enforcement procedures and actions that your illicit discharge ordinance is implemented.

3.9d A plan to detect and address illicit discharges to your system, including illegal dumping and spills. The plan must include:

- Dry weather field screening for non-storm water flows
- Field tests of selected chemical parameters as indicators of discharge sources;
- Address HSTSs that flow into the storm drainage system.

The description must address the following;

- Procedures for locating priority areas or ambient sampling to locate impacted reaches;
- Procedures for tracing the source of an illicit discharge, including the specific techniques you will use to detect the location of the source;
- Procedures for removing the source of the illicit discharge
- Procedures for program evaluation and assessment.

3.9e A plan to inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste. Include how this plan will coordinate with the public education and outreach program and the pollution prevention/good housekeeping program.

3.9f Identify the person or department that is responsible for overall management and implementation of your storm water illicit discharge detection and elimination program and individual BMP's.

3.9g Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

3.9.1 The Storm Water Engineer will be responsible for the overall management and implementation of the Illicit Discharge Detection and Elimination Program (3.9f). To meet permit requirements 3.9a – 3.9e, the Engineers will thoroughly document the processes of creating and implementing the relevant plans or actions (3.1 – 3.8). The Storm Water Engineer will evaluate the success of the Illicit Discharge Detection and Elimination MCM and BMP's and document achievement of the measurable goals (3.9g).

		MCM #3 Illicit Discharge: Estimated Cost				
BMP	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
3.1.1	**Illicit Discharge Plan**	$ 10,900	$ 6,800	$ 7,000	$ 7,200	$ 7,400
3.1.1.1	**Problem Areas**	$ 10,700	$ 34,000	$ 35,000	$ 35,900	$ 36,800
3.2.1	**System Map**	$ 251,000	$ 255,200	$ 263,900	$ 272,900	$ 282,000
3.3.1	**HSTS Database**	$ 34,400	$ 29,600	$ 30,400	$ 2,500	$ 2,600
3.4.1	**Ordinance**	$ 10,900	$ 6,800	$ 14,000	$ 14,400	$ 14,700
3.5.1	**Detection Plan**	$ 20,400	$ 25,500	$ 26,100	$ 26,800	$ 27,500
3.5.1.1	**Dry Weather Screening**	$ 66,300	$ 32,700	$ 33,500	$ 34,300	$ 35,100
3.5.1.2	**Chemical Tests**	$ 23,500	$ 8,100	$ 8,300	$ 8,400	$ 8,600
3.5.1.3	**Adopt Plan**	$ 4,600	$ 4,700	$ 4,900	$ 5,000	$ 5,100
3.6.1	**Inform Public**	$ 1,400	$ 1,500	$ 1,500	$ 1,600	$ 1,600
3.6.1.1	**Brochures**	$ 17,900	$ 17,100	$ 17,700	$ 18,400	$ 19,100
3.6.1.2	**News Release**	$ 1,400	$ 3,000	$ 3,000	$ 3,100	$ 3,200
3.7.1	**Monitor**	$ 2,300	$ 2,400	$ 2,400	$ 2,500	$ 2,600
3.8.1	**Non-Storm Water List**	$ 4,000	$ 4,100	$ 2,100	$ 2,200	$ 2,200
3.9.1	**Documentation**	$ 22,200	$ 23,200	$ 23,800	$ 24,400	$ 25,000
Total		$ 481,900	$ 454,700	$ 473,600	$ 459,600	$ 473,500

4. Construction Site Storm Water Runoff Control

4.1 Develop, implement, and enforce a program to reduce pollutants in any storm water runoff to your small MS4 from construction activities that result in or create a land disturbance of greater than or equal to one acre. The plan must include the development and implementation of, at a minimum:

4.1a An ordinance to require erosion and sediment controls, as well as sanctions to ensure compliance;

4.1b Requirements for construction site operators to implement appropriate erosion and sediment control BMP's.

4.1c Requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.

4.1d Procedures for site plan review, which incorporate consideration of potential water quality impacts.

4.1e Procedures for receipt and consideration of information submitted by the public.

4.1f Procedures for site inspection and enforcement of control measures.

The Storm Water Engineer will draft an ordinance establishing:

4.1.1.1 Runoff control BMP's,
4.1.1.2 Erosion control BMP's, and
4.1.1.3 Sediment control BMP's
to reduce pollutants in storm water runoff and coordinate enactment by participating local governments. *Fees for new developments or re-developments will be charged to defray the cost to the general public.*

4.1.2 The Storm Water Engineer will draft and coordinate implementation procedures for site plan review and site inspection and enforcement measures. *The ordinance will incorporate cooperation with building and construction management departments that have jurisdiction within the District.*

4.2 Document the decision process for the development of a construction site storm water control program. The decision process documentation must include the overall construction site storm water control program, individual BMP's, measurable goals, and persons responsible for the program. The statement must include at a minimum:

4.2a The ordinance you will use to require erosion and sediment controls at construction sites and why you chose that mechanism. Describe the plan and schedule to develop the ordinance.

4.2b A plan to ensure compliance with your erosion and sediment control regulatory mechanism, including the sanctions and enforcement mechanisms you will use to ensure compliance. Describe procedures for use of sanctions.

4.2c Requirements for construction site operators to implement appropriate erosion and sediment control BMP's and control waste at construction sites that may cause adverse impacts to water quality.

4.2d Procedures for site plan review, including the review of pre-construction site plans, which incorporate consideration of potential water quality impacts. Describe procedure and rationale for how you will identify certain sites for site plan review and the estimated number and percentage of sites that will have pre-construction site plans reviewed.

4.2e Procedures for receipt and consideration of information submitted by the public. Consider coordinating with public education program.

4.2f Procedures for site inspection and enforcement of control measures, including prioritization.

