DelDOT

Erosion and Sediment Control Design Guide

2020 Edition

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I PREFACE

This document provides guidelines for the design of erosion and sediment control practices for DelDOT construction projects. It was developed to provide a convenient resource for the analysis and design of erosion and sediment control measures for Erosion and Sediment Control Plans. The guide is intended primarily for use by designers but also provides valuable information for contractors and field personnel. Although it will provide direction in the analysis and design of standard erosion and sediment control practices, it does not preclude innovative or alternative designs as approved by the Stormwater Engineer.

This design guide is intended to be a living document subject to periodic updates and revisions in response to user feedback, changes in technology, and revisions to regulatory requirements. Inquiries and comments may be sent to the DelDOT Stormwater Engineer. The most current version of this document is located on the Department's website: https://deldot.gov/Business/drc/index.shtml?dc=stormwater.

II VERSION HISTORY

Version No.	Date	Description
N/A	April 2020	Initial Implementation

1.0 INTRODUCTION

Soil erosion is a naturally occurring process by which the land's surface is worn away by the action of wind, water, ice, and gravity. This natural and geologic erosion has been occurring at a relatively slow rate since the Earth was formed and it has been a tremendous factor in shaping our planet as we know it today. Both the rolling hills of the Piedmont and the broad expanse of the Coastal Plain are a result of the geologic erosion and sedimentation process in Delaware. Although geologic erosion is vital for maintaining environmental balance, construction activities can result in accelerated rates of erosion and sedimentation where soil surfaces are initially not revegetated. Vegetated cover plays a key role in controlling erosion as it shields the soil surface from raindrop impact, provides a root system to hold soil particles in place, maintains the soil's capacity to absorb water, reduces runoff velocity, and removes subsurface water between storm events through the process of evapotranspiration. If bare soil surfaces are left non-vegetated, the loss of these processes may result in an adverse impact to the environment, such as degradation of surface water quality, damage to adjacent land, and deterioration of aquatic habitat.

Erosion and sediment control (E&S) measures are activities, practices, or a combination of practices designed to protect an exposed soil surface, to prevent or reduce the release of sediment to environmentally sensitive areas, and to promote revegetation as soon as possible. The purpose of this document is to provide design guidelines and considerations so that construction and maintenance activities are carried out in a manner to minimize erosion and sediment transport, particularly where there are potential impacts to environmentally sensitive areas.

The objectives of this guide include the following:

- Provide guidelines and procedures for selecting and designing erosion and sediment control measures for Department projects.
- Provide a platform to assist with educating designers and construction personnel on erosion and sediment control design and analysis.

2.0 EROSION, SEDIMENT, AND STORMWATER MANAGEMENT (ES2M) PROGRAM

NPDES Permit Program

The Clean Water Act of 1972 gave the Environmental Protection Agency (EPA), and states which have delegated authority by the EPA, the power to regulate point sources that discharge pollutants into waters of the United States through the National Pollutant Discharge Elimination System (NPDES) permit program. Point sources are generated from a variety of municipal and industrial operations, including treated wastewater, process water, cooling water, and stormwater runoff from drainage systems. The NPDES permit program helps ensure that Delaware's water bodies can meet their designated uses, such as providing safe drinking water, being safe for swimming and fishing, and supporting aquatic life. In 1987, amendments to the Clean Water Act were passed that allowed the EPA to regulated non-point sources, which includes stormwater runoff from construction sites.

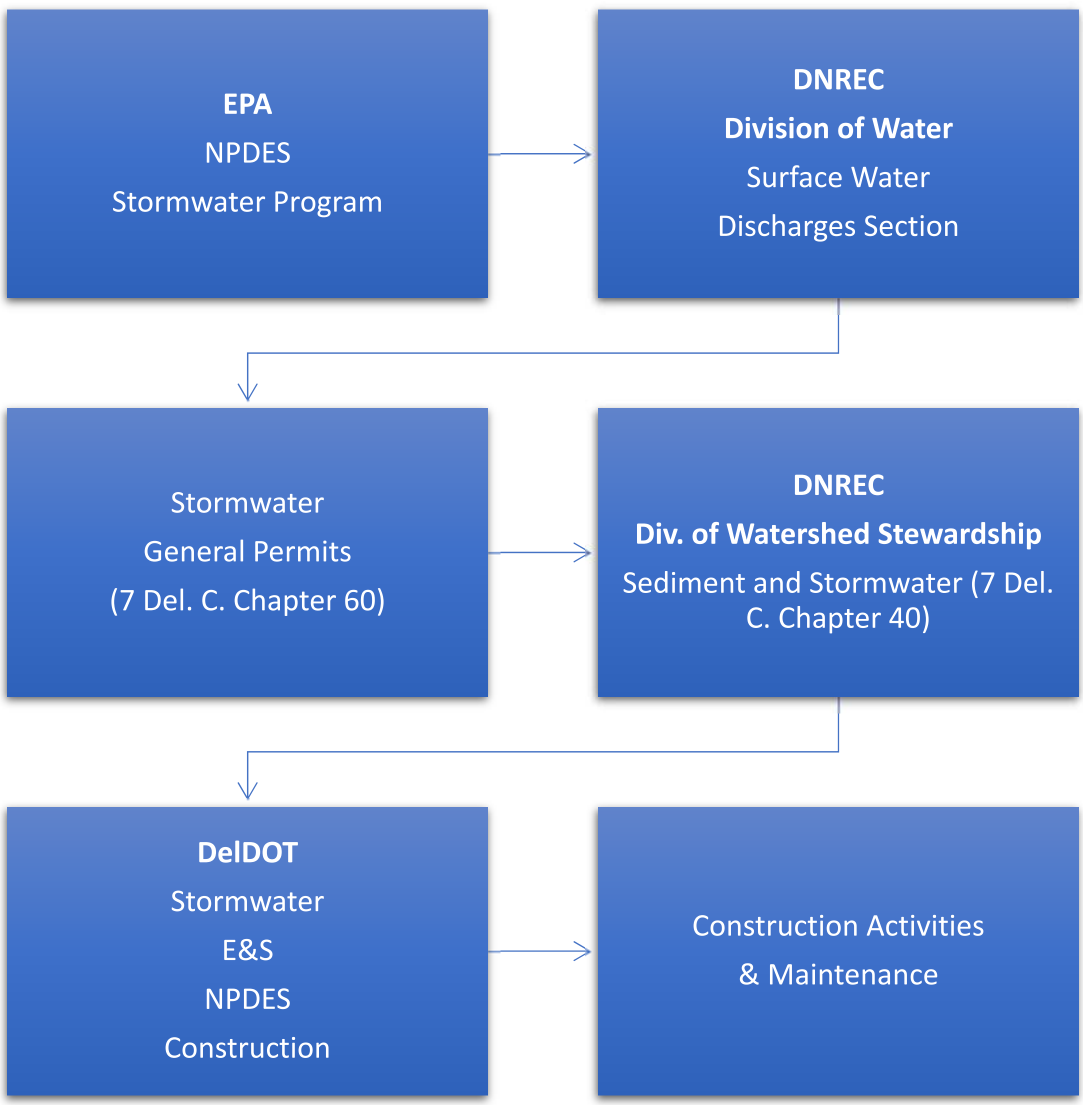
The NPDES permit limits the discharge of pollutants to protect the waters that receive them. The health of a water body is measured by the attainment of its designated uses. For example, pollutants in a waterbody are considered to be eliminated once the potential pollutants in an NPDES discharge have been reduced to levels that allow the receiving waters to meet their designated uses.

Delegation Authority

Management of the NPDES permit program, except for pre-treatment and federal facilities, is delegated to the Department of Natural Resources and Environmental Control (DNREC) under Section 402 of the Clean Water Act and State Law. The Program is managed by DNREC Division of Water under the Surface Water Discharges Section. The Sediment and Stormwater Program, managed by DNREC Division of Watershed Stewardship, provides oversight of the statewide NPDES permit program regarding stormwater management and erosion and sediment control. Within its purview, DNREC has the authority to delegate the implementation of the statewide sediment and stormwater program to conservation districts, counties, municipalities, and other state agencies. The Department has delegation of DNREC's Sediment and Stormwater Program elements. These elements are comprised of stormwater management and Erosion and Sediment Control (E&S) Plan review, construction inspection, and maintenance inspection for all Department projects.

