INTRODUCTION

What is Stormwater?

Stormwater is the surface runoff of rain and snow melt. In undeveloped areas such as grasslands and forests, the surface flow of water is slowed by vegetation; some of the water then seeps into the ground. In urban areas, buildings, and impervious surfaces such as parking lots decrease the surface area of soil and vegetation, resulting in increased amounts and faster flow of storm water runoff. A stormwater drainage system is necessary to channel this runoff out of urban areas and reduce the occurrence of flooding.

What is a 'Municipal Separate Storm Sewer System?'

The local stormwater system is called a "Municipal Separate Storm Sewer System (MS4)", indicating that it is separate from the Sanitary Sewer System. A variety of structures and land forms, both natural and artificial, are part of the MS4. These include inlets, pipes, grass and concrete channels, earth berms, ditches, box culverts, streams, detention basins, and even sinkholes. All of these are part of the path which storm water runoff travels on its way out of urban areas and into nearby streams, rivers, and lakes. Currently, the local stormwater program is required by TDEC and EPA to prevent non-stormwater discharges from entering its MS4.

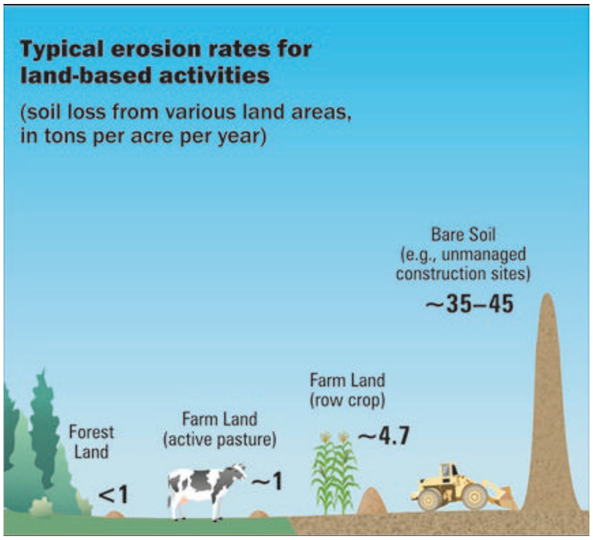
Why is Stormwater Management important?

Urbanization can increase the quantity and decrease the quality of runoff. Historically, counties have focused their stormwater management programs on reducing the effects of flooding. In recent years, the concerns include the problem of water quality degradation. Today, water quality is addressed through implementation of construction and post-construction Best Management Practices (BMPs), public education and involvement, and reduction of illicit pollution discharges. Good storm water management benefits local property owners by reducing flood damages and increasing the quality of receiving streams. Improper stormwater management carries mandated fines listed as listed in the local Ordinance.

Background and Perspective

Many areas of Tennessee are experiencing significant land development. Human activities, particularly urbanization and agriculture, alter natural drainage patterns and/or add pollutants to rivers, lakes, and streams. Typical pollutants in stormwater include elevated concentrations of sediment, oils and grease, heavy metals, salts, pesticides, nutrients, bacterial and other pollutants. Figure 1 shows increased amounts of sediment runoff based on varying land use. Recent studies have also shown that stormwater runoff is a significant source of water pollution, causing declines in aquatic health and restrictions on swimming, and limiting our ability to enjoy many of the other benefits that water provides (USEPA, 1992).

Figure 1 Soil Loss Rates and Land Use
(Dunne, T. and L. Leopold, 1978; NRCS, 2000; NRCS, 2006; ASCE and WEF, 1992)



Much of this development can generally be characterized as urban (residential, commercial, industrial, and transportation) and greatly affects the way the developed land behaves hydrologically and environmentally. In addition to adding pollution, typical urban development increases both the quantity (volume) of stormwater runoff and the rate of concentration (peak flow) at which it flows to adjacent lands or enters receiving waters. The timing of this runoff is typically affected, also, and is capable of producing negative downstream consequences.

