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Chapter 1

Introduction/ Policies and Procedures for CCRs

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ACRONYMS

AASHTO – American Association of State Highway and Transportation Officials
ASTM – American Society for Testing and Materials
BAT – Best Available Technology
BFM – Bonded Fiber Matrix
BMP – Best Management Practice
CCR – Certified Construction Reviewer
cfs – Cubic Feet per Second
CMP – Corrugated Metal Pipe
CN – Curve Number
CWA – Clean Water Act
d_{50} – Average equivalent diameter of stone aggregate
d_{max} - Maximum equivalent diameter of stone aggregate
DA – Drainage Area
DNREC – Delaware Department of Natural Resources and Environmental Control
DURMM – Delaware Urban Runoff Management Model
E & S – Erosion and Sediment
ECM – Erosion Control Matting
FEMA – Federal Emergency Management Agency
FES – Flared End Section
fps – Feet per Second
GIS – Geographic Information System
GT – Green Technology
HDPE – High Density Polyethylene Pipe
HEC – Hydraulic Engineering Center (designer of various stormwater modeling programs
IP – Inlet Protection
K - Potassium
LID – Low Impact Development
LOD – Limit of Disturbance
MS4 – Municipal Separate Storm Sewer System
MSDS – Material Safety Data Sheet

N – Nitrogen
NOAA – National Oceanographic and Atmospheric Administration
NOI – Notice of Intent
NOT – Notice of Termination
NOV – Notice of Violation
NPDES – National Pollution Discharge Elimination System
NPS – Nonpoint Source Pollution
NRCS – Natural Resources Conservation Service
NTS – Not to Scale
O & M – Operation and Maintenance
P- Phosphorus
P2 – Pollution Prevention
PAM – Polyacrylamide
PE – Professional Engineer
PLS – Professional Land Surveyor
PVC – Poly Vinyl Chloride
RCP – Reinforced Concrete Pipe
RECP – Rolled Erosion Control Products
RLA – Registered Landscape Architect
ROP – Rock Outlet Protection
RSF – Reinforced Silt Fence
RUSLE – Revised Universal Soil Loss Equation
S & S – Sediment and Stormwater
SCE – Stabilized Construction Entrance
SF – Silt Fence
SHWT – Seasonal High Water Table
SSF – Super Silt Fence
SSM – Soil Stabilization Matting
SWM – Stormwater Management
SWPPP – Stormwater Pollution Prevention Plan
t_c – Time of Concentration
t_t – Travel Time
TMDL – Total Maximum Daily Load
TR-20 – Technical Release 20 (stormwater modeling program)
TR-55 – Technical Release 55 (stormwater modeling program)
TRM – Turf Reinforcement Matting
TSS – Total Suspended Solids
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
USGS – United States Geologic Survey
WSE – Water Surface Elevation

DEFINITIONS

Adverse Impact - A negative effect on land or water resulting from a construction or development activity. Adverse impacts include increased risk of flooding; degradation of water quality; increased sedimentation; reduced groundwater recharge; negative impacts on aquatic organisms, wildlife and other resources; and threatened public health.

Aggregate – Term for stone, rock or gravel used for various purposes related to sediment and erosion control as well as stormwater management.

Aquatic Life – Any species of plant or animal living in water.

Aquifer – An underground geological formation that contains usable amounts of groundwater to supply wells or springs. The formation usually contains a stratum of sand, gravel, or fractured rock and will transmit water readily.

As-Built Plans – Engineering or site drawings that delineate a specific stormwater management facility as actually constructed.

Base Flow – The portion of stream discharge which consists of ground-water drainage and delayed surface drainage.

Benthic – Relating to or occurring at the bottom of a body of water such as a stream or lake.

Best Management Practice (BMP) - A measure that is implemented to protect water quality, reduce the potential for pollution, and prevent flooding and erosion associated with stormwater runoff. A BMP can be a program, technology, process, siting criteria, operating method or device.

Biofiltration – A stormwater conveyance swale designed and vegetated to enhance pollutant removal and infiltration of stormwater runoff.

Bioretention – A landscaped depression with a specific soil medium that is designed to provide substantial filtering and/or infiltration of stormwater runoff. This device is particularly effective at nitrogen removal.

Certified Construction Reviewer (CCR) – An individual who has completed a DNREC sponsored training course and provides on-site inspections for sediment control and stormwater management in accordance with the Sediment and Stormwater Regulations.

Check Dam – A small dam placed across a channel to reduce water velocities.

Clean Water Act (CWA) – The CWA, originally enacted by Congress in 1972, is a federal law that requires states to protect, restore and maintain the quality of the waters of the United States, including lakes, rivers, aquifers and coastal areas. As amended in 1987, the CWA is the enabling legislation for the NPDES permitting process which regulates stormwater discharges from construction activities.

Constructed Wetlands – Artificial wetlands systems designed and constructed to mitigate the impacts of urban runoff.

Design Storm – A typical rainfall event that is used to design a stormwater structure. It is designated by the rainfall frequency (i.e. 10-year storm), the rainfall duration (i.e. 24-hours), and the type of rainfall distribution (i.e. Type II).

Detention – The temporary storage of runoff in a stormwater management facility to reduce peak discharge rates and provide settling of pollutants.

Discharge – In stormwater management, the volume of water that passes over a given point or through a cross section during a unit of time. Measured in cubic feet per second.

Diversion – A channel, berm, embankment or other man-made structure constructed to divert water from one area to another.

Drainage Area – That area contributing runoff to a single point measured in a horizontal plane, which is enclosed by a ridge line.

Dry Pond – An excavated or embankment stormwater management facility designed to drain completely between runoff events.

Embankment – A dam, bank or mound of earth used to hold back water.

Erosion – The wearing away of earth surfaces by the action of wind, ice, water or gravity.

Exemption – Land development activities that are not subject to the sediment and stormwater regulations.

Filtration – The removal of pollutants and particulate matter by passing water through vegetation or other media as designed for such a purpose.

First Flush – The early stages of stormwater runoff that commonly conveys a disproportionately large amount of previously accumulated pollutants due to the rapid rate of flow.

Floodplain – For a given flood event, that area of land temporarily covered by water which adjoins a watercourse and which is necessary for conveyance of the flood event.

Forebay – A storage area provided at the inlet of a stormwater management pond to collect incoming sediments, minimizing their accumulation in the main pool of the pond.

Freeboard – The vertical distance between the design water surface elevation and the elevation of the top of the pond embankment.

Gabion – A large rectangular box of heavy gauge wire mesh which contains stone. Typically stacked and keyed into slopes or stream banks to prevent erosion from high rate and velocity flows.

Geographic Information System (GIS) – A system of computer hardware and software used for storage, retrieval, mapping and spatial analysis of geographic data.

Geotextile Fabric – Textile of relatively small mesh or pore size that is used to (a) allow water to pass through while holding sediment back, or (b) to provide support for heavier materials and a barrier for underlying soils.

Good Housekeeping – The storage, use, or cleanup of materials performed in a manner that minimizes the discharge of pollutants from a construction site.

Groundwater – Water that is naturally occurring under the earth's surface.

Hydraulic – Pertaining to, involving, moved or operated by water under pressure or under a gravity-driving force.

Hydrologic – Pertaining to the scientific study of the properties, distribution, and effects of water on or under the earth's surface, and in the atmosphere.

Impervious Surface – Hard material which resists or blocks the passage of water into the soil, thus causing water to run off the surface in greater quantities and at an increased flow rate.

Infiltration – The penetration of water through the ground surface and into the subsurface soil.

Infiltration Basin – A stormwater management facility designed to promote the percolation of collected runoff into the soil, rather than discharging runoff to receiving waters.

Land Disturbing Activity – Any land change or construction activity which may result in soil erosion or accelerated stormwater runoff, including but not limited to clearing, grading, excavating, transporting and filling of land.

Level Spreader – A device used to spread out stormwater runoff uniformly across the ground surface as sheet flow. The purpose is to prevent concentrated, potentially erosive flows from occurring.

Low Impact Development – Development designed and constructed to minimize disturbance, mimic pre-development runoff characteristics, protect environmentally sensitive areas and preserve open space.
Micropool – A smaller permanent pool within a larger stormwater management facility for collecting and controlling inflow into the facility. Also effective at pollutant reduction.

National Pollutant Discharge Elimination System (NPDES) – A nationwide system of stormwater permitting established by EPA and administered in Delaware by DNREC and its delegated agencies. The purpose is to control the discharge of pollutants from construction and land disturbing activities into receiving waters.

Nonpoint Source Pollution – Pollution which does not result from a discharge at a specific location such as a pipe, but generally results from overland runoff, atmospheric deposition or percolation.

Nonstructural Control – A BMP that does not require construction of a facility to control runoff. One example is the establishment of vegetation to prevent erosion.

Nutrients – Elements or substances such as nitrogen and phosphorus which are necessary for plant growth, but can reduce water quality when excess amounts are carried by stormwater runoff into a water body.

Operator – An individual or entity that has control over all day-to-day activities on a construction site or a portion of a construction site. The operator is responsible for compliance with the sediment and stormwater law and regulations.

Outfall – The terminus of an open or enclosed conveyance system where stormwater is discharged either overland or to a water body.

Outlet Structure – A device constructed as part of a stormwater management facility that controls the detention time of stormwater as well as the discharge of stormwater to the desired rates of flow.

Pathogens - Pathogens include viruses, bacteria, and protozoa, and are a pollutant of concern in storm water runoff.

Peak Flow – The maximum instantaneous rate of flow of water at a particular point resulting from a storm event.
Permanent Pool – Impounded water that remains in a stormwater management facility at all times.

Permeability – The quality of a soil horizon that allows water to pass through. Also used to define the rate of water flow through soil.

Point Source – Pollution arising from a well-defined origin such as a pipe discharge from an industrial plant.

Pollutant - Any constituent present in sufficient quantity to impair the beneficial uses of a receiving water body.

Pretreatment – Implementing measures to capture or trap coarse sediments before they enter a BMP in order to maintain storage volumes and prevent excess sedimentation within the structure.

Receiving Water - A river, lake, ocean, stream or other watercourse into which runoff is discharged .

Responsible Personnel – A foreman or superintendent who is in charge of on-site land disturbing activities for sediment and stormwater control associated with a construction project.

Retrofit – The modification of stormwater management systems to improve or achieve additional water quality or quantity objectives.

Riprap – A combination of large stone, cobbles or boulders used to, among other purposes, reduce runoff velocities at discharge points, line channels, stabilize stream banks and slopes

Runoff – The portion of rainfall that does not infiltrate and flows across the ground surface and eventually to receiving waters.

Sediment – Soil or other surficial materials transported and/or deposited by the action of wind, water, ice or gravity as a product of erosion.

Sinkhole - A naturally occurring closed depression, where stormwater drainage collects on the earth's surface that is a minimum of 2 feet deep and typically, is caused by dissolution of the underlying limestone, salt or gypsum. Stormwater drainage typically has no visible surface outlet, and may occur through underground channels that may be enlarged by the collapse of a cavern roof.

Soil Stabilization - Vegetation, such as grasses, and other materials, such as straw, fiber, stone, protective blankets, etc. placed to stabilize areas disturbed by grading operations or eroded by natural forces.

Source Controls - Measures implemented to prevent the introduction of sediment or other pollutants into stormwater runoff. Source controls preclude or limit the exposure of materials to storm water at the source of those materials.

Stabilization – Prevention of soil erosion through the establishment of soil cover through the implementation of vegetative or structural means.

Stormwater - Runoff from rain, snow or other forms of precipitation resulting in surface runoff and drainage.

Stormwater Pollution Prevention Plan (SWPPP) - A plan that includes site map(s), an identification of construction/contractor activities that could cause pollutants in stormwater, and a description of measures or practices to control these pollutants.