Department Oversight

Delaware's Erosion and Sediment Control Program is regulated by Chapter 40 (Erosion and Sediment Control) of Title 7 (Conservation) of the Delaware Code. Under this law, the Department must ensure that all Erosion and Sediment Control Plans adhere to the Delaware Sediment and Stormwater Regulations (DSSR).



NPDES Stormwater Program Management Oversight Flowchart

3.0 EROSION AND SEDIMENT CONTROL STRATEGY

Department Requirements

The Department requires that the E&S Plan be prepared by experienced individuals or firms. It is the expectation that the contractor will perform the construction work in conformance with the approved plan. Designers, contractors, and construction reviewers are required to meet various responsibilities concerning environmental protection in order to ensure that the project design and delivery is in compliance with applicable environmental laws and regulations.

Designer Responsibility

The designer has the responsibility to prepare the E&S Plan for the project. This plan is provided to the contractor to implement approved erosion and sediment control measures. It is required that the E&S Plan be prepared by or under the supervision of a licensed Delaware Professional Engineer who is experienced with designing erosion and sediment controls for Department projects. The plans must also be signed and sealed by a licensed Delaware Professional Engineer. In addition, it is strongly encouraged that the designer visit the site prior to or while developing the E&S Plan to see firsthand any unique site features that may lead to erosion during construction, but which may not be easily recognizable based on field survey or desktop information alone. Once the plan has been submitted for review, the designer will be responsible for addressing any deficiencies prior to approval from the Stormwater Engineer.

Contractor Responsibility

The contractor has the responsibility to ensure that all erosion and sediment control measures be installed and functioning as intended according to the approved E&S plan, Standard Construction Details, and Standard Specifications. The contractor must also repair or replace any damaged erosion and sediment controls, address site deficiencies, and notify the E&S Engineer of areas where additional erosion and sediment controls may be required but not included on the approved E&S Plan. The Contractor may amend the approved E&S Plan per the approval of the E&S Engineer.

E&S Reviewer/Certified Construction Reviewer (CCR) Responsibility

The E&S Inspector or CCR has the responsibility to report on contractor adherence to the approved E&S Plan by coordinating with the Department, designer, and contractor. The reviewer is also responsible for conducting weekly E&S inspections, preparing inspection reports, and attending preconstruction and progress meetings. Rain event E&S inspections are required on projects that have a Notice of Intent (NOI). Other duties may include performing and documenting vegetative evaluations, water quality and soil sampling/testing, and stormwater facility construction. The CCR shall function under the direction of a licensed Delaware Professional Engineer.

4.0 EROSION AND SEDIMENTATION PROCESS

Erosion

Erosion is a geological process in which earthen materials are worn away by naturally occurring agents through the detachment and transport of soil materials from one location to another, usually at a lower elevation. Natural agents such as wind and water are primarily responsible for this phenomenon but the extent to which erosion occurs can be considerably accelerated by construction activities. Although wind erosion is a common occurrence on construction projects, water is the predominant agent of erosion and sediment transport. As a result, methods of limiting water erosion and sediment transport will be the principal focus of this design guide.

Types

The four types of erosion that result from water include raindrop, sheet, rill and gully, and stream and channel.

Raindrop Erosion

Sheet Erosion

Rill and Gully Erosion

Stream and Channel Erosion

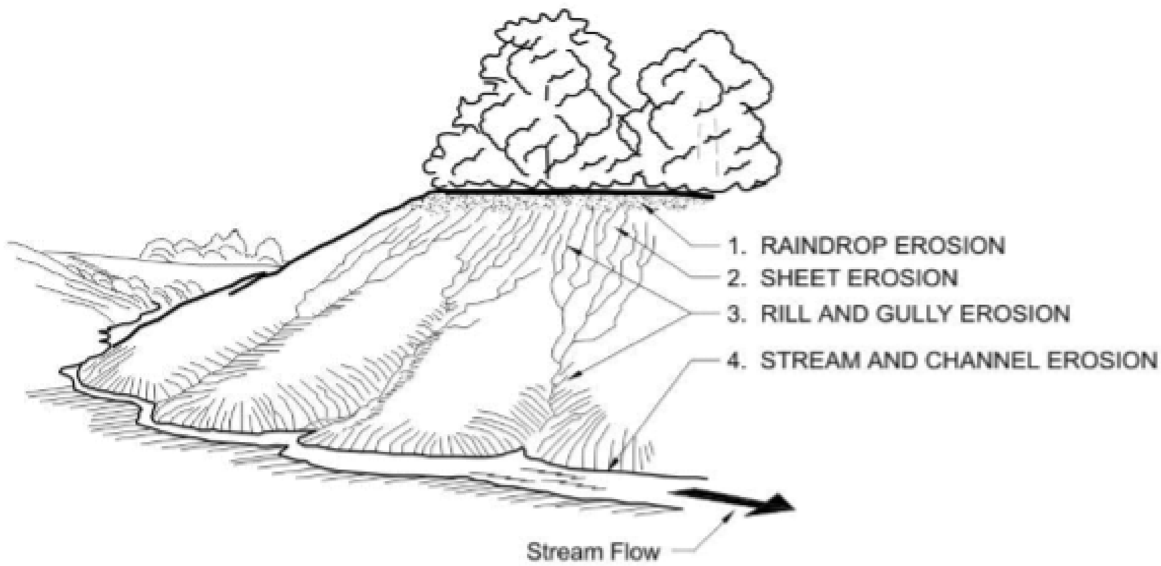
See Appendix for image sources

1. **Raindrop (splash) erosion** is the movement of soil particles caused by the direct impact of raindrops on unprotected exposed soil surfaces.

2. **Sheet erosion** is the movement of soil particles by runoff flowing over the ground surface as an unconcentrated thin sheet layer. Erosion is caused by shear stresses associated with water flow.

3. **Rill and gully erosion** are the movement of soil particles due to the concentration of runoff in depressions (rills) in the ground surface. The erosion potential is significantly greater than sheet flow due to the increased velocity and flow depth. Additional increases in velocity and flow depth further increase the erosion potential which may gradually enlarge the rills into gullies. Depressions or channels with a depth of 4-inches or less are considered rills. These channels run parallel to each other but may converge at some points. Once the channel depth exceeds 4-inches, they begin to form gullies where the width, depth, and flow strength become much more significant.

4. **Stream and channel erosion** are the movement of soil particles on the bed and banks of streams and channels due to concentrated runoff. Scouring, another facet of channel erosion, occurs along channels where eddies form as a result of sudden expansion, contraction, or change in flow direction. Scouring may lead to rapid soil loss from the channel bed or side slopes.



Types of Water Erosion

Factors Affecting Erosion

Erosion occurs as a result of several interacting factors and processes. The four main factors that affect erosion are:

- Climate
- Soil
- Vegetation
- Topography

Climate

Although the regional climate remains relatively consistent throughout the state, storm event duration and intensity may vary for a given return period based on the location of the project site. Rainfall events of greater duration and intensity are more likely to increase the potential for erosion on any given site. The climate of a location indirectly determines the amount of annual precipitation, the length of the growing season, and other factors that affect plant growth and the extent of vegetative cover. In addition, the climate may have a long-term effect on topography, especially in reference to wind eroded gully formation in certain areas of the state. Soil characteristics are also affected by climate. Arid terrain with intermittent intense rainfall events can lead to erosive environments.

Soil

Soil characteristics that have been identified as primarily affecting soil erodibility are particle size distribution and texture, cohesiveness, permeability, and fibrous organic matter content. In general, soils containing high proportions of silt and very fine sand are usually the most erodible. Erodibility typically decreases as the cohesiveness of the soil increases. However, once eroded, clays are easily transported. Well-graded gravel and predominantly gravel mixtures with trace amounts of silt are the least erodible soils. The ability of soil to absorb rainfall or surface runoff is best characterized by its permeability. The potential for erosion is reduced if the soil tends to absorb rainfall or surface runoff as this decreases the volume of water available to cause sheet or rill and gully erosion. However, after a prolonged period of hot and dry weather, there may be a lag time between the onset of rainfall and the start of infiltration due to the unsaturated nature of the exposed surface soils. In this event, the initial amount of runoff may be significant. Overall, topsoil can be effective in reducing or preventing erosion due to its permeability and fibrous nature of its organic material.

