CHAPTER 9

STORMWATER MANAGEMENT TECHNIQUES

Introduction

Techniques to lessen the impact of stormwater runoff from both existing and proposed land uses fall into two broad categories; structural, and non-structural. Structural stormwater management techniques utilize physical means to reduce or manage runoff. Stormwater detention basins, infiltration trenches, and grassed waterways are all examples of structural stormwater management techniques. It is important to note that many structural techniques should not be used in areas where limestone is prevalent, especially infiltration trenches because they accelerate sinkhole production. Non-structural stormwater management techniques generally refer to land use restrictions used to manage the amount and extent of land use changes. Floodplain, stormwater management, subdivision, and zoning regulations are all examples of effective non-structural stormwater management techniques.

The following sections present a summary of stormwater management alternatives for the Combined Watershed. The applicability of particular stormwater management techniques in individual sub-areas is site specific. It is important to consider on-site characteristics such as topography, soils, sub-surface geology, water table configuration, existing and proposed land uses, land requirements, and regulatory controls to determine the suitability of a particular stormwater management technique.

Structural Stormwater Management Techniques

Structural stormwater management techniques can be divided into two categories, volume reduction and peak reduction techniques. Volume reduction techniques decrease the amount of stormwater that runs off a site by increasing the infiltration fraction of precipitation. Peak reduction techniques decrease the magnitude of peak flows while increasing the duration of runoff period.

The next section provides a discussion of volume reduction and rate reduction techniques that may be appropriate for use in the Combined Watershed. Table 9-1 lists a description of the techniques, applicability, advantages and disadvantages, maintenance requirements, and approximate construction costs (where available) of these techniques.

Volume Reduction Techniques

Land use changes and development in the watershed will increase the volume of runoff. Reductions in the amount of runoff from new developments accomplished through the prudent implementation of a stormwater management plan for the site will play an important role in the success or failure of the watershed-wide stormwater management plan. Volume reduction techniques can be a valuable part of any stormwater management plan.

Some volume reduction techniques decrease runoff from a site by routing water to the subsurface and the local water table. Planners and developers must ensure that these types of volume reduction techniques do not degrade the water quality of local aquifers. Title 25, Chapter 97 (Industrial Wastes) Underground Disposal, Section 97.71, clearly refers to stormwater runoff as potential pollution unless, "the disposal is close enough to the surface so that the wastes will be absorbed in the soil mantle and be acted upon by the bacteria naturally present in the mantle before reaching the underground or surface waters." Discharges to sinkholes are not acceptable because of accelerated sinkhole production and groundwater contamination.

Developers typically use volume reduction techniques in conjunction with peak reduction techniques as part of the overall stormwater management plan. Volume reduction techniques normally are not sufficient by themselves to provide adequate attenuation of stormwater runoff, except for use at individual homes and small parking lots. Volume reduction techniques help decrease the size of the peak reduction facilities, thereby lowering capital costs.

Peak Reduction Techniques

Peak reduction techniques are generally temporary storage facilities that decrease peak flows from a site. Proper design of peak reduction facilities can decrease peak discharges to acceptable values within the constraints of the watershed-wide stormwater management plan. The design of peak reduction facilities must consider pre-development peak flows, anticipated post-development peak flows, applicable release rates, and site constraints. A site-by-site approach to the design of peak reduction facilities in the watershed is undesirable, and may actually increase downstream peak flows.

Non-Structural Stormwater Management Techniques

Non-structural stormwater management techniques rely primarily on federal, state, and local regulations. Applicable federal laws regulating activities in waters of the United States include, but are not limited to, Section 404 of the Clean Water Act (PL 92-500) and the River and Harbor Act of 1899. These laws regulate activities such as filling, dredging, and wetland encroachment. State regulations include, but are not limited to, the Dam Safety and Encroachment Act (P.L.177) which regulates activities such as stormwater detention pond outflows into receiving streams in or near waters of the Commonwealth. The Dam Safety and Encroachment Act is under the jurisdiction of the PA DEP. On the local level, ordinances such as, floodplain management, stormwater management, subdivision, and stormwater management, zoning regulate development. All non-structural stormwater management techniques affect runoff by regulating land use.

Table 9-1
Structural Stormwater Management Techniques
Fishing Creek/Cedar Run Watershed

Description	Applicability	Advantages	Disadvantages	Maintenance
VOLUME REDUCTION TECHNIQUES				
Drain runoff from impervious areas over pervious areas	Use in low density development areas outside principal drainageways. Do not use in natural or man made drainageways.	• Inexpensive to install and maintain • Promotes groundwater recharge • Promotes green space preservation	• May degrade groundwater quality	• Periodic inspections for sedimentation • Harvest vegetation and collect thatch
Infiltration pits, trenches and dry wells	Use when soil permeability is below bottom of structure, and runoff is free of particulate matter	• Inexpensive to construct • Provides groundwater recharge • Reduces pipe capacities and costs when used in conjunction with storm sewer bedding • Reduces ponding and local flooding • Multi-purpose use • Effective for controlling “first flush” pollutants	• Requires sediment free runoff (otherwise filters may be required) • Limited to small applications • Clogged systems must be replaced • Must provide contingencies for ponding in a clogged or full system • Accelerates sinkhole production	• Must clean and maintain sediment filters
Concrete grid and modular pavement	Use on large parking areas and on-street parking. Use as erosion control devices in drainageways and at detention basin outfalls (must be protected from undermining)	• Increased flexibility eases repair of underground utilities, replacement of pavement units, and installation of signs and plantings • Flexibility prevents buckling • Aesthetically pleasing	• Installation expensive and labor intensive • Susceptible to damage from fertilizers and de-icing agents • Shifting units result in uneven surface and present a safety hazard • Potential groundwater quality degradation	• Maintain vegetation in voids • Reset shifted units and replace broken units

