Chapter 3
STORMWATER POLLUTANTS

Sediment from erosion is the pollutant most frequently associated with construction activities. However, other pollutants are also carried into the stormwater system and streams. Stormwater pollutants can be categorized into the following nine categories: sediments, nutrients, heavy metals, toxic materials (including pesticides and herbicides), oil and grease, bacteria and viruses, biological and chemical oxygen-demanding substances, floatable waste materials, and construction waste materials.

These pollutants originate from a variety of locations such as residences, commercial properties, industry, schools, offices, parking lots, roads, restaurants, grocery stores, i.e. potentially from every property in the city. Automotive vehicles and other motorized equipment are a major source of pollutants, so that parking lots and roads are considered a major factor of nonpoint source pollution. A typical single-family household contains dozens of hazardous chemicals for indoor or outdoor use, which are often disposed incorrectly on the lawn or out in the woods.

Typical construction activities that contribute stormwater pollutants include: site grading, clearing and grubbing, paving operations, demolition, materials storage, equipment fueling, vehicle maintenance, painting, and use of other chemicals. By taking an activities inventory, the engineer/designer/contractor/owner can identify potential pollutant sources and then select appropriate BMPs to address these sources. Each of the BMP fact sheets includes a list of the targeted constituents. The list is a general guide to selecting BMPs and is not intended to address any particular type of residence, commercial property, industry, or institution. A matrix of pollutant removal guidelines is given in Tables 3-1 through 3-5. The designer must use care and common sense in evaluating potential BMPs, which is discussed further in Chapter 4.

In addition to pollution, stormwater runoff and streams can also suffer degradation from thermal effects and from pH changes. These basic water characteristics can degrade aquatic habitats such as streams and lakes. Concrete and asphalt tend to store large amounts of heat efficiently, which is then transferred to stormwater runoff. Concrete and asphalt channel linings are often used for urban streams. In addition to the type of channel lining used, thermal pollution is also caused by a lack of natural shade.

3.1 Sediments

Most sediments are generated from soil and rock erosion, although some sediments are organic in nature. Manmade materials may also decompose or erode to create sediments. Sediments vary in terms of size and specific weight, which are the two main factors that determine when and how far sediment will travel. There are several complex equations that are used to predict how much sediment a stream or channel can carry. These equations generally yield different answers and rely on estimating several variables. In theory, a stream will deposit sediment if it tries to carry more than its sediment-carrying capacity, and a stream will pick up sediment if it has not yet reached its sediment-carrying capacity.
Sediment is harmful to aquatic life because it blocks sunlight that is necessary for photosynthesis and interferes with animal respiratory organs. Sediment can also accumulate on natural streambeds and other habitats, smothering the plants and creatures that live there.

3.2 Nutrients

Phosphorous, nitrogen, and other plant nutrients are generated naturally due to organic activities in the soil, biological and chemical decomposition, etc. Streams and other natural channels have a limited ability to moderate and adjust to large amounts of manmade nutrients such as fertilizers. Nutrients are also generated by phosphorous-bearing soils, chemicals, food processing plants, lumber activities, restaurants, and wastewater treatment systems.

Nutrients can create excessive growth of vegetation or algae, which results in impaired use of water in lakes and other sources of water supply by creating taste and odor problems. Excess algae can also deplete dissolved oxygen levels that results in fish kills. Collectively, the problems associated with excessive levels of nutrients in a receiving water are referred to as eutrophication impacts. The size of a receiving water is the principal factor in determining the ability to handle increased nutrients.

3.3 Heavy Metals

Heavy metals, even in low concentrations, are generally toxic to all life forms. Heavy metals are of particular concern because they are toxic to aquatic organisms, can be bio-accumulative, and have the potential to contaminate drinking water supplies. Significant portions of heavy metals in urban runoff are generated from cars and trucks. Gasoline and diesel fuels contain heavy metals, which are discharged through the vehicle exhaust and settle on the roadways and parking lots.