Stormwater System - The system of drainage, curbs and gutters, curb inlets, swales, catch basins, manholes, ditches, pipes, lakes, ponds, channels, creeks, streams, storm drains, and similar conveyances and facilities, both natural and manmade, through which stormwater is collected, stored, or conveyed.

Structural Control – A practice that involves design and construction of a facility to mitigate the adverse impacts of stormwater runoff.

Subsoil – The bed or stratum of earth lying below the surface layer of soil.

Surface Water – Water on the earth's surface exposed to the atmosphere such as rivers, lakes, streams and oceans.

Swale - A natural or manmade depression or wide shallow ditch used to store, route or filter runoff.

Terrace – A swale extending across a slope to intercept runoff and increase the potential for infiltration.

Time of Concentration - The time required for stormwater runoff to flow from the most hydraulically remote point of the watershed (longest time)

to the location being analyzed. The origin of the time of concentration flow path is not necessarily the longest distance away.

Total Maximum Daily Load (TMDL) - TMDLs are pollutant load allocations for all point sources and nonpoint sources, and are intended to achieve a pollutant reduction goal along with a safety factor. TMDLs are developed in response to identification of pollutants as impairing a specific body of water.

Total Suspended Solids (TSS) - TSS is the weight of particles that are suspended in water. Suspended solids in water reduce light penetration in the water column, can clog the gills of fish and invertebrates, and are often associated with toxic contaminants because organics and metals tend to bind the particles.

Underdrain – Perforated pipe(s) installed at the bottom of a stormwater management facility such as bioretention or biofiltration swales to remove excess runoff.

Vegetated Filter Strip – A vegetated section of land designed to accept runoff as sheet flow from upstream development. It may adopt any form from grass meadow to a small forest, with the vegetation facilitating pollutant removal.

Vegetation - The collection of plant life (including trees, shrubs, bushes and grass) which is found on a project site or property. Vegetation is desirable because it helps to reduce the quantity of stormwater runoff, encourages sediment settling and nutrient uptake, controls extreme temperatures, and provides habitat.

Water Quality – Those characteristics of stormwater runoff from a land disturbing or development activity that relate to the chemical, physical, biological, or radiological integrity of water.

Water Quantity – Those characteristics of stormwater runoff that relate to the rate and volume of stormwater runoff to downstream areas resulting from land disturbing or development activities.

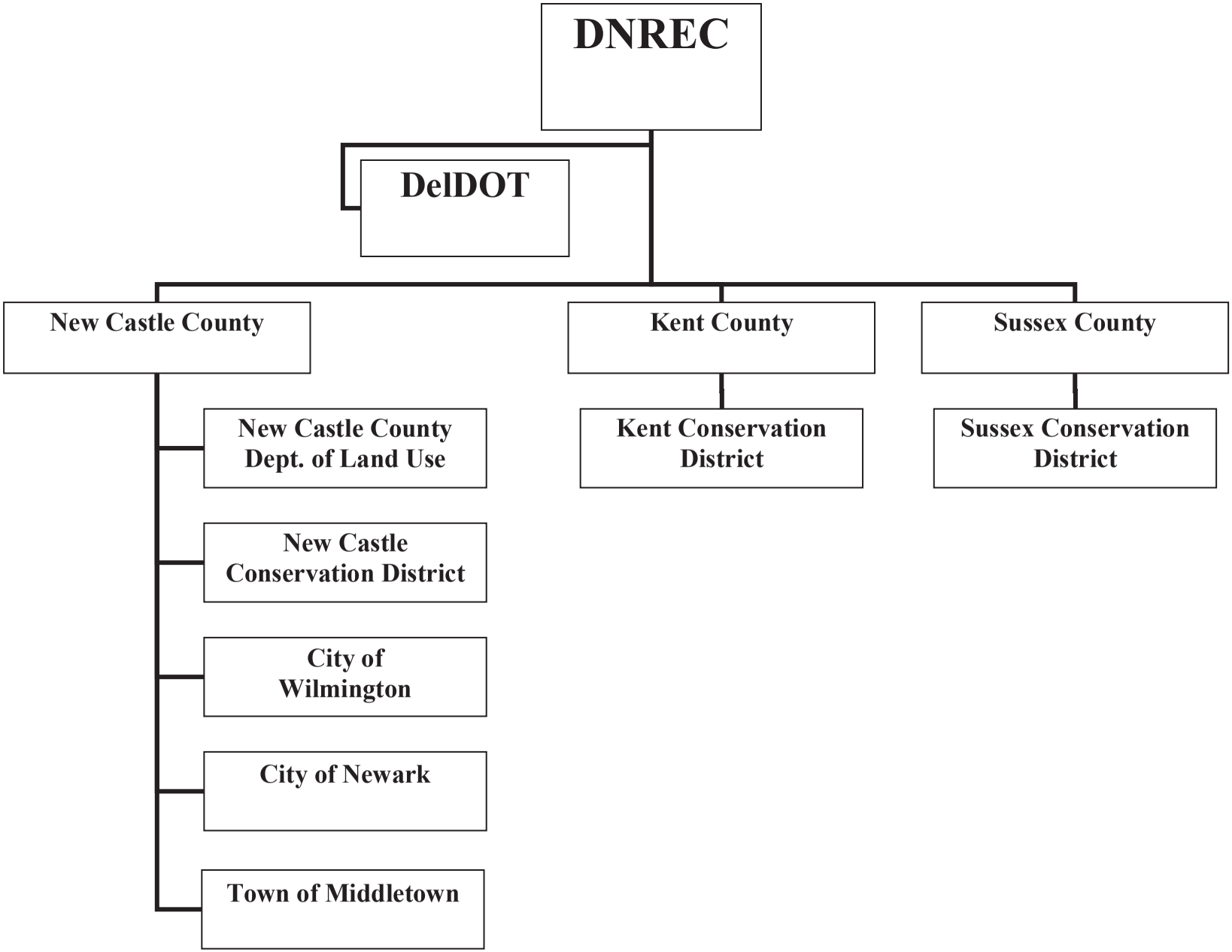
Watershed - The area that drains to a particular stream or to a particular point. A watershed is bounded by drainage divides.

Wet Pond - An excavated or embankment stormwater management facility designed with a permanent pool of water.

2-year frequency storm - A storm event with a fifty percent chance of being equaled or exceeded in a given year.

10-year frequency storm - A storm event with a ten percent change of being equaled or exceeded in any given year.

100-year frequency storm - A storm event with a one percent chance of being equaled or exceeded in any given year.


DNREC
DelDOT
New Castle County
Kent County
Sussex County
New Castle County Dept. of Land Use
New Castle Conservation District
City of Wilmington
City of Newark
Town of Middletown
Kent Conservation District
Sussex Conservation District

LIST OF DELEGATED AGENCIES

The following agencies have delegation of Sediment and Stormwater Program elements consisting of plan review, construction inspection, and maintenance inspection for their geographic boundaries.

1) State Agencies

a. Department of Natural Resources & Environmental Control
Division of Watershed Stewardship
Sediment and Stormwater Program
89 Kings Highway
Dover DE 19901

Phone: (302) 739-9921
Fax: (302) 739-6724

http://www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/StormWater.htm

Responsible for all aspects of administration of the state sediment and stormwater management program under the Delaware Sediment and Stormwater Law and Regulations. Responsible for plan review and inspection of State and Federal Projects.

b. Department of Transportation
800 Bay Road
P.O. Box 778
Dover DE 19903

Phone: (302) 760-2251
Fax: (302) 739-6360

http://www.deldot.net/

Delegated Area: DelDOT Construction

2) New Castle County

a. New Castle County Dept. of Land Use
Licensing Division
87 Reads Way
Corporate Commons
New Castle DE 19720

Phone: (302) 395-5400
Fax: (302) 395-5488

http://www.co.new-castle.de.us/landuse/home/webpage1.asp

Delegated Area: All unincorporated areas of New Castle County

b. New Castle Conservation District
2430 Old County Road
Newark DE 19702

Phone: (302) 832-3100, Ext. 3
Fax: (302) 834-0783

Delegated Area: All Incorporated areas of New Castle County (except City of Newark, City of Wilmington and Town of Middletown).

c. City of Newark
Public Works Department
220 Elkton Road
Newark DE 19711

Phone: (302) 366-7040
(302) 366-7045
Fax: (302) 366-7160

http://newark.de.us/docs/departments/public_works.html

Delegated Area: City of Newark

d. City of Wilmington
Dept. of Public Works
800 North French Street
Wilmington DE 19801

Phone: (302) 576-3056
Fax: (302) 571-4423

http://www.ci.wilmington.de.us/departments/pubworks.htm

Delegated Area: City of Wilmington

e. Town of Middletown
19 West Green Street
Middletown DE 19709

Phone: (302) 378-2711
Fax: (302) 378-5675

http://www.middletownde.org/town_offices.htm

Delegated Area: Town of Middletown

3) Kent County

Kent Conservation District
800 Bay Road, Suite 2
Dover, DE 19901

Phone: 302-741-2600 (X 3)
Fax: 302-741-0347

http://kentcd.org/

Delegated Area: Kent County

4) Sussex County

Sussex Conservation District
23818 Shortly Road
Georgetown DE 19947

Phone: (302) 856-7219
Fax: (302) 856-0951

http://www.sussexconservation.org/sed_sw.htm

Delegated Area: Sussex County

Application for
Sediment and Stormwater Management

CERTIFIED CONSTRUCTION REVIEWER

Project Information

Project Name: _____

Approval Number: _____ Approval Date: _____

Location: _____

Owner Information

Owner/Developer Name: _____

Address: _____

_____

Phone: _____ Fax: _____

Certified Construction Reviewer Information

CCR Name: _____ Certification No.: _____

Employer: _____

Address: _____

_____

Phone: _____ Fax: _____

E-mail: _____

Supervising Registered Delaware Professional Engineer Information

P.E. Name: _____ Registration No.: _____

Employer: _____

Address: _____

_____

Phone: _____ Fax: _____

E-mail: _____

The following certifications shall be completed prior to approval of this application:

Owner/Developer Certification

"I/We understand the conditions imposed by the requirement of DNREC that a Sediment and Stormwater Certified Construction Reviewer be present on site for the purpose of ensuring the adequacy of construction pursuant to the approved sediment and stormwater management plan and requirements of Section 12, *Delaware Sediment and Stormwater Regulations*. I/We hereby authorize the right of entry for periodic site inspections by the Certified Construction Reviewer, State of Delaware Department of Natural Resources and Environmental Control Personnel and/or authorized agents."

_____ _____
Owner/Developer Signature Date

_____
Owner/Developer Printed Name

Certified Construction Reviewer Certification

"I understand the responsibilities required of me to perform the duties of Certified Construction Review as outlined in Section 12, *Delaware Sediment and Stormwater Regulations*, and I understand the site review procedures as required by DNREC, Division of Watershed Stewardship, Sediment and Stormwater Program"

_____ _____
Certified Construction Reviewer Signature Date

_____
Certified Construction Reviewer Printed Name

Professional Engineer Certification

"I understand the responsibilities of the Sediment and Stormwater Management Certified Construction Reviewer as outlined in Section 12, *Delaware Sediment and Stormwater Regulations*, and I agree that _____ will work under my direction to provide sediment and stormwater management site review for this project as required by DNREC."

_____ _____
Professional Engineer Signature Date

_____
Professional Engineer Printed Name

Application Approval

Approved by: _____ Date: _____

Title: _____

Certified Construction Reviewer Policy for State and Federal Projects

1.0 Statement of Policy

As of July 1, 2004, unless waived, State and Federal construction projects under the review of the Department of Natural Resources and Environmental Control Sediment and Stormwater Program (DNREC) will require a Certified Construction Reviewer (CCR) to provide inspection duties. The CCR shall review and report on all erosion and sediment controls as well as stormwater management facility construction throughout the duration of the project.