Vegetation

In nature, the extent of vegetative cover largely determines the level of erosion that takes place on land. Vegetative cover is a very durable and highly effective erosion control measure. It achieves its objective by shielding the ground from direct rainfall impact, improving soil permeability, reducing runoff velocity, and holding soil particles in place with a root structure from living and dead vegetation (topsoil). Because vegetative cover is so effective in controlling soil erosion, it is usually the primary choice for long-term erosion control.

Topography

Topography refers to the shape, length, inclination, and aspect of a slope. The length and inclination are critical factors with longer and steeper slopes producing greater soil erosion. Slope also affects soil erosion. For example, in Delaware, south-facing slopes tend to dry faster and have a better growing regime than north-facing slopes since slopes on the south side tend to receive more direct sunlight. The shape of a slope also influences the potential extent of erosion. Concave slopes with less inclination at the base are generally less erodible than convex slopes.

Sedimentation is the deposition of soil particles previously held in suspension by flowing water. The phenomenon of sedimentation occurs at those locations experiencing a reduction in flow velocity. Initially, the larger particles settle out and, as the flow velocity continues to decrease, the smaller particles settle, eventually leaving only the clay sized particles. These particles are the smallest and the last to be deposited. Sedimentation can also occur in slower-moving, inactive waterbodies, or in treatment facilities such as stormwater management ponds. Suspended material, particularly fine organic material such as silt, can have low **total suspended solids (TSS)** test values but high turbidity measurements. Both TSS and turbidity can have detrimental effects on the aquatic environment. For the purpose of this design guide, the process of sediment control is equivalent to the control of the sedimentation process.

5.0 DEVELOPING THE EROSION AND SEDIMENT CONTROL PLAN

In Delaware, construction projects may not commence land disturbing activities without an approved Stormwater Pollution Prevention Plan (SWPPP). A SWPPP is comprised of two parts; a Stormwater Management Plan and an E&S Plan. Since this design guide is based solely on erosion and sediment control, stormwater management requirements will not be discussed in detail. However, it is important to note that the Stormwater Management Plan in addition to the E&S Plan must both be completed and approved in order to receive SWPPP approval, thus allowing the project to begin construction.

The only exception where construction projects are exempt from both stormwater management and erosion and sediment control requirements is when the project will disturb less than 5,000 square feet. For all other projects with a land disturbance of 5,000 square feet or more, compliance with the DSSR is achieved through an approved SWPPP that adheres to the stormwater management criteria for either a Standard Plan or Detailed Plan.

Standard Plan	Detailed Plan
Entails a set of pre-defined standards or specifications for minor land disturbing activities that may preclude the need for the preparation of a detailed plan under specific conditions found in Sections 3.7.11 through 3.7.22 of the DSSR.	A plan developed by a licensed Delaware Professional Engineer which does not meet standard plan criteria and involves additional design development of stormwater management Best Management Practices (BMPs) and post-construction stormwater management systems to be compliant.

The key differences between the two types of plans involves the extent of stormwater management design whereas the level of erosion and sediment control design typically remains constant for each plan type. Stormwater management still remains an essential role that must be addressed during design and for conformance with either Standard Plan or Detailed Plan criteria prior to final approval and acceptance. Also, if any construction phase or combination of phases result in 20 or more acres of unstabilized areas at any given time, construction site BMPs shall include supporting design computations for storage, conveyance, stability, and treatment capabilities based on runoff of a 2-year storm event with bare earth conditions. Additional information for stormwater management requirements is provided in the DSSR.

The following sections provide the framework for assessing the site for potential erosion and sedimentation, the general principles for erosion and sediment control, and design guidelines for erosion and sediment control measures.

6.0 SITE ASSESSMENT

Prior to preparing an E&S Plan, it is imperative to evaluate the undeveloped site to identify environmentally sensitive areas and assess site-specific conditions. Understanding the hydrologic and other natural features of the site will aid the designer in preparing a more thorough plan. The site assessment consists of two parts. The first part involves gathering desktop background information while the second part involves visiting the project site to verify the desktop background information and to more accurately assess site conditions.

Background Information

When reviewing the site background information, the designer should use a combination of research tools such as the DNREC's Stormwater Assessment Study GIS Web App, LiDAR contours, and current site aerials to gather information including, but not limited to, existing topographic maps (or field survey), streams and water features, groundwater depths, wetlands, tax ditches, hydrologic soil groups, site development history, existing site features, receiving waters, storm drains, and other stormwater conveyance systems within and adjoining the project site. During the desktop review, the designer can prepare a plan to take with them while conducting the site visit. It is the responsibility of the designer to ensure they have reviewed the appropriate information.

Field Review

The designer responsible for the erosion and sediment control design should conduct a thorough walk-through of the entire project site to assess site-specific conditions such as soil types, drainage patterns, existing vegetation, and topography. Using the information gathered from the desktop review, the designer can verify and confirm the following:

- Existing drainage patterns to see how runoff currently drains from the site.
- Location of all discharge points. Discharge points may also be used as points of analysis for bare earth condition design if the project proposes to disturb 20 acres or more at any given time during construction.
- Slopes and slope lengths, as these topographic features are a major factor affecting erosion on the site.
- General soil type/consistency to estimate erosion potential.
- Major and minor areas of flooding or ponding water, which may become hot spots for erosion and sediment transport.
- Pollution or pollution sources such as soil contamination from the prior use of the site.
- Natural and manmade features, including trees, streams, wetlands, slopes, structures, etc. that may need to be protected or affect the installation E&S controls.

7.0 GENERAL PRINCIPLES FOR AN EFFECTIVE EROSION AND SEDIMENT CONTROL PLAN

Effective erosion and sediment control is comprised of two key elements. First, the soil surface must be protected from the erosive forces of wind, rain, and runoff. Second, the eroded soil must be retained on-site. Erosion control is the prevention or minimization of soil erosion. Sediment control is the trapping of suspended soil particles. Erosion control is the preferred approach although sediment control is necessary because some erosion is unavoidable. The following principles form the basis for creating an effective E&S Plan.

Minimize Disturbance

Minimizing the amount of clearing and grading reduces the area where bare soil becomes exposed. Where site conditions allow, this is the most cost-effective method for reducing soil erosion. It is critical to accurately identify the limits of disturbance on the E&S Plan.

Phase Construction to Limit Soil Exposure

Site construction is often a long process. Each phase should be given careful consideration for its duration and not be treated as a snapshot in time. Plan construction activities in a sequence of phases that minimize the soil area exposed at one time and reduce the length of time between initial exposure and final grading as much as possible.

Consider Contributing Drainage Areas

In most instances, phased construction activities may overlap multiple drainage sub-areas within the project limits. Place erosion and sediment controls on the plans based on each contributing drainage sub-area starting at the outfall location within the project limits and working upstream. The sequence of construction may warrant the installation of additional controls outside the current phased work area in order to prevent erosion or sedimentation.

Install Perimeter Controls

All perimeter locations where disturbed areas could contribute to sediment laden runoff leaving the project limits shall show the installation of sediment control devices. This could be as simple as silt fence or a more complex stream diversion setup. Also, consider if the potential runoff will be sheet or concentrated flow when installing perimeter controls.

Protect Steep Slopes and Cuts

Topography significantly influences the amount of erosion, particularly for slopes steeper than 4:1. It is recommended to minimize creating or disturbing steep slopes where possible or to safely convey flows through or around them.

Stabilize Bare Ground

Temporary erosion control measures, such as seeding and mulching, can significantly reduce erosion within the site. In general, the erosion potential from bare ground is over 15 times greater when compared to ground with a mulch cover and 100 times greater when compared to ground with established vegetation. As a result, the sequence of construction needs to ensure soil is stabilized as soon as possible.

Protect Waterways and Stabilize Drainage Courses

Construction and the resulting sedimentation can severely impact natural waterways, which requires sufficient sediment controls and protection by a buffer when feasible. Engineered drainageways, such as swales, have the potential to transport sediment even if they are properly designed. If possible, use waterway construction practices to divert clean water around disturbed areas while safely conveying runoff with minimal erosion.

Employ Flocculants

When sediment traps and basins are used to retain sediment, design features such as improved outlet devices or flocculants can greatly enhance sediment retention by causing solids to aggregate and precipitate to the bottom of the sediment trapping device.

