Chapter 2: Erosion, Sediments and Pollution

2.1 – Introduction

As part of the NPDES program, it is necessary to set policies and procedures that determine acceptable Erosion Prevention and Sediment Controls (EPSC) to guide development and building in Montgomery County. These Best Management Practices (BMPs) are considered to be the minimum acceptable level that developments and building sites are to plan for and install. It is important to note that these minimums may not be adequate in all situations, and those responsible for development and building in Montgomery County can be required to plan and maintain more stringent standards and requirements than are outlined here. As technology and engineering practice advance, this manual will be changed as necessary to meet new situations, technologies and environmental requirements.

Nonpoint source pollution comes in the form of particulate or dissolved pollutant matter being picked up by runoff over surfaces and conveyed to Montgomery County's municipal separate storm sewer system (MS4), creeks and waterways. This generally includes sediment eroded from denuded areas during construction and other pollutants from impervious surfaces after construction. Nonpoint source pollution is most prevalent in runoff from small frequent storm events. While most storm events typically result in less than 1.25-inches of rainfall, it is important to note that the Montgomery County Storm Water Resolution requires that planning be based on a ten year, 24 hour storm event, and permanent retention/detention structures must be designed based on a 100 year, 24 hour storm event.

2.2 – The Erosion Process

Water Erosion

Short-term storm water quality management predominately focuses on EPSC for construction sites. However, for some fully developed sites, EPSC can also be a concern. Soil erosion is the process by which soil particles are removed from land surfaces by wind, water or gravity. Natural erosion generally occurs at slow rates. However, the rate of erosion increases when land is cleared or altered and left disturbed. Erosion rates will also increase when flow rates and velocities discharged from a site exceed the erosive range.

Land disturbing activities remove vegetation and disrupt the structure of the soil surface, leaving the soil susceptible to rainfall erosion, stream and channel erosion, and wind erosion if left unstabilized. The materials transported by the erosion process settle during sedimentation in down gradient areas. This can lead to property and environmental damage and flooding problems.

The rainfall erosion process begins when raindrops impact the soil surface and dislodge minute soil particles. These soil particles then become suspended in the water droplet. The sediment laden water droplets accumulate on the soil surface until a sufficient quantity has developed to begin flowing under the forces of gravity.

The initial flow of sediment-laden water generally consists of a thin, slow-moving sheet, referred to as sheet flow. While sheet flow is generally not highly erosive on its own, it does begin the transport of previously suspended sediment. Due to irregularities in the soil surface and uneven topography, sheet flow will usually begin to concentrate into rivulets, where the flow picks up velocity and erosive energy as a result of gravitational forces.

The increasing erosive energy of water flowing in rivulets will begin to cut small grooves, or rills, in the soil surface. Rill erosion of the soil surface tends to concentrate more flows, which then flow faster and gain erosive energy as a result of gravitational forces. In turn, the rills become deeper and larger, and may join together with adjacent rills. Typically, rills run parallel to the slope and each other, are small enough to be stepped across, and are generally enlarged by direct erosion of the rill's sides and bottom by the action of flowing water.

The joining together of several adjacent rills, or sufficient enlargement of a single rill will begin gully erosion. Gully erosion of the soil surface tends to concentrate more flows, which then flow faster and gain erosive energy as a result of gravitational forces. Typically, gullies run parallel to the slope, may have one or more lateral branches, and are enlarged by four key actions. First, gullies often have a "head cut" at the upstream end which progresses its way upstream as water flowing into the gully erodes away the lip of the head. This mechanism is similar to a waterfall working its way upstream. Second, the flow in a gully tends to undercut the banks. Once sufficiently undercut, the bank collapses into the gully, where the collapsed soil is then washed away. Third, when banks collapse into the gully, flowing water is diverted around the temporary blockage of soil. This temporary blockage of soil increases velocities along one or both banks, which results in increased bank erosion. Fourth, the concentration of flows in the gully can result in scour of the gully floor until a stable slope is obtained.

Stream and Channel Erosion

One or more of the following factors that disrupt the balance required for stable streams and channels generally precipitate erosion within streams and channels.