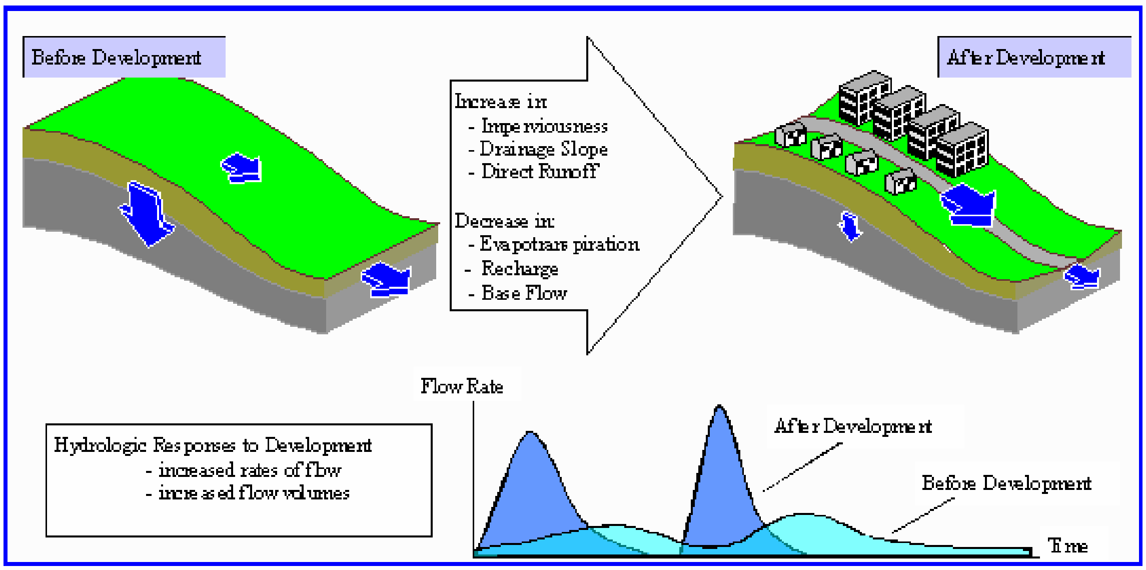
Effects of Urbanization

There are two main environmental impacts that typically result from urbanization. First, the hydrology of the area is changed. This change typically consists of increased runoff volumes, flows, and velocities, and reduced groundwater recharge. The timing of this runoff and base flow are also typically affected and may have negative downstream consequences. Second, urbanization increases a variety of human activities that generate pollutants within a watershed. The pollutants are transported in runoff and, subsequently, discharged to our streams and lakes. These activities may range from construction to automobile use to various types of private and public development and pedestrian uses after construction is completed.

Hydrologic Changes

When an undeveloped area changes to support urban land uses, dramatic impacts in the local hydrology result as illustrated in Figure 1. Urbanization typically changes the natural hydrology of a watershed through increased imperviousness thereby increasing direct runoff and decreasing evapotranspiration, deep infiltration, and shallow infiltration. When an area is developed, natural drainage patterns are modified as runoff is channeled into road gutters, culverts, storm drains, and paved channels. The results of these modifications typically produce an increase in runoff volume and velocity, and a shorter time for the runoff to leave the watershed, causing higher peak flows.

Figure 2 Changes in Watershed Hydrology from Urbanization



In addition, higher flows can cause flooding and adverse effects on natural streams. Before development, at bank full capacity, natural streams can handle a flow approximately equal to the 2-year frequency peak discharge. After development, this bank full capacity can be exceeded several times per year. The new flow regime also can lead to channel and bank erosion and unwanted meandering and widening (Minnesota PCA, 1989).

The box below summarizes the typical impacts that urbanization has on both water quantity and water quality in water bodies such as lakes and streams.

Typical Effects of Urbanization

Hydrologic Changes

- Increased runoff volumes
- Reduced times of concentration for the contributing drainage areas, resulting in higher flow velocities and peak flows
- Increased frequency of flows for given storm events
- Decreased groundwater recharge
- Habitat destruction from flow changes, channel erosion, and channel improvement

Pollutant Generation

- Human activities create several types of biological, chemical and physical pollutants which are transported to receiving waters

Urban Storm Water Pollutants

Pollutants most frequently associated with stormwater include construction sediment and post-construction nutrients, bacteria, oxygen-demanding substances, oil and grease, heavy metals, other toxic chemicals (e.g., pesticides and herbicides), and floatables (e.g., fast-food litter and debris from traffic litter and fly away). In addition, urban runoff usually has a higher water temperature resulting from natural land being converted to paved areas and removal of stream shade.