8.0 EROSION AND SEDIMENT CONTROL DESIGN GUIDELINES

Selecting erosion and sediment control practices, adjusting them to specific site conditions, and arranging them into a system for preventing erosion and controlling sediment mobilized by site runoff is not a static process. The controls installed prior to initial site clearing may need to be adjusted and supplemented by other needed practices as site grading activities increase. Effective site management requires a continuous program of adaptive responses to changing conditions, including installing erosion and sediment controls, monitoring their effectiveness, adjusting and augmenting them with other practices, and staying ahead of the construction operation and maintenance challenges. The designer shall take these factors into account when preparing the E&S Plan. The following standard erosion and sediment control measures provide a general description, applicability, design criteria, and considerations to aid the designer with developing the E&S Plan.

8.1 SEDIMENT TRAPPING DEVICES

There are two main types of sediment trapping devices used on construction projects. The first one involves the physical filtration of sediment by trapping soil particles as water passes through such as silt fence or compost filter logs. The other type involves the settling process, which allows sediment to fall out of inflows that are slowed and temporarily impounded in stormwater management ponds, traps, or in small pools created by berms or compost filter logs. The following information addresses the applicability and design of sediment trapping devices.

8.1.1 SILT FENCE, REINFORCED SILT FENCE, SUPER SILT FENCE

Description

Silt fence, reinforced silt fence, and super silt fence are sediment trapping devices that provide a temporary barrier of woven geotextile fabric used to intercept sediment laden runoff via sheet flow from small drainage areas of disturbed soil. The purpose is to filter sediment laden runoff and allow sediment deposition to occur along the inside perimeter of the fence.

Applicability

It is only feasible for non-concentrated, sheet flow conditions due to the porosity of the geotextile fabric. The maximum service life is limited to its ultraviolet stability or if it has been damaged due to construction activities, such as buildup of excess sediment, undercutting, sags, tears, or other failures.

Design

No design computations are required for these devices other than verifying the steepness of the upstream side slope and the slope length. Refer to Standard Construction Details. All types of fence shall be placed downstream of disturbed areas and as parallel as possible to the contour line. The areas downstream of the fence must be undisturbed or stabilized. Ensure silt fence is installed in sheet flow conditions only. Any concentrated flows directed toward the fence will overwhelm the geotextile with sediment, thus overtopping the fence and releasing sediment. Also, the ends of the silt fence shall be turned upslope to prevent sediment from escaping. The type of silt fence specified for each location on the plan shall meet the maximum slope length requirements shown in the table below. For scenarios that exceed the maximum slope length, the designer should consider employing compost filter logs or diversions as mid-slope treatment options to maintain sheet flow conditions in the upstream contributing drainage area.

SLOPE	STEEPNESS	MAXIMUM SLOPE LENGTH		
		SF	RSF	SSF
S < 33%	S < 3:1	L ≤ 75'	75' < L ≤ 150'	L > 150'
33% ≤ S < 50%	3:1 ≤ S < 2:1	L ≤ 50'	50' L ≤ 100'	L > 100'
S ≥ 50%	S ≥ 2:1	N/A	L ≤ 50'	L > 50'

Maximum Slope Lengths for Silt Fence Installations


Silt Fence


Reinforced Silt Fence


Super Silt Fence

Considerations

Compost filter logs (minimum 18” diameter) or other approved E&S controls may be used in lieu of silt fence in hard to reach areas or where trenching is not possible due to tree roots, uneven ground, impervious or frozen ground cover, or proximity to environmentally sensitive areas.

For situations where adjacent side slopes warrant the installation of silt fence but also experience a longitudinal slope along the fence line, the designer should consider temporary swales or berms or direct the concentrated flow away from running along the silt fence. If site conditions do not allow for temporary diversion swales or berms, additional segments of silt fence or compost filter log may be installed perpendicular to the silt fence containing sediment from the adjacent side slope to reduce concentrated flow velocity and minimize erosion and sedimentation. This type of installation shall be discussed with the Stormwater Engineer prior to submitting the E&S Plan.

8.1.2 SEDIMENT BASIN/TRAP

Description

A sediment basin/trap functions as a sediment control device formed by excavation and/or embankment with a controlled outlet to intercept and detain sediment-laden runoff, resulting in the settling of suspended sediment, which protects drainageways, properties, and rights-of-way downstream of the device from sedimentation.

Applicability

A sediment basin/trap is typically installed in a drainageway or at points of discharge from a disturbed area. A sediment basin can be a temporary or permanent sediment control device. It is considered a temporary device when runoff from the contributing drainage area is greater than 2 acres and when it will be removed prior to the end of construction. It is considered a permanent device if it will be converted to a permanent stormwater facility during the final stages of construction.

A sediment trap is a temporary sediment control device with a contributing drainage area of less than 2 acres. It is intended to be constructed in-line with an existing, proposed, or temporary ditch or at concentrated points of discharge from a disturbed area. The sediment trap will be removed prior to the end of construction. Refer to Standard Construction Details.

Design

The designer shall size the volume of a sediment trap or temporary sediment basin to be a minimum of 3,600 cubic feet per acre of contributing drainage area with a maximum drainage area dependent on outlet type. The 3,600 cubic feet is equivalent to 1-inch of sediment per acre.

Minimum required volume for a sediment trap/basin is based on the following equation:

$$V = 3{,}600\ x\ C.D.A.$$

V = Minimum required volume of sediment trap/basin (ft^3)
C.D.A. = Contributing Drainage Area (Ac.)

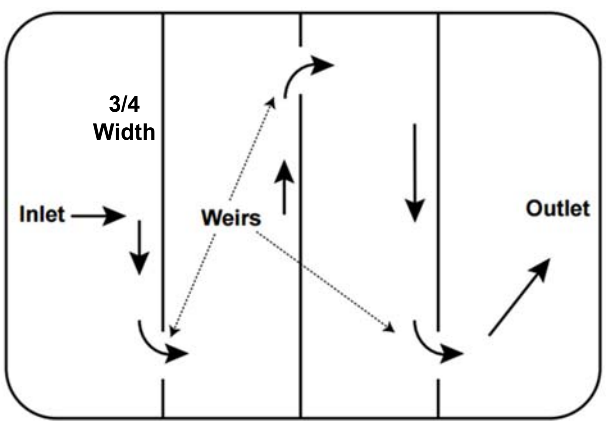
For temporary sediment basins, the designer shall design a wedge-shaped basin with the inlet located at the narrow end whenever possible. The sediment traps or temporary sediment basins, the length to width ratio shall be 2:1 or greater. For sediment traps, when the minimum length to width ratio cannot be achieved, the designer shall incorporate solid or porous baffles into the sediment trap design to increase settling time. Solid baffles are the simplest to install, but porous baffles are more efficient.

Solid Baffles

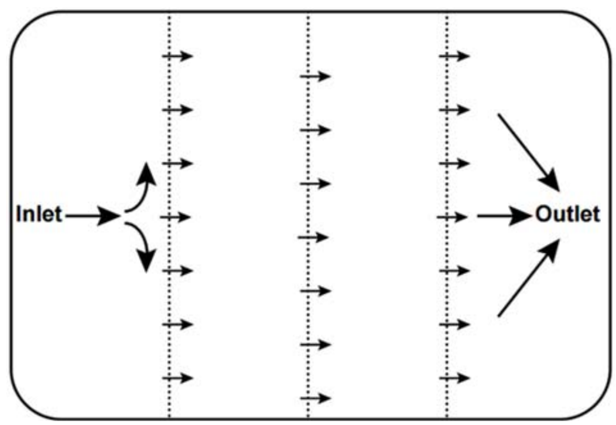
Solid baffles lengthen the flow path of the incoming sediment discharge which maximizes the area of the sediment trap to be used for sedimentation. Solid baffles may consist of plywood or similar materials installed three quarters across the width of the trap or along the entire width of the trap with a notch or weir cut into the baffles at opposite ends to create a long, back-and-forth path. The weir should be sized to accommodate the design storm event and safely convey larger storm events to stabilized outfalls.