4.2g Identify the person or department that is responsible for overall management and implementation of your construction site storm water control program and individual BMP's.

4.2h Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

4.2.1 The Storm Water Engineer will be responsible for the overall management and implementation of the Construction Site Storm Water Runoff Control program (4.2g). Requirements 4.2a – 4.2c will be addressed by thoroughly documenting the creation of BMP's 4.1a, 4.1b, and 4.1c. Requirements 4.2d – 4.2f will be addressed by thoroughly documenting the creation of BMP 4.1.2. The Senior Engineer and the Engineer will work together to evaluate the success of the Construction Site Storm Water Runoff Control program and BMP's and document achievement of the measurable goals (4.2hg).

		MCM #4 Construction Runoff: Estimated Cost				
BMP	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
4.1.1	**Ordinance**	$ 134,800	$ 133,800	$ 137,400	$ 138,800	$ 137,600
4.1.1.1	**Runoff BMP**	$ 6,300	$ 7,700	$ 5,800	$ 5,900	$ 6,100
4.1.1.2	**Erosion BMP**	$ 6,300	$ 7,700	$ 5,800	$ 5,900	$ 6,100
4.1.1.3	**Sediment BMP**	$ 6,300	$ 7,700	$ 5,800	$ 5,900	$ 6,100
4.1.2	**Site Plan Review**	$ 6,300	$ 17,200	$ 10,600	$ 10,900	$ 11,200
4.2.1	**Documentation**	$ 14,100	$ 12,100	$ 12,500	$ 12,800	$ 13,100
Total		$ 174,100	$ 186,200	$ 177,900	$ 180,200	$ 180,200

5. Post-Construction Storm Water Management

5.1 Develop, implement, and enforce a program to address storm water runoff from new development and redevelopment projects that disturb greater than or equal to one acre. The program must ensure that controls are in place that would prevent or minimize water quality impacts;

5.1a Implement strategies which include a combination of structural and/or non-structural BMP's appropriate for your community;

5.1b Adopt an ordinance to address post-construction runoff from new development and redevelopment projects;

5.1c Ensure adequate long-term inspection and maintenance of BMP's.

5.1.1 The Butler County Storm Water District will develop a riparian corridor and buffer zone plan and Post Construction ordinance for the community. New riparian corridors and buffers will be established in developing areas and a plan to restore riparian corridors buffers in redeveloping areas will be prepared and implemented.

5.1.1.1 The Butler County Storm Water District will address the long term O&M of the riparian corridor and buffer zone.

5.1.2 The Butler County Storm Water District will coordinate with the Department of Development and local governments to draft new language to update current zoning ordinances to implement Post-Construction Storm Water management.

5.1.2.1 The Butler County Storm Water District will develop a plan to provide for long term O&M of the BMP's.

5.2 Document the decision process for the development of a post-construction storm water management program (SWMP). The decision process documentation must include the overall post-construction storm water management program, individual BMP's, measurable goals, and persons responsible for the program. The statement must include at a minimum:

5.2a The program to address storm water runoff from new development and redevelopment projects. Include any specific priority areas for this project.

5.2b How the program will be specifically tailored for the local community, minimize water quality impacts, and attempt to maintain pre-developed runoff conditions.

5.2c Any non-structural BMP's in your program, including, where appropriate:

- Policies and ordinances that provide requirements and standards to direct growth to identified areas, protect sensitive areas such as wetlands and riparian areas, maintain and/or increase open space, provide buffers along sensitive water bodies, minimize impervious surfaces, and minimize disturbance of soils and vegetation.
- Implement policies or ordinances that encourage infill development in higher density urban areas and areas with existing storm sewer infrastructure.
- Implement education programs for developers and the public about project designs that minimize water quality impacts.
- Implement other measures such as minimization of impervious area after development, minimize directly connected impervious area, and source control measures often thought of as good housekeeping, preventive maintenance, and spill prevention.

5.2d Any structural BMP's in your program, including, where appropriate:

- Storage practices such as wet ponds and extended-duration outlet structures.
- Filtration practices such as grassed swales, bioretention cells, sand filters, and filter strips.
- Infiltration practices such as infiltration basins and infiltration trenches.

5.2e Define the ordinances you will use to address post-construction runoff from new development and redevelopment, why you chose that ordinance, and a plan and schedule to implement it.

5.2f Define a method to ensure long-term operation and maintenance (O&M) of the selected BMP's.

5.2g Identify the person or department that is responsible for overall management and implementation of your post-construction SWMP and individual BMP's.

5.2h Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

5.2.1 The Storm Water Engineer will be responsible for the overall management and implementation of the Post-Construction Storm Water Management program (5.2g). Requirements 5.2a, 5.2b, 5.2c, and 5.2e will be addressed by thoroughly documenting the creation of BMP's 5.1.1 and 5.1.2. Requirement 5.2e and 5.2f will be addressed by thoroughly documenting the creation of BMP 5.1.2. The Storm Water Engineer will evaluate the success of the Post-Construction Storm Water Management program and BMP's and document the achievement of the measurable goals (5.2g).

		MCM #5 Post Construction: Estimated Cost				
BMP	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
5.1.1	**Riparian/Buffer Plan**	$ 8,900	$ 17,800	$ 9,100	$ 9,400	$ 9,600
5.1.1.1	**O&M**	$ 8,600	$ 4,400	$ 6,700	$ 6,900	$ 7,000
5.1.2	**Zoning Ordinance**	$ 4,300	$ 11,000	$ 4,600	$ 6,900	$ 7,000
5.1.2.1	**BMP O&M**	$ 8,600	$ 4,400	$ 6,700	$ 6,900	$ 7,000
5.2.1	**Documentation**	$ 9,500	$ 9,800	$ 10,000	$ 10,300	$ 10,600
Total		$ 39,900	$ 47,400	$ 37,100	$ 40,400	$ 41,200

6. Pollution Prevention/Good Housekeeping for Municipal Operations

6.1 Develop and implement an O&M program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from governmental operations.

