

# CHAPTER 1. INTRODUCTION

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## 1.1 EROSION CONTROL

The purpose of this manual is to serve as a guide for reducing erosion and preventing sediment from leaving construction sites. In addition, this manual will provide information to contractors, developers, consultants, and planners to help guide them in (1) selecting erosion control practices and (2) preparing plans to reduce erosion on construction sites. Use of this manual is not limited to sites that require a National Pollution Discharge Elimination System (NPDES) permit for storm water discharge. This manual also contains information that a builder can use for building an individual house on a site as well as erosion and sediment control plan recommendations for larger tracts, even if an NPDES permit is not required.

In general, soil erosion is the removal of soil by water, wind, ice, and gravity. This manual deals primarily with soil erosion caused by raindrops. Raindrops strike the soil at a speed of approximately 25-30 feet per second. The impact of the raindrop causes particles of soil to be detached and splash into the air. After the soil particles become dislodged, they can be carried by surface runoff. Surface runoff begins when the soil is saturated and cannot absorb the falling rain. Scouring of the exposed soil by runoff can cause more erosion. As the runoff increases, it tends to be concentrated into rivulets and then into grass channels. As the speed of runoff increases, more soil particles are transported.

The dropping of sediment occurs when the surface flow lessens and the soil particles start to drop. The heavier particles such as gravel and sand settle first, and then the lighter particles settle. Little by little, silt and clay can be transported by rain and finally be carried downstream from its upland point of origin.

Rainfall on unprotected soil causes serious erosion and results in sediment being deposited in waterways and a general degradation of the environment. Public criticism can be very strong when streams are dirty, drainage areas clogged, water supplies threatened, and unsightly deposits of silt occur on the landscape. Certainly, the floods of 1993 demonstrated the power of water and its ability to move silt in staggering volumes.

Removal of soil by water at construction sites that are not protected can result in rills, gullies, sheet erosion, damaged slopes, eroded ditches, plugged drainage structures and culverts, and flooded work areas. Stream channels can be filled with sediment to the point where the flow elevation is raised enough to flood areas adjacent to the stream.

Sediment always damages the areas where it is deposited. For example, sediment buries crops and lawns, kills trees, and fills ditches and other drainage systems. Sediment reduces the storage capacity of reservoirs and fills small ponds and lakes. It also damages aquatic life. Sediment can render an area inadequate for its intended use. Sediment that reaches navigable waterways, such as the Mississippi River, requires the navigation channels to be cleared on a continuous basis.

The information contained in this manual will enable the reader to understand how erosion begins and how various factors affect erosion and sedimentation. This knowledge will then enable the user to apply the best management practices to control erosion and sedimentation.

Erosion and sedimentation are natural processes accelerated by human activities. This manual will therefore provide the user with information to minimize erosion and sediment problems on land undergoing construction activities. Control methods will show how to use plants, water, and soil to improve the quality of the environment.

### Erosion Process

The erosion process is influenced by soil erodibility, climate, vegetative cover, topography, and season. Figure 1.1 illustrates the erosion process.



Figure 1.1. Erosion process (Source: [photogallery.nrcs.usda.gov](http://photogallery.nrcs.usda.gov))

### Soil Erodibility

The soil type determines how vulnerable the soil is to erosion, or its erodibility. Properties determining how easily a soil erodes are texture, structure, organic matter content, and permeability. The most erodible soils generally contain a high percentage of fine sand and silt. The presence of clay or organic material tends to decrease soil erodibility. Clays are sticky and tend to bind soil particles together and resist erosion. But while clays resist erosion, they are easily transported once they have eroded. Well-graded and well-drained gravels are usually the least erodible soils.

### Climate

Rainfall characteristics such as frequency, intensity, and duration directly influence the amount of runoff that occurs. As the frequency of rainfall increases, water has a reduced chance to drain through the soil between storms. When the water cannot drain, the soil will remain saturated for longer periods of time and the volume of storm water runoff may be greater. Erosion risks are high where rainfall is frequent, intense, or lengthy.

## **Vegetative Cover**

Vegetative cover is an extremely important factor in reducing erosion from a construction site. Vegetation protects soil from the forces of raindrop impact and runoff scour. While the top growth shields the soil surface from the raindrop impact, the root mass holds the soil particles in place. Grass buffer strips can be used to filter sediment from surface runoff. Grasses also slow the speed of runoff and help maintain the infiltration capacity of the soil. Establishing and maintaining vegetation can be an effective means for minimizing erosion during development.

## **Topography**

Slope length and steepness influence both the volume and velocity of surface runoff. Long slopes produce more runoff to the bottom of slopes. Steep slopes increase runoff velocity. Both situations increase the potential for erosion.

## **Season**

Temperature has a significant influence on soil erosion. Seasonal variation in temperature and rainfall changes the erosion potential during the year. Frozen soils are relatively erosion-resistant. However, a high erosion potential may exist in the spring when the surface soils first thaw and the ground underneath remains frozen. A low-intensity rain at that time may cause serious erosion because the frozen subsoil prevents water infiltration. Erosion increases during the summer months because of more frequent, intense rains.

## **Types of Erosion**

To deal with water erosion problems effectively, five major types of erosion and their characteristics must be understood so that appropriate control measures can be selected.