2.0 Requirements

Reports shall be prepared by the CCR on a **weekly** basis. Given special circumstances, written requests for reduction in inspection frequency will be considered by DNREC. The request shall include the most recent CCR report, the requested inspection frequency (i.e. every two weeks, monthly), and justification for the reduced frequency request. If the request is approved, the CCR shall continue to submit a report following all significant rain events. Furthermore, if the site becomes non-compliant or the construction activity increases, the frequency of required CCR reviews shall return to the standard weekly review or as otherwise directed by DNREC.

In addition to the weekly reports, DNREC shall be notified at the following stages of construction:

1. Five days prior to the start of construction to schedule a pre-construction meeting.
2. Following installation of perimeter controls.
3. Prior to construction of all permanent stormwater management facilities on site.
4. Upon project completion, to schedule a final inspection.

3.0 Guidelines

The following guidelines have been prepared to assist CCRs, owner/developers, construction managers, contractors and engineers in understanding their responsibilities regarding implementation of the CCR requirement on DNREC projects. This document should be used in conjunction with Section 12 of the Delaware Sediment and Stormwater Regulations, as well as the Delaware Erosion and Sediment Control Handbook, the appropriate Stormwater Management Facility Construction Checklist(s), and Pond Code 378.

3.1 CCR Responsibilities

3.1.1 The CCR shall be certified by DNREC and possess a current, valid certification. Contact DNREC, Division of Soil and Water Conservation at (302) 739-9921 for information about certification or re-certification. The CCR must complete his/her portion of the CCR application and sign the Certified Construction Reviewer's Certification on the application.

3.1.2 The CCR shall review and become familiar with all elements of the approved sediment and stormwater management plan. Any questions or issues raised during this review should be discussed with the owner/developer, construction manager, contractor, design consultant and DNREC at the pre-construction meeting prior to the start of construction.

3.1.3 The CCR, at a minimum, shall perform **weekly** sediment and stormwater reviews of the site. The CCR shall prepare a report which accurately reflects the condition of the site and its level of conformity with the approved plans and specifications. The CCR shall coordinate with the construction manager to establish dates by which any deficiencies will be resolved. Those dates shall also be reflected on the report. The weekly report shall then be forwarded to the supervising Professional Engineer (P.E.) for review. The CCR shall forward the report within three (3) business days of the review to DNREC (Fax 302-739-6724), the owner/developer, construction manager, and the contractor.

3.1.4 The CCR shall review all perimeter controls in accordance with the approved plan and the Delaware Erosion and Sediment Control Handbook. The CCR shall submit a report to DNREC stating that all perimeter controls are functioning prior to beginning any other work on the site.

3.1.5 The CCR shall provide documentation on all stages of the stormwater management facility construction and accurately complete the applicable Stormwater Management Facility Construction Checklist(s). The CCR shall be present on site to observe all checklist items.

3.1.6 If an erosion or sediment control practice has failed, the CCR shall note the conditions in his/her report and immediately contact DNREC to facilitate either field modifications or a design revision to the erosion and sediment control practice.

3.1.7 The CCR may approve minor changes or deviations (i.e. soil stockpile location, silt fence location, additional sediment controls, modification to the construction entrance) to the approved sediment and stormwater management plan. Those changes must be documented in the next weekly report and the CCR must notify DNREC within three (3) business days of their approval.

3.2 Owner/Developer Responsibilities

3.2.1 The owner/developer is responsible for ensuring that all work is completed in accordance with the approved sediment and stormwater management plan, Pond Code 378, the Delaware Sediment and Stormwater Regulations and the Delaware Erosion and Sediment Control Handbook. The owner/developer shall clearly direct all employees and contractors to comply with all appropriate plans and regulations.

3.2.2 The owner/developer is responsible for providing a CCR on those sites that are required to have one, in accordance with Section 12 of the Delaware Sediment and Stormwater Regulations and this policy.

3.2.3 The owner/developer is responsible for completing his/her portion of the CCR application and signing the Owner/Developer Certification on the application.

3.2.4 The owner/developer shall be present or represented at both the pre-construction meeting and the final inspection of the site.

3.3 Contractor Responsibilities

3.3.1 The contractor shall construct all sediment and stormwater controls in accordance with the approved sediment and stormwater management plan, Pond Code 378, the Delaware Sediment and Stormwater Regulations, and the Delaware Erosion and Sediment Control Handbook.

3.3.2 The contractor shall maintain close communication with both the CCR and DNREC to provide at least 48 hours notice prior to all required construction inspection steps.

3.3.3 The contractor shall cooperate with the CCR and/or DNREC when corrective action is required.

3.4 Profesional Engineer (P.E.) Responsibilities

3.4.1 The P.E. must be registered and licensed in the State of Delaware. After verification of qualifications, the P.E. must complete his/her portion of the CCR application and sign the Professional Engineer's Certification on the application.

3.4.2 The P.E. shall be available to assist the CCR with any questions that may arise during the course of CCR inspections.

3.4.3 The P.E. shall oversee and verify the accuracy of the CCR review. The P.E. shall sign the CCR reports and the applicable Stormwater Management Facility Construction Checklist(s) prior to submittal to DNREC. The P.E. shall only sign those documents or reports that have been prepared under his/her supervisory control and review.

3.5 DNREC Responsibilites

3.5.1 DNREC shall review and approve the CCR Application prior to the start of construction.

3.5.2 DNREC shall be represented at the pre-construction meeting. Any concerns about plan implementation or general procedures shall be discussed and resolved at this meeting.

3.5.3 DNREC shall issue stop work orders and/or pursue other enforcement actions when a site is referred by the CCR. A CCR may refer a site for failure to implement the approved sediment and stormwater plan.

3.5.4 DNREC shall perform periodic performance evaluations of the CCR. If it is determined that the CCR is not providing adequate site control or is not referring problem situations, DNREC shall suspend or revoke his/her certification.

3.5.5 DNREC shall perform a final inspection of the site to determine whether the construction activities conform to the approved Sediment and Stormwater Management Plan. If DNREC identifies deficiencies during the final inspection, a letter will be issued to both the CCR and owner/developer listing those deficiencies. These deficiencies must be satisfactorily corrected prior to project closeout.

3.5.6 DNREC shall provide general education for those persons involved in land disturbing activities, including owner/developers and contractors, through the Contractor Certification Program. DNREC is responsible for the education and certification of the CCRs through the CCR course. Once certified, DNREC shall provide technical assistance to the contractors and CCRs.

New Castle County Guidelines

for the

Certified Construction Reviewer, Owner/Developer, Site Contractor and Professional Engineer

The following guidelines have been prepared to assist Certified Construction Reviewers (CCR), owners/developers, contractors and engineers in understanding their various responsibilities with regard to the implementation of the CCR program in New Castle County (NCC). This document should be used in conjunction with those portions of the Delaware Sediment and Stormwater Regulations which pertain to the CCR program, as well as the Delaware Erosion and Sediment Control Handbook, the Sediment/Stormwater Management Basin Construction Checklist and Small Pond Code 378.

For non-residential development, NCC requires a CCR to report on all sediment and stormwater controls (S & S) as well as stormwater management facility construction. For residential development, NCC requires the CCR to report solely on the stormwater management facility construction. If a residential site has environmental concerns, NCC reserves the right to require a CCR review of all S & S practices, in addition to the stormwater management facility.

CCR Responsibilities:

1. In accordance with Section 12.4 of the Delaware Sediment Stormwater Regulations, the CCR **shall** be certified by Department of Natural Resources and Environmental Control (DNREC) and possess a current, valid certification card. NCC only acknowledges certifications issued by DNREC. Contact DNREC, Division of Soil and Water Conservation (302.739.4411) for information about certification or re-certification.

2. The CCR **shall** review and become familiar with all elements of the approved sediment and stormwater management plan that they will be responsible for reviewing on site. Any questions or issues raised during this review should be discussed with the owner/developer, site contractor, design consultant and/or NCC prior to the start of construction. The CCR **shall** attend the NCC pre-construction meeting, if scheduled, to discuss the plan and declare any reservations that he/she may have concerning the implementation of the plan.

3. On non-residential sites, the CCR **shall** perform, at a minimum, **weekly** S & S reviews of the site, in accordance with Section 12.7(A) of the Delaware Sediment and Stormwater Regulations. The Delaware Sediment and Stormwater Regulations, Delaware Erosion and Sediment Control Handbook, Pond Code 378 and the approved sediment and stormwater management plan shall all be considered by the CCR as they pertain to the site review. Based on this review, reports shall be prepared which accurately reflect the condition of the site and its compliance/non-compliance status with the approved plans, specifications and applicable regulations. These reports shall include a date by which all deficiencies must be resolved in order to accomplish the design principles of the approved plans. The weekly report shall then be reviewed, signed, sealed and dated by the supervising Professional Engineer (P.E.). The site contractor, the owner/developer and NCC (Fax # 302.395.5488, Attn: Engineering Section) shall receive facsimile copies, or other correspondence agreed

upon or directed by NCC in writing, of these reports [within three (3) business days of the review].

4. Inspection frequency may be reduced only by providing a formal written request to NCC. The request shall include the latest CCR report, which must be representative of a site that is compliant, and justification for requesting a reduced frequency. There must not be any outstanding violation notice on the site and the CCR must have been diligent in providing the Department with the required reports, up to the time of the request. Granting the request shall be at the written discretion of NCC. If the request is approved, the CCR **shall** be required to submit a CCR report following any significant rain event, in addition to the reduced frequency. If it is determined that the site is non-compliant or the construction activity increases, then the frequency of required CCR reviews shall return to the standard weekly reviews or as otherwise directed by NCC. The CCR **shall** indicate on the final CCR report that the project has been completed.

5. All sites for which a CCR is required, the CCR **shall** maintain a presence, be observant and provide documentation on all stages of the stormwater management facility construction required, pursuant to Section 14.7 of the Delaware Sediment and Stormwater Regulations, to accurately complete the Sediment/Stormwater Management Basin Construction Checklist. The CCR **shall** be familiar with all items on the checklist and competent to perform the required reviews. The CCR is not only responsible for accurately reporting what is observed, but **shall** alert the design consultant, owner/developer, site contractor and NCC (Engineering Section, 302.395.5470) immediately of any problems or discrepancies with respect to the design principles of the approved sediment and stormwater management plan.

6. The CCR **shall** be present to observe and report on the compaction testing of any stormwater management facility [See owner/developer guideline #2]. If the compaction testing reveals that sufficient compaction has not been achieved, then NCC **shall** be notified and no further work on the basin shall be completed until further directed by NCC. If the CCR is not able to complete certain items on the checklist, the CCR **shall** notify the owner/developer before the job begins (preferably before the pre-construction meeting).

7. If an erosion or sediment control practice has failed, a field modification of the approved sediment and stormwater management plan may be required. An important role of the CCR is to work with the site contractor and NCC to facilitate such a change, if deemed necessary. Problems that relate to inadequacies in the approved plan shall be referred to NCC, who will either work with the CCR and site contractor on field modifications or require a revised plan from the design consultant, pursuant to Section 14.6 of the Delaware Sediment and Stormwater Regulations.

8. The CCR is responsible for reviewing all perimeter controls on non-residential sites in accordance with the approved Pre-Bulk Grading Plan and the Delaware Erosion and Sediment Control Handbook. NCC shall receive a satisfactory Perimeter Control Review by the CCR, prior to requesting a NCC Perimeter Control Inspection (PCI).

9. For those instances when the proposed stormwater management facility is to be used as a temporary sediment basin during the construction phase of the project, the CCR **shall** be responsible for submitting a Sediment/Stormwater Management Basin Construction Checklist with all applicable sections completed, accompanied by any supporting documentation, to NCC for all sites prior to requesting a PCI.