Porous Baffles

Porous baffles are more effective at improving a sediment trap's efficiency by using materials that do not block the incoming flows as much as solid baffles. Porous baffles may consist of jute net with Polyacrylamide (PAM) flocculants or other similar materials. As sediment laden water enters the sediment traps and flows through the baffle material, velocity is significantly reduced which allows the water to back up and spread across the entire width of the baffles, therefore increasing sediment deposition.



Sediment Trap with Solid Baffles



Sediment Trap with Porous Baffles

Placement

Sediment traps and temporary sediment basins shall be placed so they can be installed prior to grading or filling in the drainage area they are to capture, and they are to remain functional throughout construction. The designer shall consider the physical space required to install the sediment trap/basin based on its design dimensions and the proposed construction activity (i.e. embankment construction) by providing additional room within the Limit of Construction (LOC) and/or Temporary Construction Easement (TCE) for construction equipment and personnel to maneuver around the sediment trap. Ideally, sediment traps and temporary sediment basins should be located where they can obtain the maximum storage benefit from the terrain and for ease of cleanout and disposal of the trapped sediment.

The designer can choose from two types of sediment trap/temporary sediment basin outlets based on function, location, and drainage area. The two types include pipe outlet and riprap outlet. A description of each one is provided below.

Pipe Outlet

A pipe outlet sediment trap or temporary sediment basin consists of a trap or basin formed by excavation or embankment. The outlet is comprised of a perforated riser and a pipe through the embankment. The pipe outlet sediment trap/basin may be used for drainage areas up to a maximum of 5 acres. The outlet shall be designed as follows:

1. The required storage for this trap/basin shall be at least 3,600 cubic feet per acre of contributing drainage area with the volume measured from the bottom up to the crest elevation of the outlet. Wet pool storage will enhance performance and shall be provided whenever practicable, but it is not required. For sediment traps/basins with a wet pool, the volume may be equally divided between the permanent pool storage and dry storage up to the crest elevation of the outlet.
2. The outlet pipe and riser shall be comprised of corrugated metal with a minimum diameter of 15-inches and capable of attaching a skimmer dewater device. All pipe connections shall be watertight.
3. The top of the embankment shall be at least 1.5-feet above the crest of the riser. An overflow spillway shall be stabilized with riprap underlain with geotextile.
4. The top two-thirds of the riser shall be perforated with 1-inch nominal diameter holes or slits spaced 6-inches vertically and horizontally and placed in the concave portion of the corrugated metal pipe. No holes or slits will be allowed within 6-inches of the top of the horizontal barrel.
5. The riser shall be wrapped with 0.25 to 0.5-inch hardware cloth mesh wire then wrapped with filter cloth at least 6-inches above the highest hole and 6-inches below the lowest hole. The top of the riser pipe shall not be covered with filter fabric.
6. The riser shall have a base with enough weight to prevent flotation of the riser. Two approved bases are: a 12-inch thick concrete base with the riser embedded 9-inches into the concrete base, or a minimum 0.25-inch thick steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The steel plate shall have 2.5-feet of stone, gravel, or earth placed on it to prevent flotation. In either case, each side of the square base dimensions shall be equal to the riser diameter plus 24-inches.

Riprap Outlet

A riprap outlet sediment trap or temporary sediment basin consists of a trap or basin formed by excavation and embankment. The outlet is constructed through a partially excavated channel lined with riprap underlain with geotextile. The outlet channel shall discharge to an appropriately stabilized area or to a stable watercourse. The riprap outlet may be used for drainage areas of up to a maximum of 10 acres. The outlet shall be designed as follows:

1. The required storage for this trap/basin shall be at least 3,600 cubic feet per acre of contributing drainage area with the volume measured from the bottom up to the crest elevation of the riprap outlet channel. Wet pool storage will enhance performance and shall be provided whenever practicable, but it is not required. For sediment traps/basins with a wet pool, the volume may be equally divided between the permanent pool storage and dry storage up to the crest elevation of the outlet.
2. The maximum height of embankment shall not exceed 5-feet.
3. The elevation of the top of any dike directing water to a riprap outlet sediment trap/basin shall equal or exceed the minimum elevation of the embankment along the entire length of the trap/basin.

Embankment

All embankments for sediment traps shall not exceed 5-feet in height as measured at the low point of the original ground along the centerline of the embankment. Embankments shall have a minimum top width of 4-feet and side slopes of 2:1 or flatter.

All embankments for temporary sediment basins shall not exceed 15-feet in height as measured at the low point of the original ground along the centerline of the embankment. Embankments shall have a minimum top width of 10-feet. The inside side slopes of the temporary sediment basin shall be 2:1 or flatter and the outside side slopes shall be 3:1 or flatter.

Excavation

Excavated portions of sediment traps and temporary sediment basins shall have side slopes of 2:1 or flatter. For sediment traps/basins that require a depth greater than 3-feet, the designer shall provide a minimum 10-foot safety bench.

Inflow

Additional design consideration shall be provided to ensure non-erosive flow to all major points of inflow into sediment traps/basins. In many instances, the difference in elevation of the inflow and the bottom of the trap/basin is considerable, thus creating potential for severe gullying and sediment generation. Diversions, grade stabilization practices, or other water control devices shall be installed as necessary to control runoff and protect points of entry into the trap/basin. Points of entry should be located to maximize the travel distance of the incoming runoff to the outlet from the trap/basin.

Outlet

The outlet shall be designed and constructed to minimize sediment leaving the trap/basin and to prevent erosion at and below the outlet. Sediment traps/basins shall provide non-erosive flow to the receiving downstream ground, channel, watercourse, or storm drain system.

Considerations

Sediment basins or traps shall be constructed and become functional prior to any land disturbing activity to the upstream contributing drainage area. The designer shall consider the timing of the installation when developing the sequence of construction.

8.1.3 INLET SEDIMENT CONTROL, DRAINAGE INLET/CURB INLET/CULVERT INLET

Description

Inlet sediment control involves installing a barrier around a drainage inlet or a culvert opening to temporarily collect and filter sediment laden water to prevent sediment from entering into the inlet of a closed storm drain system. Inlet sediment control should be employed when the drainage area to an inlet is disturbed, when it is not possible to temporarily divert the storm drain outfall into a sediment trap, or when watertight blocking of the inlets is not advisable.

Applicability

Each proposed and existing inlet within and immediately downstream of the project site shall have inlet sediment control shown on the E&S Plan, particularly those inlets located downstream of a disturbed area. The three types of inlet sediment control are drainage inlet, curb inlet, and culvert inlet. A description of each one is provided below.

Design

No design computations are required. Refer to Standard Construction Details.

Inlet Sediment Control, Drainage Inlet

This type of inlet protection shall be installed on drainage inlets located in open space areas such as ditches, medians, and sump areas. It is the preferred type when site conditions allow because it provides considerable temporary ponding. If the drainage inlet is not located at a low point, the designer shall install check dams downstream from the inlet to reduce high velocities caused by the upstream runoff bypassing the drainage inlet. An alternate application includes installation of a compost filter log around the perimeter of the drainage inlet to provide safe ponding as conditions allow per approval from the Stormwater Engineer.

Inlet Sediment Control, Curb Inlet

This type of inlet protection shall be installed on drainage inlets where Inlet Sediment Control, Drainage Inlet cannot be installed. The applicable drainage inlets are located in areas consisting of impervious cover such as parking lots, sidewalks, roadways, curbs, etc. Since this type of inlet sediment control provides significantly less ponding than Inlet Sediment Control, Drainage Inlet, it is inherently much less effective. However, this type of inlet sediment control is necessary since Inlet Sediment Control, Drainage Inlet cannot physically be installed due to impervious ground cover and having vertical obstructions within areas of pedestrians and motorists poses serious safety issues. As a result, additional controls shall be placed upstream, such as check dams or sediment traps, to reduce the velocity and sediment load to this type of inlet sediment control, where practicable. It is imperative that additional controls be placed upstream of inlets with significant contributing drainage areas, especially ones that are unstabilized, when using this type of inlet sediment control. In addition, for curb inlets with a throat opening along the face of the curb, additional controls (i.e. compost filter logs) are required to prevent sediment entering the drainage inlet. An alternate application involves placing a sandbag over the tail flap of the sediment bag to divert runoff away from the throat opening under normal storm events while still allowing the inlet to intercept stormwater under larger storm events.