Most artificial surfaces (galvanized metal, paint, wood preservatives, roof shingles, plastic, asphalt) contain metals that can enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Careful maintenance, inspection, and repair can limit the cumulative effect from these surfaces.

3.4 Toxic Materials

Toxic materials are commonly used in residences, commercial facilities, industry, etc. Toxic materials are often synthetic organic compounds, such as adhesives, cleaners, solvents, or sealants. Accidental spills and leakage or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental harm in receiving waters. City of Knoxville programs for the collection of household hazardous waste have reduced the amount of toxic materials released by residential properties.

Herbicides, insecticides and rodenticides (collectively termed pesticides) are commonly used on construction sites, lawns, parks, golf courses, etc. Unnecessary, excessive, or improper application of these pesticides may result in direct water contamination. It is highly recommended that Knoxville residents and businesses avoid these products whenever possible.

3.5 Oil and Grease

These products are widely used throughout the City of Knoxville wherever automotive vehicles are found. Oil and grease can be spilled or leaked onto the ground and then washed into waterways. Sources include leakage during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. These products can cause severe harm to plant and animal life due to the additional effect of heavy metals and toxic hydrocarbon compounds contained in oil and grease products.

Oil and grease products have properties which affect the methods of capture and treatment. Most oil, grease, hydrocarbons, and other fuels are lighter than water. Therefore, skimmers and separators can be used to capture these pollutants. Oil and grease may form emulsions in turbulent or flowing water, which

then makes this type of pollution very hard to remove. In addition, petroleum products and fuels create flammable vapors and are very detrimental to fish and other aquatic organisms.

3.6 Bacteria and Viruses

Bacteria and viruses are commonly found in organic materials that are part of stormwater. Principal sources include sanitary sewer overflows and leakages, animal excrement from farms, food particles, water used to prepare or clean food or food packaging, and restaurants. The presence of pathogens can make an otherwise attractive stream or lake into a public hazard that must be avoided.

Bacteria and viruses can cause fish kills and human illnesses. These pollutants are usually indicated by the fecal coliform count, which has been a source of concern for streams located within the City of Knoxville. Older sanitary sewer lines near streams are often the source of bacteria and viruses. The search for illicit sewer connections has been an ongoing effort and much progress has been made.

3.7 Oxygen Demanding Substances

Some chemicals and substances are classified as oxygen-demanding substances. This means that in the presence of water, they will extract dissolved oxygen (DO) or even liberate bound oxygen from the water molecule. In chemical terms, oxygen is a very active electron-acceptor and can react with most anything.

Lower DO levels are often the cause of fish kills in streams and reservoirs. The degree of DO depletion is measured by the biochemical oxygen demand (BOD) test that expresses the amount of easily oxidized organic matter present in water. The chemical oxygen demand (COD) test is less frequently used and it measures all of the oxidizable matter present in water. BOD is generally caused by the decomposition of organic matter in stormwater; sometimes non-organic materials in the water can intensify DO depletion. Dissolved oxygen in streams and lakes also depends heavily on temperature.

3.8 Floatable Materials

Floatable waste materials have the potential to be easily carried downstream. It is important that every contractor, business, commercial property, etc. have an effective plan to handle all waste materials. Floatable waste materials may or may not contain other stormwater pollutants. Floatable waste materials will often clog drainage structures, and should be prevented from reaching the stormwater drainage system. Screens and floatable booms are the primary ways to capture these pollutants if they have already entered the stormwater system. Floatable waste materials can harm aquatic animals that try to ingest small pieces of floating matter.

3.9 Construction Waste

Common construction waste materials include: wash water from concrete mixers, paints and painting equipment cleaning activities, solid organic wastes resulting from trees and shrubs removed during land clearing, wood and paper materials derived from packaging of building products, food containers such as paper or aluminum cans, industrial or heavy commercial process water, cooling water, vehicle washing, and sanitary wastes. The discharge of these wastes can lead to unsightly and polluted receiving waters.

