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ABSTRACT

One of two training program texts built around the Virginia Erosion and Sediment Control Law and Program, this guide presents a program designed to meet the needs of job superintendents and inspectors. (The other guide, containing a program for engineers, architects, and planners, was designed to train professional people who need engineering and technical information to plan and design control systems on land development projects.) In the program presented here the emphasis is changed from engineering and design to the fundamentals of good conservation practice application for persons who have responsibility on a construction project to see that erosion and sediment control measures are properly installed and functioning. The course is presented in four parts of two or three units each. Part I presents the Virginia program and defines erosion and its damages. Part II covers types of erosion and the characteristics of sedimentation processes. In part II the principles of erosion and sediment control, a control plan, and details of control practices are presented. Part IV describes the roles of the job superintendent and inspector. Each unit includes purpose and significance, content, questions, summary (including question answers), and references. The text is supplemented by figures and photographs. (MF)

# COMPREHENSIVE EROSION AND SEDIMENT CONTROL PROGRAM FOR JOB SUPERINTENDENTS AND INSPECTORS

Prepared by Harry L. Porter, Jr.





March 1976

SCAMP

Sediment Control Manpower Project – EPA Grant No. T-900556-01-0
National Association of Conservation Districts
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April 27, 1976

To the Users of this Training Program:

Ladies and Gentlemen:

On behalf of the Virginia Soil and Water Conservation Commission, I am pleased to present the "Comprehensive Erosion and Sediment Control Training Program For Job Superintendents and Inspectors". This is the second of two training program texts which have been developed for the Commission by Mr. Harry L. Porter, Jr. The first program, entitled "Comprehensive Erosion and Sediment Control Training Program for Engineers, Architects, and Planners", was designed to train professional people who need engineering and technical information to plan and design adequate erosion and sediment control systems on land development projects. This second program differs from the first in that the emphasis is shifted from engineering and design principles, to the fundamentals of good conservation practice application. This course is designed for those persons who have the responsibility on a construction project to see that erosion and sediment control measures are properly installed and that they are functioning as intended.

Mr. Porter has developed this program under the same general format as the first. The idea is to give the user a basic knowledge of the erosion and sedimentation process so that he will be able to understand the principles behind the use of various conservation practices. Once again, this training program is built around the Virginia Erosion and Sediment Control Law and Program, however, the concepts and principles are universal and the program should be easily adaptable to other states.

The Commission expresses its sincere appreciation to the National Association of Conservation Districts for printing both of these training program texts as part of the National Sediment Control and Manpower Program which is funded through a grant from the U. S. Environmental Protection Agency. Further appreciation is extended to Mr. Harry L. Porter, Jr. for the fine job he has done in preparing these texts, and to all other individuals and agencies that have contributed in any way.

Sincerely,

Joseph B. Willson, Jr.
Director

Acknowledgments

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Figures

Note: All photographs courtesy of U.S.D.A., Soil Conservation Service.

## Preface

This program is designed to meet the needs of job superintendents and inspectors who will be helping to carry out the Virginia Erosion and Sediment Control Program. It is intended to add new knowledge and skills to the trainees capabilities. It provides a way for him to actually demonstrate measurable performance of this knowledge and skill.

Behavioral objectives are basic to this training program. They are statements telling what the trainees should actually be able to do as a result of the training. A comprehensive list was prepared including all the things which a job superintendent or an inspector should be able to do to carry out his responsibilities under the Virginia Erosion and Sediment Control Program.

When the list of objectives was complete, the objectives were put into the proper sequence. The sequence is such that each ability mastered provides the building block for the next objective. These objectives then become the basis for the sequence, design, and content of the entire training program.

The behaviorial objectives are spelled out in the program. When possible, the objectives indicate the acceptable level of performance. The trainee will not only know what he is to learn, but also what is considered acceptable. This provides both the trainee and the instructor a means of measuring how well they are doing.

The program is divided into four parts. The parts are divided into units. Each unit begins with a statement of the purpose and significance of the unit. Next, the behavioral objectives for the unit are stated. Objectives are followed by subject matter content. Criterion questions are included following the content. Of necessity, these are very similar to the objectives. The questions are included so that the trainee can test himself on his ability to perform the objectives. A summary follows the questi[illegible] It answers the questions and briefly lists other pertinent points, with very little discussion.

The "content" section of some units will refer to and assign pages in the Appendix. It is essential that these pages be read as part of the content for that unit. Some of the criterion questions will be drawn from the Appendix assignments and the summary will cover both the material in the body of the unit under "content" and the assigned Appendix material.

## How To Use This Program

First, read the program preface to get an understanding of the purpose and organization of the whole program.

The program is designed to be used in sequence from beginning to end.

Each subject matter unit will have a short statement on the purpose and significance of that unit. This will prepare you for the subject and help you to know the applications to be made of it. The next section gives the specific objectives. Read these carefully, they will tell you not only what you should be able to do upon completion of the unit, but also what is considered an acceptable level of performance.

Read the "content" section including the assigned pages in the Appendix. When you feel that you have mastered the subject and can perform as stated in the objectives, move on to the questions and check yourself. Read the summary to see how well you did. If performance was satisfactory, move on to the next unit; if not, check the content including any assigned Appendix material until you feel sure you have mastered the unit.

PART I INTRODUCTION

Unit 1. The Virginia Erosion and Sediment Control Program

Purpose and Significance:

This unit introduces the Virginia Erosion and Sediment Control Law and the Virginia Erosion and Sediment Control Handbook. It discusses the relationship of these two items to the local erosion and sediment control ordinance and the local erosion and sediment control handbook. The purpose of the Virginia Erosion and Sediment Control Program is presented and discussed. Basic responsibilities for various aspects of the program are indicated. Reading in the local handbook will supplement the discussion in this training program.

A knowledge of the items discussed in this unit is basic to understanding the total erosion and sediment control program and your own responsibilities and working relationships. The information will provide a basis for understanding the more specific parts of the training program which are to follow.

Objectives:

When you have completed this unit you will be able to:

1. Name the two State of Virginia items which provide the legal basis for the Virginia Erosion and Sediment Control Program and name the corresponding items at the county, city, district, or town level.

2. State the purpose of the program.

3. Discuss the responsibilities for:

(a) Developing and submitting an erosion and sediment control plan.

(b) Installing the approved plan.

(c) Checking on the installation and functioning of elements of the plan.

(d) Enforcement.

4. Discuss what the job superintendent and inspector need to know to implement the program.

Content:

The Virginia Erosion and Sediment Control Law is in Appendix A, on pages V-35 to 42. (Appendix A is the Virginia Handbook.) You should read these pages. Learn the purpose as stated. The law also indicates the broad responsibilities for implementing the program. The Virginia Soil and Water Conservation Commission has the overall responsibility for state program development. Soil and water conservation districts have responsibilities to assist with local programs as determined by local jurisdiction, or a district may adopt a program in localities which failed to adopt their own program by July 1, 1975. (The Virginia Soil and Water Conservation Commission is an agency of the state. In addition to the powers granted under the Erosion and Sediment Control Law, the Commission has responsibility for the Small Watershed Program (PL-566), coordination of shore erosion programs of state agencies, administrative leadership in the program for accelerating the Virginia portion of the National Cooperative Soil Survey, coordination and assistance with the programs of Soil and Water Conservation Districts, and administration of the Conservation, Small Watershed Flood Control and Area Development Fund. Soil and Water Conservation Districts are subdivisions of state government responsible under state law for conservation work within their boundaries. Districts are responsible for dveloping programs to deal with land and water resource problems, and to coordinate help from public and private sources to accomplish their soil and water conservation goals.)

The program is implemented by the Commission and districts in cooperation with counties, cities, towns, and other subdivisions of the state. These local jurisdictions have passed ordinances, usually patterned after the model ordinance, Appendix A, on pages V-23 to 33, and have developed and adopted an erosion and sediment control handbook. These local handbooks contain: (1) the local ordinance; (2) guidelines for erosion and sediment control planning and guidelines for erosion and sediment control plans (from the state handbook): (3) procedures for plan submission and review; and (4) standards and specifications for mechanical and vegetative practices. The local handbook requirements may be more stringent than those of the state, but they cannot be less stringent. The law applies to land disturbing activities involving, but not limited to, clearing, grading, excavating, transporting and filling land. See pages II-15 and 16 of Appendix A. At the local level, this boils down to include construction activities such as residential, industrial, and commercial developments and certain utility installations. An exception may be made if the site is less than 10,000 square feet in size.

In all programs, the owner, lessee, or the duly authorized agent of the owner or lessee is responsible for developing an erosion and sediment control plan and submitting it to the plan approving authority designated by the local program. See Appendix A, page V-15. The application or letter of submission which accompanies the plan must name the person who is responsible for carrying out the plan. The plan approving authority will base approval on the requirements of the local handbook. Approval will be granted within 45 days if the plan meets these requirements and if the person responsible for carrying out the plan has certified that he will properly perform the measures in the plan. The local program will name the department and/or person responsible for plan approval, inspection, and enforcement. Read Appendix A, pages V-13 to 20, or the section in your local handbook covering plan submission, review, on-site inspection, and ordinance enforcement.

The job superintendent * will ordinarily be responsible for carrying out the scheduling, procedures, and practice installation detailed in the erosion and sediment control plan. The person designated to inspect must determine whether all elements of the plan are installed as called for and must judge the effectiveness of measures. He should assist the job superintendent to make minor adjustments as needed.

Both the job superintendent and the inspector must be familiar with the ordinances and responsibilities under the local program. They must be knowledgeable about the erosion and sediment control plan and must know all of the practices which are included in the program. They cannot carry out their responsibilities without a knowledge of the erosion and sedimentation process and an understanding of the principles of erosion and sediment control.

When you have read the above material including the pages referred to in Appendix A, test yourself by answering the following questions.

Questions:

1. Name the two Virginia documents which provide the legal basis for the Virginia Erosion and Sediment Control Program and their counterparts at the county, city, or town level?

2. State the purpose of the Virginia Erosion and Sediment Control Program?

3. Who is responsible for developing and submitting an erosion and sediment control plan? Installing the plan? Inspection of the installation and evaluation of the effectiveness of the plan? Enforcement of the plan?

4. What subject areas must the job superintendent and inspector be familiar with in order to effectively carry out their responsibilities.

Summary:

The two documents which provide the legal basis for the state program

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* This title is used throughout the program to designate the person responsible for construction activities on-site. The position may be variously titled as job foreman, construction engineer, construction foreman, or other similar titles.

are the Virginia Erosion and Sediment Control Law and the Virginia Erosion and Sediment Control Handbook.

The counterpart of the state law is the county, city, or town ordinance. The counterpart of the state handbook is the county, city, or town handbook.

The basic purpose of the state law and program is "... to protect the land, water, air, and other natural resources of the commonwealth."

The landowner, lessee, or duly authorized agent of the owner or lessee must develop an erosion and sediment control plan. The application or letter of submission must name the person responsible for installing the features of the plan on the land. This would normally be the developer or his job superintendent.

At some point in the plan approval or permit issuing process, the person responsible for carrying out the approved plan must certify that he will do so.

The local program names the department and/or person responsible for administration of the program, including inspection. This may be the building inspector, county engineer, zoning administrator, or other position or department.

The department or person charged with inspection is also charged with enforcement. In cases where legal action is required, the appropriate county, city, or town authority may take such action.

Both the job superintendent and the inspector must be knowledgeable about the program procedures and responsibilities. They should understand the erosion and sedimentation processes and the principles of control. They should be thoroughly familiar with the erosion and sediment control elements and practices in the plan.

Unit 2. Definitions and Damages

Purpose and Significance:

This unit defines erosion and distinguishes between natural and man-made erosion. It discusses major activities of man which accelerate erosion and names and describes some specific damages which result from erosion and sedimentation. The extent of the problem is indicated and briefly discussed.

An understanding of the nature and extent of the problem and of the specific damages which result from it should strengthen the resolve to help solve it.

Objectives:

1. Define erosion and distinguish between geologic and accelerated erosion.

2. Name three major activities of man which cause accelerated erosion.

3. List at least six kinds of damage caused by erosion and sediment.

Content:

In the previous unit you learned the purpose of the Virginia Erosion and Sediment Control Program. The problem which it seeks to correct is extensive. Sediment is by far the greatest single pollutant, by volume, of our lakes, rivers, and streams. Sediment is the end result of the equally destructive process of erosion.

Soil erosion is the process by which soil materials are torn loose and transported by erosive agents. Here in Virginia, the primary concern is with water as the erosive agent. Ice, wind, and gravity are the erosive agents in some cases in the state.

Erosion is not a recent phenomenon. It has been going on since the beginning of time. By this process, whole mountains have eroded away, and sediment deposits several miles thick have been formed. Features as spectacular as the Grand Canyon have resulted from erosion. These types of erosion have taken place over millions of years. This slow natural process is called geologic erosion. In the well vegetated forests, pastures, and meadows of Virginia, the process continues at a slow rate. It seldom is discernable to us in these areas. Geologic erosion produces about thirty percent of the total annual sediment production in the United States. It usually continues as a slow natural process unless it is interfered with by the activities of man.