Construction activities can disturb the banks of streams and channels. Once vegetation or other bank protection measures are disturbed, flows may begin to erode the unprotected soil, causing the stream or channel to widen. One of the benefits of Montgomery County's water quality buffer program is that it mandates an undisturbed area along the top of the stream bank, reducing the potential for stream bank disturbances during construction activities.

Construction activities can disturb the flow within a stream or channel. However, these types of activities should be avoided and the disturbance should be minimized. Stream or channel disturbances are often necessary when traversing banks with temporary stream crossings, culvert installations, bridge construction, etc. By diverting flows within the channel, velocities are generally increased in some areas to compensate for decreases in other areas. The increases in velocity may exceed those normally experienced by the channel, resulting in bank erosion and bottom scour. These issues should be addressed in the development plans and minimized to the extent feasible.

Development can increase the quantity and rate of flow to streams and channels. The increased quantity and rate of flow can cause bank erosion and bottom scour. Montgomery County's detention policies address this issue for new development.

Wind Erosion

Dust is defined as solid particles or particulate matter small enough to remain suspended in the air for a period of time and large enough to eventually settle out of the air. Dust from a construction site originates as inorganic particulate matter from rock and soil surfaces and material storage piles. The majority of dust generated and emitted into the air at a construction site is related to earth moving, demolition, construction traffic on unpaved surfaces, and wind over disturbed soil surfaces.

2.3 - Factors Affecting Water Erosion

There are five primary factors that influence erosion: soil characteristics, vegetative cover, topography, climate, and rainfall. These five factors are also components in the Revised Universal Soil Loss Equation (RUSLE), which was originally developed for the United States Department of Agriculture with regard to soil losses on farming land. For more information on RUSLE, see the official website:

http://topsoil.nserl.purdue.edu/nserlweb/weppmain/overview/rusle.html.

The RUSLE formula is:

$$A = R\ K\ L\ S\ C\ P$$

Where A = predicted soil loss (tons per acre per year)
R = rainfall erosion index
K = soil erodibility factor
L = slope length factor
S = slope steepness factor
C = vegetative cover factor
P = erosion control practice factor

Soil characteristics that determine the erodibility of the soil include particle size, particle gradation, organic content, soil structure, and soil permeability. Soil characteristics affect soil stability and infiltration capacity. The less permeable the soil, the higher the likelihood for increased runoff and erosion. Soils with a high percentage of silt and clays are generally the most erodible. Soil characteristics play a different role in channel flow. The shear stress developed by flowing water over the channel banks and bottom can cause the soil particles to move and become suspended in the runoff (scour).

Vegetative cover plays an important role in controlling erosion by shielding the soil surface from the impacts of falling rain and by slowing the velocity of runoff. This permits greater infiltration, maintains the soil's capacity to absorb water, and holds soil particles in place. Vegetative root structures create a favorable soil structure, improving its stability and permeability.

Topography such as slope length and steepness are key elements in determining the volume and velocity of runoff. As slope length and steepness increases, the rate of runoff and the erosion potential increase as well. Steep slopes should be limited to short lengths whenever possible.

Climate is a key factor that influences erosion. Factors such as humidity, temperature extremes, freeze/thaw cycles, and average wind speeds can have significant effects on soil stability and structure. In addition, these factors affect the permeability of the soil.

Rainfall frequency, intensity, and duration are fundamental factors in determining the amounts of erosion produced. When storms are frequent, intense, or of long duration, erosion risks are high. In Montgomery County, the months with highest rainfall are December through May, which coincides with the period of minimal vegetative cover. The most intense storms occur during the spring and summer months. This leads to the conclusion that the spring is potentially the most erosive season.

2.4 - The Sedimentation Process

Once soil particles are eroded by and suspended in water or wind, they can be carried great distances before conditions allow the soil particles to settle. The settling of soil particles is known as the process of sedimentation. Excessive levels of sedimentation can plug storm drains, block streams and channels, damage habitat, and result in the formation of habitats in undesirable locations. Another major problem is that other pollutants can attach to sediment particles and be carried along with the sedimentation. While sedimentation can be forced to occur by creating conditions that slow the flow of water or air, it is always more effective to control erosion than it is to control sedimentation.