### **Raindrop (Splash) Erosion**

When the vegetative cover is destroyed, the soil becomes directly exposed to the impact of raindrops. The soil particles are separated as raindrops strike the bare soil.

The pounding action of the rain destroys the soil structure. As the soil dries, a hard crust often forms. This crust slows plant establishment and reduces water infiltration, thereby increasing future runoff and erosion. Raindrop erosion is related to rain intensity and raindrop size. Some splashed particles may rise as high as 30 inches and move as much as 60 inches horizontally. On a slope, the particles will move down the slope because of gravity.

### **Sheet Erosion**

Erosion caused by water flowing over the soil surface is referred to as sheet erosion. The shallow, moving sheets of water are not usually detaching agents, but the flow of water transports soil particles that have become detached by raindrop impact. The shallow water usually moves as a uniform sheet for only a few feet before concentrating in low spots and other uneven spaces.

## **Rill Erosion**

Rill erosion begins when the shallow sheet flow begins to concentrate in the low areas of the soil surface. When the flow begins to change from sheet flow to a deeper flow in the low areas, the turbulence and velocity of the water increases. This deeper flow now has the energy both to detach and transport soil particles. The small channels cut into the soil surface by this action are called rills. For the most part, rills are only a few inches deep, but are well-defined channels.

The Alutin Rill Erosion Method is a rapid method of measuring rill erosion that is fairly accurate for losses up to 100 tons per acre. The formula for this method is as follows:

The soil loss in tons per acre is equal to the sum in square inches of the cross-sections of rills along a measured lineal distance of 13.7 ft (14 ft) across the slope. For greater accuracy, a 42 ft or 84 ft measurement across the slope can be used, and the sum of the rill measurements can be divided by 3 for 42 ft and 6 for 84 ft.

## **Gully Erosion**

Gullies are formed when runoff cuts rills deeper than ordinary tillage can eliminate. Gullies can become enlarged both up and down the slope. In some soils, a heavy rain can change a rill into a major gully in a very short time. Gullies are difficult to stabilize and costly to control. Erosion loss can be measured by the cross-section method before and after a storm.

## **Channel Erosion**

Channel erosion occurs when the velocity of the flow in a stream is increased or when the bank vegetation is damaged or destroyed. This type of erosion is most common at bends in the stream or where the flow is restricted. Damage may also occur where storm drainage is discharged into the main stream. Eroding streambanks are difficult and expensive to repair. Erosion loss can be measured by the cross-section method before and after a storm.

## **Basic Soils Information—Important for Planning Erosion Control**

Knowing basic soils information is important for planning erosion control measures on any given site. Soil texture is based on the combination of individual particles. Particles are classified on the basis of size and fall into the three categories: sand, silt, or clay. The percent of sand, silt, or clay in a soil sample provides the basis for textural classification, such as silt loam or silty clay loam. Three standard soil textural classifications are used: United States Department of Agriculture (USDA), American Association of State Highway and Transportation Officials (AASHTO), and the Unified Soil Classification System (USCS) as described in ASTM D 2487. The limits of the different textural classes are defined within each of the classification systems. See Table 1.1.

A valuable tool in planning for construction activities is the County Soil Survey. This information is available through the Iowa Soil and Water Conservation District (SWCD) extension offices located in each county and is available on the web at <ftp://pub.gis.iastate.edu/nrcs/ssurgo/>. This survey contains useful information for consultants, planners, engineers, developers, builders, community decision makers, and nearly all other professionals dealing with land use activities.

**Table 1.1. Soil textural classes and general terminology used in soil descriptions (Source: US Environmental Protection Agency 1977).**

Name	Texture	Basic soil textural common class names
Sandy soils	Coarse	Sand Loamy sand
	Moderately coarse	Sandy loam Fine sandy loam
	Medium	Very fine sandy loam Loam Silt loam Silt
	Moderately fine	Clay loam Sandy clay loam Silty clay loam
Clay soils	Fine	Sandy clay Silty clay Clay

## 1.2 REGULATORY REQUIREMENTS

Erosion and sediment control requirements exist at the federal, state, and local levels of government. Some local governments (city and county) have adopted site development or sediment control ordinances or regulations, and it is recommended that contractors or developers check with local units of government to determine whether local ordinances may affect their proposed activities.

### Federal and State Erosion and Sediment Control Requirements

The U.S. Environmental Protection Agency (EPA) issued final regulations on December 8, 1999, identifying which activities or facilities are now required to have storm water permits. Authority to issue the federal NPDES permits within the state of Iowa has been granted to the Iowa Department of Natural Resources (DNR). Thus, compliance with the federal NPDES storm water permit requirements can be achieved by obtaining a permit from the Iowa DNR. The following three topics are discussed in this section:

1. Identify construction projects that need a permit for their storm water discharge
2. Obtaining a permit for storm water discharge for a construction project
3. Determining the erosion and sediment control requirements needed in the NPDES storm water discharge permit

### Construction Projects that Need a Permit for Storm Water Discharge

Effective March 10, 2003, any land-disturbing activity that will “disturb” an area of one or more acres is required to have an NPDES permit for its storm water discharge.

The one-acre limit is based on the “common plan of development.” This common plan of development means that multiple, separate, or distinct construction activities may be taking place