The erosion with which we are concerned results from man's use of the land. This type is called accelerated erosion since the geologic rate has been speeded up by the intervention of man. In this country, accelerated erosion began when the first settlers from Europe cleared the protective cover from sloping land and planted soil exposing crops. Today, in addition to agriculture, surface mining, and construction activities are the major causes of accelerated erosion. Accelerated erosion produces about seventy percent of all of the sediment produced in the United States.

It has been estimated that four billion tons of sediment is produced in this country each year. (Ref. 1)

Figure 1. A Recreation Lake Severely Damaged By Sediment

One of the most frequently mentioned damages due to sediment is the reduction of reservoir capacity. It is estimated that one and one-third billion cubic yards of sediment is deposited in reservoirs each year. (Ref. 2) This represents a loss in water storage capacity of 270 billion gallons or an amount sufficient for a city of 5-1/2 million people. One source reports costs ranging from $.90 to $2.40 per cubic yard for removal of sediment. (Ref. 3) At the conservative estimate of $1.00 per cubic yard the annual removal cost, if it were possible to remove it, would be 1-1/3 billion dollars. Since reservoir sites are a scarce resource, sediment must be controlled to preserve existing storage capacity.

Sediment clogs stream channels. Reduction in channel capacity contributes to flooding, interfers with navigation, and may cause excessive channel erosion. It is estimated that the volume of material excavated annually from streams, estuaries, and harbors exceeds one-half billion cubic yards. (Ref. 4) The Rappahannock River, which drains 616 square miles, averages 142 tons of sediment per square mile or 87,472 tons per year.

A third major damage caused by sediment is the reduction in water quality. Most industrial water supplies and all domestic water supplies must be silt free. Removing sediment is one of the major purposes of water treatment. In 1960, sediment removal from their water supply cost Washington, D.C., $0.34 per million gallons, or $20,100 per year. (Ref. 5)

Deposits of sediment in streets, culverts, storm drains, and waterways represent another substantial damage.

Figure 2. Sediment From A Shopping Center Development

Figure 3. Single Storm Damage From An Industrial Site Development

The Environmental Protection Agency reports street removal costs of \$8.00 per cubic yard in California and \$6.60 per cubic yard in Virginia. (Ref. 5). Basement removal costs were \$77.00 per cubic yard in California and \$65.00 per cubic yard in Virginia. Storm sewer cleanout by hydro-flush method was \$68.00 per cubic yard in California and \$62.00 per cubic yard in Virginia.

Sediment causes both direct and indirect damages to aquatic life. It may physicall[illegible]e or kill the organism or indirectly damage it by affecting the [illegible]upply and spawning areas. Fish can tolerate fairly high turbidi[illegible] though physiological stress may make them more susceptible to disease. Damage to their habitat may be more severe. Ritchie reports several types of damages. (Ref. 6) Reduction of light limits photosynthesis and hence food supply. Organic matter, frequently deposited with sediment, uses oxygen in decomposing and thus reduces the oxygen supply. Sediment reduces survival rate of eggs. It has destroyed fish and oyster spawning areas in the Upper Chesapeake.

Damages to the soil resource from erosion has received considerable attention in agricultural areas. It is also a significant damage in urbanizing areas. These damages result in much higher landscaping costs and maintenance costs or in dissatisfaction with landscaping results on badly damaged soil. Some damages result in much higher construction costs because of regrading, mud removal, and high initial landscaping costs. Other damages include soil deposits on land; reduced esthetic values of land and water; lost or reduced recreational values of ponds, lakes, and streams; and the sealing of soil surfaces, which results in increased runoff.

Even the brief review of damages indicates that erosion and sediment represent a very visible problem that affects many people. There is a realization among the public that technical solutions to the problem are available. People simply are annoyed by the loss of streams, lakes, and the beauty of the natural areas that attracted them to the suburbs in the first place.

Test your knowledge of erosion, the activties of man that cause much of it, and the damages that result from it by answering the following questions.

Questions:

1. Define erosion and describe the difference between geologic and accelerated erosion.

2. Name three activities of man which cause accelerated erosion.

3. List at least six kinds of damage caused by erosion and sediment.

Summary:

Erosion is the process by which soil materials are torn loose and transported by water, wind, ice, or gravity. Its rate under natural conditions is usually very low. This erosion is called geologic erosion. When man removes the protective vegetation through farming, mining, construction, or other activities, the process is greatly accelerated. For this reason, it is called accelerated erosion.

The three major causes of accelerated erosion are agriculture, surface mining, and construction activities.

Sediment damages include filling of ponds, lakes, and reservoirs; clogging of stream channels and harbors; reduced quality of water supplies; reduced quality for recreation; deposits in streets, basements, storm sewers, and waterways; damages to aquatic life; and reduced esthetic values.

Erosion seriously damages the land resources, causes higher construction costs, and reduces esthetic values of the land.

PART I References

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3. Comparative Costs of Sediment and Erosion Control, Construction Activities, EPA 430/9-73-016, July, 1973.

4. Roehl, John W., "Cost of Dredging and Maintaining Channels," Journal of Soil and Water Conservation, v. 20, No. 4, 1965.

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PART II THE EROSION AND SEDIMENTATION PROCESSES

Unit 1. The Erosion Process

Purpose and Significance:

This unit describes the five types of erosion and names the erosive force or forces which cause each type. The factors which influence the amount of erosion are described. The unit also tells how to recognize that erosion is taking place.

An understanding of the types of erosion and of the forces causing it is basic to evaluating the effectiveness of the control program. In order to recognize hazardous conditions in time to deal with them, it is essential to understand the factors which influence erosion. It is important for both the job superintendent and the inspector to be able to identify hazardous areas and to recognize signs of erosion so that remedial adjustments can be made.

Objectives:

1. Define the five types of erosion and indicate the erosive agents responsible for each.

2. Name the four factors which influence the amount of erosion and discuss the characteristics of each that determine their influence.

3. Describe conditions which indicate that erosion is taking place.

4. Name some conditions that may subject an area to erosion damage.

Content:

The definition of erosion which was used in Part I emphasizes that erosion is a process. First, soil particles are torn loose from the soil mass by an erosive agent. This makes the detached particles readily available for transport. In the second part of the process, the particles are transported. In Virginia, the primary concern is with erosion caused by water.

It will help in understanding the erosion process by water if the detaching capacity of the erosive agent and the transporting capacity are thought of as separate variables. It should be noted also that soil materials vary in their detachability and transportability.

The erosive effects of water are of two sorts, both of which depend on the kinetic energy or the energy of motion. The first is the energy developed by raindrops as they fall, and the second is the energy derived from its motion as it runs off of the land. The force of falling rain is applied vertically, while that of runoff is applied horizontally. They both perform work in detaching and transporting soil particles, but their actions are different.

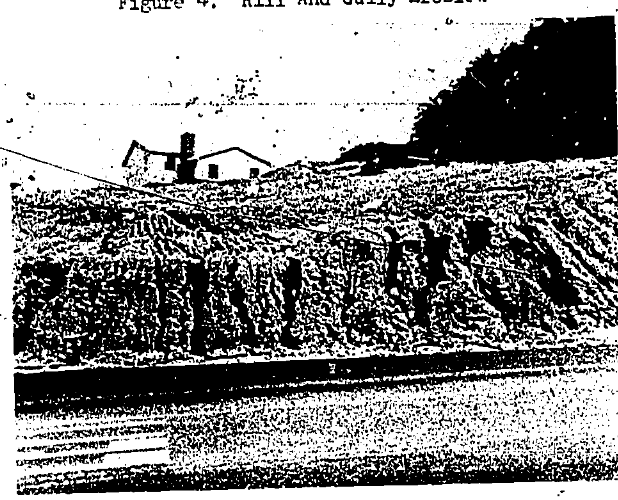
The five types of erosion and their definitions are as follows:

Raindrop erosion is the first effect of a rainstorm on the soil. Raindrop impact dislodges soil particles and splashes them into the air. These detached particles are then vulnerable to the next type of erosion. See high speed photos of falling raindop, Figure 5, page 14.

Sheet erosion is the erosion caused by shallow sheets of water as it runs off the land. This type of erosion is very much dependent on raindrop splash to detach soil particles and to keep the particles in suspension as the shallow, slow-moving flow moves downslope. The shallow surface flow rarely moves as a uniform sheet for more than a few feet before concentrating in the surface irregularities.

Rill erosion is that which develops as the shallow surface flow begins to concentrate in the low spots of the irregular conformation of the surface. As the flow changes from shallow sheet flow to deeper flow in these low areas, the velocity and turbulence of the flow increase. The energy of this concentrated flow is able to both detach and transport soil materials. This action begins to cut tiny channels, which may reach a depth of several inches. These rills are easily obliterated by harrowing or other conventional surface treatments.

Figure 4. Rill And Gully Erosion



Gully erosion occurs as the flow in rills comes together and enlarges the channel. The major difference between rill and gully erosion is the size of the channels. Gullies are too large to be repaired with conventional tillage equipment and usually require heavy equipment and special techniques to stabilize them.

Channel erosion is the cutting of channel banks and beds in either permanent streams or intermittent streams and waterways. It occurs as the velocity and turbuluence of flow becomes strong enough to dislodge and transport bank and bed materials.

There are four major factors which have a direct influence on the process of erosion. These are climate, soils, topography, and vegetation.

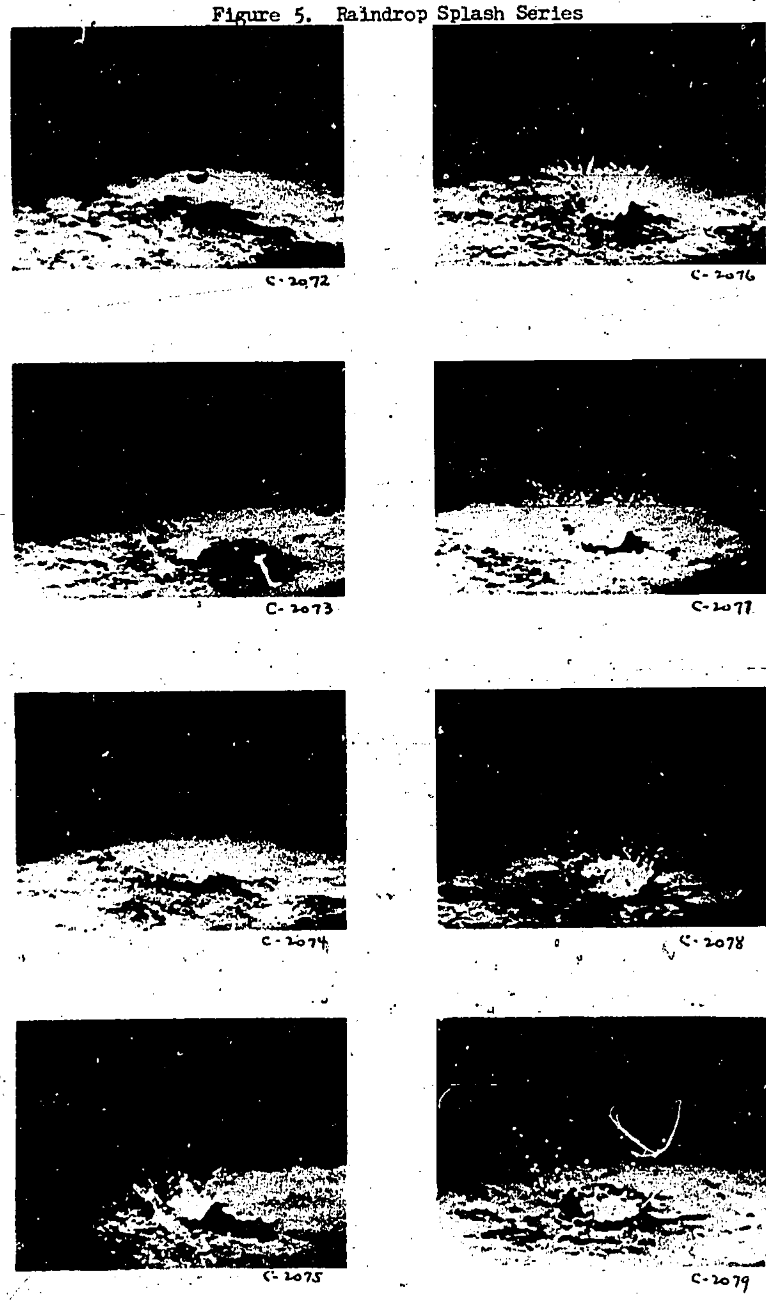
We will first discuss climate since it is the source of the major erosive agent in the erosion process. When we talk about climate, we are primarily concerned with rainfall, although temperature and snow cover are sometimes very important. The effects of rainfall are of two distinct sorts.

The action of raindrops striking bare soil is the first step in the erosion process. The erosive capacity of the rainfall comes from the energy of its motion as it falls. Erosion is a work process in the true mechanical sense in which energy is expended to overcome resistance. This fact gives the key to control of raindrop erosion. An intervening cover of mulch or vegetation can absorb the force of rain. The energy of falling rain depends on the amount of rainfall and the velocity of the drops. Drop velocity varies with drop size. Fine mist, with droplets about 0.25 m.m. in size, falls at about one inch per second. The largest drops, 6 to 8 m.m. fall at about thirty feet per second. The most erosive rains are those of moderate to high intensity. These rains are not scattered uniformly throughout the year. In Virginia, they are concentrated in the months of May through August.