6.1a Include employee training to prevent and reduce storm water pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbance, and storm water system maintenance.

6.1.1 The Storm Water Engineer will develop and implement a plan for government employee training to reduce pollutant runoff and provide one joint training class per year.

6.1.1.1 Coordinate a Maintenance Schedule with local governments and

6.1.1.2 Establish an Inspection Plan for the storm water facilities and inspect them once per year.

6.1.2 The Storm Water Engineer will develop and coordinate implementation of an illegal dumping and control plan.

6.2 Document the decision process for the pollution prevention/good housekeeping program. The decision process documentation must include the overall pollution prevention/good housekeeping program, individual BMP's, measurable goals, and persons responsible for the program. The statement must include at a minimum:

6.2a The O&M program to reduce pollutant runoff must include a list of governmental operations that are impacted by the new program. You must also include a list of industrial facilities you own or operate that are subject to the permit.

6.2b The government employee training program you will use to prevent and reduce storm water pollution activities. Coordinate this program with the public information and outreach program.

6.2c The program must specifically address the following areas:

- Maintenance activities, maintenance schedules, and long-term inspection procedures for controls to reduce floatables and other pollutants to your MS4.
- Controls for reducing or eliminating the discharge of pollutants from streets, roads, municipal parking lots, maintenance and storage yards, waste transfer stations, salt/sand storage locations, and snow disposal areas you operate.
- Procedures for the proper disposal of waste removed from your MS4 and your municipal operations, including dredge spoil, accumulated sediments, floatables, and other debris.
- Procedures to ensure that new flood management projects are assessed for impacts on water quality and existing projects are assessed for incorporation of additional water quality devices or practices.

6.2d Identify the person or department that is responsible for overall management and implementation of your pollution prevention/good housekeeping program and individual BMP's.

6.2e Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

6.2.1 The Storm Water Engineer and the Public Information Specialist will be responsible for the overall management and implementation of the Pollution Prevention/Good Housekeeping program (6.2d). Requirements 6.2a, 6.2b, and 6.2c will be addressed by thoroughly documenting the creation of BMP's 6.1.1 and 6.1.2. The Storm Water Engineer will evaluate the success of the Pollution Prevention/Good Housekeeping program and BMP's and document the achievement of the measurable goals (6.2e).

		MCM #6 Pollution Prevention/Housekeeping: Estimated Cost				
BMP	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
6.1.1	**Training Plan**	$ 4,300	$ 13,000	$ 4,600	$ 3,100	$ 3,200
6.1.1.1	**Maintenance**	$ 6,600	$ 4,100	$ 4,300	$ 4,400	$ 4,500
6.1.1.2	**BMP Inspection**	$ 4,000	$ 4,100	$ 4,300	$ 4,400	$ 4,500
6.1.2	**Dumping Plan**	$ 6,300	$ 4,100	$ 4,300	$ 4,400	$ 4,500
6.2.1	**Documentation**	$ 7,500	$ 3,000	$ 3,000	$ 3,100	$ 3,200
Total		$ 28,700	$ 28,300	$ 20,500	$ 19,400	$ 19,900

Initial Cost Estimate For BMP's

Table 1 provides an initial cost estimate for the Butler County Storm Water District. The BMP costs include personnel hours, material and equipment costs, contracted consulting work, and contracted surveying work. The overhead and miscellaneous project costs are

those that could not be directly charged to a specific BMP. The total man-hours for each employee do not equal one full time equivalent (FTE). Therefore, an FTE adjustment, for each employee, was included in the overhead.

Table 1

	1	2	3	4	5
Public Education	$ 32,200	$ 21,400	$ 20,300	$ 20,700	$ 21,100
Public Involvement	$ 70,100	$ 66,500	$ 68,100	$ 69,800	$ 71,800
Illicit Discharge	$ 481,900	$ 454,700	$ 473,600	$ 459,600	$ 473,500
Runoff Control	$ 174,100	$ 186,200	$ 177,900	$ 180,200	$ 180,200
Post Construction	$ 39,900	$ 47,400	$ 37,100	$ 40,400	$ 41,200
Pollution Prevention	$ 28,700	$ 28,300	$ 20,500	$ 19,400	$ 19,900
Total BMP Costs	$ 826,900	$ 804,500	$ 797,500	$ 790,100	$ 807,700
Overhead					
FTE Adjustment	$ 60,700	$ 78,800	$ 124,300	$ 132,700	$ 141,100
Office Furnishings & Equipment	$ 30,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Office Supplies	$ 10,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Rent	$ 20,000	$ 20,800	$ 21,600	$ 22,500	$ 23,400
Telephone Service	$ 8,000	$ 8,300	$ 8,600	$ 8,900	$ 9,300
Vehicle Expenses	$ 22,000	$ 22,900	$ 23,800	$ 24,700	$ 25,700
Subtotal	$ 150,700	$ 140,800	$ 188,300	$ 198,800	$ 209,500
Miscellaneous Project Costs					
Permit Fee	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
Repay Start up costs (1)	$ 40,000	$ 42,400	$ 44,900	$ 47,600	$ 50,500
Billing System (2)	$ 100,000	$ 106,000	$ 112,400	$ 119,100	$ 126,200
Subtotal	$ 150,000	$ 158,400	$ 167,300	$ 176,700	$ 186,700
Total annual cost (rounded)	$ 1,128,000	$ 1,104,000	$ 1,153,000	$ 1,166,000	$ 1,204,000

1	$200,000	@ 6% per year
2	$500,000	@ 6% per year

APPENDIX VI
Title 26: Maryland Department of the Environment
Subtitle 17 Water Management

26.11.02.01 Purpose and Scope.

A. The primary goal of the State and local stormwater management programs is to maintain after development, as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, siltation and sedimentation, and local flooding.