10. The CCR may approve, and document in the field review report, minor changes or deviations (i.e. soil stockpile location, silt fence location, additional sediment controls and modification to the construction entrance) in the field implementation of the approved sediment and stormwater management plan. If the CCR approves any changes or deviations, he/she must notify NCC [within three (3) business days of the approval]. If it is determined by NCC that the recommendation is not within the purview of the CCR, then NCC reserves the right to rescind the approval given by the CCR and/or require a revised sediment and stormwater management plan. The CCR **shall** notify the design consultant, site contractor, owner/developer and NCC [within three (3) calendar days] of any inadequacies of the approved plan. If NCC determines the approved plan(s) to be deficient, that plan(s) shall be voided, the site may be issued a stop work order and the submission of a revised plan shall be required for review and approval by NCC. Any of the previously stated directives will by declared in writing by NCC.

11. The CCR is responsible for contacting NCC if there is difficulty achieving compliance or establishing communication with the owner/developer and/or the site contractor. NCC will first attempt to resolve any outstanding issues but, if further enforcement action is warranted, the site may be referred to DNREC by NCC, pursuant to Sections 12.7(C) and 14.8 & 9 of the Delaware Sediment and Stormwater Regulations.

12. The CCR is accountable to DNREC for the quality of his/her reports and performance as the site reviewer. All reports shall be honest and accurate. If it is determined that the CCR is not providing adequate site control or is not referring problem situations, DNREC may suspend or revoke the certification of the CCR in accordance with Sections 12.8 & 9 of the Delaware Sediment and Stormwater Regulations.

Owner/Developer Responsibilities:

1. The owner/developer is responsible for ensuring that all work done on site is in accordance with the approved sediment and stormwater management plan, Pond Code 378, the Delaware Sediment and Stormwater Regulations and the Delaware Erosion and Sediment Control Handbook. It is the owner/developer's responsibility to ensure that all employees and contractors are clearly directed to comply with all appropriate plans and regulations.

2. In the event that the CCR is not employed by the geo-technical firm which is performing the compaction testing of any stormwater management facility, then the owner/developer **shall** be responsible for forwarding the results of the compaction testing to NCC [within three (3) business days of the testing date]. The owner/developer is ultimately responsible for making sure these items are completed by a competent CCR.

3. Work on a stormwater management facility may proceed provided that the work does not preclude the review and approval by the CCR and/or the supervising engineer of any items previously completed. If work proceeds without the CCR being present, NCC and/or DNREC reserve the right to require the contractor to disassemble and reconstruct the completed work at the owner's expense.

4. The owner/developer **shall** provide [at least twenty-four (24) hours] adequate notice to the CCR and NCC for all required inspections or reviews, as deemed necessary by the approved sediment and stormwater management plan, Pond Code 378 and the Delaware Sediment and Stormwater Regulations, of work completed by the site contractor, according to Section 14.1 of the Delaware Sediment and Stormwater Regulations.

5. The owner/developer is responsible for providing a CCR on those sites that are required to have one, in accordance with Section 12 of the Delaware Sediment and Stormwater Regulations and this policy.

6. The owner/developer is responsible for directing the site contractor to cooperate and comply with the direction given by the CCR and/or the NCC Inspector. Any corrective action(s) or maintenance required as deemed necessary by the CCR must be resolved [within three (3) business days or otherwise directed].

7. The owner/developer is responsible for notifying NCC before initiation of construction and upon project completion when a final inspection will be performed to ensure compliance with the latest approved sediment and stormwater management plan, pursuant to Section 14.2 of the Delaware Sediment and Stormwater Regulations. The owner/developer is also responsible for ensuring that there is a CCR actively monitoring and reporting on the site until the site is complete. If a CCR is not performing adequately or ceases to work on that site for some reason, a new CCR must be retained immediately and NCC must be formally notified of the change in personnel. NCC may request a new pre-construction meeting with the owner/developer and the new CCR as well as other necessary parties to ensure the transition to the new CCR occurs with continuity and does not adversely affect S&S controls at the site.

Site Contractor Responsibilities:

1. The site contractor is responsible for performing all site work in accordance with the latest approved sediment and stormwater management plan, Pond Code 378, the Delaware Sediment and Stormwater Regulations and the Delaware Erosion and Sediment Control Handbook.

2. The site contractor is responsible for assuring a site contact, with a current and valid DNREC Blue Card, is on-site at all times during which time construction is actively taking place with his/her copy of the approved sediment and stormwater management plan, pursuant to Section 13.2 of the Delaware Sediment and Stormwater Regulations.

3. The site contractor is responsible for installing and maintaining all S & S controls in accordance with the approved sediment and stormwater management plan, the Delaware Erosion and Sediment Control Handbook and/or as otherwise deemed necessary by NCC. The site contractor is responsible for cooperating with the CCR and/or NCC when corrective action is required on site. The site contractor is responsible for installing all stormwater management facilities in accordance with the latest approved sediment and stormwater management plan, Pond Code 378 and the Delaware Sediment and Stormwater Regulations.

4. The site contractor is responsible for sending personnel to the Contractors Certification Course, pursuant to Section 13.1 of the Delaware Sediment and Stormwater Regulations. Contact DNREC, Division of Soil and Water Conservation, (302.739.4411) about this program.

P.E. Responsibilities:

1. The P.E. is responsible for overseeing the CCR review, for verifying the accuracy of the CCR review and for signing, sealing and dating the CCR reports and the Sediment/Stormwater

Management Basin Construction Checklist, pursuant to Section 12.3 of the Delaware Sediment and Stormwater Regulations.

2. The P.E. **shall** approve and seal only those documents which in their considered opinion do not endanger the life, health, property and the public welfare in conformity with accepted engineering standards, according to the Code of Ethics approved by the Council of Delaware Association of Professional Engineers (DAPE), October 11, 2000.

3. The P.E. having knowledge of any alleged violation of the Code of Ethics shall be forthright and candid in cooperating with the DAPE Council in furnishing such information or assistance as may be required.

4. The P.E. **shall** not affix their seal to any document not prepared under their supervisory control and review, according to the Code of Ethics.

5. The P.E. **shall** be completely objective and truthful in all professional reports, statements, or testimony, and **shall** include all relevant and pertinent information, according to the Code of Ethics.

NCC Responsibilities:

1. NCC **shall** be responsible for the review and approval of the Sediment and Stormwater Management Plans in accordance with the Delaware Sediment and Stormwater Regulations, Pond Code 378, the Delaware Erosion and Sediment Control Handbook and the NCC Drainage Code.

2. NCC **shall** be responsible for the coordination of the pre-construction meeting and the issuance of meeting minutes to all parties in attendance. The purpose of this meeting is to provide an opportunity for all the parties (owners/developers, site contractors, design and review engineers, CCRs, inspectors, etc.) to assemble and discuss any permit and plan related issues prior to the start of work. Any concerns about plan implementation or general procedures shall be discussed and resolved at this meeting.

3. NCC **shall** perform periodic inspections of S & S controls for non-residential sites once the PCI has passed and site work begins. NCC will continue regular S & S inspections of all residential sites until the job is complete.

4. NCC **shall** monitor all sites under the responsibility of a CCR. Any site deficiency stated in an inspection report issued by NCC, but not referenced by the CCR in his/her report, must be addressed in addition to any/all site deficiencies stated in the CCR report. When there is a considerable disagreement between the reports, NCC and the CCR **shall** meet to resolve any inconsistencies before the subsequently scheduled site review/inspection.

5. NCC **shall** be responsible for tracking and analyzing the CCR reports in addition to ensuring that the Sediment/Stormwater Management Basin Construction Checklist has been completed.

6. When a site is determined to be in violation of the approved sediment and stormwater management plan by the CCR and the site contractor operating on the behalf of the Owner/Developer failed to comply with the resolution of any deficiencies by the given date stated by the CCR in the inspection report, the site may be issued a stop work order and/or

other enforcement action will be pursued (pursuant to Section 12.08.005 of the New Castle County Drainage Code) and/or criminal charges will be filed by NCC. The Department reserves the right to refer the site to appropriate State, pursuant to Section 12.7(C) of the Delaware Sediment and Stormwater Regulations, and Federal agencies for enforcement.

7. NCC **shall** periodically audit the CCR's performance. NCC shall notify the CCR if his/her performance does not meet the requirements and standards of this policy and/or Sections 12, 13 and 14 of the Delaware Sediment and Stormwater Regulations. If the CCR's performance does not improve within a reasonable period of time. NCC reserves the right to refer that CCR to DNREC which may suspend or revoke his/her certification, pursuant to Sections 12.8 & 9 of the Delaware Sediment and Stormwater Regulations.

8. NCC will perform a final inspection of the site to determine whether the construction activities conform to the approved Sediment and Stormwater Management Plan. This final review will be initiated upon the receipt of a CCR report stating that the construction activities have terminated and the site is in compliance with the approved plan. NCC **shall** issue a letter to both the CCR and owner/developer stating the above, if the findings of the NCC inspection are in accord with the CCR report. In the event that NCC identifies deficiencies during the final site review, then a letter **shall** be issued to both the CCR and owner/developer listing those deficiencies.

DNREC Responsibilities:

1. DNREC is responsible for the certification of the CCR's through the CCR course.

2. DNREC is responsible for providing general education for the contractors and developers through the Contractor Certification Program.

3. DNREC is responsible for enforcement of site compliance on sites that have been referred by NCC.

4. DNREC is responsible for providing technical assistance to NCC and the CCR.

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MEMORANDUM

To: All Interested Parties

From: Timothy M. Riley, District Coordinator

Date: March 13, 2000

Subj: Certified Construction Reviewer Policy

At their meeting on February 28, 2000, the Board of Supervisors of the Kent Conservation District, with the assistance of a Sediment and Stormwater Advisory Committee, approved the subject policy. This policy is effective April 1, 2000, and has the potential to affect all landowners, land developers, contractors, and engineers doing work in Kent County, DE.

Starting April 1, 2000, all projects for which an approved Sediment and Stormwater Plan is required by KCD that meet the following criteria will require a Department of Natural Resources and Environmental Control (DNREC) Certified Construction Reviewer (CCR) for inspection and reporting activities:

- All commercial, industrial, and institutional land development projects.
- All residential land development projects with a total site area of the record plan of 50 acres or greater that is planned to be mass or bulk graded.
- All residential land development projects adjoining Silver Lake in Dover.

These guidelines will affect any new plan submitted for initial review on or after April 1, 2000. A copy of the full policy is available by request at the District office.

If you desire or need to have someone on your staff certified as a CCR by the Department of Natural Resources and Environmental Control, please contact Jeanne Feurer of DNREC at (302) 739-4411 to obtain information about future course offerings.

Any questions regarding the policy may be directed to Tim Riley, or Jared Adkins at the District office, (302) 697-2600 ext. 3.

Kent Conservation District
Certified Construction Reviewer Guidelines

The following guidelines have been prepared to assist the Certified Construction Reviewer (CCR), owners, developers, contractors, and engineers to understand their various responsibilities with regard to the implementation of the CCR Program in Kent County. This document should be used in conjunction with those portions of the Delaware Sediment and Stormwater Regulations which pertain to the CCR Program, as well as the Delaware Erosion and Sediment Control Handbook and the Sediment/Stormwater Management Basin Construction Checklist.

The Kent Conservation District (KCD) currently requires a CCR to report on all erosion and sediment control and stormwater management facility construction located in the Dover/Silver Lake Watershed. KCD can also require a CCR to report on all erosion and sediment controls for residential sites larger than 50 acres, sites with sensitive environmental concerns, or sites deemed necessary by KCD.

Certified Construction Reviewer (CCR) Responsibilities

1. The CCR must be certified by DNREC and possess a current, valid certification card. This card is valid for 5 years, after which re-certification is required. Contact Joann Gedney of DNREC at 302-739-9921 for information about certification or re-certification.

2. The CCR must review and become familiar with the relevant parts of the approved plan. Any questions or issues raised during this review should be discussed with the contractor, consultant or KCD, as appropriate, prior to the start of construction. The CCR should attend the KCD preconstruction meeting and be prepared to discuss the plan and any questions or concerns he or she may have.