So far we have concentrated on the force of falling rain and its capacity to detach and move soil material. The second damaging effect is the compacting, puddling, and sealing of the soil surface. As indicated above, large drops strike with tremendous impact, compacting the soil under the point of impact. Repeated strikes churn the surface into a slurry. As this semi-fluid mass attempts to infiltrate into the soil, it does a very effective job of sealing the pore space against further entry of water. As drops continue to beat against the surface, they sort and compact the material until an almost complete seal is formed. Even on sands this action reduces water intake and increases runoff.

Runoff is the second damaging aspect of rainfall. It begins when the rate of rainfall exceeds the intake capacity of the soil.

Figure 5. Raindrop Splash Series



When a hard rain is unimpeded as it strikes the soil, runoff begins a few minutes after the start of the rain. In the early stages, damage may result from runoff acting as a transporting agent for the soil particles dislodged by raindrop splash. Runoff at first is in a layer of water flowing more or less uniformly over the ground. Depth of this flow is usually very shallow. For instance, runoff from bare ground on 20% slope at rates ranging from 1.25 to 3.68 inches per hour produced depths of flow ranging from 0.06 to 0.15 inches. Flows of this sort have practically no capacity to detach soil, but they do have capacity to transport particles dislodged and kept in suspension by raindrop impact. Sheet erosion is the result of the combination of these two erosive agents. The effects of this type of erosion occur on all exposed land surfaces except in rills and gullies. Because it removes soil in thin layers from 95 percent of the soil surface, it is difficult to observe, even though the total soil loss may be tremendous.

Under normal field conditions, runoff occurs both as sheet flow and as channelized flow. As water moves downslope, it tends to follow the path of least resistance. It tends to concentrate in the depressions and irregularities of the surface. This is the beginning of channelized flow. It often begins only a few feet below the top of a slope. As the amount of water in these early channels increases, the velocity and turbulence also increase. The erosive capacity of the flowing water is derived from its velocity, turbulence, and the amount and type of abrasive material that it carries. The velocity increases with the depth of flow and the slope gradient. Roughness of the channel will reduce velocity but increases turbulence. As slope length increases, water accumulates to greater depths, hence developing higher velocities.

Detachment of soil by flowing water is confined primarily to areas of concentrated flow (rills, gullies, and other channels). The detachment of soil is by rolling, lifting, and abrading. The force is exerted in the direction of flow and it detaches some particles by simply rolling them out of place. As velocity and turbulence increase, the currents and eddies actually lift some particles from their place and set them in motion. As particles of soil already being carried by the flow strike or drag against the sides or bottom of the channel, they knock particles loose and set them in motion (abrading).

The second factor influencing erosion is the soil. When all other factors are held constant, different kinds of soil erode at different rates. Differences in soil erodibility may cause more than a tenfold difference in sediment yield. The relative soil erodibility has been determined for all Virginia soils, and areas of particularly erodible soils should be identified in the erosion and sediment control plan.

The soil properties which influence erodibility are particle size and gradation, percent of organic matter, soil structure, and soil permeability. Erodibility tends to increase with greater silt (.002 to 0.05 m.m.) and very fine sand (0.05 to 0.1 m.m.) content and to decrease with greater sand (0.1 to 2.0 m.m.), clay (less than .002 m.m.) and organic matter content. Soils with high clay content are generally more resistent to detachment but once detached, the clay particles are easily transported. Deep permeable soils are less erodible simply because more of the rainfall soaks in.

The third factor influencing erosion is topography. The most important effects of topography are the result of slope length and slope steepness. The longer the slope, the greater the depth of runoff. The build-up in depth of flow with added length causes an increase in velocity.

Steepness of slope influences erosion in more than one way. There is more raindrop splash downhill than uphill on sloping land, so that the net movement of soil in the splash is downslope. The velocity of flow increases with slope steepness.

The direction of slope has an indirect effect in that vegetation is harder to establish and maintain on the hot south and southwest facing slopes.

The fourth factor influencing erosion is vegetation or surface cover. It is the most important from the standpoint of control. Research has shown that the amount of erosion is proportional to the amount of bare soil that is exposed to raindrop impact. (Ref. 1) Osborn reported that the amount of cover far outweighed factors such as type or species of vegetation in preventing splash erosion. (Ref. 2) However, the short sod grasses were somewhat more effective in preventing soil splash.

The most important function of vegetative cover and mulch is to shield the soil from the impact of falling rain. This prevents splash erosion and also prevents sealing of the soil surface. Another important function of vegetation is the slowing of runoff velocity. Vegetation is frequently used to provide a protective lining in shallow waterways. In these channels, vegetation provides protection by reducing the velocity near the bed of the channel. Vegetation with a dense uniform growth near the soil surface and with a strong fibrous root system is most effective in reducing erosion. Good uniform stands of Bermuda grass, Kentucky bluegrass, or tall fescue meet these requirements. All three have a high percentage of basal leaves (leaves originating near the soil surface). They provide good surface cover even after mowing and with good management will retain their density indefinitely.

The effects of splash erosion are easy to see in nature. Splashed soil particles can be seen clinging to the foundations of buildings that are adjacent to bare soil. Particles can be seen on stems of weeds which are growing in a sparsely vegetated field. Pedestals of soil capped with protective stones can be seen where raindrop splash carried away unprotected material. Figure 6 shows an extreme case of pedestal formation.

Figure 6. Pedestals Capped By Protecting Stones

The erosion caused by the combined forces of raindrop splash and sheet runoff may be hard to see in completely bare stone free areas. A smooth puddled appearance after rains is some indication of the compacting and sealing effect. Mud deposits at the base of slopes or where runoff from bare gound flows onto vegetated areas is a good indicator. If stones are present, the pedestals may be slightly undercut by the flowing water.

When the process gets to the rill and gully stage, it is easy to detect. Even tiny rills indicate that corrective measures are needed.

Eroding channels show excessive areas of bare undercut or freshly disturbed straight sided banks.

In addition to being able to recognize that erosion has taken place, it is important to recognize erosion prone areas in time to take corrective measures.

Almost any bare sloping area with slopes more than a few feet long is a potential erosion hazard. Long reaches of ditches, trenches, or other channels are potential hazards. Equipment work along drainage-ways and streams can cause damage to stable channels. Storm drain systems should be properly protected. Note the areas on the plan which are marked as high erosion hazard areas. Continually check all areas and be ready for rain.

Questions:

1. Define the five types of erosion, and name the erosive agent or agents for each type.

2. Name the four factors which influence erosion, and for each factor describe the characteristics which determine the influence on erosion.

3. Describe some field conditions that indicate that splash erosion and sheet erosion has taken place. Describe conditions that indicate an eroding stream channel.

4. Describe some field conditions that indicate erosion prone areas.

Summary:

Raindrop erosion is the erosion resulting from raindrop impact and the splash of soil materials which it knocks loose. It is the first effect of rain on the soil.

Sheet erosion is the loss of a shallow layer of soil as the soil particles dislodged by raindrop impact are carried off by surface runoff. The primary erosive agent is raindrop splash which dislodges and keeps the particles in suspension. Runoff is the secondary erosive agent.

Rill and gully erosion is the erosion which develops as the shallow surface flow gathers in surface irregularities. Tiny channels form as the flowing water gains enough velocity and turbulence to dislodge and transport soil material. The difference between rills and gullies is a matter of size. Rills can be obliterated with ordinary tillage equipment while gullies require heavy equipment and special techniques for stabilization.

Channel erosion is the cutting of banks or beds of ditches and streams.

The four major factors influencing erosion by water are climate, soils, topography, and vegetation.

Rainfall is the most important aspect of climate. The total kinetic energy of a storm and its intensity determines the erosive

effect. The kinetic energy is largely determined by the amount of rain, the drop size, and the resultant velocity of the drops.

Soils differ greatly in erodibility, other factors being equal. Erodibility may be ten times as great on some Virginia soils as on others. In general, silts and very fine sands are most erodible, and erodibility decreases as sand content, clay content, and organic matter increase. Thus the characteristics which are important are particle size and gradation, organic matter content, permeability, and type of soil structure. These characteristics determine the detachability of soil particles, the rate at which water moves into and through the soil, and the transportability of the particles.

Topography is the third influencing factor. Velocity of runoff increases with slope gradient and with depth of flow. Since slope length adds to the amount of contributing watershed, it results in deeper and higher velocity flows with each increase in length.

Vegetation, the fourth influencing factor, acts as an energy absorbing layer between the soil and the falling rain. This effect is roughly proportional to the percentage of the soil surface covered. A second effect is the slowing of runoff velocity, and a third is the maintenance of infiltration capacity.

The presence of soil particles clinging on the sides of stakes, posts, foundation walls, stems of weeds, and other objects on bare soil areas is evidence that splash erosion has taken place. Pedestals, formed when small stones protected the soil under them and allowed the adjacent soil to splash away, are further evidence of splash erosion.

A puddled or crusted soil surface indicates probable sheet erosion. Deposits of mud at the toe of slopes or where runoff goes from bare soil into vegetation are further evidence.

The occurrence of rills and gullies indicate very high rates of loss. Stream channels with more than occasional bare straight-sided or undercut banks are probably eroding excessively.

Bare sloping areas which exhibit none of these signs have probably not received any rain or at least no erosive rain. Unprotected drainageways and channels with no evidence of cutting have probably not received high velocity flows as yet.

Unit 2. The Sedimentation Process

Purpose and Significance:

This unit discusses sources of sediment, sediment transport, sediment yield, and deposition of sediment. The characteristics of transported material are discussed and related to source. Transporting capacity is related to the characteristics of the material transported and characteristics of the transporting flow. The factors governing deposition are discussed and related to types of sediment materials.

A knowledge of all of these items is essential to understanding the function of the various elements of the erosion and sediment control plan. It is particularly important in checking the effectiveness of all sediment trapping practices.

Objectives:

1. Indicate the sources of sediment and discuss the relationships between source and size of the material.

2. Describe the behavior of the various sizes of soil material in a flow.

3. Explain how, why, and where sediment is deposited.

Content:

Sedimentation includes erosion, transportation, and deposition of sediment. Erosion has been discussed as a separate item in the preceding unit. In this unit, our main concern with erosion is as the source of sediment.

Sediment is transported as suspended material in the flow, as material bounced along the surface or bed, and as material which slides and rolls along the bed. As you would suspect, the suspended load is made up of very fine materials. Clays and colloids are generally evenly distributed throughout the flow. They move along with the flow and behave as if they were a part of the fluid material of the flow. Silts are more or less evenly distributed in turbulent flow, but have a tendency to be more concentrated near the bottom. Sands and larger material bounce, roll, and slide along the bed. These are referred to as bed load.

The nature of the sediment is primarily determined by the source. The splash erosion process with the associated sheet flow is incapable of moving sands and coarser material very far. Splash erosion and associated sheet erosion remove the very fine material. These materials are carried as suspended load. This type of material, particularly the clay, stays in suspension for long periods of time. The amount of very fine material moving in a flow is related to the rate of supply of the material. It is seldom present in amounts equal to the carrying capacity of the flow. The amount of these materials supplied depends on the soil material make-up, the resistance to detachment, and the detaching capacity of the erosive agent.

The amount and type of bed load are related directly to the flow. The movement of bed load tends to be in balance with flow conditions. This has an important bearing on channel stability. If the flow becomes loaded beyond its transporting capacity, deposition will occur. However, if the load is less than the transporting capacity, the flowing water attacks the channel in an effort to achieve a balance between load and capacity. Any change in sediment load or in flow characteristics will have an effect on channel stability. Velocity, turbulence, and the size and type of materials available are the primary factors determining the sediment load.

Deposition of sediment is the inverse of erosion. It occurs when the carrying capacity of the flow is reduced to a point below that needed to carry the sediment load. Deposition, like erosion, is a selective process which results in a gradation in the size of material in the deposits. When flow is diminished the coarser fragments are deposited first.

Sediment deposits may occur on land or in various forms in bodies of water. Deposits can occur on land when the runoff from slopes reaches more gently sloping land or is slowed by vegetation. The runoff loses velocity and hence the capacity to carry the same sediment load. Deposits occur in water as a faster flowing stream flows into a slower one or into a lake, reservoir, pond, or ocean. A stream flowing from a steeper gradient to a lesser one will also lose velocity and carrying capacity and will form deposits.

To develop adequate sediment control it is necessary to know the source, amount, and nature of the sediment. If the sediment is mainly from splash and associated sheet erosion, land treatment is the most appropriate control. Sediment traps and basins are much less efficient than land treatment in trapping the very fine material from this type of erosion. If the sediment is mainly coarse material from gullies and channels, there are two ways to control the erosion, thus reducing sediment at its source. One is to alter the flow characteristics by reducing grades, widening cross sections, reducing obstructions and roughness which could cause turbulence, and reducing the flow by storage and controlled release structures. The other is to provide some protective cover to the channel banks and perhaps to the bed.

When sediment cannot be controlled at its source, it must be removed from the flow before going off site by the use of sediment traps or sediment basins.

This completes a rather brief discussion of a very complex process. The discussion did cover the most important general concepts in the area of concern. Test your understanding of this unit by answering the following questions.

Questions:

1. What is the usual source of the clay and silt materials in the sediment load? What is the source of the sands and coarser materials? Explain why for both cases.