B. These regulations for stormwater management apply to the development or redevelopment of land for residential, commercial, industrial, or institutional use, but do not apply to agricultural land management practices. This chapter specifies the minimum content of county and municipal ordinances, responsibilities of the Administration regarding the review of the county and municipal stormwater management programs, and approval of State-constructed projects for stormwater management by the Department of the Environment.

26.11.02.01-1. Incorporation by Reference.

A. In this chapter, the following documents are incorporated by reference.

B. Documents Incorporated.

(1) The 2000 Maryland Stormwater Design Manual, Volumes I & II (Maryland Department of the Environment, April 2000) is incorporated by reference by the Administration and shall serve as the official guide for stormwater management principles, methods, and practices.

(2) USDA Natural Resources Conservation Service Maryland Conservation Practice Standard Pond Code 378 (January 2000).

(3) 40 CFR §122.26(b)(14)(i)--(xi).

26.11.02.02 Definitions

A. The following definitions describe the meaning of terms used in this chapter and the 2000 Maryland Stormwater Design Manual, Volumes I & II. The definitions will be valid unless the context in which they are used clearly requires a different meaning. Terms not defined below shall have the meanings given to them in the relevant statutes or, if not defined in statutes, the meanings attributed by common use. The definitions for these terms are provided below as a convenience, but persons affected by the Department's regulations should be aware that these definitions are subject to amendment by the General Assembly.

B. In this chapter, the following terms have the meanings indicated.

(1) "Administration" means the Water Management Administration.

(2) "Agricultural land management practices" means those methods and procedures used in the cultivation of land in order to further crop and livestock production and conservation of related soil and water resources.

(3) "Approving agency" means the entity responsible for review and approval of stormwater management plans.

(4) "Aquifer" means a porous water-bearing geologic formation generally restricted to materials capable of yielding an appreciable supply of water.

(5) "Best management practice (BMP)" means a structural device or nonstructural practice designed to temporarily store or treat stormwater runoff in order to mitigate flooding, reduce pollution, and provide other amenities.

(6) "Channel protection storage volume" means the volume used to design structural management practices to control stream channel erosion. Methods for calculating the channel protection storage volume are specified in the 2000 Maryland Stormwater Design Manual, Volumes I & II.

(7) "Department" means the Department of the Environment.

(8) "Design Manual" means the 2000 Maryland Stormwater Design Manual, Volumes I & II, that serves as the official guide for stormwater management principles, methods, and practices.

(9)"Detention structure" means a permanent structure for the temporary storage of runoff which is designed so as not to create a permanent pool of water.

(10) "Develop land" means to change the runoff characteristics of a parcel of land in conjunction with residential, commercial, industrial, or institutional construction or alteration.

(11) "Direct discharge" means the concentrated release of stormwater to tidal waters or vegetated tidal wetlands from new development or redevelopment projects in the Critical Area.

(12) "Direct runoff" means the flow of rainwater, snowmelt, or spring flow over the land surface toward stream channels.

(13) "Drainage area" means that area contributing runoff to a single point measured in a horizontal plane, which is enclosed by a ridge line.

(14) "Extended detention" means a stormwater design feature that provides gradual release of a volume of water in order to increase settling of pollutants and protect downstream channels from frequent storm events. Methods for designing extended detention BMPs are specified in the Design Manual.

(15) "Extreme flood volume" means the storage volume required to control those infrequent but large storm events in which overbank flows reach or exceed the boundaries of the 100-year floodplain.

(16) "Flow attenuation" means prolonging the flow time of runoff to reduce the peak discharge.

(17) "Infiltration" means the passage or movement of water into the soil surface.

(18) "Off-site stormwater management" means the design and construction of a facility necessary to control stormwater from more than one development.

(19) "On-site stormwater management" means the design and construction of systems necessary to control stormwater within an immediate development.

(20) "Overbank flood protection volume" means the volume controlled by structural practices to prevent an increase in the frequency of out-of-bank flooding generated by development. Methods for calculating the overbank flood protection volume are specified in the Design Manual.

(21) "Person" means the federal government, the State, any county, municipal corporation, or other political subdivision of the State, or any of their units, or an individual, receiver, trustee, guardian, executor, administrator, fiduciary, or representative of any kind, or any partnership, firm, association, public or private corporation, or any other entity.

(22) "Recharge volume" means that portion of the water quality volume used to maintain ground water recharge rates at development sites. Methods for calculating the recharge volume are specified in the Design Manual.

(23) "Redevelopment" means any construction, alteration, or improvement exceeding 5,000 square feet of land disturbance performed on sites where existing land use is commercial, industrial, institutional, or multifamily residential.

(24) "Retention structure" means a permanent structure that provides for the storage of runoff by means of a permanent pool of water.

(25) "Retrofitting" means the construction of a structural BMP in a previously developed area, the modification of an existing structural BMP, or the implementation of a nonstructural practice to improve water quality over current conditions.

(26) "Sediment" means soils or other surficial materials transported or deposited by the action of wind, water, ice, or gravity as a product of erosion.

(27) "Stormwater management" means, for:

(a) Quantitative control, a system of vegetative and structural measures that control the increased volume and rate of surface runoff caused by man-made changes to the land; and

(b) Qualitative control, a system of vegetative, structural, and other measures that reduce or eliminate pollutants that might otherwise be carried by surface runoff.

(28) "Stormwater management plan" means a set of drawings or other documents submitted by a person as a prerequisite to obtaining a stormwater management approval, which contain all of the information and specifications required by an approving agency.

(29) "Stormwater Management Subtitle" means Environment Article, Title 4, Subtitle 2, Annotated Code of Maryland and cumulative supplement.