Inlet Sediment Control, Culvert Inlet

This type of inlet protection shall be installed at the upstream end of a pipe inlet where drainage and curb inlet sediment controls are not applicable. The designer shall install a compost filter log check dam barrier surrounding the pipe inlet to capture sediment before it enters the upstream end of the culvert. For large contributing drainage areas or will runoff will result in ponding greater than 14-inches for the 1-year storm event, the designer shall consider using stone or triple stacked compost filter logs in lieu of a single compost filter log. The designer will adapt the size and shape of the check dam per the Standard Construction Detail.

Considerations

It may be necessary to switch from one type of inlet sediment control to another during the normal course of construction as top units are installed on inlet boxes and as the surrounding drainage areas change cover type and/or become stabilized. As a result, the sequence of construction and the item quantities for each type should reflect this transition accordingly.

8.2 DEWATERING PRACTICES

Dewatering practices are used to remove sediment in ponds, sediment basins and traps, and from water that is pumped or otherwise discharged from foundations, trenches, excavations, cofferdams, and other low areas. The following information addresses the applicability and design of dewatering practices.

8.2.1 PORTABLE SEDIMENT TANK

Description

A portable sediment tank is a portable device through which sediment-laden water is pumped and filtered. The purpose of the sediment tank is to trap and retain sediment prior to discharging the water.

Applicability

A portable sediment tank may be used on sites where space is limited or has topographical challenges, such as projects located in urban or well-developed areas or areas with adjoining steep slopes.

Design

Refer to Standard Construction Details. The portable sediment tank location shall be shown on the plan. The maximum pump discharge into a portable sediment tank is 125 GPM. If higher flow rates are required, several unconnected or connected in parallel portable sediment tanks may be used to provide adequate dewatering. Alternative types of portable sediment tanks may be used per the approval of the Stormwater Engineer.

The designer shall carefully consider the location of the device. The portable sediment tank shall be located on a level surface or side slope flat enough to allow it to function properly. In addition, it shall be positioned for ease of clean-out and disposal of the trapped sediment and to minimize interference with construction activities and pedestrian traffic. The LOC shown on the plan shall provide enough room to accommodate the physical size of this device for installation, removal, and maintenance.

8.2.2 SUMP PIT

Description

A sump pit is a temporary pit that is constructed to trap sediment and filter water for pumping to a suitable discharge area. Its purpose it to remove surface water from excavations while minimizing sedimentation. In addition, sump pits can be used to dewater other erosion and sediment control practices, such as sediment traps and basins, when directed by the Engineer.

Applicability

The sump pit shall be constructed in all areas where surface water collects and must be pumped away during excavation, cofferdam dewatering, or maintenance or removal of sediment traps and basins.

Design

No design computations are required. Refer to Standard Construction Details. Sump pit locations shall be identified on the plans. When determining sump pit locations on the plans, the designer shall consider the diameter of the sump and its location within the lowest excavated portion of the work area relative to the LOC.

The designer shall ensure that any turbid discharge from the sump pit must pass through an additional sediment trapping device prior to ultimate discharge from the project site.


8.2.3 SKIMMER DEWATERING DEVICE

Description

A skimmer dewatering device is an appurtenance to a sediment trapping structure consisting of a perforated pipe drain that floats on the surface. As the sediment trapping structure fills with water, the skimmer drains the cleanest water from the basin to maximize settling.

Applicability

A skimmer dewatering device shall be installed where the discharge from a sediment trapping structure can be accomplished via gravity flow. In general, this device shall be the preferred option.

Design

No design computations are required. Refer to Standard Construction Details. One skimmer is required per outlet structure. The number of skimmers and their locations shall be determined by the designer and included on the plans. The designer shall provide additional details for outlet structures that do not provide an orifice or do not provide an orifice large enough to accommodate a watertight connection to the skimmer drain pipe.

8.3 WATER CONTROL PRACTICES

Water control practices are used to reduce the velocity of concentrated flows, safely convey construction site runoff, and provide a limited barrier for sediment to reduce the potential for erosion of ditches and slopes located within the project limits and receiving areas downstream of the site. The following information addresses the applicability and design of water control practices.

8.3.1 CHECK DAM

Description

A check dam is a small dam constructed across a swale or channel which acts as a grade control structure. Its purpose is to reduce the velocity of concentrated flows, thereby reducing erosion of the swale or channel. Although this practice may also trap small amounts of sediment generated in the swale or channel, it is not intended to be a sediment trapping practice and should not be used as such.

Applicability

The check dam is intended for use in small open channels. Check dams may be installed as temporary structures during the construction phase or may remain as permanent stormwater management structures. They should not be used in a free-flowing stream.

Design

Check dams shall be shown on the plan per their designed spacing. Refer to Standard Construction Details. When using multiple check dams in a channel, the designer shall start by placing one check dam at the outfall point and then work upstream to place all subsequent check dams. The check dams shall be placed to provide maximum velocity reduction, such as in reasonably straight sections of a channel, in order to minimize the potential for erosion due to curves in the channel. For spacing, the check dams shall be placed so that the toe of the upstream dam is at the same elevation as the top of the downstream dam. For channel slopes less than 1%, the maximum check dam spacing is 200 feet. For a 1-year storm event that generates ponding greater than 14-inches, the designer shall consider using stone or triple stacked compost filter logs in lieu of a single compost filter log.

Check dam spacing is based on the following equation:

$$X = \frac{Y}{S}$$

X = maximum check dam spacing (ft)
Y = check dam height (ft), use 1.5' for compost filter log and 2.0 feet for stone check dam
S = channel slope (ft/ft)

Compost filter log check dam length is based on the following equation:

$$L = B_W + 4$$

L = Length of compost filter log check dam (ft)
B_W = bottom width of the swale or channel (ft)

The designer shall show the ends of the check dam curving slightly upstream, resembling a crescent shape. All swales, whether temporary or permanent, shall be lined Erosion Control Blanket Mulch (ECB) along the flow line and receive appropriate seeding immediately after construction.

Considerations

For slopes greater than 10%, the designer shall perform shear stress calculations to verify the channel is capable of supporting velocities in excess of 3 ft/s. If not, check dams may not be practical and additional channel erosion and energy dissipation devices shall be considered.

8.3.2 TEMPORARY SLOPE DRAIN

Description

A temporary slope drain is a temporary, flexible conduit used to convey water down a slope where there is a high potential for erosion. A drainage channel or swale at the top of the slope typically directs upgradient runoff to the pipe entrance for a safe and non-erodible conveyance down the slope.

Applicability

A temporary slope drain shall be used where concentrated flow of surface runoff must be conveyed down a slope or where there is a high potential of flow concentration or rill development.

Design

The designer shall employ temporary slope drains with a 15" diameter to safely convey runoff from a 2-year storm event with bare earth conditions. The size of the contributing drainage area may warrant multiple temporary slope drains to be installed. Refer to Standard Construction Details. If the design runoff exceeds full flow capacity, the designer shall employ additional temporary slope drains as needed. The temporary slope drain pipe outlet must discharge to a temporary or permanent stabilized outfall (i.e. riprap energy dissipator) and then into a sediment trapping device such as a sediment basin or trap.

8.4 SOIL STABILIZATION PRACTICES

Soil stabilization practices are used to cover bare soil and to reduce the potential of soil erosion during construction. It is critical to promptly stabilize soils after construction activities have stopped on any portion of the site. Temporary stabilization techniques shall be employed throughout the duration of the project. The following information addresses the applicability and design of soil stabilization practices.

8.4.1 VEGETATIVE STABILIZATION

Description

Vegetative stabilization involves the planting of vegetation, by means of seeding and mulching, to provide stabilization on disturbed areas which reduces damage from sediment and runoff to downstream or off-site areas. The grade of the slope plays a key part in determining the applicable mulch for erosion control.

Applicability

There are two general types of vegetative stabilization: temporary and permanent.

Temporary stabilization is intended to temporarily stabilize the soil and provide protection to disturbed areas that will be inactive for an extended period or until permanent stabilization or other erosion control measures are established. Additionally, soil stabilizers are an acceptable alternate to seeding and mulching due to seasonal or time constraints to achieve adequate stabilization.

Permanent stabilization is intended to permanently stabilize the soil on disturbed areas by establishing perennial vegetation. This type of stabilization requires the preparation of the seedbed, selection of an appropriate seed mixture, proper planting techniques, and protection of the seeded areas with mulch.