2. How does clay and other very fine material behave in a flow? How does silt behave? How does sand and gravel behave?

3. Explain why, how, and where sediment is deposited?

Summary:

The usual source of clays and silts is from splash erosion. Coarser materials such as sands and gravel usually come from gullies and channel banks and beds. The splash erosion process with the associated sheet flow is incapable of moving sands and coarser materials very far. It can move great quantities of the very fine materials. On the other hand, sands or gravel can be detached and bounced, slid, or rolled along the bed by the rapid and turbulent flow in the gullies and channels. These flows will continue to carry clays but will have a much higher proportion of coarser material.

Clay and other very fine material move along suspended in the flowing water. They move with the flow and behave as a part of it. Silt is suspended in the flow but may be more concentrated near the bottom in the less turbulent situations. Gravel is usually bounced or rolled along the bed.

Sediment is deposited when the flow loses energy and can no longer carry the load. Since the energy or transporting capacity is derived from the velocity of flow, anything that reduces the velocity will reduce the carrying capacity. This happens as a stream grade is reduced, as the flow becomes wider and shallower, or as it is slowed by flowing into a still body of water. As runoff on land reaches a shallower grade or is slowed by vegetation, it will deposit sediment.

PART II References

1. Hudson, Norman, Soil Conservation, Ithaca, N.Y.: Cornell University Press, 1971.

2. Osborn, Ben, "Effectiveness of Cover in Reducing Soil Splash by Raindrop Impact," Journal of Soil and Water Conservation, v. 8, No. 6; v. 9, Nos. 1 and 2.

PART III CONTROL

## Unit 1. Principles of Erosion and Sediment Control

Purpose and Significance:

The principles for an effective erosion and sediment control program are presented and discussed. The principles relate directly to the things you have already learned concerning the nature of the erosion and sedimentation process. They are based on the need to buffer or neutralize the forces of the erosive agents and of the transporting agents.

No plan can foresee all the eventualities of the day-to-day construction job. A knowledge of control principles will enable you to recognize areas that need attention and to provide it before problems develop. If problems develop despite preventive efforts, this knowledge will help you to come up with the best solutions.

Objectives:

1. Describe eight principles of erosion and sediment control.

Content:

The preceding units discussed erosion and sedimentation caused by water. It was pointed out that the energy of raindrops is a potent agent for loosening soil particles in poorly protected areas. This same raindrop energy puddles and seals the soil surface so that instead of soaking in, water soon begins to run off. This runoff generally moves the loose soil particles in proportion to its volume and velocity. This flow may pick up more particles as velocity and turbulence increase and will continue to carry this load until the water is slowed down by spreading, by reduced gradient, or by flowing into areas of vegetation or still water. The principles which follow are based on interceding at some point in this process to absorb energy or to reduce the opportunities for the process to continue.

The first principle is to recognize and protect the very critical erosion areas on the development site. Although this is one of the basic considerations in developing the plan, it is necessary for job superintendents and inspectors to recognize the critical areas and understand the intent of the plan in leaving these areas undisturbed or providing special protection to them.

Susceptible areas include drainageways, stream channels and the area adjacent to them, areas of steep slopes, areas of highly erodible soils, long reaches of open ditches on slopes, stream crossings, and other potentially hazardous areas. These critical areas are to be identified in the plan. As job superintendents, you will need to caution and train your workers to respect the measures that are taken to protect the site. As an inspector you need to be alert to equipment use or other activities that may be increasing the risk in these areas.

The second principle is to protect the bare soil from raindrop impact. This means keeping the area of soil that is exposed and the length of time that it is exposed to an absolute minimum. Work should be organized so that mulches and temporary or permanent seeding can follow grading as soon as possible. This may call for limiting grading at any one time to areas that can be stabilized immediately. Jobs should be done in stages not only to reduce time of exposure but also to avoid the periods of most erosive rains, mid-May through August in most of Virginia.

The third principle is to maintain the infiltration function of the land to the maximum extent possible. This involves mulching and vegetating exposed areas immediately, as does the second principle. It also involves keeping unnecessary compaction by construction equipment and other traffic to a minimum. It means protecting areas of existing vegetation as well as the newly mulched and seeded areas. Street and parking areas can be graveled early to help reduce runoff while prepared drainageway vegetation is being established. Swales and wetlands serve this purpose and should be protected to preserve the capacity to store and allow water to soak in.

The fourth principle is to keep runoff velocities low. The destructive energy generated by runoff from steep or long slopes can be minimized by the use of interceptors or diversions to shorten slopes and carry the water off at a controlled grade and velocity. Intercepted runoff must be outletted on stable areas, or mechanical measures must be used to carry it to a safe outlet.

The fifth principle is to protect denuded areas from runoff generated above them. Again, diversions and interceptors are used to carry runoff to safe outlets.

The sixth principle is to prepare drainageways on the site to receive the concentrated and increased runoff which will be generated and to control the release of this runoff from the site to prevent channel erosion downstream.

The seventh principle is to trap sediment at the perimeter of the development site in temporary or permanent sediment basins. The sediment basin is the "last ditch" sort of control, but it should be there if all else fails. Sediment basins must be checked frequently, and periodic cleanouts should be scheduled. The plan will identify the level at which cleanout must be done.

The eighth principle is to maintain the installed erosion and sediment control practices. Practices must be diligently checked, especially if there is a threat of rain. A close-of-day check is strongly recommended, and a check for damages after each rain is equally important. Look for damaged diversion berms, damaged waterways, sediment traps, downdrains, and other critical runoff carrying practices. Be sure that outlet areas are properly protected. Check for rills and repair them before they become gullies.

Questions:

1. Briefly describe eight principles of erosion and sediment control.

Summary:

Briefly, the principles for erosion and sediment control are:

Protect critical erosion areas by giving them special attention and treatment if needed. These would include drainageways, stream channels, steep slopes, highly erodible soils, stream crossings, and other areas.

Protect bare soil from raindrop impact by keeping the size of the area denuded and the time of exposure to a minimum.

Maintain the infiltration capacity of the land to the extent possible. This involves mulching and vegetating areas promptly as well as avoiding unnecessary compaction. It also includes maintaining existing vegetated areas, swales, and wetlands which have water recharge capabilities.

Keep runoff velocities low by using diversions to artifically shorten the slopes. Outlet diversions onto protected areas or in special structures.

Protect denuded areas from runoff coming from the areas above them. Use interceptors or diversions to carry this runoff to safe outlets.

Prepare drainageways on the site to safely handle the concentrated and increased runoff which will be generated, and control the release of runoff from the site to prevent channel erosion downstream.

Trap sediment at the perimeter of the site.

Maintain the control measures by daily checks followed by repairs as needed.

Unit 2. The Erosion and Sediment Control Plan

Purpose and Significance:

This unit reviews the "Guidelines for Erosion and Sediment Control Planning" and the "Guidelines for Erosion and Sediment Control Plans" which are on pages II-3 to 12 of Appendix A. They are also included as required items in every local handbook.

The guidelines for plans indicate the items that are required in erosion and sediment control plans. The guidelines for planning indicate when various types of practices must be applied in relation to the scheduling of the development activities.

Both inspectors and job superintendents should be familiar with all elements of erosion and sediment control plans since both are concerned with the effectiveness with which the set of plans is applied to the actual conditions of the site. This includes being aware of the required sequence and timing for installation of erosion and sediment control practices.

Objectives:

1. Describe the two parts of an erosion and sediment control plan.

2. List six things which the plan must spell out.

3. Be able to explain what must be shown in the plan for each temporary practice. For each permanent practice.

4. Name the major features of a maintenance program for the erosion and sediment control facilities.

5. List what must be shown on the map concerning proposed alterations of the area.

6. List the elements on staging, or phasing, which must be described in the narrative.

Content:

Read the "Guidelines for Erosion and Sediment Control Planning" Appendix A, on pages II-3 to 5 and the "Guidelines for Erosion and Sediment Control Plans" on pages II-7 to 12. These two sections are required to be in each local handbook, so you may look up the appropriate pages in your local handbook.

It is important to note that the guidelines for planning, Appendix A, page II-5, indicate that the first construction activity shall be the installation of the needed erosion and sediment control structures "prior to or during the first phase of land grading." Also, note that these structures are to be seeded immediately after they are built. Storm water management facilities must also be among the first activities carried out.

Any graded areas (except streets and parking areas where underground utilities are planned) should be seeded and/or mulched as soon as rough grading is done unless it is to be permanently stabilized within thirty days of the initial removal of vegetation. In this regard there may be many instances where mulching would be desirable even though plans called for permanent stabilization in thirty days. For instance, if you are dealing with a particularly erosion prone area and the work is being done during the period of the most erosive rains, costly damages could occur during a very short period.

The guidelines for plans are quite specific as to content. Study page II-7 and the top half of II-8 of Appendix A carefully, then proceed to the numbered items on the middle of page II-8 through II-10. These numbered items elaborate on the required elements of the plan.

The following sample erosion and sediment control plan illustrates the required elements for a plan. Note that soils data for this site need not be on a map since the entire area is Cecil silt loam. An actual plan would include mulch type and rates for the structures, seed mixture and rates for the structures, and mulch and seed specifications for all other areas to be seeded.

EROSION-SEDIMENTATION CONTROL PLAN - SAMPLE NARRATIVE

ELEMENTARY SCHOOL

DESCRIPTION: The project is a 20,000 square-foot school building with exercise fields on a 6-acre site.

DATES OF CONSTRUCTION: Project is scheduled to start on May 1, 1975; to be completely stabilized by October 1, 1975.

SOIL DATA: The entire site is Cecil silt loam eroded rolling phase.

TREE PROTECTION: Trees along the perimeter will be protected from equipment damage by appropriate signs and barriers.

EROSION CONTROL PROGRAM: Not more than one-half the site is to be cleared at one time. Anchored mulch and temporary seeding will be done immediately after grading to all graded areas except building site and 30-foot border and parking area. Parking lot to be covered with gravel after grading.

SEDIMENT CONTROL PROGRAM: Control will be achieved through installation of one temporary sediment basin of 0.5 acre-foot capacity and one temporary sediment trap of 0.15 acre-foot capacity. Fifteen hundred feet of earth diversions to direct storm runoff to the basins.

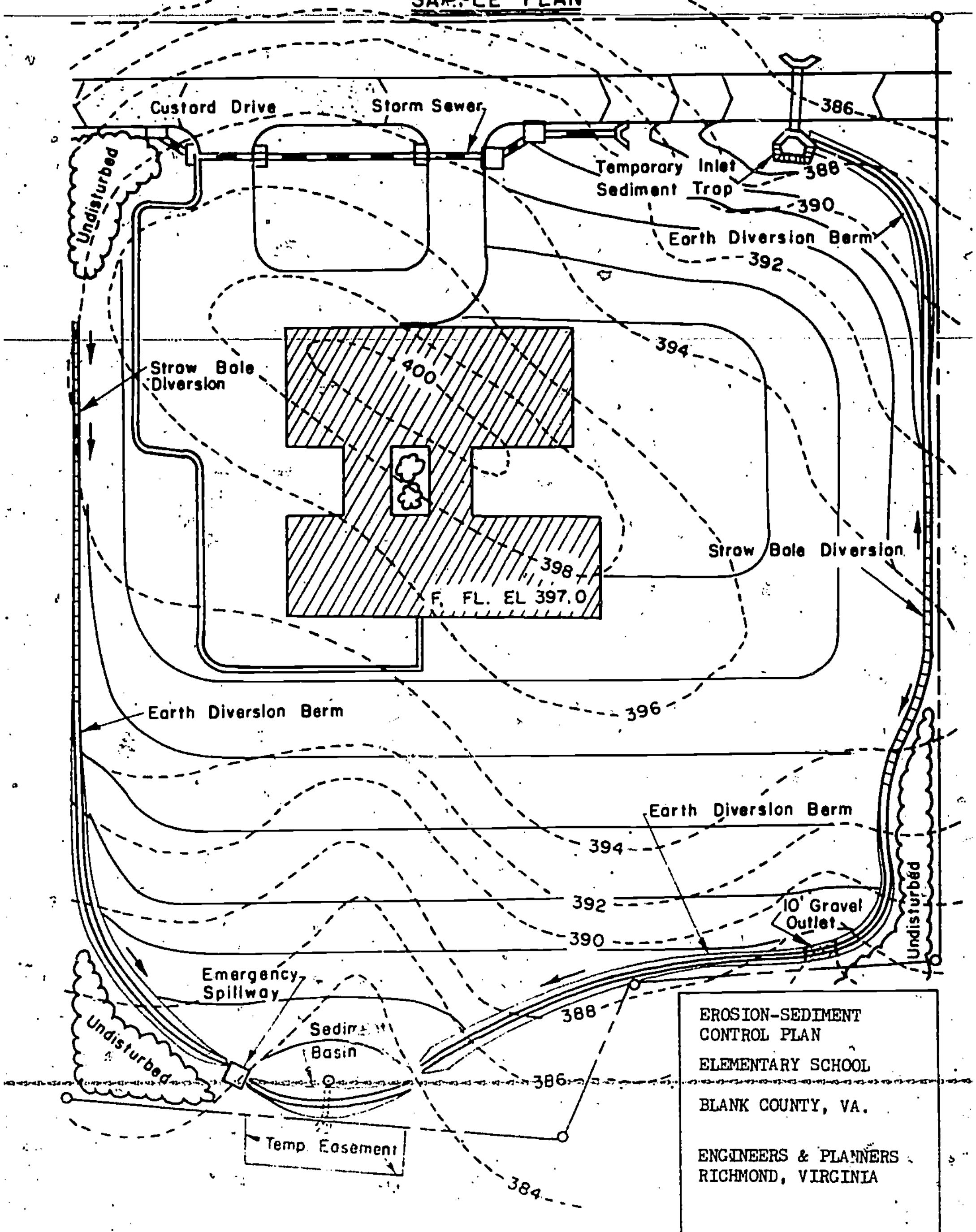
SAFETY PROTECTION: The sediment basins will be posted and the larger one fenced to exclude children.