3. On non-residential sites, the CCR must perform, at a minimum, weekly sediment and stormwater (S&S) inspections of the site in accordance with the approved plan, the Delaware Sediment and Stormwater Regulations and the Delaware Erosion and Sediment Control Handbook. Based on these inspections, weekly reports shall be prepared which accurately and honestly reflect the condition of the site and it's compliance with the plans, specifications and regulations. The weekly report must be reviewed and signed by the responsible P.E. Copies of these weekly reports shall be sent (within 5 calendar days of the inspection) to the site contractor, the owner/developer, and the KCD site inspector. These reports can also be faxed to KCD at 302-741-0347 or emailed to the appropriate inspector.

4. For all sites, residential and non-residential, the CCR must monitor and report on all stages of the stormwater management facility construction using the Basin Checklist. The CCR should be present on site and observe all stormwater management checklist items from the DNREC Pond Inspection Manual. The CCR is responsible for accurately reporting what they observe and should alert the contractor immediately to any problems or discrepancies. The report should reflect any problems which develop in the field and how they are addressed.

5. The CCR is responsible for performing all required inspections specified in the Basin Checklist including, for embankment ponds, supervision of the compaction testing. The CCR should be present for the compaction testing to record and report on the results. No further work should be done until the compaction test results are acceptable. The CCR should be familiar with all items on the checklist and competent to perform the required inspections. If the CCR is not able to complete certain items on the checklist, they should notify the owner/developer before the job begins (preferably at or before the preconstruction meeting). The owner/developer is still responsible for making sure these items are completed.

CCR Responsibilities (continued)

6. The CCR is responsible for notifying the owner/developer, contractor, and KCD inspector of any problems or deficiencies on the site (either E&S or SWM). If a control practice has failed, a design change may be needed. An important role of the CCR is to work with the contractor and KCD to facilitate such a change, if necessary. Problems that relate to inadequacies in the approved plan must be referred to KCD, who will either work with the CCR and contractor on field modifications or require a revised plan from the design engineer.

7. No work on a stormwater management facility should proceed until the CCR inspects and approves the work previously completed. If work proceeds without the CCR being present, KCD and/or DNREC reserve the right to require disassembly and reconstruction of the completed works at the owner's expense.

8. The CCR is responsible for contacting KCD if they are having difficulty with compliance or communication with the owner and/or contractor. KCD will first attempt to resolve any outstanding issues but, if further enforcement action is called for, sites will be referred to DNREC through KCD.

9. The CCR is answerable to KCD and/or DNREC for the quality of their reports and performance as site inspector. All reports should be honest and accurate. Auditing of CCR performance will be done and certification can be revoked.

Owner/Developer Responsibilities

1. The owner/developer of a site is responsible for insuring that all work done on site is done in accordance with the approved plans, the Delaware Sediment and Stormwater Regulations, and the Delaware Erosion and Sediment Control Handbook. It is the owner/developer's responsibility to insure that all employees and contractors are clearly directed to comply with all appropriate plans and regulations.

2. The owner/developer is responsible for providing a CCR on those sites which are required to have one, in accordance with the Delaware Sediment and Stormwater Regulations and KCD policy.

3. The owner/developer is responsible for directing the site contractor to cooperate and comply with the directions of the CCR and KCD inspector. Any items requiring maintenance or correction on the weekly CCR reports should be corrected as soon as possible.

4. The owner/developer is responsible for insuring that there is a CCR actively monitoring and reporting on the site at all times until the site is complete. If a CCR is not performing adequately or ceases to work on that site for some reason, a new CCR must be retained immediately and KCD must be notified of the change of personnel.

5. The owner/developer is responsible for having compaction testing done by a qualified geotechnical professional for all constructed embankments of any stormwater management facilities.

6. The owner/developer must understand that the CCR is required to notify KCD if the site is not in compliance and/or the contractor is not responding to the punchlist items. The CCR could lose his/her certification if he/she does not perform his/her duties in accordance with the regulations.

Site Contractor Responsibilities

1. The contractor is responsible for performing all site work in accordance with the approved plans, the Delaware Sediment and Stormwater Regulations, and the Delaware Erosion and Sediment Control Handbook.

2. The contractor is responsible for maintaining close communication with the CCR and the KCD inspector for all required inspections. The contractor should keep the CCR informed of the work progress and should contact the KCD and the CCR at least 48 hours prior to work on all checklist items or any other required inspections. The contractor is also required to contact KCD at least 48 hours before beginning any site work.

3. The contractor is responsible for installing, in a timely manner, and maintaining all sediment and stormwater controls as necessary in accordance with the approved plans and the Delaware Erosion and Sediment Control Handbook. The contractor is responsible for cooperating with the CCR and/or the KCD inspector when corrective action is required on site. The contractor is responsible for installing all stormwater management facilities in accordance with the approved plans. Any problems which develop in the course of these installations should be brought to the immediate attention of the design engineer, CCR, KCD and the developer by the contractor.

4. Any change or deviations in the field implementation of the approved plan must be reviewed and approved by KCD prior to installation.

5. The contractor is also responsible for sending personnel to the Contractors Certification Course. Contact Joann Gedney of DNREC (302-739-9921) about this program.

P.E. Responsibilities

1. The professional engineer overseeing the CCR is responsible for reviewing, verifying the accuracy of, and signing the weekly CCR reports and pond checklists. The P.E. is "on call" to assist the CCR with any questions that may arise in the course of their inspections.

KCD Responsibilities

1. KCD is responsible for review and approval of the Sediment and Stormwater plans in accordance with the Delaware Sediment and Stormwater Regulations and the Delaware Erosion and Sediment Control Handbook.

2. KCD is responsible for coordination of the preconstruction meeting and the issuance of minutes to all parties in attendance. The purpose of this meeting is to provide an opportunity for all the parties (owner, contractors, design and review engineers, CCR's, inspectors, etc.) to get together to discuss any plan related issues prior to the start of work. Any concerns about plan implementation or general procedures should be raised and resolved at this meeting.

KCD Responsibilities (continued)

3. KCD is responsible for periodic inspections of sediment and stormwater controls once site work begins

on all sites. Once the perimeter control inspection has been passed, S&S inspection will be the primary responsibility of the CCR except for periodic checks by the KCD inspector. KCD will continue regular Sediment and Stormwater inspection of all residential sites until the job is complete.

4. KCD will still periodically monitor sites under CCR responsibility. Any inspection reports issued by KCD take precedence over the reports written by the CCR. When there is disagreement in the reports, KCD and the CCR will meet to resolve inspection report differences.

5. KCD will inspect stormwater management facilities in addition to the CCR, who must monitor the entire installation. The KCD inspector must be notified 48 hours prior to all required inspections.

6. KCD is responsible for tracking and monitoring the CCR reports and checking the pond inspection checklists for completion.

7. When a site is found to be in violation by the CCR, KCD will take enforcement action and, when necessary, turn the site over to DNREC for enforcement.

8. KCD will audit CCR performance on a project by project basis. KCD will notify the CCR if his/her performance does not comply with the requirements of the CCR Program. If the CCR's performance does not improve within a reasonable period of time, the CCR may be referred to DNREC.

DNREC Responsibilities

1. DNREC is responsible for certification of the CCR's through the Certified Construction Reviewer course. Contact Joann Gedney of DNREC (302-739-9921) for information on this program.

2. DNREC is also responsible for providing general education for the contractors and developers through the Contractor Certification Program. Contact Joann Gedney of DNREC (302-739-9921) for information on this program.

3. DNREC is responsible for enforcement of site compliance on sites which have been referred by the CCR through KCD.

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SUSSEX CONSERVATION DISTRICT
Sediment and Stormwater
Certified Construction Reviewer Policy

The following policy has been prepared to assist the Certified Construction Reviewer (CCR), landowners, land developers, contractors, and engineers in understanding the responsibilities regarding the implementation of the CCR Program in Sussex County. This document should be used in conjunction with section 12 of the Delaware Sediment and Stormwater Regulations.

The Sussex Conservation District (SCD) will require a CCR to report on all activities related to the approved Sediment and Stormwater Plan for the **designated** land development projects listed below. This requirement will become effective for all **affected** land development plans submitted to SCD, *December 1, 2003*. A request for a waiver of the CCR requirement must be submitted to the SCD in writing by the owner/developer. The decision to waive the requirement will be made by the SCD Sediment and Stormwater Program Manager, with appeal provisions to the SCD Board of Supervisors. Any contest to the requirement of the CCR provision must be reconciled prior to the project pre-construction meeting. During construction, the Sussex Conservation District reserves the right to suspend CCR responsibilities when they deem appropriate. This request to suspend CCR activities must be submitted to the SCD in writing.

COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL CCR REQUIREMENTS

A CCR will be required for Sediment and Stormwater review on all commercial, industrial and institutional land development projects for which an approved Sediment and Stormwater Plan is required by SCD unless waived, which meet the following conditions:

- When the disturbed area of the project is 2 acres or greater.
- When deemed necessary by the SCD.

A CCR will be responsible for submitting a weekly written report to the SCD Sediment and Stormwater Program Manager during the following stages of construction:

- Pre-construction Meeting (no written report necessary)
- Clearing and grubbing of the site area
- Installation of the perimeter controls (SCD will be notified at the completion of this stage)
- Installation of the stormwater management facility and completion of a stormwater construction checklist (if necessary)
- Construction of major infrastructure (stormdrain, sewer, roadways, utilities) and completion of site work to rough grade.
- Temporary stabilization of site areas not currently being graded (At this point, the frequency of the required inspections may be reduced through approval of SCD until site grading resumes. This approval must be requested by the owner/developer in writing).
- Final grading and stabilization, conversion of sediment basin to permanent SWM pond, and final site inspection. Final site inspection will be arranged with SCD prior to a request for certificate of occupancy.

RESIDENTIAL CCR REQUIREMENTS

A CCR will be required for Sediment and Stormwater review on all residential land development projects for which an approved Sediment and Stormwater Plan is required by SCD unless waived, which meet the following conditions:

- Total site area of the record plan is 50 acres or greater and the site will be mass or bulk graded including lot disturbance.
- When deemed necessary by the SCD.

For residential land development projects meeting the above conditions, the CCR will be responsible for submitting a weekly written report to SCD during the following stages of construction:

- Pre-construction Meeting (no written report necessary, but attendance is required)
- Clearing and Grubbing of the site area
- Installation of the perimeter controls (SCD will be notified at the completion of this stage)
- Installation of the stormwater management facility and completion of a stormwater construction checklist (if necessary)
- Construction of major infrastructure (stormdrain, sewer, roadways, utilities) and completion of site earthwork to rough grade.
- Temporary stabilization of site areas not currently being graded (At this point, the frequency of the required inspections may be reduced through approval of SCD until site grading resumes. This approval must be requested by the owner/developer in writing).
- SCD will assume inspection for the individual home construction including final lot stabilization prior to certificate of occupancy.
- Final site and road grading and stabilization, conversion of sediment basin to permanent SWM pond, and final site inspection will be inspected by the CCR. Final site inspection will be arranged with SCD.

In addition, Section 12, paragraph 2 of the Delaware Sediment and Stormwater Regulations states that SCD "may require that any project, already under construction, have on site a certified construction reviewer if on that project, significant sediment control or stormwater management problems necessitate more frequent inspections".

ENVIRONMENTALLY SENSITIVE AREAS CCR REQUIREMENTS

The Sussex County Council, in the latest update of the Sussex County Comprehensive Land Use Plan in 2002, designated lands within Sussex County that are considered environmentally sensitive. Many of these areas are considered prime location for development. In order to protect the environmentally sensitive areas during development the Sussex County Council has placed additional design requirements that must be addressed for development. In order to be consistent with the policies of Sussex County and to ensure the continued protection of the Environmentally Sensitive Development District during construction, the Sussex Conservation District recognizes the importance of proper inspection and construction review for projects lying within this District.