Design

No design computations are required for seeding. For mulching, the designer shall select the appropriate type by calculating shear stress assuming uniform flow along the side slopes of an open channel or embankment using the following equation:

$$\tau = \gamma \; x \; d \; x \; S$$

τ = Shear Stress (lb/ft^2)
γ = unit weight of water (assume 62.4 lb/ft^3)
d = depth of flow (ft)
S = energy gradient (ft/ft)

Following soil disturbance or redisturbance, temporary stabilization shall be completed within 14 calendar days on all disturbed or graded areas unless otherwise directed on the E&S Plans.

All temporary swales shall be lined with an Erosion Control Blanket Mulch (ECB) as per the Approved Product List (APL).

All permanent swales shall be lined with the appropriate mulch blanket per the manufacturer on the APL and extend a minimum of 2-feet upslope from the bottom of swale. The selected blanket shall be shown with the centerline of the blanket matching the centerline of the swale and extending upslope. Depending on the depth of flow, side slope, and length, the side slopes may require matting in excess of 2-feet upslope.

The designer shall also provide adequate seeding and mulching quantities for stabilization to account for land disturbing activities in each construction phase and the maintenance required to fully cover the site and establish vegetation. Although permanent seeding and mulching quantities will be calculated separately as part of the Construction Plans, it is recommended to provide additional temporary seeding and mulching quantities in the Engineer's Estimate. The table below provides guidelines for additional temporary seeding quantities for projects of various sizes and construction durations.

DURATION	PROECT SIZE		
	SMALL	MEDIUM	LARGE
SHORT (< 2 MO)	1X	2X	-
REGULAR	3X	5X	7X
LONG (> 1 YR)	-	8X	10X

Recommended Additional Quantities for Temporary Seeding

8.4.2 STABILIZED CONSTRUCTION ENTRANCE

Description

A stabilized construction entrance is intended to dislodge soil and other debris from construction equipment and vehicle tires prior to exiting the construction site from the project limits onto the roadway or other impervious surface leading to the roadway away from the project site. Its purpose is to prevent site access points from becoming sediment sources. It also reduces the need to remove sediments from adjacent streets or roadways.

Applicability

A stabilized construction entrance shall be used at all points of construction egress.

Design

No design computations are required. Refer to Standard Construction Details. Stabilized construction entrances shall be shown on the plan at all points of construction egress. Vehicles leaving the site must travel over the entire length of the pad. If the entrance creates an opening in the perimeter silt fence, the designer shall tie the ends of the silt fence into the entrance to provide a continuous sediment barrier. If the entrance is placed across a ditch or other open drainage conveyance system, the designer shall ensure the entrance will not impede drainage by placing a culvert or other necessary drainage structures in the conveyance channel.

In lieu of traditional stone, alternate forms of stabilized construction entrances are acceptable per approval from the E&S Engineer, such as HDPE mats. These mats are typically lined with small raised pyramids which scrape, clean, deform, and wipe debris from the tires of passing construction vehicles prior to exiting the site. These types of mats may be more economical depending on project scope.

Considerations

The designer shall consider providing additional quantities in the Engineer's Estimate for stone topdressing to account for voids in the stone being filled with sediment as construction equipment enters and exits the site throughout the duration of the project. The additional quantities should be based on multiple factors including, but not limited to, anticipated traffic volume, length of service, site erosion potential, etc.

8.5 WATERWAY CONSTRUCTION PRACTICES

Waterway construction practices are used to reroute water from a stream or restrict flows to a designated portion of the stream channel to allow for construction activities to take place in the stream, along the banks, or beneath the active channel. The primary purpose of these practices is to allow for construction to occur in dry or dewatered conditions, providing conveyance of stream discharges, and protecting water quality by passing upstream flows, up to a specified design storm event threshold, around the active construction zone. The following information addresses the applicability and design of water control practices.

8.5.1 STILLING WELL

Description

A stilling well is a riprap-lined plunge pool placed within the stream channel and located immediately upstream of the proposed upstream sandbag dike or cofferdam. A dewatering hose, occasionally with a float attached to the suction end, pumps clean water out of the stilling well through the sandbag dike and around the work area to the downstream receiving channel onto a stabilized outfall.

Applicability

A stilling well shall be used for waterway construction practices in combination with sandbag dikes, sheet piles, cofferdams, etc.

Design

Stilling well locations and dimensions shall be shown on the plans. The minimum size of the stilling well shall be 5’ X 5’. Refer to Standard Construction Details.

8.5.2 SANDBAG DIKE

Description

A sandbag dike is a type of waterway construction practice consisting of sandbags, impervious sheeting, a built-in weir, and in some instances, a flexible diversion pipe. The sandbags are installed upstream and downstream of the work area within the stream channel to hold back water. The weir or flexible pipe diverts the base flow of the stream to a stabilized outfall downstream of the work area. Its purpose is to prevent sediment from entering a water body due to construction activities within the stream channel.

Applicability

A sandbag dike is generally applicable for all streams with constant flow and for streams with intermittent/seasonal flow depending on what time of year and how long construction activities are to occur. They may also be applicable for use in ditches, channels, swales, and excavations. Streams with higher flows or a wide channel cross-section or larger projects that require major encroachment into the watercourse may warrant the installation of sheet piles to create a cofferdam.

Design

The sandbag dike stream diversion shall be designed to divert the flows listed in the Stream Diversion Sizing Table. In addition, the maximum elevation of the top of the sandbag dike or sheet piles must be 6-

inches below the top of bank elevation. The designer shall provide a weir sized to accommodate flows greater than the stream diversion flow specified in the Stream Diversion Sizing Table but shall not exceed the 2-year storm event. Refer to Standard Construction Details.

CONSTRUCTION TIME	DESIGN STORM EVENT
1 - 30 days	Estimate of Ordinary High Water or Base Flow
31 – 90 days	25% of the 2-year storm
91-150 days	50% of the 2-year storm
151 days or more	100% of the 2-year storm

Stream Diversion Sizing Table

If streamflow data is not available to determine stream base flow, the designer may approximate stream discharge by using simple field methods to estimate velocity and the cross-sectional area of the stream.

The designer can use the Float Method to estimate stream velocity. This method involves an open reel tape measure, stopwatch, and a floatation device (e.g. foam ball, tennis ball, float, etc.) to determine the time it takes for the float to travel over a preset distance.

The designer can also estimate the cross-sectional area of the stream channel by using an open reel tape measure and survey rod. By holding the open reel tape measure across the stream channel, the designer can use the survey rod to measure the vertical distance from various points along the channel bottom (or at fixed intervals along the tape measure) to the water surface elevation to develop a cross-section. If the channel shape varies greatly, multiple sections shall be measured to determine an average cross-section.

Once the velocity and cross-sectional area have been estimated, the designer shall use the following formula to calculate stream base flow:

$$Q = V x A$$

Q = Stream flow (ft^3/s)
V = Stream velocity (ft/s)
A = Average cross-sectional area of stream channel (ft^2)

Considerations

It is recommended that an appropriate dewatering device also be used with this practice, such as a sump pit with a portable sediment tank or dewatering bag.

8.5.3 SANDBAG DIVERSION

Description

A sandbag diversion is a strategy for controlling construction activities in or adjacent to streams. Its purpose is to prevent sediment from entering a water body due to construction activities within the approach areas and to maintain stream flow while minimizing the amount of disturbance within the stream itself.

Applicability

A sandbag diversion shall be applicable to streams with low flows and where it is not possible or beneficial to install typical sediment trapping erosion and sediment controls on the stream bank. For streams with higher flows, a wide channel cross-section, or for larger projects that require major encroachment into the watercourse, the installation of sheet piles or a rapidly deployable modular system used to create a cofferdam may be warranted.

Design

The designer shall size the effective channel width to convey a 1-year storm event or by using one-third of the stream width, whichever is greater. The top of the diversion structure must be a minimum of 1-foot above the peak elevation of the 1-year storm event. Refer to Standard Construction Details.

Considerations

The designer shall consider the timing of when to install the diversion. The construction activity shall be planned to minimize the time needed for the stream diversion and removed as soon as practicable, such as when the existing stream and surrounding work area has been stabilized.