It is important that every contractor have an effective plan to handle all construction waste materials. Construction materials should be organized and secured at the end of each workday. Recycling programs and markets are commonly available and are usually profitable to the contractor in terms of waste reduction and lessened disposal costs.

3.10 BMP Pollutant Removal Matrix

Almost every BMP contains a graphical list of targeted constituents for BMP pollutant removal; this information is included on the first page of each BMP factsheet. The list of targeted constituents is a subjective estimate of pollutant removal effectiveness for the average BMP installation. In some instances, the selected BMP may be very effective. In other instances, there may be mitigating factors that nullify the potential stormwater quality benefits of a particular BMP. The list is a general guide to selecting BMPs and does not address every type of residential, commercial, industrial or institutional property use.

Tables 3-1 through 3-5 summarize the BMP pollutant removal information in a matrix form. The legend symbology is slightly different than the BMP factsheets for ease of display.

BMP Factsheets	Effectiveness of Pollutant Removal	Tables 3-1 through 3-5
●	Significant Benefit	●
◗	Partial Benefit	◑
○	Low or Unknown Benefit	---

Table 3-1 **Activities & Methods (AM)** Name of BMP	#	Targeted Constituents: Sediment	Nutrients	Heavy Metals	Toxic Materials	Oil & Grease	Bacteria & Viruses	Oxygen Demand	Floatable Materials	Construction Wastes
Employee Training	**AM-01**	●	●	●	●	●	●	●	●	●
Construction Scheduling	**AM-02**	●	◑	---	---	---	---	---	---	◑
Preservation of Existing Vegetation	**AM-03**	●	●	---	---	---	---	●	●	---
Maintenance of Existing Drainage Systems	**AM-04**	●	---	◑	---	◑	◑	●	●	---
Storm Drainage System Flushing	**AM-05**	●	---	◑	---	◑	---	---	◑	---
Material Delivery and Storage	**AM-06**	◑	◑	◑	◑	◑	◑	◑	◑	◑
Spill Prevention and Control	**AM-07**	---	◑	●	●	●	●	●	◑	---
Waste Management and Recycling	**AM-08**	---	●	●	●	●	●	●	●	●
Sanitary and Septic Waste Management	**AM-09**	---	●	---	---	---	●	●	---	---
Contaminated Soil Management	**AM-10**	◑	---	●	●	---	---	---	---	---
Dust Control	**AM-11**	●	---	---	◑	◑	---	---	---	---
Dewatering Operations	**AM-12**	●	---	◑	◑	◑	---	---	---	---
Pesticides, Herbicides and Fertilizer Use	**AM-13**	---	●	---	●	---	---	●	---	---
Vehicle and Equipment Cleaning	**AM-14**	◑	◑	◑	◑	◑	---	◑	---	---
Vehicle and Equipment Fueling	**AM-15**	---	---	●	●	●	---	---	---	---
Vehicle and Equipment Maintenance & Repair	**AM-16**	---	---	●	●	●	---	---	---	---
Paving Operations	**AM-17**	◑	---	◑	◑	◑	---	---	---	---
Concrete Waste Management	**AM-18**	---	---	---	◑	◑	---	---	---	◑
Structure Construction and Painting	**AM-19**	---	---	---	◑	---	---	---	●	●