PLAN OF OPERATIONS: All mechanical controls are to be placed, mulched and secured prior to or as the first step in clearing and grading. Following their completion, the school site and area east of the school building are to be stripped and the topsoil stockpiled at the southeast corner of the site. This area will then be brought to grade as nearly as possible without disturbance to other areas. All areas brought to grade will then be mulched and seeded with temporary vegetation. Mulch will be anchored with mulch anchoring tool. As soon as mulch is anchored, the remainder of the site except for the area at the south sediment basin will be graded and a stockpile of soil material established near the topsoil stockpile for filling the sediment basin as the last step in grading.

STORM WATER MANAGEMENT: The peak runoff for a 10-year frequency rainfall after development shall not exceed the 10-year frequency peak before development. This will be accomplished by use of roof top and parking lot storage. (See attached calculations.) All calculations are based on the methods set forth in the Soil Conservation Service publication, "URBAN HYDROLOGY FOR SMALL WATERSHEDS," Technical Release No. 55, SCS, USDA, January 1975.

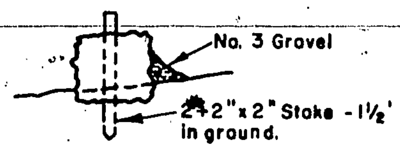
MAINTENANCE PROGRAM: All measures are to be inspected daily by the site inspector and superintendent. Any damaged structural measures will be repaired by the close of the day. Sediment basins are to be cleaned out in accordance with the specifications and the material disposed of by spreading on the site. Mechanical controls will be removed after areas above them have been stabilized with vegetation. The sediment basin at the south end will be left until all other mechanical measures have been removed and the areas permanently stabilized.

## SAMPLE PLAN


Custard Drive
Storm Sewer
Temporary Inlet Sediment Trap
386
388
390
Earth Diversion Berm
392
Undisturbed
394
Straw Bale Diversion
400
398
F. FL. EL 397.0
Straw Bale Diversion
396
Earth Diversion Berm
Earth Diversion Berm
394
392
390
10' Gravel Outlet
Undisturbed
Emergency Spillway
Basin
388
Undisturbed
386
Temp. Easement
384
EROSION-SEDIMENT CONTROL PLAN
ELEMENTARY SCHOOL
BLANK COUNTY, VA.
ENGINEERS & PLANNERS
RICHMOND, VIRGINIA

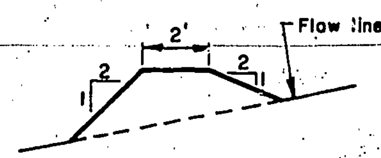
## DETAILS OF MECHANICAL CONTROLS

SAMPLE

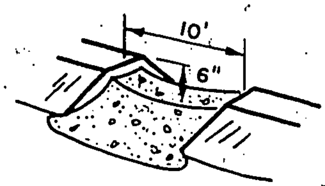



STRAW BALE DIVERSION

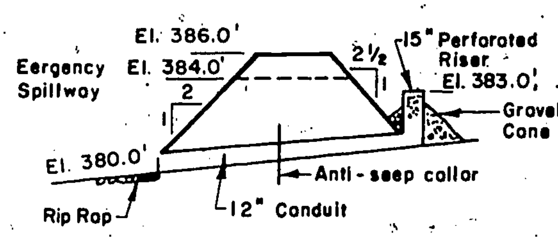
SAMPLE



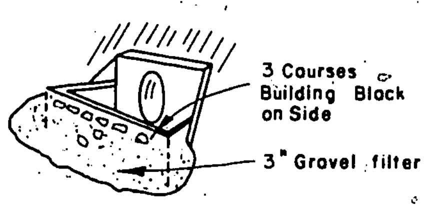

EARTH DIVERSION BERM
(Height Varies)



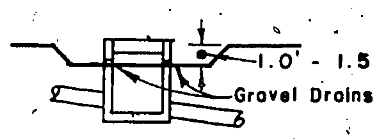

GRAVEL OUTLET




SEDIMENT BASIN - Clean Out at El. 382.0'




TEMPORARY SEDIMENT TRAP
AT CULVERT HEADWALL




TEMPORARY SEDIMENT TRAP
AT ALL INLETS

EROSION & SEDIMENT CONTROL PLAN NOTES:

ELEMENTARY SCHOOL

1. No disturbed area will be exposed for more than 30 calendar days without seeding, mulching, or other protective measures.

2. All mechanical erosion and sediment control measures are to be placed prior to or as the first step in clearing and grading.

3. All storm and sanitary sewer lines not in streets are to be mulched and seeded within 15 days after backfill. No more than 500 feet are to be open at any one time.

4. Electric power, telephone and gas supply trenches are to be compacted, seeded, and mulched within 15 days after backfill.

5. All temporary earth berms, diversions, and sediment control dams are to be mulched and seeded within 10 days after grading. Straw, hay, or comparable mulch is required.

6. Trees along the perimeter will be protected from equipment damage by appropriate signs and barriers.

7. Any disturbed area not paved, sodded, or built upon by November 1 is to be seeded on that date with temporary vegetation and mulched.

8. All land, on or off site, which is disturbed by construction and which is not built upon or surfaced, shall be adequately stabilized to control erosion and sedimentation.

9. All erosion and sediment controls, including seeding and mulching shall be in accordance with standards and specifications contained in the local erosion and sediment control handbook.

When you have read the assigned pages in Appendix A; the contents, including the sample plan, test yourself by answering the following questions.

Questions:

1. Give a brief description of the two parts of an erosion and sediment control plan.

2. List six things which the plan must include.

3. Explain just what must be shown in the plan for each temporary practice. For each permanent practice.

4. What are the major features of a maintenance program for the erosion and sediment control facilities?

5. What must be shown on the map concerning proposed alterations of the area?

6. What are the elements of phasing which must be described in the narrative?

Summary:

The plan shall consist of two parts -- one, a narrative report describing the project and giving the purpose, schedule or phasing of major construction activities, schedule for installation of erosion and sediment control practices, and the engineering assumptions and calculations for the control measures; and two, a map or maps of the same scale or a base map with overlays depicting topography, limits for clearing and grading, other proposed alterations of the area, and the location of the control measures and facilities.

The plan must include the type, magnitude, and location of existing and anticipated conservation problems; delineations of the areas of clearing and grading, areas to be mulched, and the areas to be established to temporary or permanent vegetation; schedules showing the staging of the major land disturbing activities, and the timing and sequence of installing conservation practices and facilities; the location of erosion and sediment control practices such as sediment basins, diversions, waterways, storm drains; and the topography of the area. It should also identify the predominant soils, describe existing vegetative cover, and describe the existing drainage pattern.

For each temporary practice its location (on map), dimensional details, the design considerations, and the calculations for mechanical measures must be indicated. The extent of vegetative measures should be given in the narrative in acres or thousands of square feet and should be located on the map. Timing and sequence must be included for all practices. The same type of information must be given for permanent practices.

The maintenance program should assign responsibility for checking all practices and critical areas. It should specify the schedule for checking; how repairs are to be handled, including both vegetative and structural measures; sediment removal methods, frequency, and disposal; and the removal of temporary measures after they have served their purpose.

Proposed alterations are shown on a map or maps which must delineate the limits of clearing and grading; the areas of cuts and fills; roads, buildings, pond areas, other structures; and stormwater management facilities.

The schedule for phasing of land disturbing activities should show the sequence of land clearing operations, removal and stockpiling of topsoil, major earth moving and grading, control facility installation, and program of operations.

Unit 3. Erosion and Sediment Control Practices

Purpose and Significance:

This unit covers in detail all erosion and sediment control practices which are in Appendix A, the Virginia Handbook. It familiarizes the reader with the purposes, places of applicability, and the specifications for all practices. It also discusses the operational and scheduling techniques that help reduce erosion and sediment problems.

It is important to become familiar with the name, purpose, and place where applicable for all practices. Tables give guidance on choice of vegetation in case adjustments must be made because of date of seeding change or other reasons. The important features of structural practices, including how to check capacity and stability requirements, should be understood.

It is important to know each practice well enough to relate it to the one or more erosion control principles which it helps to satisfy. For this reason, the practices are grouped and discussed under the major principle to which they apply.

Objectives:

1. Describe procedures or methods used to reduce the hazard to the very critical areas.

2. Name at least six practices in the Virginia Handbook which have as a primary function the protection of bare soil from raindrop impact.

3. Name practices, procedures, and techniques which provide protection by maintaining the infiltration capacity of the soil.

4. Name each practice which provides protection by keeping runoff velocities low.

5. Name the practices which are used to protect denuded areas from runoff which comes from the areas above them.

6. Name the practices which are used to safely conduct concentrated runoff on the site and also the measures that are used to control the release of this runoff from the site to prevent erosion downstream.

7. Name the practices which are used to trap sediment.

Content:

The first principle which was listed in the unit on principles of erosion and sediment control had to do with recognition and protection of the extremely critical erosion areas. One of the first things to be done on the development site is to recognize critical areas and plan all activities in such a way that these areas will be protected. In most cases, protection for these areas means taking precautions to see that they are not disturbed. Concern here is with operational procedures and techniques rather than with the named practices. It may be necessary to fence critical areas or erect barriers to keep traffic and equipment from damaging them. The work crew should be instructed to protect them. It may be necessary to provide safe crossings for streams and drainageways. In some cases, fertilization and/or additional planting may be needed. Providing protected roads and equipment storage areas early in the development will reduce the hazard to other areas. Protection of these areas needs to be included in your daily inspection and maintenance program.

The second principle which was discussed was to protect bare soil from raindrop impact. The practices which satisfy this principle provide the first line of defense against erosion. These are the mulching and vegetative practices. They are among the most effective erosion control practices in the program, and fortunately they are usually the lowest cost practices.

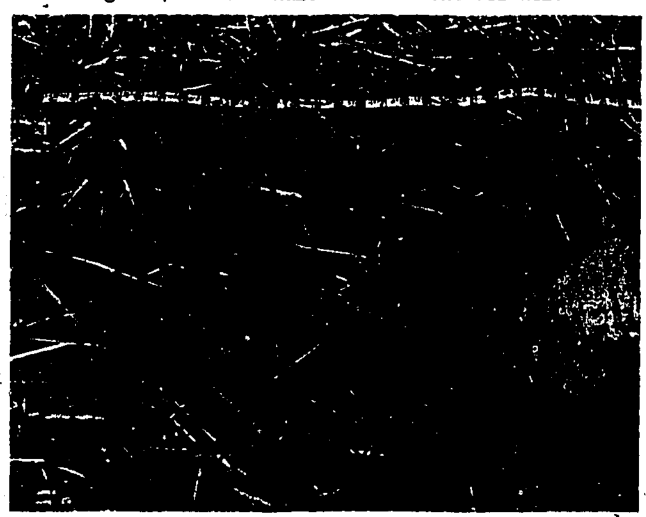
The practices in this category are listed below together with the page number in Appendix A where their standards and specifications may be found.

| Practices Which Protect Soil From Raindrop Impact | Appendix A Pages |
|---|---|
| 1. Disturbed area stabilization (with mulching only) | III-114-115 |
| 2. Disturbed area stabilization (with temporary seeding) | III-116-119 |
| 3. Disturbed area stabilization (with permanent seeding) | III-123-130 |
| 4. Disturbed area stabilization (with sod) | III-131-134 |
| 5. Disturbed area stabilization (with Bermuda grass) | III-135-138 |
| 6. Disturbed area stabilization (with ground covers) | III-139-140 |
| 7. Tidal bank stabilization (vegetative) | III-147 |

Study the above references carefully. Also, read Appendix A, pages III-3 and 4 down to <u>Mechanical Practices</u>. The superintendent will find excellent directions on how to install the practice and the necessary amounts, dimensions, and other criteria. The inspector will find the important specifications which must be followed if the practice is to perform as intended. The schedule and phasing section of the plans will include the timing and sequence for installing these measures.

In checking or inspection of the performance of these practices, remember that the amount of erosion is proportional to the amount of bare soil. Well distributed straw mulch at two tons per acre should cover about 90 percent of the soil surface. Continuous bare areas of more than a few feet long, if oriented up and down slope, can be potential damage areas. Mulch that is not well anchored may be blown off by the winds which precede violent storms and may be completely ineffective when the rain comes.

Figure 7. Straw Mulch At Two Tons Per Acre



Permanent vegetation practices should provide almost 100 percent surface cover after two or three months from seeding and should be predominantly of the specified grasses or at least of permanent types of equal erosion control value.

Maintaining infiltration is the third principle. All of the above practices help to serve the principle of maintaining the infiltration capacity of the soil by preventing raindrop impact from sealing the surface.