It is recommended that an appropriate dewatering device also be used with this practice, such as a sump pit with a portable sediment tank or dewatering bag.

8.5.4 GEOTEXTILE-LINED CHANNEL DIVERSION

Description

A geotextile-lined channel diversion is a strategy for controlling construction activities in or adjacent to streams. Its purpose is to prevent sediment from entering a water body due to construction activities within the approach areas and to maintain stream flow.

Applicability

A geotextile-lined channel diversion shall be applicable to all streams where it is not beneficial to install erosion and sediment controls along the banks.

Design

The designer shall size the diversion channel using Manning's Equation and must convey the stream base flow plus an additional 6-inches of freeboard. The maximum steepness of the side slopes shall be 2:1. The depth and longitudinal slope may vary depending on site conditions but shall be enough to ensure continuous stream flow within the diversion. Refer to Standard Construction Details.

Considerations

The designer shall consider the timing of when to install the diversion. It is recommended that the construction activity be planned to minimize the time needed for the stream diversion and removed as soon as practicable, such as when the existing stream and surrounding work area has been stabilized.

8.5.5 TURBIDITY CURTAIN

Description

A turbidity curtain is a floating barrier composed of a geotextile material which minimizes sediment transport from a disturbed area adjacent to or within a water body. Its purpose is to provide sedimentation protection for a watercourse from upslope land disturbance or from dredging or filling within the watercourse. It is intended to deflect and contain sediment within a limited area and provide enough residence time so that soil particles will fall out of suspension and not travel to other areas.

Applicability

A turbidity curtain may be utilized in both non-tidal and tidal watercourses where intrusion into the watercourse by construction activities and subsequent sediment movement is unavoidable. Turbidity curtains shall be used when conducting pile installation, pile removal, pile jacketing, scour protection installation, or soil boring work in the watercourse.

Design

No design computations are required. Refer to Standard Construction Details. The designer shall include the location of the turbidity curtain on the plan. The designer shall consider the direction of flow within the water body since the turbidity curtains are used to trap sediment and not intended to act as a water impoundment dam. Since turbidity curtains are not intended to stop the flow from a significant volume of water, they are not as effective when installed across channels.

Considerations

The type and construction of turbidity curtains varies based on application. Lighter weight turbidity curtains are recommended for small lakes, ponds, and areas protected from strong currents and high winds. In addition, lighter weight curtains are easier to deploy and remove. Heavier duty turbidity curtains shall be used on rivers, streams, and open lakes and bays. All turbidity curtains shall be installed per manufacturer's specifications.

When quantifying the length of the floating curtain, it is recommended to provide an additional variance in the straight-line measurements to account for the stress on the curtain from potential wave action during high winds.

8.6 POLLUTION PREVENTION PRACTICES

Pollution prevention practices are employed to reduce the potential for stormwater runoff to transport construction site wastes that may contaminate surface or groundwater. Its purpose is to prevent the generation of nonpoint source pollution from construction sites though effective handling, storage, and disposal of construction site wastes. The following information addresses the applicability and design of pollution prevention practices.

8.6.1 CONCRETE WASHOUT

Description

A designated and protected area used to rinse out concrete mixers and pumps after delivery onsite. Since the wash water from concrete producing equipment is alkaline and contains high levels of chromium, if not disposed of in a secure area, it can leach into the ground, discharge into storm drain networks, or drain to surface waters causing contamination, increased pH, and potential pipe clogging. The concrete washout station may be prefabricated or constructed onsite. It allows for the concrete to cure in the protected area and then to be buried or removed offsite. Once the concrete has hardened, it is no longer considered hazardous.

Applicability

Concrete washouts shall be designated for all sites that will generate concrete wash water or liquid concrete waste from onsite concrete mixing or delivery. The washout area may vary in size based on the scale of the project.

Design

No design computations are required. Refer to Standard Construction Details. The locations for the concrete washout areas are not required to be shown on the plans except for sites that require an on-site concrete batching plant. For these projects, the designer shall ensure the proposed concrete washout area is proportional to the amount of concrete work on the project. It is advisable to locate the washout areas away from waterbodies and drainage paths where feasible. It is also recommended that a stabilized construction entrance be provided at the ingress to a concrete washout.

9.0 REFERENCES

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*All photos from DelDOT and DNREC sources.

10.0 GLOSSARY

Base flow: The stream discharge from ground water accretion.

Best Management Practice (BMP): Structural or non-structural practice that minimizes the impact of stormwater runoff on receiving waterbodies and other environmental resources, especially by reducing runoff volume and the pollutant loads carried in that runoff.

Certified Construction Reviewer (CCR): A qualification by DNREC indicating the holder has educational training, expertise, and experience as an authorized construction site reviewer that has the assigned responsibility for site control of the approved SWPPP for all required reporting.

Clearing: The removal and disposal of all unwanted surface material such as brush, grass, weeds, and downed trees and excluding the ordinary mowing of grass, pruning of trees, or other forms of long-term landscape maintenance. The soil disturbance during this process is minimal.

Delaware Sediment and Stormwater Regulations (DSSR): Established rules for sediment and stormwater management required for land changes or construction activities for residential, commercial, industrial, or institutional land use.

Department: The Delaware Department of Transportation (DelDOT) or its agent.

Dewatering: Removing water from an area or the environment using an approved technology or method, such as pumping.

Disturbed area: An area in which the natural vegetative soil cover has been removed or altered and is susceptible to erosion.

Drainageway: A route or course along which water moves or may move to drain a region.

Engineer: The licensed Delaware Professional Engineer responsible for signing and sealing the approved E&S Plan.

Erosion: The process by which the ground surface, including soil and deposited material, is worn away by the action of wind, water, ice, or gravity.

Erosion and Sediment Control (E&S): Devices and conservation measures used to reduce or eliminate soil particles from leaving a land area.

Erosion and Sediment Control (E&S) Engineer: The individual within the Department responsible for amending the approved E&S Plans prior to and during construction.

Erosion and Sediment Control (E&S) Plan: A set of drawings, calculations, specifications, details, and supporting documents related to minimizing or eliminating erosion and sedimentation caused by stormwater on a construction site. It includes information on construction, installation, operation, and maintenance.

Excavation: An act by which soil or rock is cut into, dug, quarried, uncovered, removed, displaced, or relocated and the conditions resulting from those actions.

Free-flowing: Any existing stream or channel flowing in a natural condition without impoundment, diversion, straightening, riprapping, or other modification to the waterway.

GPM: Gallons per minute.

Grading: Causing disturbance of the earth, including excavating, filling, stockpiling of earth materials, grubbing, root mat or topsoil disturbance, or any combination of them. The soil disturbance during this process is significant.

Grubbing: The removal and disposal of all off all unwanted vegetative matter from underground, such as stumps, roots, buried logs, and other debris.

Limit of Construction (LOC): The boundary that defines the project area and which all project related construction and non-construction activities take place.

National Pollutant Discharge Elimination System (NPDES): The NPDES permit program addresses water pollution by regulating point sources that discharge pollutants to the waters of the United States.

Notice of Intent (NOI): A document required by DNREC as part of the NPDES General Permit for small MS4s which allows stormwater discharges associated with construction activities which are greater than or equal to one acre of disturbance.

Runoff: That portion of precipitation (including snowmelt) which travels over the land surface, and from rooftops, either as sheet flow, shallow concentrated flow, and channel flow, into the main water courses.

Sediment: Soil, including soil transported or deposited by human activity or the action of wind, water, ice, or gravity.

Sedimentation: The deposition or transportation of soil or other surface materials from one place to another as a result of an erosion process.

Stormwater Engineer: The individual within the Department responsible for reviewing and approving E&S Plans.

Stormwater Management Plan: A set of drawings, calculations, specifications, details, and supporting documents related to the management of stormwater for a site, which includes information on construction, installation, operation, and maintenance.

Temporary Construction Easement (TCE): A short-term, non-perpetual easement that grants the non-exclusive right of entry within a designated area within the project limits but outside the right-of-way for the purposes of construction related activities.

Total Suspended Solids (TSS): The total amount of organic or inorganic particles suspended in and carried by water which are large enough to more easily be removed by sedimentation than smaller particles which cause turbidity.

Turbidity: A measure of the degree to which water loses its transparency due to the presence of suspended particulates.

Watercourse: A natural or artificial channel through which water flows.