Therefore, all projects, residential, commercial, and industrial lying within the Environmentally Sensitive Development District would require a Certified Construction Reviewer on site during all land forming, shaping and construction of stormwater management facilities, until stabilization of the site has occurred. The purpose is to insure that no soil materials leave the site during land disturbing activities. The CCR will be responsible for submitting a weekly written report to SCD during the following stages of construction:

- Pre-construction Meeting (no written report necessary, but attendance is required)
- Clearing and Grubbing of the site area
- Installation of the perimeter controls (SCD will be notified at the completion of this stage)
- Installation of the stormwater management facility and completion of a stormwater construction checklist (if necessary)
- Construction of major infrastructure (storm drain, sewer, roadways, utilities) and completion of site earthwork to rough grade.
- Temporary stabilization of site areas not currently being graded (At this point, the frequency of the required inspections may be reduced through approval of SCD until site grading resumes. This approval must be requested by the owner/developer in writing).
- SCD will assume inspection for the individual home construction including final lot stabilization prior to certificate of occupancy.
- Final site and road grading and stabilization, conversion of sediment basin to permanent SWM pond, and final site inspection will be inspected by the CCR. Final site inspection will be arranged with SCD.

Certified Construction Reviewer (CCR) Responsibilities

1. The CCR must be certified by the Department of Natural Resources and Environmental Control (DNREC) and possess a current, valid certification. This certification is valid for 5 years, after which re-certification is required. Contact DNREC's Sediment and Stormwater Program Manager at (302) 739-4411 for information about certification or re-certification. After verification of certification, the CCR must complete his/her portion of the CCR application and sign the Certified Construction Reviewer's Certification on the application.

2. The CCR must review and become familiar with the relevant parts of the approved plan. Any questions or issues raised during this review should be discussed with the contractor, consultant or SCD, as appropriate, prior to the start of construction. The CCR should attend the SCD pre-construction meeting and be prepared to discuss the plan and any questions or concerns he or she may have.

3. The CCR must perform, at minimum, **weekly** sediment and stormwater (S&S) inspections of the site in accordance with the approved plan, this policy and the Delaware Erosion and Sediment Control Handbook. *During periods of active disturbance or when other noteworthy events occur,* weekly reports shall be prepared that accurately and honestly reflect the conditions of the site and it's compliance with the plans, specifications and regulations. *During periods when no active disturbance is occurring at the site, reports may be submitted on a monthly basis with the approval of the Sussex Conservation District.* The report must be reviewed and signed by *his/her* responsible Professional Engineer. Copies of these weekly reports shall be sent (within 5 calendar days of the inspection) to the site contractor, the owner/developer, and the SCD (Attn: Sediment and Stormwater Program Manager, 23818 Shortly Road, Georgetown, DE 19947). These reports can also be faxed to SCD at (302) 856-0951. **If a potential environmental impact or safety issue is observed, SCD must be notified within 24 hours**.

4. The CCR must monitor and report on all stages of the stormwater management facility construction using applicable checklists. The CCR must be present on site and observe all stormwater management checklist items. The CCR is responsible for accurately reporting what they observe and should alert the contractor immediately to any problems or discrepancies. The report must reflect any problems that develop in the field and how they are addressed.

5. The CCR is responsible for performing all required inspections specified in the stormwater checklist or as discussed at the pre-construction meeting. The CCR should be familiar with all items on the checklist and competent to perform the required inspections. If the CCR is not able to complete certain items on the checklist, they should notify the owner/developer before the job begins (preferably at or before the pre-construction meeting). The owner/developer is still responsible for making sure these items are completed and properly inspected by a qualified CCR or Professional Engineer."

Certified Construction Reviewer (CCR) Responsibilities (continued)

6. The CCR is responsible for notifying the owner/developer, contractor, and SCD of any problems or deficiencies on the site. If a control practice has failed, a design change may be needed. An important role of the CCR is to work with the contractor, design engineer, and SCD to facilitate such a change, if necessary. Problems that relate to inadequacies in the approved plan must be referred to SCD, who will either work with the CCR and contractor on field modifications or require a revised plan from the design engineer.

7. The CCR is responsible for contacting SCD if they are having difficulty with compliance or communication with the owner and/or contractor. SCD will first attempt to resolve any outstanding issues, but if further enforcement action is necessary, sites will be referred to DNREC through SCD.

8. All CCR reports are expected to be honest and accurate. Auditing of CCR performance will be done and CCR certification can be revoked.

Owner/Developer Responsibilities

1. The owner/developer of a site is responsible for ensuring that all work done on site is done in accordance with the approved plans, the Delaware Sediment and Stormwater Regulations, and the Delaware Erosion and Sediment Control Handbook. It is the owner/developer's responsibility to ensure that all employees and contractors are clearly directed to comply with all appropriate plans and regulations.

2. The owner/developer is responsible for providing a CCR on those sites that are required to have one, in accordance with the Delaware Sediment and Stormwater Regulations and SCD policy. After selecting a CCR for their site, the owner/developer must complete his/her portion of the CCR application and sign the Owner/Developer's Certification on the application.

3. The owner/developer is responsible for directing the site contractor to cooperate and comply with the directions of the CCR and SCD inspector. Any items requiring maintenance or correction on the weekly CCR reports should be corrected as soon as possible.

4. The owner/developer is responsible for ensuring that there is a CCR reporting on the site weekly until the construction has reached a stage of completion as identified earlier in this policy, a request for suspension of CCR inspection requirement is approved, or a final inspection has been held. If a CCR is not performing adequately or ceases to work on that site for some reason, a new CCR must be retained immediately and SCD must be notified of the change of personnel. Any change will require the approval of a new SCD CCR application.

5. The owner/developer is responsible for having compaction testing done by a qualified geotechnical professional for all constructed embankments of any stormwater management facilities.

6. The owner/developer must understand that the CCR is required to notify SCD if the site is not in compliance and/or the contractor is not responding to the punchlist items. The CCR could lose his/her certification if he/she does not perform his/her duties in accordance with the regulations.

7. If suspension of the CCR inspection is requested, the Owner must submit this request to SCD in writing.

Site Contractor Responsibilities

1. The contractor is responsible for performing all site work in accordance with the approved plans, the Delaware Sediment and Stormwater Regulations, and the latest version of the Delaware Erosion and Sediment Control Handbook.

2. The contractor is responsible for maintaining close communication with the CCR and the SCD inspector for all required inspections. The contractor should keep the CCR informed of the work progress and should contact the SCD and the CCR at least 48 hours prior to work on all required inspection items. The contractor is also required to contact SCD and the CCR at least 48 hours before beginning any site work.

3. No work on a stormwater management facility shall proceed until the CCR inspects and approves the work previously completed unless prior approval has been granted by SCD. If work proceeds without the CCR being present, without prior approval, SCD and/or DNREC reserve the right to require disassembly and reconstruction of the completed works at the owner's expense.

4. The contractor is responsible for installing and maintaining, in a timely manner, all sediment and stormwater controls as necessary in accordance with the approved plans and the Delaware Erosion and Sediment Control Handbook. The contractor is responsible for cooperating with the CCR and/or the SCD inspector when corrective action is required on site. The contractor is responsible for installing all stormwater management facilities in accordance with the approved plans. They are also responsible for bringing any problems that develop in the course of these installations to the immediate attention of the design engineer, CCR, SCD and the developer.

5. Any change or deviations in the field implementation of the approved plan must be reviewed and approved by SCD prior to installation. If necessary, the proposed change will be directed through the design and review process. This decision will be at the discretion of SCD.

6. The contractor must also ensure that the individual on-site responsible for daily implementation of the Sediment and Stormwater plan has completed the Contractors Certification Course. Contact DNREC's Sediment and Stormwater Program Manager at (302) 739-4411 for information on this program.

Professional Engineer's (P.E.) Responsibilities

1. The P.E. must be registered and licensed in the State of Delaware. After verification of qualifications, and selection, the P.E. must complete his/her portion of the CCR application and sign the Professional Engineer's Certification on the application.

2. The P.E.'s primary responsibility is reviewing, verifying the accuracy of, and signing the weekly CCR reports and The P.E. is available to assist the CCR with any questions that may arise in the course of their inspections.

Sussex Conservation District Responsibilities

1. SCD is responsible for review and approval of the Sediment and Stormwater plans in accordance with the Delaware Sediment and Stormwater Regulations and the Delaware Erosion and Sediment Control Handbook.

2. SCD is responsible for reviewing the CCR application and approving or disapproving it within 3 days. If the application is disapproved, written justification for the disapproval will be provided.

3. At the owner/developer's request, SCD is responsible for coordination of the pre-construction meeting and the issuance of minutes to all parties in attendance. The purpose of this meeting is to provide an opportunity for all the parties (owner, contractors, design and review engineers, CCR's, inspectors, etc.) to get together to discuss any plan-related issues prior to the start of work. Any concerns about plan implementation or general procedures should be raised and resolved at this meeting.

4. SCD is responsible to conduct an inspection with the CCR of the perimeter controls once site work begins on all sites. After the perimeter control inspection, S&S inspection will be the primary responsibility of the CCR except for periodic checks by the SCD inspector. The SCD inspector must be notified 48 hours prior to all required inspections, as discussed at the pre-construction meeting.

5. SCD will periodically monitor sites under CCR responsibility. SCD will track and verify a sample of CCR inspection reports to determine accuracy in the field. Any correspondence generated by SCD on a site being inspected by a CCR will be copied to all necessary parties.

6. When a site is found to be in violation by the CCR, SCD will become involved to attempt to resolve all outstanding issues. If necessary, SCD will refer the site to DNREC for enforcement.

7. SCD will notify the CCR if his/her performance does not comply with the requirements of the CCR Program. If the CCR's performance does not improve within a reasonable period of time, the CCR may be referred to DNREC to begin the suspension and/or revocation process.

8. SCD will review requests to discontinue CCR inspections and approve or deny those requests within 5 working days. The time/events at which CCR inspections must resume will be specified by SCD at the time of the suspension approval.

Department of Natural Resources and Environmental Control Responsibilities

1. DNREC is responsible for certification of the CCR's through the Certified Construction Reviewer course. Contact DNREC's Sediment and Stormwater Program Manager at (302) 739-4411 for information on this program.

2. DNREC is also responsible for providing general education for the contractors and developers through the Contractor Certification Program. Contact DNREC's Sediment and Stormwater Program Manager at (302) 739-4411 for information on this program.

3. DNREC is responsible for enforcement of site compliance on sites referred by the CCR through SCD.

This policy is hereby declared effective on December 1, 2003

DelDOT CCR Specifications
(See also DelDOT Supplemental Specifications)

Section 110 - Erosion, Sediment Control and Water Pollution

the surety, and an invoice or purchase order on the supplier's letterhead documenting the cost of the materials. No payment allowance will be permitted for amounts less than $25,000.00 for each material of a qualifying Contract item.

F. Materials Measurement and Payment. The method of measurement for materials shall be in units which are easily inventoried and acceptable to the Engineer. Payment allowance for materials shall be included in the progress estimate as a new and separate item and shall be subject to retainage provisions. Submit proof of payment to the Engineer prior to processing the next progress estimate in the form of a paid invoice from the Material supplier. Failure to submit proof of payment prior to the processing of the progress payment will result the deduction of the applicable material payment, in its entirety, from progress payments until such time as the proof of payment is received by the Engineer. As the materials are incorporated in the Project and paid for in place, an equal percentage shall be deducted from progress estimates until 100% of the allowance has been deducted. At the conclusion of the work for which the materials are required, the cost of materials remaining in storage for which payment allowance has been made will be deducted from the progress estimate.