Stormwater Pollutants of Concern

- Sediment
- Nutrients
- Bacteria
- Oxygen Demanding Substances
- Oil and Grease
- Metals
- Toxic Pollutants
- Floatables (Debris)
- (Increased) Temperature

Water Quality Issues

Since the passage of the Clean Water Act (CWA), the quality of our Nation's waters has improved dramatically. Despite this progress, however, degraded water bodies still exist. According to the 1996 National Water Quality Inventory, a biennial summary of State surveys of water quality, approximately 40 percent of surveyed U. S. water bodies are still impaired by pollution and do not meet water quality standards. A leading source of this impairment is polluted stormwater runoff. In fact, according to the Inventory, 50 percent of impaired rivers in the U. S. are affected by urban/suburban and construction sources of storm runoff.

Tennessee has approximately 60,200 stream miles and 537,000 publicly-owned lake acres within its boundaries. All of the streams and lakes in Tennessee are classified, at minimum, for fish and aquatic life and recreation, in concert with Congress' national goal that all waters be both "fishable and swimmable."

Of the approximately 99% of the lake and reservoir areas that have been assessed, about 7 percent have impaired water quality for supporting aquatic life and about 20 percent have recreational impairment. See **3.6 Discharges in Impaired or High Quality Watersheds** in this manual for a list of impaired and high quality streams in the local program areas. While no single cause of stream and river impairment is dominant, conventional pollutants such as siltation, suspended solids, nutrient enrichment, and organic enrichment/low dissolved oxygen affect the highest number of river miles.

This manual provides general guidance in developing and implementing best management practices (BMPs) for stormwater runoff quality, with consideration also given to quantity (flow).

Local government officials and private owners have a responsibility to consider both the rules of law for liability for stormwater runoff quantity issues and applicable state and federal requirements related to stormwater quantity at the local level. These requirements and responsibilities are summarized as follows:

Water Use Rights

Existing water use and drainage law in Tennessee result mainly from judicial decisions stating the application of the common law in this state. There has been little statutory treatment of individual rights and obligations. The doctrine of riparian rights, which prevails in most of the eastern United States, is the basis for the existing law of Tennessee for controlling rights to the use of water in well-defined streams. As applied in Tennessee it has been referred to as the "reasonable use" doctrine and can be stated as follows (Marquis, et al., 1955):

> *...each riparian owner has an equal right to have the stream flow through his land in its natural channel, without material diminution in quantity or alteration in quality but with this limitation or qualification, however, that each proprietor is entitled to the reasonable use of the water for domestic, agricultural or manufacturing purposes (American Association, Inc. v. Eastern Kentucky Land Co., 2 Tenn. Ch. App. 132, 173 (1901), affirmed by Tenn. Sup. Ct. without modification).*

Rights to natural stream flow in Tennessee are reinforced in another early case:

> *The owner of land, across or over which a stream of water flows, has a right to have it flow over his land in its natural channel, without unreasonable detention, undiminished in quantity, and unimpaired in quality, except so far as it inseparable from a reasonable use of the water of the stream for the ordinary and useful purposes of life by those above him on the stream. (Tenn. 1901, Cox v. Howell, 65 S.W. 868, 108 Tenn. 130, 58 L.R.A. 487)*

Regulatory Framework

This Best Management Practices (BMP) manual is a support document for an evolving stormwater management program. The latest version has been designed and structured to be a "living document" that grows, evolves, and matures along with the program it supports. As a supporting and largely technical document, the manual provides guidance to the implementation of an effective stormwater management program.

"Quantity follows Quality." Promoting and controlling water quality as a first priority and water quantity control will be accomplished in the proper context. Water quantity (flooding) control at the local government level should focus on the control of more frequent storm events. The BMP Manual is consistent with this philosophy. Additionally, the manual serves as a tool for local government compliance with National Pollutant Discharge Elimination System (NPDES) stormwater rules.

It is the purpose and intent of the BMP Manual to provide the user and practitioner with a viable selection of approved and effective means to meet local legal requirements for stormwater management.

The manual covers the application of BMP for construction activity and property development. The manual is not an enforcement or design document but rather a technical guide to the proper selection and use of various physical constructs or BMP is designed to meet the governing requirements in the applicable jurisdiction.