Table 3-2 **Erosion & Sediment (ES)** Name of BMP	#	Targeted Constituents								
		Sediment	Nutrients	Heavy Metals	Toxic Materials	Oil & Grease	Bacteria & Viruses	Oxygen Demand	Floatable Materials	Construction Wastes
Stabilized Construction Entrance	**ES-01**	●	---	---	---	◑	---	---	---	---
Tire Washrack	**ES-02**	●	---	---	---	---	---	---	---	---
Construction Road Stabilization	**ES-03**	●	---	---	---	---	---	---	---	---
Gradient Terraces	**ES-04**	●	---	---	---	---	---	---	---	---
Surface Roughening	**ES-05**	●	---	---	---	---	---	---	---	---
Topsoil	**ES-06**	●	---	---	---	---	---	---	---	◑
Mulch	**ES-07**	●	◑	---	---	---	---	---	---	---
Seeding	**ES-08**	●	◑	---	◑	---	---	---	---	---
Sodding	**ES-09**	●	---	---	---	---	---	---	---	---
Trees, Shrubs and Vines	**ES-10**	●	◑	---	---	---	---	---	---	---
Erosion Control Matting	**ES-11**	●	---	---	---	---	---	---	---	---
Geotextiles	**ES-12**	●	---	---	---	---	---	---	---	---
Check Dams	**ES-13**	●	---	---	---	---	---	---	---	---
Silt Fence	**ES-14**	●	---	---	---	---	---	---	---	---
Straw Bale Barrier	**ES-15**	●	---	---	---	---	---	---	---	---
Sandbag Barrier	**ES-16**	●	---	---	---	---	---	---	---	---
Brush or Rock Filter Berm	**ES-17**	●	---	---	---	---	---	---	---	---
Temporary Sediment Trap	**ES-18**	●	---	---	---	---	---	---	---	◑
Sediment Basin	**ES-19**	●	◑	---	---	---	---	---	◑	◑
Bank Stabilization and Soil Bioengineering	**ES-20**	●	---	---	---	---	---	---	---	---

Table 3-2 *(continued)* **Erosion & Sediment (ES)** Name of BMP	#	Targeted Constituents								
		Sediment	Nutrients	Heavy Metals	Toxic Materials	Oil & Grease	Bacteria & Viruses	Oxygen Demand	Floatable Materials	Construction Wastes
Diversions and Downdrains	**ES-21**	●	---	---	---	---	---	---	---	---
Channel Linings	**ES-22**	●	◑	---	---	---	---	---	---	---
Riprap	**ES-23**	●	---	---	---	---	---	---	---	---
Temporary Inlet Protection	**ES-24**	●	---	---	---	---	---	---	◑	◑
Outlet Protection	**ES-25**	●	---	---	---	---	---	---	---	---
Level Spreader	**ES-26**	●	---	---	---	---	---	---	---	---
Floating Sediment Curtain	**ES-27**	●	---	---	---	---	---	---	---	---
Gabions	**ES-28**	●	---	---	---	---	---	---	---	---
TDOT Standard Details for Erosion Control	**ES-29**	●	---	---	---	---	---	---	---	◑
TDEC Erosion and Sediment Control BMPs	**ES-30**	●	---	---	---	---	---	---	---	◑

Table 3-3

Industrial & Commercial (IC)

Name of BMP	#	Targeted Constituents: Sediment	Nutrients	Heavy Metals	Toxic Materials	Oil & Grease	Bacteria & Viruses	Oxygen Demand	Floatable Materials	Construction Wastes
Non-Stormwater Discharges to Storm Drains	**IC-01**	---	●	●	●	●	●	●	◑	◑
Outdoor Loading and Unloading of Materials	**IC-02**	---	●	●	●	●	---	●	●	---
Outdoor Container Storage of Liquid Materials	**IC-03**	---	---	●	●	●	---	●	---	---
Outdoor Process Equipment Operations	**IC-04**	●	---	●	●	●	---	---	---	---
Grounds Construction and Maintenance	**IC-05**	---	◑	●	●	◑	---	◑	◑	●
Over-Water Operations	**IC-06**	◑	◑	◑	◑	●	●	◑	●	---
Food Service and Handling	**IC-07**	---	●	---	◑	●	●	●	---	---
Power or Pressure Washing	**IC-08**	●	◑	●	●	●	---	◑	---	---
Swimming Pools and Spas	**IC-09**	---	---	---	●	---	---	●	---	---
Dumpsters	**IC-10**	◑	●	◑	◑	●	●	●	◑	◑
Kitchen Exhaust Cleaning	**IC-11**	---	●	---	◑	●	●	●	---	---
Air Conditioners and Refrigeration	**IC-12**	---	---	---	●	---	---	◑	---	---
Farms and Agriculture	**IC-13**	●	●	---	●	---	●	◑	---	---
Response to Sanitary Sewer Overflows	**IC-14**	---	●	---	◑	---	●	●	◑	---