Section 110 - Erosion, Sediment Control and Water Pollution. (1/3/2008)

Delete Section 110 in its entirety modify as follows:

110.01 Definitions
110.02 Legal Authority
110.03 Sediment and Stormwater Permit Approval
110.04 Description of Work
110.05 Completion of the Work
110.06 Plan Changes
110.07 Limits of Construction
110.08 Division of Responsibilities
110.09 Vegetative Stabilization
110.10 Temporarily Stockpiled Material
110.11 Channel and Ditch Scour Protection
110.12 Sediment-Laden Runoff
110.13 Dewatering Operations
110.14 Clean Water Diversions
110.15 Stream Diversions
110.16 Temporary Stream Crossings
110.17 Wash Water
110.18 Waste Water
110.19 Water Pollution Violations Enforced
110.20 Maintenance
110.21 Erosion and Sediment Control Reports
110.22 Failure to Implement and Maintain Erosion and Sediment Control Measures

110.23 Contractor Payment
110.24 Fines Resulting from Non-Compliance

110.01 Definitions.

Clearing. The clearing of trees, brush, shrubs, downed timber, rotten wood, rubbish, and any other vegetation, except where excluded by the definition for grubbing, as well as the removal of fences and structures. See Subsection 201.01.
*Disturbed Area***.** An area where any activity has been initiated which may result in soil erosion from water or wind or movement of sediments or pollutants into state waters or onto lands in the state, or which may result in accelerated stormwater runoff, including, but not limited to, clearing, grubbing, grading, excavating, transporting, filling, and backfilling of land.
Grubbing. Shall mean the removal of trees, stumps, roots, brush, root mat, and debris from the ground.
Limited Suspension of Activity. Suspension of specific land disturbing work activities when the Contractor fails to implement and maintain the erosion and sediment controls after verbal or written direction to do so by the Engineer. This suspension would be specific to the land disturbing activities that are not compliant. During a Limited Suspension of Activity, progress payments for these specific activities will be withheld until the Contractor has corrected the problems. Time charges will continue and no claim for delay will be considered during a Limited Suspension of Activity.
Phasing. Staged construction sequencing as shown in the Plans.
Significant Rain Event. A rain event that generates erosion.
Site Reviewer. A person on the Contractor's staff assigned to erosion and sediment control review, implementation and maintenance. The level of training (Contractor's Certification or Certified Construction Reviewer) required for the Site Reviewer will be noted in the project plans.

A. *Contractor's Certification (Blue Card).* Introductory training for erosion and sediment control provided by the Department of Natural Resources (DNREC). For projects designated as having Minor erosion potential, the Contractor must submit as part of his bid, the name and certification number for someone other than the Superintendent who has a Blue Card certification.
B. *Certified Construction Reviewer (CCR, Gold Card).* Advanced training for erosion and sediment control provided by the Department of Natural Resources (DNREC). For projects designated as having Medium or Major erosion potential, the Contractor must submit as part of his bid the name(s) and certification number(s) for the individuals on his staff who have a CCR (Gold Card) certification as noted on the plans.

110.02 Legal Authority. The Department is a delegated agency of DNREC as defined in Chapter 40, Title 7 of the Delaware Code and the Delaware Sediment and Stormwater Regulations. Any project built by Contract with the Department shall maintain compliance with the aforementioned law and regulations at all times throughout the life of that project. As a delegated agency, the Department shall enforce

compliance with the law and regulations through the Contract documents or may refer a violation to DNREC for enforcement action.

110.03 Sediment and Stormwater Permit Approval. A signature, date, and seal in the Stormwater Engineer's block on the title sheet of the Plans indicates that the Plans were designed in conformance with the applicable State and Federal stormwater regulations and that the Sediment and Stormwater Permit is approved. All work shall be completed pursuant to the Plans and as directed by the site reviewer and the Stormwater Engineer.

Neither review and approval of the erosion, sediment control, and water pollution control plans nor errors and omissions in the plans shall relieve the Contractor from its responsibilities for compliance with the Delaware Sediment and Stormwater Regulations or other applicable laws or regulations and the more stringent water pollution control requirements shall apply.

110.04 Description of Work. Erosion and sediment control measures shall be applied to erodible earth material exposed by any of the Contractor's land disturbing activities on the Project. The work shall consist of the application of temporary and permanent erosion and sediment control items as provided in the Contract or ordered by the Site Reviewer or the Engineer. The temporary erosion control items shall be coordinated with the permanent erosion control items specified. The items shall include, but are not limited to, the use of berms, dikes, dams, sediment basins, traps, geotextiles, stone check dams, silt fences, phased construction, special land grading methods, mats and nets, aggregates, mulches, grasses, slope drains, chemical binders, tackifiers, and other erosion and sediment control items or approved methods as designated in the Contract documents or as directed by the Site Reviewer or the Engineer.

110.05 Completion of the Work. The Contractor shall implement the temporary and permanent erosion control items for each phase of construction as detailed in the Contract documents. Additional erosion and sediment control items may be required during the Project as deemed necessary by the Site Reviewer and the Engineer in order to provide continuous erosion and sediment control protection.

Before starting each phase of any land-disturbing activity, the Site Reviewer shall make certain that all erosion and sediment control items required in that phase are properly installed and functional.

A. ***Construction Phasing.*** For Project sites in excess of 20 ac (8 ha), the construction must be phased in 20 ac (8 ha) increments. Once grading is initiated in one 20 ac (8 ha) increment, a second 20 ac (8 ha) increment may be cleared and grubbed provided the Contractor installs and maintains effective erosion and sediment control measures on both sections in such quantities and locations as deemed acceptable by the Site Reviewer and the Engineer.

When balancing earthwork, such as when borrow from a cut is used as fill at a noncontiguous location distant from the cut, more than a total of 20 ac (8 ha) may be allowed to be grubbed and graded within the overall limits of the Project at any one time with prior written approval from the Engineer. In such cases, one

20 ac (8 ha) increment in cut and one 20 ac (8 ha) increment in fill may be grubbed and graded at each separate location concurrently. Examples of when this would likely occur would be on interchange construction or on a new alignment.

The Site Reviewer or the Engineer may further limit the area of clearing, grubbing, stripping, and grading operations to the Contractor's capability and actual progress of keeping the finish grading, mulching, seeding, and other temporary or permanent erosion control measures current according to the approved progress schedule and construction sequence.

B. *Construction Sequence.* The Contractor shall sequence the construction to comply with the following constraints unless indicated otherwise on the Plans:

1. Implement temporary erosion and sediment control items prior to any operation, which exposes soil to erosion, such as during the clearing portion, and prior to the grubbing portion of each phase of construction.
2. Schedule and perform the clearing and grubbing operations so that grading operations and permanent stabilization can follow immediately thereafter. Once earthwork has begun, the operation shall be continuous from clearing and grubbing through to completion of grading and final stabilization in accordance with Subsection 110.09 A.2. Any interruption in these operations in excess of 14 calendar days must be approved by the Engineer and shall require interim stabilization in accordance with Subsection 110.09 A.1.
3. Vegetatively stabilize bare soil areas in each phase of construction in accordance with Subsection 110.09 A.1 prior to advancing the work into the next phase of construction.
4. Vegetatively stabilize all cut and fill slopes of the highway excavation and embankment as the work progresses in height increments not to exceed 4’ (1.2 m) of embankment. This will minimize exposed soil on the slopes to bands of 9-12 feet as measured along the slope face. Excavate roadside ditches as early in the Project as possible to establish good drainage.
5. Vegetatively stabilize all grass ditches, swales, and medians within seven calendar days after their initial excavation.
6. Remove temporary erosion and sediment controls after final stabilization is complete in accordance with Subsection 110.09 A.2. Return land contours to original grade or as indicated on the Plans, and vegetatively stabilize any remaining bare soil areas.

110.06 Plan Changes. The Contractor shall not deviate from the erosion, sediment control, and stormwater management aspects of the Contract shown in the Plans and contract documents, other than as specified in 110.08.A.2.b without prior review and approval by the Engineer, the Stormwater Engineer, the Department’s Environmental Section and appropriate regulatory authorities.

For plan changes initiated by the Contractor, revised construction Plans shall be submitted for review and approval by the Engineer, the Stormwater Engineer, the

Department's Environmental Section and appropriate regulatory authorities. The revised Plans shall be prepared in accordance with current Department standards for roadway design, traffic control, erosion and sediment control, and stormwater management. Revised Plans shall also conform to all applicable Federal, State, or municipal pollution control laws, rules, or regulations. All supporting design calculations and cost analyses required by the Engineer shall accompany the submission. The number of copies required to be submitted for review shall be determined by the Engineer depending on the nature of the proposed revision.

Contractor proposed revisions to the Plans, as well as review time by the Department, will not justify a delay in the progress schedule. All costs involved in preparing plan revision documents for changes proposed by the Contractor shall be the responsibility of the Contractor.

110.07 Limits of Construction. The Contractor shall not perform any work including, but not limited to, clearing, grubbing, construction phasing, equipment storage, and material stockpiling outside the limits of construction shown on the Plans without prior approval of the Engineer.

If the Contractor should require additional lands that are not within Department rights-of-way or easements, it shall be the Contractor's responsibility to make all arrangements with the property owners and to acquire all permits from the appropriate regulatory authorities for the use of these lands.

The Contractor shall acquire a statement signed by the property owners, which releases the Department from all claims arising from the use of the property being considered. The signed statement from the property owner and copies of all permits acquired by the Contractor shall be transmitted by the Contractor to the Engineer for the Engineer's records prior to initiating any operation on the property being considered for use.

110.08 Division of Responsibilities.

A. *Site Reviewer.* The Site Reviewer is responsible for the following:

1. On Projects with Erosion Potential identified as Minor, Medium, or Major:
    a. The Site Reviewer shall review and become familiar with all elements of the approved sediment and stormwater management plan. Any questions or issues raised during this review should be discussed with the Contractor, Designer and the Department at the pre-construction meeting. The Site Reviewer should bring up any questions about the plans at this meeting.
    b. The Site Reviewer shall inspect all perimeter controls in accordance with the approved plan and the Department's Standard Construction Details for Erosion and Sediment Control prior to the Contractor beginning any earth disturbing activities and shall submit an Erosion and Sediment Control Report (E & S Report) to the Department stating that all perimeter controls are in place and functioning.
    c. The Site Reviewer shall perform sediment and stormwater reviews of the site jointly with a member of DelDOT's construction inspection

staff. These inspections shall be completed at least weekly and immediately after any significant rain event. The Site Reviewer shall prepare an E & S Report, which details any corrective actions that need to be implemented and a completion date for each. If no deficiencies exist, the report shall document that all erosion and sediment control measures are in place and functioning. The Site Reviewer and the Inspector shall sign and date the E & S Report at the conclusion of the field inspection. By close of business that day, the report shall be forwarded, via email or FAX, to the Contractor's Superintendent for Implementation with copies sent to the Department's Construction Engineer, the Project Resident, the Stormwater Engineer, and the Contractor's engineer.

d. With concurrence of the Engineer, once all land disturbing activities are completed and all permanent erosion and sediment controls and stormwater management elements are in place and vegetatively stabilized, the Site Reviewer shall contact the Stormwater Engineer and schedule an as-built inspection of these features.

2. On Projects with Erosion Potential identified as Medium and Major the Site Reviewer shall be responsible for all of the requirements under 110.08A.1. plus the following (Site Reviewer must be a CCR):
    a. The Site Reviewer shall accurately fill out a Stormwater Management Facility Construction Checklist(s) for permanent stormwater management ponds. The Site Reviewer shall be present during the construction of these facilities to observe all checklist items for compliance with approved plans and applicable pond construction codes.
    b. The Site Reviewer with concurrence of the DelDOT Project Resident may approve minor changes or deviations to the approved erosion and sediment control/ stormwater management plan. Changes, so approved, shall be documented in the Site Reviewer's weekly report.