Table 9-1 (cont.)
Structural Stormwater Management Techniques
Fishing Creek/Cedar Run Watershed

Description	Applicability	Advantages	Disadvantages	Maintenance
Porous asphalt pavement	Use in low volume traffic areas not subjected to heavy loads or the turning or stopping action of large vehicles. Requires a permeable soil sub-base	• Reduces or eliminates additional storage facilities • Water free surfaces enhance skid resistance • Eliminates need for crowns and cross slopes • Increases groundwater recharge	• Asphalt cement prone to stripping by de-icing agents • Prone to clogging problems • Susceptible to freeze/thaw damage if adequate sub-surface drainage is not provided • Increased aggregate base or asphalt thickness required • More expensive than conventional pavement • Conveys oils and solvents to groundwater • Weeds may grow through pavement	• Remove debris and sediment from surface
Grassed waterways, filter strips, and seepage areas	Use in small developments with open space for stormwater control and along roadside drainage systems	• Less expensive than curbs and gutters • Enhances groundwater recharge • Eliminates flooding of roadways from inlet by-passing • Multi-purpose recreational use • Plantings in filter strips effectively screens parking areas • Positive aesthetics, increases time of concentration, and enhances infiltration	• Requires more regular maintenance than curb and gutter systems • Requires wider right-of-ways • Driveway culverts trap debris • May require guide rails along roadway • May not be compatible with local subdivision • Receptacle for lawn debris • Sedimentation discourages vegetative growth • Seepage areas accumulate contaminants in upper layers of soil • Overflows from seepage areas may damage down stream areas • May accelerate sinkhole • production	• Remove obstructions along drainageways & repair erosion & sedimentation damage • Maintain vegetation & remove dead material • Maintain soil permeability to eliminate insect breeding problems

Table 9-1 (cont.)
Structural Stormwater Management Techniques
Fishing Creek/Cedar Run Watershed

Description	Applicability	Advantages	Disadvantages	Maintenance
Peak Reduction Techniques				
Detention basins	Use in practically any situation	• Provides local & watershed-wide stormwater control • Enhances sediment and debris control • Ease of constructability • Considerable design flexibility • May enhance groundwater recharge • May reduce downstream erosion problems • Effective for controlling "first flush" pollutants • Multi-purpose use	• Converts sheet flow to point discharges • May promote sinkhole development in Karst terrain • Shallow sloped bottoms discourages vegetative growth • Standing water is a safety concern • Reduces amount of salable land • Undersized outlets collect debris • Concentrates pollutants in the soil	• Maintenance access must be provided • Remove debris • Fill localized depressions to eliminate insect breeding • Maintain earth-work to prevent piping around outlet structure & erosion on spillway • Maintain veg.
Oversized conveyance system storage	Use anywhere storm sewers can be installed	• Does not use valuable land space • Minimal maintenance needs	• Sediment accumulation must be flushed from the system • Constrictions in on-line systems may trap debris in inaccessible locations • Additional cost of oversized storm sewer and constricted outlets	• Periodic inspection and cleaning of storm sewers
Parking lot storage	Use wherever large paved lots can be used to temporarily store runoff without causing safety concerns or inconvenience	• Easily incorporated into parking lot grading • Reduces downstream storage requirements	• Can cause inconvenience • Requires significant slope on parking area to limit spread of water • May cause hazardous conditions in winter weather	• Remove debris at outlet • Must keep parking lots clean

Table 9-1 (cont.)
Structural Stormwater Management Techniques
Fishing Creek/Cedar Run Watershed

Description	Applicability	Advantages	Disadvantages	Maintenance
Parking lot storage	Use wherever large paved lots can be used to temporarily store runoff without causing safety concerns or inconvenience	• Easily incorporated into parking lot grading • Reduces downstream storage requirements	• Can cause inconvenience • Requires significant slope on parking area to limit spread of water • May cause hazardous conditions in winter weather	• Remove debris at outlet • Must keep parking lots clean
Rooftop detention	Use on large flat roofs in highly urbanized settings	• Requires no additional land space • Poses no safety hazard or inconvenience to general public • Stored water con be used for landscape maintenance • May significantly impact local runoff problems	• Failure generally leads to on-site property damage • Not well suited to retrofitting • Little impact on watershed-wide runoff control • May require modification to local building codes • May not receive regular inspection and maintenance • Results in higher roof loadings	• Routine leak detection inspections • Downspouts must be kept free of debris
Cistern storage	Use anywhere construction costs are not prohibitive	• Cisterns are unobtrusive • Can easily be fit into existing sites • Provides a free source of non-potable water • Sumps are well suited for residential roof drainage • Effective for controlling “first flush” pollutants	• Difficult to clear accumulated debris • Difficult to drain, may require pump • Requires large volume if no outlet is provided • Susceptible to deterioration, expensive and difficult to maintain	• Regular inspection and debris removal

Table 9-1 (cont.)
Structural Stormwater Management Techniques
Fishing Creek/Cedar Run Watershed

Description	Applicability	Advantages	Disadvantages	Maintenance
Other Peak Reduction Techniques with Limited Potential				
Gravel parking lots & driveways	Use in log term parking areas and on very small lots	• Reduces runoff • Reduces construction costs	• Runoff fraction increases as gravel consolidates • Mud con become a major problem • Susceptible to pothole development • Material may be removed during large storm events	• Fill potholes • Excavate soft spots and muddy areas, and replace with new, clean aggregate
Rooftop gardens	Use wherever adequate space is available	• Provides free source of non-potable water	• Extremely limited effect on local and watershed-wide runoff control	• Not available