There are several operational procedures and techniques which help maintain infiltration. Avoiding unnecessary compaction by construction equipment and traffic may be a major consideration. Don't confuse the compaction needed in a dike of a sediment basin or diversion with the firming needed for a seedbed. Putting the gravel base down early for roads or parking areas will provide protection and allow some infiltration. Swales and wetlands should be protected in order to preserve their capacity for storage and insoak of water.

Temporary level spreaders (see Appendix A, pages III-25) and topsoiling disturbed areas (pages III-120) will increase infiltration in certain circumstances. When the level spreaders outlet on soils with good infiltration and permeability, some of the water will soak in. Topsoiling will increase infiltration when the topsoil material has a higher infiltration rate than the material in the area covered. It will also have a lasting beneficial effect on infiltration by supporting good vegetative cover.

In checking and inspecting level spreaders, it is important to check that the spreader is of the designed length, that the lip is level, and that the area below it is well vegetated and shaped so that the water will not reconcentrate. The interceptor or diversion also must outlet properly into the spreader. The condition of the spreader lip and the area below should be checked daily.

Figure 8. Mulch Can Be Anchored By Machine

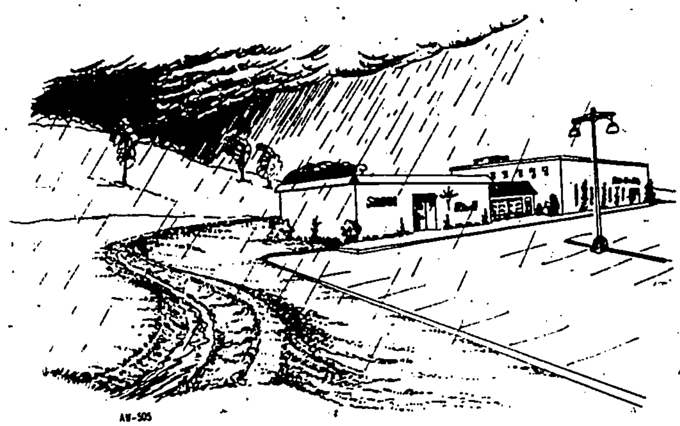
The fourth principle is to keep runoff velocities low. All of the vegetative practices help to accomplish this to some extent, as do practices and procedures which maintain infiltration capacity. However, there are several specific structural practices which are designed to carry runoff at safe velocities to safe disposal areas. Study the standards and specifications for these practices.

| Practices Which Keep Runoff Velocities Low | Appendix Pages |
|---|---|
| 1. Temporary diversion dike | III-11 to 13 |
| 2. Temporary interceptor dike | III-14 to 16 |
| 3. Temporary straw bale barriers | III-20 & 21 |
| 4. Temporary level spreader | III-25 to 27 |
| 5. Waterway or outlet (Note: This practice is designed to keep velocities within safe limits for the type of channel lining that is used whether vegetation, stone, or pavement.) | III-28 to 32 |
| 6. Diversion | III-33 to 37 |
| 7. Temporary perimeter dike (This practice functions to reduce runoff velocity more by chance than by design, and it will only function in this way when the grade along the perimeter is low.) | III-17 to 19 |
| 8. Land grading (This practice can help keep runoff velocities low if it is designed to keep surface flow from concentrating, if it reduces steep grades, and if it shortens the length of slope.) | III-53 & 54 |

Figure 9. Waterway Developed In Natural Drainageway

All of these practices need to be checked both upon installation and daily to see that they will accomplish the intended purpose. The first three practices are not designed, but do have a minimum size. The channels and berms should be checked to see that this size is retained. Since these structures usually slow the runoff, sediment may be deposited in the channels and must be removed. Damage to the berm or blockage of the channel should be repaired immediately. The outlet area should be checked at the same time and repairs made as needed. Waterways and diversions are designed structures and must have the dimensions called for in the plan. Damage to the vegetal or other lining material should be repaired immediately. Repairs must be able to withstand flow immediately, so must be made with suitable techniques and material. Sod, seed with jute matting, or seed with carefully tied down mulch may be used in vegetated channels. Repairs to stone or pavement lined channels should be of the same quality or better than the original material.

Figure 10. Diversion




All of these practices require mulching and seeding or some more erosion resistant cover. The mulching and seeding or other cover is an integral part of the practice and should be considered as such when checking or inspecting.

Land grading should be checked to see that it does not create problems, such as unprotected points of concentration of runoff, slopes near buildings or adjacent property which may cause runoff or slippage problems, drastic changes in size of drainage area, excessively steep areas, or other hazards.

The fifth principle is to protect denuded areas from runoff generated on areas above them. Diversions, temporary diversion dikes, temporary interceptor dikes, and temporary straw bale barriers are used for this purpose as appropriate. It should be noted that straw bale barriers are effective only where the contributing areas is very small.

The sixth principle is to prepare drainageways on the site to receive the concentrated and increased runoff which will be generated and to control the release of this runoff from the site so as to prevent channel erosion downstream.

Waterways and outlets referred to under the fourth principle are important structures for this purpose. These must be in good shape to receive runoff before diversions, interceptors, and other components of the water management system empty into them.

| The Other Practices In This Category Are | Appendix Pages |
|---|---|
| 1. Temporary grade stabilization structure | III-38 to 40 |
| 2. Temporary downdrainage structure | III-68 to 70 |
| 3. Riprap | III-57 & 58 |

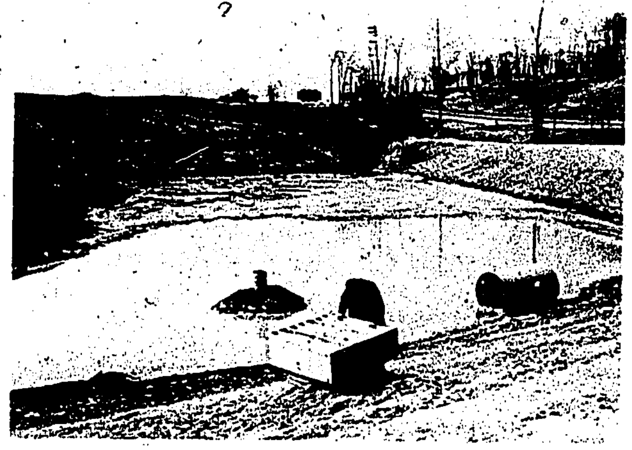
4. Water storage and release facilities
   (Standards and specifications for these facilities are not included in the <u>Virginia Handbook</u>. However, the Virginia program does require that an analysis be made of peak runoff with the present use and with the use after development. Where analysis indicates that the new runoff peaks may cause excessive channel erosion, control facilities should be provided.)

The grade stabilization structures and downdrains must be checked frequently to see that the inlet end is free from blockage and that the runoff is not flowing outside or around the inlet and causing cutting at this point. The lining material of flumes should be checked to see that it is in good condition. The outlet end should be checked to see that runoff is not causing erosion or undercutting at this point.

The seventh principle is to trap sediment at or near the perimeter of the development site in temporary or permanent sediment trapping facilities.

| Practices Which Trap Sediment At The Perimeter | Appendix Pages |
|---|---|
| 1. Temporary Gravel outlet structure | III-22 to 24 |
| 2. Sediment Basin | III-41 to 48 |
| 3. Sediment Trap | III-49 to 52 |

Figure 11. Sediment Basin



The temporary gravel outlet is always used in conjunction with and as a part of a diversion dike, interceptor dike, or perimeter dike. It must outlet onto a protected area or into a stable watercourse.

Sediment basins require that a specified capacity be maintained in the basin. The design will state the maximum sediment level allowed. Cleanout should be scheduled to maintain capacity. Points of entry and points of runoff release should be checked to see that no erosion problems have developed. The vegetation on the embankment and particularly the emergency spillway should be maintained in good condition.

Sediment traps require checking and cleanout after each storm.

There are four additional practices in the Handbook which do not fall into any of the above categories. However, they are valuable additions to the control program.

| Practices Not Falling Into Above Categories | Appendix Pages |
|---|---|
| 1. Construction entrance | III-10 |
| 2. Subsurface drain | III-59 to 67 |
| 3. Guide for protection of trees on disturbed areas | III-153 to 156 |

| Practices Not Falling Into Above Categories (Cont.) | Appendix Pages |
|---|---|
| 4. Guide for tree planting on disturbed areas | III-157 to 159 |

Also there are some important operational procedures which are discussed on pages III-[illegible] and [illegible] of Appendix A under the heading Miscellaneous Practices.

This completes the discussion and references on erosion and sediment control practices and procedures. Test yourself by answering the following.

Questions:

1. What are the procedures or methods you would use to prevent damages to streambanks, steep slopes, areas of highly erodible soil, and other critical areas?

2. Name at least six practices which have as a primary function the protection of bare soil from raindrop impact.

3. What types of practices help to maintain the infiltration capacity of the soil? What operational procedures or techniques help to maintain infiltration?

4. Name at least eight practices which provide protection by keeping runoff velocities low.

5. What practices are used to protect denuded areas from runoff which is generated on the area above them?

6. What practices are used to safely conduct concentrated runoff on the site? What means are used to control the release of runoff from the site to prevent erosion downstream?

7. Name three practices which trap sediment.

Summary:

Critical erosion areas should be recognized and, if necessary, fences or barriers constructed for protection. If a stream must be crossed, a culvert and safely graveled crossing should be built. The work crew should be trained to protect these areas. Roads and equipment storage should be located in the less hazardous areas. The condition of these areas should be checked as part of the regular maintenance program.

Mulching and the vegetative practices have a primary function--the protection of bare soil from raindrop impact. Specifically, these practices are: disturbed area stabilization (with mulching only); disturbed area stabilization (with temporary seeding); disturbed area stabilization (with permanent seeding); disturbed area stabilization (with sod); disturbed area stabilization (with Bermuda grass); disturbed area stabilization (with ground cover); and tidal bank stabilization (vegetation).

The disturbed area stabilization practices with mulch and/or vegetation all help to maintain the infiltration capacity of the soil. Avoiding unnecessary compaction of the soil will also help. Putting the gravel base down early for roads and parking areas will help maintain infiltration and will protect these areas. Protecting swales, wetlands, and other well vegetated areas will preserve storage and infiltration capacity. Temporary level spreaders and topsoiling also will help maintain infiltration.

All of the vegetative practices, as well as the practices and procedures which favor infiltration, also help to keep runoff velocities low. However, the eight specific practices which help accomplish this are temporary diversion dikes, temporary interceptor dikes, temporary straw bale barriers, temporary level spreaders, waterways or outlets, diversions, temporary perimeter dikes (when gradient is not too steep), and land grading.

Denuded areas are protected from runoff coming from areas above them by diversions, temporary diversion dikes, temporary interceptor dikes, and temporary straw bale barriers.

The practices which are used to conduct concentrated runoff on site are waterways and outlets, grade stabilization structures, temporary downdrainage structures, and riprap. The latter may be the lining material for waterways and other structures and is used to safely outlet these structures into stable streams or drains. When construction has caused or will cause increases in the peak discharge to the extent that downstream channel stability is threatened, storage and controlled release facilities should be provided.

The three practices used to trap sediment are temporary gravel outlet structures, sediment basins, and sediment traps. The gravel outlet is always used in conjunction with a diversion dike. The sediment traps are relatively small and are of several types. The basins are for trapping sediment from larger areas.

PART IV IMPLEMENTATION

Unit 1. The Roles of the Job Superintendent and of the Inspector

Purpose and Significance:

This unit discusses the roles of those who must take the "on paper" plans for erosion and sediment control and see that they are carried out, as planned, on the actual field site. This unit begins with an elaboration of the responsibilities of the job superintendent and inspector which were discussed in the first unit of Part I. It continues with a discussion of their roles in carrying out these responsibilities. The previous units have dealt with important information concerning erosion, plans, and practices. This unit deals more with individual roles and working relationships in actually applying plans on the land. It should help both the job superintendent and the inspector to approach their job with confidence and to appreciate the importance of their individual roles and of working together in carrying out their responsibilities.

Objectives:

1. Describe how the job superintendents and inspectors responsibilities stem directly from provisions of the Virginia Erosion and Sediment Control Law and Program including an explanation of how this specific assignment traces down to each.

2. Describe the various parts of the job superintendent role in erosion and sediment control.

3. Describe the various aspects of the role of the inspector in the erosion and sediment control program.

4. Indicate why teamwork is needed to carry out their responsibilities.

Content:

Since this unit takes up where the first unit in Part I left off, it may be worthwhile to review the summary of that unit. In that discussion it was brought out that the owner or lessee of the property on which the construction activities were to take place or the agent of the owner or lessee must develop an erosion and sediment control plan and submit the plan for approval. When he submits it, he must name the person who will be responsible for carrying out the plan. Plan approval is contingent on two things. It must meet the requirements of the local control program, and the person responsible for carrying out the plan must certify that he will properly perform the control measures included in the plan.

The local program names the department or person responsible for overall administration of the erosion and sediment control program. This department or person is, "responsible for developing and implementing a systematic program for on-site inspection to ensure that the erosion and sediment control measures on approved erosion control plans are actually provided."

In short, this means that the public, through its representatives in the legislature, has expressed its goals for erosion and sediment control. This has resulted in the Virginia law and program. This program has certain safeguards to see that the publics goals will be carried out.

1. There is an approved erosion and sediment control plan for the construction site which meets the standards and criteria of the local program.