(30) "Water quality volume" means the volume needed to capture and treat 90 percent of the average annual runoff volume at a development site. Methods for calculating the water quality volume are specified in the Design Manual.

(31) "Watershed" means the total drainage area contributing runoff to a single point.

26.11.02.03 General Provisions

A. The Administration is responsible for the implementation and supervision of the stormwater management program which is established by the Stormwater Management Subtitle. This responsibility shall include, but is not limited to:

(1) Establishment of policies, procedures, standards, model ordinances, and criteria relating to stormwater management;

(2) The review and approval of:

(a) County stormwater management ordinances,

(b) Municipal stormwater management ordinances,

(c) Stormwater management program implementation and operation, and

(d) Stormwater management plan for State and federal construction projects which shall be subject to the requirements of this chapter;

(3) Inspection and enforcement of stormwater management on all State and federal construction projects which shall be subject to the requirements of this chapter;

(4) Inspection and enforcement in conjunction with local governmental authorities;

(5) Development of guidelines and regulations;

(6) Assisting the local jurisdictions with improving and maintaining their technical capabilities regarding:

(a) Hydrologic and hydraulic analyses,

(b) Utilization of State adopted standards and specifications for stormwater management, and

(c) Stormwater management plan review;

(7) Training assistance to local jurisdictions for construction and maintenance inspections of stormwater management systems;

(8) Development of public educational programs; and

(9) Evaluation of effectiveness of stormwater control measures in eliminating adverse stream quality impacts.

B. Matters of policy, procedures, standards, criteria, approvals, inspection, and enforcement relating to the Stormwater Management Subtitle shall be established by the Administration subject to the jurisdiction of the Secretary of the Environment. The stormwater management programs which are adopted by the counties and municipalities shall include stormwater management criteria consistent with the standards, procedures, and regulations of the Administration. A variation of requirements by a county or municipality on a specific watershed may not be valid unless approved by the Administration. All State and federal development in

the watershed shall be reviewed subject to the same variations and requirements by the Administration.

C. Initially, and at least once every 3 years after that, the Administration shall inspect and review the stormwater management programs of the counties and municipalities and evaluate the effectiveness of the programs.

(1) To be found acceptable, a stormwater management program shall have:

(a) An Administration-approved stormwater management ordinance in in effect;

(b) Stormwater management planning and approval processes that provide:

(i) Stormwater management for every land development subject to this chapter, and

(ii) The ability and the information necessary to review adequately proposed installation and maintenance measures for stormwater management;

(c) Inspection and enforcement procedures that ensure the proper construction and maintenance of approved stormwater management measures.

(2) Upon completion of its review and evaluation, the Administration shall submit the findings within 30 days to the appropriate governing authority. The Administration shall also publish the results of the periodic reviews in one document and conduct a public informational meeting concerning the reviews.

D. If a county or municipality is found not to have an acceptable stormwater management program, the Department may:

(1) Issue an order requiring that necessary corrective action be taken within a reasonably prescribed time; or

(2) Impose other sanctions as authorized by law.

E. In order to assure that Administration-approved programs reflect the policies and practices established in the Design Manual, each county or municipality shall submit proposed revisions to its ordinance to the Administration on or before December 31, 2000. Descriptions of other program elements shall be submitted as requested by the Administration in order to ensure that the policies and practices established in the Design Manual have been implemented by July 1, 2001.

26.11.02.04 Stormwater Management Ordinances.

A. Each county and municipality shall adopt ordinances necessary to implement a stormwater management program. Subsequently, counties and municipalities shall submit any proposed amendments to the Administration for review and approval. By joint action with the county, a municipality may adopt the stormwater management ordinance of its respective county.

B. Each local ordinance shall provide for:

(1) Submission and approval of a stormwater management plan;

(2) Exemptions and waivers;

(3) Criteria and procedures for stormwater management;

(4) Proper implementation of stormwater management in accordance with the approved plan;

(5) Maintenance responsibilities and requirements including periodic inspection; and

(6) Penalties for noncompliance with the ordinances including suspension of construction activities when appropriate.

26.11.02.05 When Stormwater Management is Required.

A. Unless the particular activity is exempted by this regulation, a person may not develop any land without an approved stormwater management plan from the approving agency. A grading or building permit may not be issued for a property unless a stormwater management plan has been approved that is consistent with:

(1)The Stormwater Management Subtitle;

(2) This chapter;

(3) The county or municipal ordinance;

(4) The Design Manual for new development; and

(5) Policies established by the local approving agency for redevelopment.

B. The following activities are exempt from the provisions of this chapter:

(1) Additions or modifications to existing single family detached residential structures if they comply with §B(2) of this regulation;

(2) Developments that do not disturb over 5,000 square feet of land area; and

(3) Land development activities which the Administration determines will be regulated under specific State laws which provide for managing stormwater runoff

C. Waivers.

(1) County and municipal ordinances may contain waiver policies for individual developments if the ordinances are approved by the Administration. The Administration will approve county and municipal ordinances and waiver policies if:

(a) They reasonably ensure that a development will not adversely impact stream quality;

(b) Waiver decisions are made on a case-by-case basis; and

(c) The cumulative effects of the waiver policy are evaluated.

(2) Stormwater management quantitative control waivers shall be granted only to those projects within areas where watershed management plans have been developed consistent with §E of this regulation.

(3) If watershed management plans consistent with §E of this regulation have not been developed, stormwater management quantitative control waivers may be granted to projects:

(a) That have direct discharges to tidally influenced receiving waters;

(b) That do not increase the post-development peak discharge for the 2-year storm event by more than 10 percent in those areas of the State where the 2-year storm serves as the overbank flood protection volume according to the Design Manual; or

(c) When the approving agency determines that circumstances exist that prevent the reasonable implementation of quantity control practices.