The BMP Manual is designed to provide measures for compliance within the context of current jurisdictional rules but it also contemplates a greater degree of engineering sophistication for an evolving storm water management program. The development and maintenance of calibrated hydrologic/water quality models for each basin is necessary before true performance-based controls are appropriate and relationships can be made to the "total maximum daily loading" (TMDL) requirements that will become the compliance measure for local stormwater management. Until then, generalized performance measures and certain minimum controls are the option of choice.

Permits and Local Requirements

In the area referenced by this manual, three different jurisdictional authorities issue permits modeled after the State of Tennessee's permit program. These entities are City of Chattanooga, Town of Signal Mountain, and Hamilton County. For a map of areas included in the Hamilton County program, go to:

http://www.hamiltontn.gov/waterquality/docs/stormwaterboudarymap.pdf

Most land disturbing activities of 1 or more acres undertaken in the local program area are regulated. Section 2 – Local Requirements of this Manual describes if a Land Disturbance Permit is required. A Runoff Management Permit may also be required for one or more acres as described in the local Stormwater Ordinance.

Permit compliance like the State's permit program is assessed based on the utilization of certain BMPs, prevention of non-storm water discharges into the storm water system and local water bodies, and the visible character of discharges from storm events. The BMP Manual provides a choice of acceptable practices that can be specified as required controls applicable to the respective permit.

BMP Selection

It is not the intent of this manual to dictate the actual selection of BMPs, but rather to provide the framework for an informed selection of BMPs. In selecting and implementing BMPs that will achieve MEP ('maximum extent practicable'), it is important to remember to reduce the discharge of pollutants in stormwater to the maximum extent practicable. This means choosing effective BMPs, and rejecting BMPs that would not be technically feasible or be cost prohibitive. Proper sequencing of construction activities and maintenance are essential to maximize the effectiveness of structural BMPs.

Overall flow and/or volume design considerations vary for temporary BMPs and permanent or post-construction BMPs. Temporary BMPs used during construction should be designed to function adequately during peak flows from a 2-year, 24-hour storm event. If impacting high quality or impaired streams, other requirements such as a 5-year, 24-hour storm event design, sediment basins and buffer zones may apply (see 3.6 Discharges in Impaired or High Quality Watersheds). Designing BMPS to function effectively for a 5-year, 24-hour storm event design is recommended for a safety factor as storms of shorter duration may surpass anticipated levels of peak flow.

Permanent or Post-Construction BMPs should be designed to treat the 'first flush' (or first ¾ of an inch) of stormwater runoff (see 3.3 First Flush/Water Quality Requirement).

The following factors should be considered in deciding if a BMP is practical:

1. Pollutant Removal – Will the BMP address the pollutant of concern?
2. Water Quantity – Will the BMP be an effective facility for managing and controlling water runoff flow and volume?
3. Regulatory Compliance – Is the BMP compatible with stormwater regulations as well as other regulations for air, hazardous wastes, solid waste disposal, etc.?
4. Implementation – Is the BMP compatible with land uses, facilities, or development activity in question?

5. Cost – Will the cost for implementing the BMP exceed the pollution control and flow management benefits expected to be achieved?
6. Technical Feasibility – Is the BMP technically feasible considering soils, geography, water resources, maintenance and special site considerations?

For the BMPs selected, the owner must demonstrate a “good faith” effort to implement and provide for long-term maintenance for them. Both publicly and privately-owned facilities require regular inspection and maintenance to ensue effective stormwater water quality and quantity management as intended by the designer. **See Section 3 – BMP Selection Guidelines** in this Manual**.**

BMP Inspection and Maintenance

Both temporary and permanent BMPs need regular inspections to ensure their effectiveness. Three types of BMP inspections are performed: routine inspections, inspections performed before rain events, and inspections performed after rain events. Each BMP in this Manual includes maintenance descriptions.

A construction site operator has several options to ensure that regular inspections are occurring. At small sites, the site superintendent or another management staff member can perform the task. At large sites, a firm with expertise in erosion and sediment control can be contracted to implement an inspection, maintenance, and repair program for the site. TDEC requires self-inspection for permitted construction projects. State and local programs require Level I Erosion Prevention and Sediment Control Certification for site operators responsible for inspection and documentation of erosion and sediment control BMPs. See http://www.tnepsc.org/ for training schedules. It is the responsibility of the construction site operator to assure that a mechanism for regular inspections is established and implemented through the duration of the project.