2. There is a certification by the person responsible for doing the work that he will properly perform all measures in the erosion control plan.

3. There is a department or person named in the local program who has the assigned responsibility to ensure that the plan is carried out.

4. The final safeguard provides that, should the permit holder fail to comply, the authority named in the local program may take the legal steps to obtain compliance.

Read the part of your local program covering these responsibilities.

The roles of both the job superintendent and the inspector are largely determined by the commitments summarized above. Both roles are extremely important in achieving the public goals for erosion and sediment control.

The job superintendent must recognize his key role in attaining the public's goal of effective erosion and sediment control. He is a leader in erosion and sediment control by virtue of his responsibility for complying with the certification that the control measures in the approved plan will be carried out. He is a translator of plans who takes erosion and sediment control measures described in a plan and located on a map and converts them into actual measures applied to the land. He is a trainer who must instruct workers on how to install and maintain measures and how to carry out all construction activities in a manner that is the least disruptive to the site. He is an organizer and manager who can develop and carry out a program for checking and maintaining all erosion and sediment control measures. He is the most knowledgeable person about the construction site. He is a specialist in erosion and sediment control who is knowledgeable about the erosion and sediment control plan and thoroughly familiar with erosion and sediment control practices. He is a cooperator and communicator who works closely with the inspector in all stages of installing and maintaining the plan.

The inspector role is equally important in attaining effective control. He is also a leader in erosion and sediment control by virtue of the assigned responsibility for enforcing the local erosion and sediment control program. He, too, is a reinforcement to the job superintendent in translation of the plans into actuality. He is an organizer who develops and follows an inspection schedule, and keeps complete records on the status of installation and maintenance at each visit. He is an inspector in that he checks to see that all measures in the plan are installed according to design at the proper time and in the proper place, and that they are being properly maintained. He is an erosion and sediment control specialist who is thoroughly familiar with the program requirements, the erosion and sediment control plans, and with erosion and sediment control practices. He is a cooperator, communicator, and trainer who works closely with the job superintendent at all times. He is an enforcer who, when necessary, must promptly initiate the procedures to ensure compliance with the requirements in the plan.

The similarity of the two roles is obvious. In the multi-faceted roles, perhaps, the most important item is a business-like and cooperative attitude between the superintendent and inspector.

Questions:

1. Briefly describe the provisions of the Virginia Erosion and Sediment Control Program which determine the responsibilities of the job superintendent. Describe the provisions which determine the responsibilities of the inspector.

2. List the various roles which a job superintendent must assume.

3. List the various roles which the inspector must assume.

4. Indicate how a cooperative attitude and teamwork can be mutually beneficial.

Summary:

The provision of the Virginia law which most positively places responsibility on the job superintendent is the requirement of a certification that the approved plan will be carried out. The person responsible for carrying it out is named in the application that is submitted with the plan. The person so-named would normally be the contractor or developer, but the on-site responsibility logically falls to the job superintendent.

Local programs must name a department or person who has the assigned responsibility to ensure that the plan is carried out. The local program also requires that the department or person so named will carry out an inspection program including a system for recording results. It requires that enforcement procedures be used if necessary to attain compliance with the approved plan.

The job superintendent is a leader in erosion and sediment control. He is a translator or converter of plans into actuality. He is a trainer to his crew in how to install and maintain the elements of a plan. He is an organizer and manager of a program for installation, checking, and maintaining the features of the plan. He is an expert about the construction site and a specialist in erosion and sediment control. He is also a cooperator and communicator in his relationship with the local enforcement authorities.

The inspector must also assume a leadership role in the erosion and sediment control program. He is a reinforcement to the superintendent in translating plans into action. He is an organizer of a program of inspection and record keeping. He is an inspector, an erosion and sediment control specialist, and a cooperator with the superintendent in carrying out his responsibilities. Lastly, he must be an enforcer who firmly requires that all features of the plan be installed. He will promptly follow the procedures which have been prescribed to ensure compliance.

Both positions are concerned with carrying out an erosion and sediment control program. The job superintendent is the expert on the features of the development site. The inspector will usually have a better understanding of all of the control measures and practices and will be invaluable in helping to fit measures to the site.

## Unit 2. Installation and Inspection of the Erosion and Sediment Control Plan

Purpose and Significance:

This unit is a discussion of how the job superintendent and the inspector carry out their erosion and sediment control jobs. It discusses the steps in the installation of a plan and items which should receive attention at each step. Suggestions for organization of the work of the superintendent and the inspector are given. Topics covered are study of the plan and site, organizing for installation, site preparation, grading and utility installation, construction, maintenance, and permanent stabilization. Within each of the above steps, specific items of concern will be discussed. For the inspector there is a discussion of scheduling, items to check, record keeping, handling changes in the plan, and handling violations.

The unit gets to the basics of how to do each of the two jobs. It presents suggestions which may be used directly and others that will help the job superintendent or inspector to develop their own approach to doing the work. It points out steps which should be carried out by each, including those which they should do working together.

Objectives:

1. List the steps which the job superintendent should cover in installing and completing the erosion and sediment control plan, and indicate the specific things which he should do at each step.

2. Describe one method of constructing a scheduling or "progress of work" chart.

3. Discuss the purpose of the pre-construction conference between the job superintendent and inspector.

4. Discuss the importance of timing in the installation of the erosion and sediment control measures.

5. List and briefly describe at least ten items which should be given attention during inspection.

6. List the things that should be documented at each inspection.

Content:

Part I, Unit 1, included a discussion of what the job superintendent and the inspector should be knowledgeable about in order to do their jobs. Both should know the state law and local ordinance requirements, their own responsibilites, the erosion and sedimentation process, principles of control, the erosion and sediment control practices, and the nature and contents of an erosion and sediment control plan. With all of this knowledge well in hand, you are ready to consider how to go about installing the plan on the land.

Installation of an erosion and sediment control plan will be discussed as seven distinct steps and primarily from the standpoint of the job superintendent. The steps are:

a. study of the plan and site and organizing for installation,
b. pre-construction conference between the job superintendent and inspector,
c. site preparation,
d. checking and maintenance,
e. grading and installing utilities,
f. building construction, and
g. permanent stabilization.

1. Study the plan and the site:

The job superintendent must be thoroughly familiar with the erosion and sediment control plan, and with the construction site. First, note all of the critical areas indicated in the plan and, then, actually identify their location and extent on the land. These should include stream channels and associated flood plain areas, drainageways and outlets into streams, points where land disturbing activities are adjacent to or must cross streams and drainageways, steep slopes and highly erodible soils, runoff entering the site from off-site. Note what the plan calls for to protect these areas. Also, you may discover critical areas not specifically treated in the plan, make a note to discuss this with the inspector at the pre-construction conference.

Second, locate all control measures and determine their "fit" on the land. Note the needs for adjustments and plan to discuss this at the pre-construction conference.

Third, check the scheduling for the installation of erosion and sediment control practices, the scheduling of all earth disturbing activities, and the relationship between the sequence and timing of practice installation and all earth disturbing activities. Note that timing and sequence of installation are important elements of an erosion and sediment control plan. The site must be ready for rain before the earth disturbing activities are started. For this reason, certain practices must be in place and ready to provide protection before other areas are exposed. The staging of major earth disturbing activities to limit the size of bare area exposed at any time is another important element of the plan which should be noted.

The fourth part of this step is to develop a schedule or program of work for carrying out the plan. You may already have your own approach to this; if so, be sure to incorporate installation of all features of the erosion and sediment control plan into your scheduling system. Scheduling aids are presented following the discussion of the other six steps of plan installation.

2. The pre-construction conference:

The next step is a pre-construction conference and site review with the erosion and sediment control inspector. The site review will help both parties in meeting their responsibilities. It should be called for by the job superintendent and should be held on the construction site. All aspects of the plan should be discussed to ensure that the job superintendent and the inspector are in agreement in interpreting the plan, and on the scheduling, procedures, and practices which are to be followed. Particularly be in agreement on the critical problem areas and on the practices which are to prevent damage to adjacent properties.

Discuss the location of all measures. If the study of the plan indicated that adjustments in location were needed, discuss these with the inspector. The inspector may authorize minor adjustments such as moving a diversion from a property line to a grading limit, or shifting an outlet to match a natural depression in the land. Major adjustments may require formal revision of the plan, and should be approved by the plan approval authority.

Discuss the sequence of installation of practices and earth disturbing activities. The guidelines for erosion and sediment control planning require that debris basins and other appropriate erosion and sediment control measures be installed prior to or as a first phase of land grading. Other appropriate measures would include construction entrance, diversion dike, interceptor dike, perimeter dike, gravel outlet structure, level spreader, waterway or outlet, and grade stabilization structure. The inspector must hold firm on establishment of these practices before grading begins. As mentioned earlier, the site must be made ready for rain.

All controls included in the plan must be installed or a revision made and approved. If you are convinced that a measure is not needed or even harmful, you as job superintendent should point these cases out to the planning engineer, and help to plan more effective measures. Conversely, if the inspector finds planned controls are ineffective, he must report this to the plan approving authority and additional practices may be required.

Discuss all critical areas and possible trouble spots. Reach agreement on the proper protection for these areas.

Discuss the plans for checking and maintenance of practices and plans for disposal of temporary measures and establishment of permanent stabilization.

3. Site preparation:

Site preparation is the next step following the pre-construction conference. One of the first things to do in this step is to lay out all equipment travel and storage areas and other necessary traffic routes. Choose route locations that pose the least threat to the critical areas which have been identified. Minimize damage to already well vegetated areas. Choose safe areas for stockpiling. These should be a safe distance from waterways and streams. Barriers may be required to keep traffic within the delineated areas or at least out of the critical areas. If needed, they should be installed before opening the site to general construction traffic.

Build the required sediment basins and traps, then build diversion dikes, perimeter dikes, level spreaders, and other appropriate practices. Note that compacting, seeding, and mulching are required parts of these practices. Build waterways and outlets and install the vegetation or lining material called for in the plan. If these are to receive water immediately then sod, jute matting, riprap, or other approved erosionresistant lining material must be used.

Instruct the work force on the location of critical areas and sediment control practices and on the need to protect these areas from damage.

4. Establish a system for checking and maintenance of erosion control measures:

Maintenance is included here as the next major step, although it differs from the other steps. It must begin as soon as the first practice is installed and must continue through all the succeeding steps until the permanent erosion control measures are established and functioning. The features of a maintenance program are described in the narrative part of the plan. All structural measures should be checked at the close of each work day and, particularly, at the end of the work week. Also, check before and after each rainstorm. Check to see that diversion berms have not been breached by equipment. Check the condition of level spreader areas, waterways, and other outlets. Make sure that traffic is keeping within the established access routes. Check for sediment deposits or other impeding material in channels. Be prepared to make prompt repairs when damages are discovered. When repairing waterways or other channels, the new lining material should be at least as erosion resistant as the original material.

Check all sediment traps and clean out after each storm. Clean sediment basins when the deposited material reaches the level designated in the plan.

All vegetated areas require some maintenance. This includes repair or replacement of damaged areas and fertilization as called for in the plan. Mowing and removal of excessive growth should be performed as needed.

The essentials of the maintenance program are that it should begin as soon as any practices are installed. It should include daily and after-storm checks, and it should provide for immediate repairs to damaged areas. Vegetative practices and vegetative cover on structural practices require maintenance fertilizer and, perhaps, mowing.

5. Grading and utility construction:

The fifth major step is the grading and utility installation. If stockpiling of fill or topsoil is planned, use the pre-selected, relatively safe stockpile area. To minimize the hazard of erosion, flatten the slopes of the pile at the end of each working period. Be prepared to mulch and seed the stockpile as soon as it is completed.

Graded areas, which can be brought to final grade at this stage and during a satisfactory season for seeding, should be seeded, sodded, or otherwise stabilized with the permanent material and techniques indicated in the plan. If they cannot be seeded, they should be stabilized with anchored mulch. Areas which are to remain at rough grade, for more than 30 days before permanent stabilization, should be mulched and seeded to temporary cover immediately following rough grading.

Utilities such as storm sewers, sanitary sewers, electrical conduits, water mains, and gas mains are usually installed at this time. To minimize the amount of area disturbed, the work should be organized and the trenches sized to take several utilities in one trench. The installation should be carefully coordinated to reduce the time that thr trenches must stay open. Ordinances in some local programs may place limits on the lengths of trenches that can be open at any one time. Excavated materials should be placed on the side of the trench away from streams and drainageways. If sediment laden water must be pumped from utility trenches, it should be conveyed safely to a sediment trap or basin. As soon as possible, trenches should be filled, compacted, mulched, and seeded to temporary or permanent vegetation.

As soon as the storm sewers are installed, sediment traps should be installed, to prevent sediment from entering the system. If called for, storm drain outlet protection should be installed.

6. Building construction:

The sixth major step or stage is building construction. Two major hazards are common during this step. Additional equipment and work force bring added risk to areas which should be protected. Efforts to control traffic must be increased during this period. All types of traffic should be made to stay on the established travel routes.

The second major hazard is from the excavated material. This phase usually results in huge volumes for disposal and stockpiling for backfill. Again, this must be placed in areas where it will not wash into drainageways or onto previously stabilized areas. The slopes on these areas should be flattened and they should be protected by anchored mulch and a temporary seeding.