(4) Stormwater management qualitative control waivers apply only to:

(a) In-fill development projects where stormwater management implementation is not feasible;

(b) Redevelopment projects if the requirements of §D of this regulation are satisfied; or

(c) Sites where the approving agency determines that circumstances exist that prevent the reasonable implementation of quality control practices.

D. Redevelopment.

(1) An approving agency shall require that stormwater management be addressed for redevelopment. Proposed redevelopment project designs shall include:

(a) A reduction in impervious area;

(b) The implementation of stormwater management practices; or

(c) A combination of both §D(1)(a) and (b) of this regulation to result in an improvement to water quality.

(2) Unless otherwise specified by watershed management plans developed according to §E of this regulation, all redevelopment projects shall reduce existing site impervious area by at least 20 percent.

(3) Where site conditions prevent the reduction of impervious area, stormwater management practices shall be implemented to provide water quality control for at least 20 percent of the site's impervious area.

(4) When a combination of impervious area reduction and stormwater management practice implementation is used for redevelopment projects, the combination of impervious area reduction and the area controlled by a stormwater management practice shall equal or exceed 20 percent.

(5) An approval authority may allow practical alternatives where conditions prevent impervious area reduction or on-site stormwater management. Practical alternatives include, but are not limited to:

(a) Fees paid in an amount specified by the approving agency;

(b) Off-site BMP implementation for a drainage area comparable in size and percent imperviousness to that of the project;

(c) Watershed or stream restoration;

(d) Retrofitting; or

(e) Other practices approved by the appropriate authority.

(6) The recharge, channel protection storage volume, and overbank flood protection volume requirements specified in the Design Manual do not apply to redevelopment projects unless specified by the approving agency.

(7) On-site or off-site channel protection storage volume requirements as specified in the Design Manual may be imposed if watershed management plans developed according to §E of this regulation indicate that downstream flooding or erosion need to be addressed.

(8) Variations of this redevelopment policy shall be approved by the Administration.

E. An approving agency may develop quantitative waiver and redevelopment provisions for stormwater management that differ from the requirements of this chapter. These provisions shall be developed only as part of an overall watershed management plan. Watershed management plans developed for the purposes of implementing different stormwater management policies for waivers and redevelopment shall:

(1) Include detailed hydrologic and hydraulic analyses to determine hydrograph timing;

(2) Evaluate both quantity and quality management;

(3) Include cumulative impact assessment of watershed development;

(4) Identify existing flooding and receiving stream channel conditions;

(5) Be conducted at a scale determined by the approving agency; and

(6) Specify where on-site or off-site quantitative and qualitative stormwater management practices are to be implemented.

26.11.02.06 Minimum Control Requirements.

A. County and Municipal Requirements.

(1) The minimum control requirements established in this section and the Design Manual shall be contained in each county and municipal ordinance as they apply to the applicable parts of the State. The minimum control requirements for each county and municipality are provided in §A(2) and (3) of this regulation.

(2) Caroline, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, and Worcester counties and their incorporated municipalities shall require that the recharge volume, water quality volume, and the overbank flood protection volume for the 2-year frequency storm event be used to design BMPs according to the Design Manual.

(3) The City of Baltimore, Allegany, Anne Arundel, Baltimore, Calvert, Carroll, Cecil, Charles, Frederick, Garrett, Harford, Howard, Montgomery, Prince George's, St. Mary's, and Washington counties and their incorporated municipalities shall require that the recharge volume, water quality volume, and channel protection storage volume sizing criteria be used to design BMPs according to the Design Manual. Control of the 10-year frequency storm event is required according to the Design Manual if the appropriate approving agency determines that historical flooding problems exist and downstream floodplain development and conveyance system design cannot be controlled.

(4) An approving agency may require more than the minimum control requirements specified in this regulation if hydrologic or topographic conditions warrant or if flooding, stream channel erosion, or water quality problems exist downstream from a proposed project.

B. Alternate minimum control requirements may be adopted subject to Administration approval. The Administration shall require a demonstration that alternative requirements will control flood damages, accelerated stream erosion, water quality, and sedimentation, including, if necessary, comprehensive watershed studies.

C. Development in watersheds designated as interjurisdictional flood hazard watersheds within this chapter may not increase the downstream peak discharge for the 100-year frequency storm event and shall comply with flood management plans as approved by the Department in accordance with the Flood Hazard Management Act of 1976 (Environment Article, Title 5, Subtitle 8, Annotated Code of Maryland).

26.17.02.07 Interjurisdictional Flood Hazard Watersheds.

A. The watersheds specified in this regulation are interjurisdictional in nature and have documented flood damages to residential, commercial, industrial, or institutional structures. Development in the interjurisdictional flood hazard watershed may not increase the downstream peak discharge for the 100-year frequency storm event. Additionally, development shall comply with flood management plans as approved by the Department in accordance with the Flood Hazard Management Act of 1976 (Environment Article, Title 5, Subtitle 8, Annotated Code of Maryland). The following watersheds and all their tributaries are designated as interjurisdictional flood hazard watersheds:

(1) Carroll Creek in Frederick City and Frederick County;

(2) Gwynns Falls in Baltimore City and Baltimore County; and

(3) Jones Falls in Baltimore City and Baltimore County.

B. The Administration shall periodically review watersheds to be included as interjurisdictional flood hazard watersheds for the purposes of this chapter. Any additional interjurisdictional watershed to be designated will be considered with respect to the:

(1) Economic losses due to flood damages;

(2) Expected upstream development;

(3) Frequency of flooding;

(4) Number and value of structures flooded; and

(5) Threat to life.

26.11.02.08 Stormwater Management Measures.

A. The structural and nonstructural stormwater management measures established in this regulation shall be contained in all county and municipal ordinances. Each ordinance shall require that one or a combination of these practices be used in developing a stormwater management plan.