Table 3-4

Residential & Homeowners (RH)

Name of BMP	#	Targeted Constituents: Sediment	Nutrients	Heavy Metals	Toxic Materials	Oil & Grease	Bacteria & Viruses	Oxygen Demand	Floatable Materials	Construction Wastes
Non-Stormwater Discharges to Storm Drains	**RH-01**	●	●	●	●	●	●	●	●	◑
Vehicle Washing	**RH-02**	◑	◑	◑	◑	◑	---	◑	---	---
Vehicle Maintenance and Repairs	**RH-03**	◑	---	●	●	●	---	◑	---	---
Landscape Irrigation and Lawn Watering	**RH-04**	---	●	---	●	---	---	◑	---	---
Pesticides and Fertilizers	**RH-05**	---	●	◑	●	---	---	●	---	---
Household Hazardous Waste	**RH-06**	---	---	●	●	●	---	◑	---	---
Sanitary Sewer Laterals and Septic Tanks	**RH-07**	---	●	---	---	---	●	●	---	---
Pet and Animal Wastes	**RH-08**	---	●	---	---	---	●	◑	---	---
Slope and Streambank Stabilization	**RH-09**	●	●	---	---	---	---	---	◑	---
Swimming Pools and Spas	**RH-10**	---	---	---	●	---	---	●	---	---
Boats and Marinas	**RH-11**	---	●	◑	◑	◑	●	●	●	---
Tips for Wet Basements and Crawl Spaces	**RH-12**	(no targeted constituents)								

Table 3-5 **Stormwater Treatment (ST)** Name of BMP	#	Targeted Constituents: Sediment	Nutrients	Heavy Metals	Toxic Materials	Oil & Grease	Bacteria & Viruses	Oxygen Demand	Floatable Materials	Construction Wastes
Dry Detention Basin	**ST-01**	●	◑	◑	◑	◑	---	◑	◑	---
Wet Detention Basin	**ST-02**	●	●	●	●	◑	◑	◑	●	---
Infiltration Systems	**ST-03**	●	◑	◑	◑	◑	---	◑	◑	---
Constructed Wetlands	**ST-04**	◑	◑	◑	◑	◑	◑	◑	◑	---
Filter Strips and Swales	**ST-05**	◑	◑	◑	◑	◑	---	◑	---	---
Water Quality and Media Infiltration Inlets	**ST-06**	●	◑	◑	◑	◑	◑	◑	◑	---
Oil / Water Separator	**ST-07**	●	---	●	◑	●	---	◑	●	---
Underground Detention *******	**ST-08**	◑	---	---	---	---	---	---	◑	---
Multiple Systems	**ST-09**	◑	◑	◑	◑	◑	◑	◑	◑	◑
Detention Computations	**ST-10**	(no targeted constituents)								
Detention Example for Spreadsheet	**ST-11**	(no targeted constituents)								
Detention Example for HEC-1 & HEC-HMS	**ST-12**	(no targeted constituents)								
Other Hydrologic Computations	**ST-13**	(no targeted constituents)								

******* -- Underground detention structures are not allowed in the City of Knoxville except by special permission.

See Figure 4-2 of Knoxville BMP Manual for pollutant removal rates for dry detention basins (ST-01).
See Table 4-5 of Knoxville BMP Manual for pollutant removal rates for typical urban BMPs.