Excavations should be backfilled as soon as possible, and appropriate surface protection should be provided.

7. Permanent stabilization:

The seventh and last step is permanent stabilization. As mentioned earlier, this need not and should not be delayed until the entire development is completed. A significant reduction in erosion damage repair costs and regrading costs can be made if smaller areas are stabilized with permanent vegetation as soon as they are ready, unless the season is unsuitable for seeding.

Most sediment basins, dikes, sediment traps, and other control structures are to be removed, regraded, mulched, and seeded before leaving the site. However, check with the inspector before removing them -- they should not be removed until the surrounding area is stabilized and they are no longer needed.

In some cases, sediment basins, diversions, and waterways are to remain as part of the permanent runoff management system. In such cases, sediment basins should be cleaned out and seeded to suitable permanent vegetation. Diversions and waterways should be checked, repaired if needed, and left in good condition. The inspector will check on the final condition of measures which are to be retained.

When final grading is completed, all bare areas should be stabilized with permanent vegetation. Pages III-3, III-4, and the standards and specifications for permanent vegetative practices, in Appendix A, give information on various materials and methods for permanent stabilization.

Scheduling and timing are extremely important to the success of the erosion and sediment control efforts. Both the job superintendent and the inspector must be concerned with this aspect of erosion and sediment control. Certain practices must be in place before general grading begins. Utility trenches should remain open for as short a time as possible. This means close coordination of the installation of the various utilities. Immediately upon completing the installation, the trench(s) should be filled, compacted, mulched, and seeded. Temporary sediment traps should protect storm sewer inlets immediately after sewer installation. Mulching and seeding should immediately follow the general grading. Attention to timing can greatly reduce the risk of costly repairs and cleanout.

To make sure that installation is timely and well coordinated with construction activities, some method of work scheduling is needed. Failures can be very costly. They can often be prevented by foresight and scheduling. A method of work scheduling is discussed below. An example of this method, using the sample plan in Unit 2, Part III, is included.

The flow chart, or work schedule chart, is a relatively simple but effective way of scheduling. In this method, all items of work are first listed. Include ordering needed materials; contacting subcontractors well in advance; installation of structural erosion and sediment control practices; seeding, mulching, and fertilization; grading and utility installation; compacting, seeding and mulching these areas; and all other specific elements necessary to plan installation. Estimate the time needed for each job and the advance time needed for ordering materials, contacting sub-contractors, and scheduling them. Then, put all these work items in the sequence in which they must be carried out in the left-hand column of a long spread sheet. The months of the construction period should be written in across the top of the sheet. Allow wide enough column for each month so that you can enter a check under each work day to indicate the days an item in the left-hand column begins and ends.

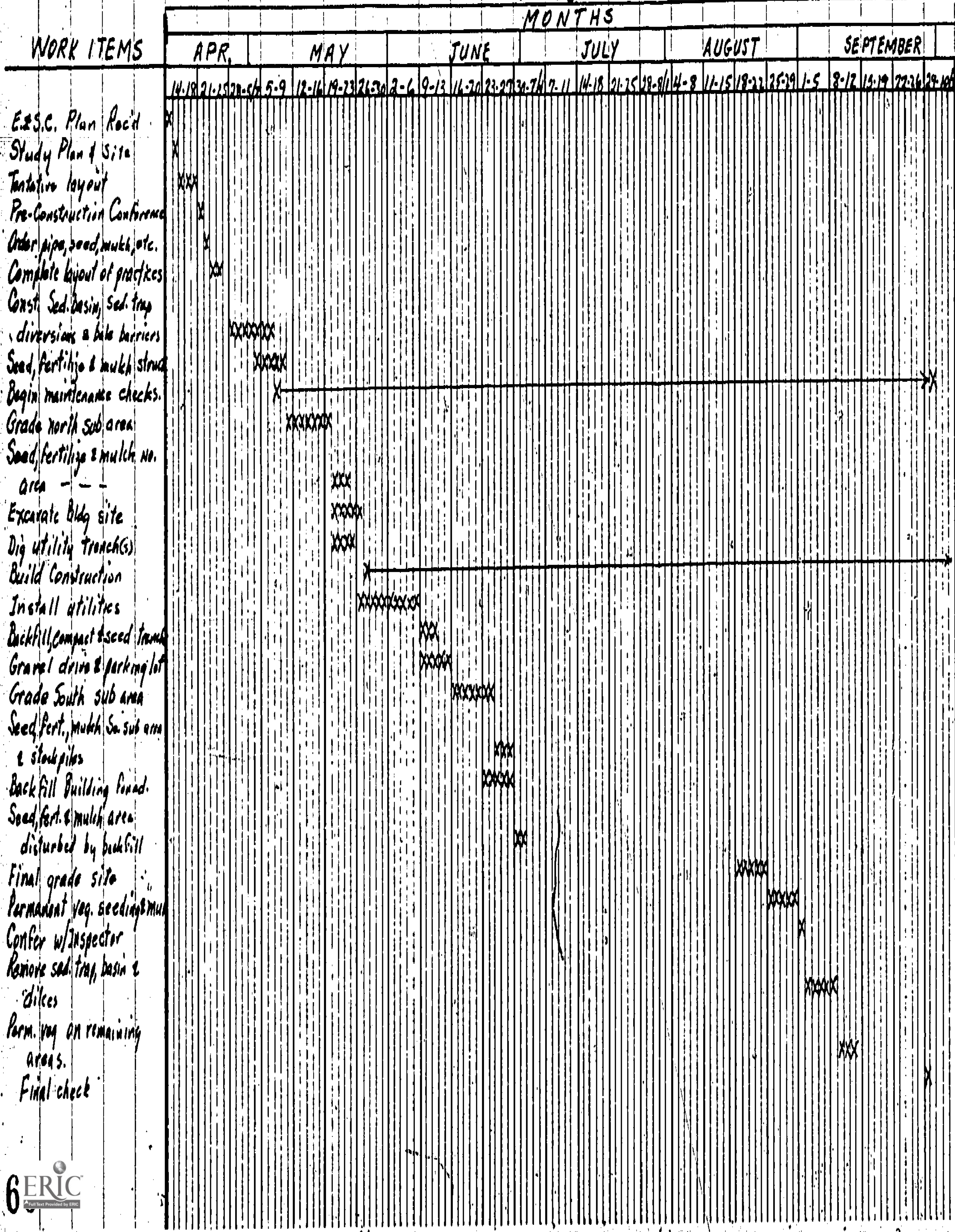
The flow chart has good display value for the superintendent, contractor, and foremen of various crews. It must be revised as construction schedules change.

More sophisticated scheduling systems are available and warranted for the more complex jobs. The Precedence Diagram and associated Project Control System provide an excellent means of work scheduling. The diagram has excellent display and management value. It shows all work items in proper relationship to each other. It indicates responsibility for carrying out each item and indicates the number of work days each item is expected to take. There is a computer program available which takes the diagram information and prints several useful reports. One is a bar graph which shows the calculated duration of all work items and the time relationships between items. It also lists all work items and indicates for each the earliest and latest start dates that are possible without delaying the process.

The important point is to have some scheduling system which eliminates unneccessary exposure of bare soil. Even a simple schedule calendar may do the job.

The inspector will need to coordinate his work with the steps previously described for the job superintendent. He will need to study the plan ahead of time. Participate in the pre-construction conference and explain plan requirements, if explanation is needed. He notes the construction schedule and plans his own schedule accordingly. He will inspect frequently through each stage, but should particularly check to see that all structural measures called for are installed

# ELEMENTARY SCHOOL WORK SCHEDULE



during site preparation. A careful check is called for at the end of each stage in staged developments. Utility construction may be particularly damaging to control practices -- make sure repairs are made immediately.

The inspector should develop and use standard inspection forms to assure proper recording of each inspection. The form should provide space to identify the project, its location, permit number, and date. Space should be provided to record the phase at time of inspection, and whether all practices called for at that phase have been installed. Also, provide space to indicate if structural practices meet design requirements, and to indicate condition of all practices. Note and date beginning of grading, utility construction, and other planned items. If plan is not being followed, record what action is being taken to correct it.

The inspector will find it helpful to develop a checklist of requirements which apply to all jobs. Such a list would include:

1. Is construction of debris basins, traps, interceptor, and diversions done prior to or as a first step in grading? Do they meet program standards and specifications?

2. Is seeding and mulching of debris basins and other structures complete? This should be done as soon as construction is completed. The vegetation is an integral part of the practice, and the practice is not complete until the seeding and mulching is complete.

3. Are storm water management facilities installed prior to or at the beginning of construction activities?

4. Are sediment traps for storm sewer inlets installed as soon as storm sewers are installed?

5. Is temporary vegetation, or if possible permanent vegetation, established as soon as possible after grading is completed?

6. Check all structures for the conveyance of runoff water and make sure the entire system is safe.

7. Is there a daily maintenance check and repair program?

8. Are critical areas delineated and properly protected?

9. Are sediment traps being cleaned after every storm? Are sediment basins cleaned to maintain designed capacity?

10. Are all practices in the plan actually installed?

11. Check for evidence of erosion, even if the plan is being followed, and report the need for adjustments to control it.

12. Check the condition of all vegetative practices.

In cases of non-compliance, report the items needed for compliance to the person responsible for enforcement. Include a recommended time for measures to be completed.

The inspector should always contact the job superintendent. He should point out any hazardous areas or other items which need attention. He may often be able to suggest ways to achieve the desired results more easily and economically. If he must take steps to get compliance, it should be done promptly and firmly.

Questions:

1. Name the seven phases or steps of plan installation that were discussed in this unit. Give the specific things that should be done at each step.

2. Describe one method of work scheduling. (This may be your own system, the one discussed in this unit, or another system.)

3. Discuss the purpose of the pre-construction conference between the job superintendent and inspector.

4. Explain why timing of installation of measures is an important element of erosion and sediment control.

5. List and briefly describe at least ten items which should be given attention during inspection.

6. List the items which should be documented at each inspection.

Summary:

The seven steps in the installation of an erosion and sediment control plan are: (1) study of plan and construction site; (2) pre-construction conference between job superintendent and inspector; (3) site preparation; (4) establishing a checking and maintenance program; (5) grading and utility installation; (6) building construction; and (7) permanent stabilization.

During study of the plan and site, the job superintendent notes the fit of the physical elements of the plan to the land. He may mark out the tentative layout at this time. He notes the scheduling and develops a work schedule for plan installation.

At the pre-construction conference all elements of the plan should be discussed. Come to agreement in interpreting the plan. Make minor adjustments, if needed. Discuss sequencing of installation and scheduling. If major changes appear to be needed, alert the planning engineer and help plan appropriate changes. Check all critical areas and agree on how to protect them.

Site preparation includes marking out and protecting critical areas; constructing all required sediment basins and traps; installing temporary diversions, interceptors, and perimeter dikes; installing storm water management facilities; and seeing that all structures are properly compacted, seeded, mulched, and fertilized.

As soon as these practices are installed, a checking and maintenance program should be started. This is a continuing responsibility through the entire construction period.

The principle point during grading and utility installation is to limit the time of exposure of the bare soil. Prompt seeding and mulching can save many dollars in eliminating costly regrading and cleanout. It is also important to follow the phasing or staging provisions in the plan in order to limit the size of the area exposed at any one time. Sediment traps should be installed on storm sewer inlets immediately upon completion of the sewers. Stockpile areas should be protected.

During building construction, care must be taken to safely handle increased traffic and to safely handle excavated material. Backfilling should be done as soon as possible. Stockpile areas should be carefully chosen and stabilized.

Permanent stabilization should start as early as possible. It is not necessary to wait until all areas can be final graded before beginning permanent seedings. Check with the inspector before removing structural controls. After removing them, seed, mulch, and fertilize the areas of the structures and other areas disturbed during their removal.

Work scheduling may be done on a simple scheduling calendar or by more sophisticated means. Any method requires that all work items be identified, put in proper sequence, and that time requirements be estimated. The flow chart described earlier provides a graphic means of displaying the schedule.

The pre-construction conference does several important things. It helps to get both parties better acquainted with the site and plan. It helps both reach agreement on the elements of the plan. It provides a means of making minor adjustments in the plan. It gives the inspector a better insight into requirements for scheduling inspections.

The proper timing of installation of practices is one of the most important factors in achieving effective erosion and sediment control. It ensures that all the structural water management and sediment control practices are in place and ready to function before the major soil-exposing activities begin. It ensures that the time of exposure of bare soil is held to a minimum. It can keep costs down and reduce time spent in cleanout and repairs.

Inspection should check the entire site and on all elements and practices in the plan. It should also evaluate the effectiveness of controls. Specifically, it should check: (1) installation of sediment basins and other structures required before grading starts; (2) capacities against the design requirements; (3) completeness of installation -- including compaction, seeding, mulch, and fertilizer; (4) storm water management facilities; (5) storm sewer inlet sediment traps; (6) adherence to sequence and staging schedules; (7) maintenance and repair program; (8) protection of critical areas; (9) sediment basin cleanout; (10) on whether all practices called for are actually installed; (11) for evidence of erosion or sedimentation; and (12) the condition of all vegetative practices.

The inspector should use a standard form and record the date, project name, and location. He should record the phase of construction at the time of inspection. Record whether all practices required at that stage are installed and indicate if condition is satisfactory. Record any corrective action needed and what was done about it.