B. Structural Stormwater Management Measures.

(1) The following structural stormwater management practices shall be designed according to the Design Manual to satisfy the applicable minimum control requirements established in Regulation .06 of this chapter:

(a) Stormwater management ponds;

(b) Stormwater management wetlands;

(c) Stormwater management infiltration;

(d) Stormwater management filtering systems; and

(e) Stormwater management open channel systems.

(2) The performance criteria specified in the Design Manual with regard to general feasibility, conveyance, pretreatment, treatment and geometry, environment and landscaping, and maintenance shall be considered when selecting structural stormwater management practices.

(3) Structural stormwater management practices shall be selected to accommodate the unique hydrologic or geologic regions of the State.

C. Nonstructural Stormwater Management Measures.

(1) The following nonstructural stormwater management practices shall be applied according to the Design Manual to minimize increases in new development runoff:

(a) Natural area conservation;

(b) Disconnection of rooftop runoff;

(c) Disconnection of non-rooftop runoff;

(d) Sheet flow to buffers;

(e) Grass channels; and

(f) Environmentally sensitive development.

(2) The use of nonstructural stormwater management practices shall be encouraged to minimize the reliance on structural BMPs.

(3) County and municipal ordinances shall allow for reductions in the minimum control requirements in Regulation .06 of this chapter when nonstructural stormwater management practices are incorporated into site designs according to the Design Manual.

(4) The use of nonstructural stormwater management practices may not conflict with existing State or local laws, ordinances, regulations, or policies.

D. County and municipal ordinances shall specify that the nonstructural stormwater management practices used to reduce the minimum control requirements in Regulation .06 of this chapter are documented and remain unaltered by subsequent property owners. Prior approval from the appropriate approving agency should be obtained before nonstructural stormwater management practices are altered.

E. Alternative structural and nonstructural stormwater management practices may be used for new development water quality control if they meet the performance criteria established in the Design Manual and are approved by the Administration. Practices used for redevelopment projects shall be approved by the appropriate approving agency.

F. For purposes of modifying the minimum control requirements or design criteria, the owner/developer shall submit to the approving agency an analysis of the impacts of stormwater flows downstream in the watershed. The analysis shall include hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications of the proposed development upon a dam, highway, structure, or natural point of restricted streamflow, established with the concurrence of the approving agency, downstream of the first downstream tributary whose drainage area equals or exceeds the contributing area to the project or stormwater management facility.

26.11.02.09 Stormwater Management Plans.

A. The design of stormwater management plans shall be prepared by any individual whose qualifications are acceptable to the approving agency. The approving agency may require that the

design be prepared by either a professional engineer, professional land surveyor, or landscape architect licensed in the State, as necessary to protect the public or the environment. If a stormwater BMP requires either a dam safety permit from the Department or small pond approval by the appropriate soil conservation district, the approving agency shall require that the design be prepared by a professional engineer licensed in the State.

B. Stormwater management and development plans shall be consistent with adopted and approved watershed management plans or flood management plans as approved by the Department in accordance with the Flood Hazard Management Act of 1976 (Environment Article, Title 5, Subtitle 8, Annotated Code of Maryland).

C. An operation and maintenance plan shall be required as a condition of stormwater management plan approval.

D. If a stormwater management plan involves direction of some or all runoff off of the site, it is the responsibility of the developer to obtain from adjacent property owners any easements or other necessary property interests concerning flowage of water. Approval of a stormwater management plan does not create any right to direct runoff onto adjacent property without that property owner's permission.

E. Contents of Stormwater Management Plans.

(1) The owner/developer is responsible for submitting a stormwater management plan in the form of construction drawings which meet the design requirements specified in the Design Manual or are otherwise consistent with this chapter. The plan shall be accompanied by a report that includes sufficient information to evaluate the environmental characteristics of affected areas, the potential impacts of the proposed development on water resources, and the effectiveness and acceptability of measures proposed for managing stormwater runoff. The owner/developer shall certify on the drawings that all land clearing, construction, development, and drainage will be done according to the approved plan.

(2) Reports submitted for stormwater management plan approval shall include:

(a) A brief narrative description of the project;

(b) Geotechnical investigations including soil maps, borings, site-specific recommendations, and any additional information necessary for the proposed stormwater management design;

(c) Description of all water courses, impoundments, and wetlands on or adjacent to the site or into which stormwater directly flows;

(d) Hydrologic computations, including drainage area maps depicting predevelopment and post-development runoff flow path segmentation and land use;

(e) Hydraulic computations;

(f) Structural computations;

(g) Unified sizing criteria volume computations according to the Design Manual; and

(h) Any other information required by the approving agency.

(3) Construction drawings submitted for stormwater management plan approval shall include the following:

(a) A vicinity map;

(b) Topography showing existing and proposed conditions, including areas necessary to determine downstream analysis for the proposed stormwater management facilities;

(c) Any proposed improvements including the location of buildings or other structures, impervious surfaces, storm drainage facilities, and all grading;

(d) The location of existing and proposed structures;

(e) Any easements and rights-of-way;

(f) The delineation, if applicable, of the 100-year floodplain and any on-site wetlands;

(g) Structural and construction details for all components of the proposed drainage system or systems and stormwater management facilities;

(h) All necessary construction specifications;

(i) A sequence of construction;

(j) Data for total site area, disturbed area, new impervious area, and total impervious area;

(k) A table showing the unified sizing criteria volumes required in the Design Manual;

(l) A table of materials to be used for stormwater management facility planting;

(m) All soil boring logs and locations;

(n) A maintenance schedule;

(o) Certification by the owner/developer that all stormwater management construction will be done according to this plan;

(p) An as-built certification signature block to be executed after project completion; and

(q) Any other information required by the approving agency.