2.5 – Storm Water Pollutants and Impacts

Sediment: Sediment from erosion is the pollutant most frequently associated with construction activities. Other potential pollutants include nutrients, metals, pesticides, oil and grease, fuels, other toxic chemicals, and miscellaneous wastes. These pollutants originate from a variety of activities including paving operations, demolition, materials storage, equipment fueling, and other activities common on construction or development sites. By taking an activities inventory, the contractor/operator can identify potential pollutant sources and then select appropriate BMPs to address these sources. Appropriate BMPs are usually specific to the construction activity or development site.

Nutrients: Phosphorous, potassium and nitrogen from fertilizers, pesticides, construction chemicals, and solid waste are often generated by site activities. These materials are commonly referred to as nutrients and can cause *eutrophication*. Eutrophication is a process where lakes, creeks and streams receive nutrients from runoff that stimulate excessive plant growth (algae and nuisance weeds). This enhanced plant growth (algal blooms and nuisance weeds) reduces dissolved oxygen in the water, which can result in oxygen starvation for other aquatic organisms.

When the nutrients are used up, the plants die and decay. The resultant decay products are generally toxic and can cause other organisms to die.

Metals: Sources of metal pollution include:

- Building Materials (galvanized metal, paint, or preserved wood) which contain metals that can enter storm water as the surfaces corrode, flake, dissolve, decay, or leach.

- Vehicle and Equipment wearing parts (brake pads and shoes) contain metals that can enter storm water as these parts wear.

- Vehicle and Equipment fuels, lubricants and coolants which contain high concentrations of metals.

It is significant to note that most metals in urban runoff originate from cars and trucks. Over half the trace metal load carried in storm water is associated with sediments to which eroded metals attach. Heavy metals are of particular concern because they are extremely toxic in low concentrations, can be both carcinogenic and teratogenic, bioaccumulate in lower organisms, and have the potential to contaminate drinking water supplies.

Toxic Materials: Many chemicals commonly used in residences, commercial facilities, and industry tend to be very toxic in even small concentrations. Two general categories of toxic materials are:

- Products that contain volatile organic compounds (VOCs) like adhesives, cleaners, solvents, and sealants

- Herbicides, insecticides, rodenticides and other chemicals used to control pests and unwanted vegetation

Accidental spills, leakage or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental damage in receiving waters. Unnecessary, excessive, or improper application of these chemicals may result in direct water contamination.

Petroleum Products: Oil and grease that is spilled or leaked onto the ground can then be transported into waterways by runoff. Sources include leakage during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. The petroleum distillates themselves and the chemical additives put in to make the products better are extremely toxic. As an example of the toxicity of petroleum products, it is known that one quart of motor will contaminate 250,000 gallons of water and make it unsafe for use by humans.

Bacteria and Viruses: Bacteria and viruses are commonly found in organic materials that are part of storm water. Principal sources include sanitary sewer overflows and leakages, animal excrement from farms and pets, 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. High levels of contamination can result in disease in humans and may kill aquatic organisms.

Most bacteria and virus species are not specifically tested for. Water is usually tested for what are known as indicator species. Indicator species are bacteria species that can be easily tested for and are generally considered to demonstrate the general health of the stream. The indicator species that are usually tested for are Escherichia Coli (E Coli), Fecal Coliform, and in some cases, varieties of Streptococcus. These organisms indicate if there is biological contamination of a stream or river, and give a general idea of what may be causing the contamination.

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 storm water pollutants. Floatable waste materials will often clog drainage structures, and should be prevented from reaching the storm water drainage system. Screens and floatable booms are the primary ways to capture these pollutants if they have already entered the storm water system. Floatable waste materials can harm aquatic animals that try to ingest small pieces of floating matter.

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 for every contractor to 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 are commonly available and are usually profitable to the contractor in terms of waste reduction and lessened disposal costs.

2.6 – Storm Water Quality

All development in Montgomery County shall be conducted in a manner that minimizes storm water pollution to the maximum extent practicable. Both structural and non-structural measures shall be employed at sites to reduce the potential for pollution discharge due to storm water runoff. Measures shall also be employed long-term, after development ceases, to reduce the potential for storm water pollution.