26.11.02.10 Construction Inspection and Enforcement.

A. Before Beginning Construction.

(1) All county and municipal ordinances shall require:

(a) Advance notification of the beginning of construction by the owner/developer;

(b) Documented regular inspections during construction of stormwater management systems

(c) Certification by a professional engineer licensed in the State documenting that structural practices have been constructed according to approved plans; and

(d) Effective enforcement procedures to ensure compliance with approved stormwater management plans.

(2) The owner/developer shall notify the appropriate approving agency at least 48 hours before beginning any work in conjunction with stormwater management system construction.

(3) Inspections shall be conducted by county or municipal staff or certified by a professional engineer licensed in the State. The periodic inspections shall be documented and reports maintained by the county or municipality. Written reports shall be prepared for every inspection and include:

(a) The date and location of the inspection;

(b) Whether construction was in compliance with the approved stormwater management plan;

(c) Any variations from the approved construction specifications; and

(d) Any violations that exist.

(4) The owner/developer and on-site personnel shall be notified in writing when violations are observed. Written notification shall describe the nature of the violation and the required corrective action.

(5) Work may not proceed until the work previously completed is approved by the appropriate inspection authority.

B. At a minimum, regular inspections shall be made and documented at the following specified stages of construction:

(1) For ponds:

(a) Upon completion of excavation to sub-foundation and, when required, installation of structural supports or reinforcement for structures, including but not limited to:

(i) Core trenches for structural embankments,

(ii) Inlet and outlet structures, anti-seep collars or diaphragms, and watertight connectors on pipes, and

(iii) Trenches for enclosed storm drainage facilities;

(b) During placement of structural fill, concrete, and installation of piping and catch basins;

(c) During backfill of foundations and trenches;

(d) During embankment construction; and

(e) Upon completion of final grading and establishment of permanent stabilization;

(2) Wetlands--at the stages specified for pond construction in §B(1) of this regulation, during and after wetland reservoir area planting, and during the second growing season to verify a vegetation survival rate of at least 50 percent.

(3) For infiltration trenches:

(a) During excavation to subgrade;

(b) During placement and backfill of under drain systems and observation wells;

(c) During placement of geotextiles and all filter media;

(d) During construction of appurtenant conveyance systems such as diversion structures, pre-filters and filters, inlets, outlets, orifices, and flow distribution structures; and

(e) Upon completion of final grading and establishment of permanent stabilization;

(4) For infiltration basins--at the stages specified for pond construction in §B(1) of this regulation and during placement and backfill of under drain systems;

(5) For filtering systems:

(a) During excavation to subgrade;

(b) During placement and backfill of under drain systems;

(c) During placement of geotextiles and all filter media;

(d) During construction of appurtenant conveyance systems such as flow diversion structures, pre-filters and filters, inlets, outlets, orifices, and flow distribution structures; and

(e) Upon completion of final grading and establishment of permanent stabilization;

(6) For open channel systems:

(a) During excavation to subgrade;

(b) During placement and backfill of under drain systems for dry swales;

(c) During installation or diaphragms, check dams, or weirs; and

(d) Upon completion of final grading and establishment of permanent stabilization;

(7) For nonstructural practices--upon completion of final grading, the establishment of permanent stabilization, and before issuance of use and occupancy approval.

C. The county or municipality responsible for inspection and enforcement of approved stormwater management plans may, for enforcement purposes, use any one or a combination of the following actions:

(1) A notice of violation shall be issued specifying the need for the violation to be corrected if stormwater management plan noncompliance is identified;

(2) A stop work order shall be issued for the site by the county or municipality if a violation persists;

(3) Bonds or securities may be withheld or the case may be referred for legal action if reasonable efforts to correct the violation have not been undertaken; or

(4) In addition to any other sanctions, a civil action or criminal prosecution may be brought against any person in violation of the Stormwater Management Subtitle or this chapter.

D. Any step in the enforcement process may be taken at any time, depending on the severity of the violation.

E. Once construction is complete, as-built plan certification shall be submitted by either a professional engineer or professional land surveyor licensed in the State to ensure that constructed stormwater management practices and conveyance systems comply with the specifications contained in approved plans. At a minimum, as-built certification shall include a set of drawings comparing the approved stormwater management plan with what was constructed. Other information shall be submitted as required by the approving agency.

F. Each county or municipality shall submit notice of construction completion to the Administration on a form supplied by the Administration for each stormwater management practice within 45 days of construction completion. If BMPs requiring soil conservation district approval are constructed, notice of construction completion shall also be submitted to the appropriate soil conservation district.

26.17.02 .11 Maintenance.

A. Maintenance requirements established in this regulation shall be contained in all county and municipal ordinances and shall provide for inspection and maintenance. The owner shall perform or cause to be performed preventive maintenance of all completed stormwater management practices to ensure proper functioning. The responsible agency of the county or municipality shall ensure preventive maintenance through inspection of all stormwater management systems. The inspection shall occur during the first year of operation and then at least once every 3 years after that.

B. Inspection reports shall be maintained by the county or municipality on all stormwater management systems and shall include the following:

(1) The date of inspection;

(2) Name of inspector;

(3) The condition of:

(a) Vegetation or filter media,

(b) Fences or other safety devices,

(c) Spillways, valves, or other control structures,

(d) Embankments, slopes, and safety benches,

(e) Reservoir or treatment areas,

(f) Inlet and outlet channels or structures,

(g) Underground drainage

(h) Sediment and debris accumulation in storage and forebay areas,

(i) Any nonstructural practices to the extent practicable, and

(j) Any other item that could affect the proper function of the stormwater management system;

(4) Description of needed maintenance.

C. County and municipal ordinances shall provide procedures to ensure that deficiencies indicated by inspections are rectified. The procedures shall include the following:

(1) Notification to the owner of deficiency including a time frame for repairs;

(2) Subsequent inspection to ensure completion of repairs; and

(3) Effective enforcement procedures if repairs are not undertaken or are not done properly.