B. *Contractor's Professional Engineer.* The Contractor's Professional Engineer is responsible for the following:

1. The Contractor's PE shall supervise the Site Reviewer and assure that he or she is performing all of his or her duties and completing all reporting requirements within the timeframes identified in this specification.
2. The Contractor's Professional Engineer shall review, sign and date all E & S Reports that proposed corrective actions that will require plan revisions.
3. The Contractor's Professional Engineer shall sign and seal any Plan Revisions the Contractor proposes to the stormwater management plan, the construction phasing, or the erosion and sediment control plans.
4. The Contractor's Professional Engineer shall review, sign and seal the Stormwater Management Facility Construction Checklist after the Site Reviewer has filled it out

C. *Engineer.* The Engineer is responsible for the following:

1. The Engineer is responsible for ensuring that all work is completed in accordance with the approved erosion and sediment control/ stormwater

management plan. The Engineer shall designate an E&S inspector on each project who shall accompany the Site Reviewer on site inspections.

2. The Engineer is responsible for assuring the contractor is providing a Site Reviewer if required by the General Notes of the construction plans. The Engineer is also responsible for referring to the Stormwater Engineer any Site Reviewer who fails to perform the duties assigned by this Contract.

D. *Stormwater Engineer.* The Department's Stormwater Engineer is responsible for the following:

1. The Stormwater Engineer or his designee shall be represented at the pre-construction meeting and at any erosion and sediment control specific meetings. Any concerns about plan implementation or general procedures shall be discussed and resolved at these meetings.
2. In accordance with subsection 110.22, when the Site Reviewer refers a site or if the condition of the site is consistently not improved by the dates noted in the weekly reports the Stormwater Engineer shall recommend that the Engineer pursue enforcement actions to gain compliance. A Site Reviewer may refer a site for failure to implement the approved erosion and sediment control/ stormwater management plan, or for failure to comply with the recommendations in the E & S Reports.
3. The Stormwater Engineer or his designee shall perform annual performance evaluations of the Site Reviewers using the Department's evaluation form. If it is determined that a Site Reviewer is not providing adequate site control or is not referring problem situations, the representative shall require the Contractor to replace the Site Reviewer for the Project and request that DNREC suspend or revoke his/her certification.
4. The Stormwater Engineer or his designee shall perform an as-built inspection of the permanent erosion and sediment controls and Stormwater management features to determine compliance with the approved Sediment and Stormwater Management Plan. If the Stormwater Engineer or his designee identifies deficiencies during the inspection, a letter will be issued to the Project Resident who will notify the Contractor. These deficiencies must be satisfactorily corrected prior to project closeout.
5. The Stormwater Engineer shall complete the Notice of Intent (NOI) at the start of the project and the Notice of Termination (NOT) at the end of the project to meet the requirements of the NPDES Permit.

110.09 Vegetative Stabilization.

A. *Interim and Final Stabilization.* An area of the work shall be considered vegetatively stabilized for erosion control if it meets the criteria in one of the following two cases:

1. *Interim Stabilization.* The seeding and mulching items, sod, or erosion and sediment control items as noted on the Plans are in place and accepted by the Engineer.
2. *Final Stabilization.* Meets the requirement for the removal of the temporary erosion controls placed during interim stabilization, and has complete vegetation growth in accordance with section 734 as determined by the

Engineer. Complete growth of vegetation includes permanent grass reaching a height of 3" (75 mm) over all seeded areas.

B. *Incremental Stabilization.* Side slopes, and other slopes 1:3 (vertical to horizontal) or steeper require placement of either temporary or permanent seeding and mulching as the work progresses in height increments not to exceed 4' (1.2 m) of embankment. This will minimize exposed soil on the slopes to bands of 9-12 feet as measured along the slope face.

C. *Tracking of Slopes.* During grading operations the Contractor shall track all slopes 1:3 (vertical to horizontal) or steeper to prevent gully and sheet erosion. The tracking shall be accomplished by driving cleated equipment such as a bulldozer up and down the slopes so the cleats make horizontally oriented indentations in the soil. All costs associated with tracking of slopes at regular increments shall be incidental to Section 202.

Prior to applying seeding items on slopes 1:3 (vertical to horizontal) or steeper, the Contractor shall track the slopes as described above in order to prepare a stable seedbed. All costs associated with tracking of slopes to prepare a seedbed shall be incidental to the topsoil item being applied to the slope surface.

D. *Maximum Soil Exposure Times.* All erodible earth material exposed by the Contractor's activities shall be vegetatively stabilized within the time frames specified below:

Location	Maximum Time to Vegetatively Stabilize
Sediment controls	Seven calendar days from initial construction (berms, ditches, traps, basins, etc.)
Areas meeting final grades	Seven calendar days from completion of grading
Areas not meeting final grades	Fourteen calendar days from ceasing work in that location

110.10 Temporarily Stockpiled Material. Erodible earth material designated on the Plans or required by the Engineer to be excavated and temporarily stockpiled for later use in the Project shall be located away from live streams and wetlands and placed only in areas deemed appropriate by the Engineer.

The Contractor shall install the erosion and sediment control items designated on the Plans or as directed by the Site Reviewer and the Engineer about the base of the pile in advance of the actual stockpiling operation. Erodible earth material shall be placed in piles of neat conformations. Side slopes shall be seeded and mulched as the pile is placed. All remaining unstabilized surfaces shall be seeded and mulched immediately following completion of the stockpiling operation.

If the Contractor proposes to stockpile erodible earth material in areas not designated on the Plans, it shall be the Contractor's responsibility to prepare and submit erosion and sediment control plans for those proposed areas, which are located within Department rights-of-way and easements for approval by the Site Reviewer and the Engineer. Materials shall not be stockpiled until an erosion and sediment control plan for the proposed stockpile has been approved by the Site Reviewer and the Engineer. The Contractor is also responsible for getting any permits that are necessary.

If the Contractor proposes to stockpile erodible earth material in areas outside of Department rights-of-way and easements, it shall be the Contractor's responsibility to prepare and submit for approval a plan for the use of the proposed site to the appropriate agencies having jurisdiction. No stockpiling operation shall commence in areas outside the Department rights-of-way and easements until the Engineer has received copies of all plans and permits approved by the appropriate regulatory agencies and received copies of statements signed by the property owners, as required under Subsection 110.07, which release the Department from any claims arising from the use of the property. The Contractor shall be responsible for all costs associated with the installation of erosion and sediment controls required by other agencies having jurisdiction on stockpiles located outside the Department's rights-of-way.

110.11 Channel and Ditch Scour Protection. Riprap or other proposed channel lining items designated on the Plans at pipe, culvert, and bridge inlets and outlets and along channel lengths shall be placed before the pipes, culverts, bridges, and channels become operational.

110.12 Sediment-Laden Runoff. Stormwater runoff from disturbed areas shall be directed to an approved sediment control measure, such as a trap or basin, prior to release to ditches, storm drain systems, streams, or surface water bodies of any type. All storm drain pipes, which convey sediment-laden runoff, shall discharge to a sediment trap or sediment basin prior to release from the Project limits of construction as shown on the Plans, or as directed by the Site Reviewer and the Engineer.

~~110.13 Dewatering Operations~~. **MOVED TO SECTION 111.**

110.14 Clean Water Diversions. Stormwater runoff from non-disturbed areas shall be directed away from work areas using any combination of berms, pipes, dikes, swales, pumps and slope drains or as shown on the Plans, or as directed by the Site reviewer and the Engineer.

110.15 Stream Diversions. The Contractor shall not conduct work in a stream without having first obtained the appropriate wetland and subaqueous lands permit(s*).*

When work is to be conducted in the flow line of a stream, whether the stream is perennial or intermittent, the Contractor shall use any combination of dikes, swales, ditches, cofferdams, pipes, pumps, and other devices as shown on the Plans, or as directed by the Engineer to direct the stream flow around the work area.

110.16 Temporary Stream Crossings. Equipment shall not be operated in live streams without a stream diversion being installed to the satisfaction of the Engineer. Temporary bridges or other structures shall be installed if the work requires the crossing of a stream by construction equipment.

110.17 Wash Water. Water containing sediment from any construction activity on the Project such as truck washing, saw cutting, milling, aggregate washing, and equipment washing and which is not regulated as a waste water under State or Federal statutes

shall be discharged to a sediment trapping device and treated by filtration or settling. Sediment-laden wash water shall not be discharged directly to any ditches, storm drain systems, streams, or surface water bodies of any type. Water mixed with Bentonite (a natural material formed from clay particles) used for drilling or augering shall be collected and removed appropriately. An appropriate use may be disposal in approved fill areas of the project.

110.18 Waste Water. Water containing pollutants such as raw sewage, bitumens, fuels, lubricants, paint, or other harmful materials, is strictly regulated under State and Federal statutes and as such shall not be discharged into waters of the State as defined in Chapter 60, Title 7 of the Delaware Code or into natural or manmade channels or storm drain systems leading to waters of the State.

The Contractor is responsible for obtaining all permits required from the appropriate issuing authority for the discharge of waste waters from the Project site. The Contractor shall pay costs associated with waste water permit acquisition. The Contractor shall submit copies of all permit approvals to the Engineer for the Engineer's records.

110.19 Water Pollution Violations. If a water pollution control violation exists on the Project which in the Engineer's judgment poses a public health or safety risk, such as a fuel or chemical spill or release of raw sewage, the Engineer shall refer the violation to the DNREC for immediate action. The cost of clean up shall be the sole responsibility of the Contractor if the DNREC investigation reveals the Contractor's actions caused the violation.

110.20 Maintenance. Erosion and sediment control items shall be maintained continuously throughout the duration of the project, including periods when the project is inactive or suspended. The Contractor shall repair, replace, or maintain any erosion and sediment control item promptly as noted on the E&S Report or as directed by the Site Reviewer or the Engineer. Any eroded surface shall be stabilized, and any accumulated sediment not trapped by a control measure shall be removed and disposed of in an approved stockpile area or hauled off-site. Access shall be maintained to all sediment control devices until construction phasing and stabilization allow the removal of those controls that are no longer required.

Costs associated with repairing, replacing, and maintaining the erosion and sediment control items are incidental to the initial construction of each item. Sediment removal will be paid for separately under Section 250.

110.21 Erosion and Sediment Control Reports. DelDOT will provide standard Erosion and Sediment Control Report forms and Stormwater Management Facility Construction Checklists to the Contractor to be used for all E&S Reports. The reports will itemize work required to maintain compliance with the Contract. The Contractor shall complete the items of work listed on or before the completion dates indicated on the reports.

110.22 Failure to Implement and Maintain Erosion and Sediment Control Measures. Controlling erosion and sedimentation is the Contractor's responsibility under the Contract. If the Contractor fails at any time to implement and maintain the required erosion and sediment control provisions of the Contract, fails to supply a Site Reviewer, or fails to routinely perform E&S inspections, complete the E & S Reports and correct deficiencies identified in the E & S Reports, the Engineer will notify the Contractor, orally or in writing, to comply with the required erosion and sediment control provisions. If the Contractor fails to perform the work as directed orally or in writing from the Engineer, the Engineer shall take any or all of the following actions listed below to gain compliance.

A. *Limited Suspension of Activity.* The Engineer will order a "Limited Suspension of Activity" for the specific land disturbing activities that are not in compliance. Activities necessary to bring the site into compliance will be permitted. The Engineer will establish completion dates for the erosion and sediment control work. Time charges will continue during a Limited Suspension of Activity.
B. *Withhold Progress Payment.* The Engineer may withhold monthly estimate and payment for all contract items.
C. *Stop Work Order.* The Engineer may suspend the performance of all construction, as noted in Subsection 105.02, until all items of work on the E & S Reports are complete and accepted.

   Time charges will continue during this “Shut-Down” period and no claims for additional time or money shall be considered due to "Shut-Downs" resulting from the Contractor's failure to implement and maintain the required erosion and sediment control items.
D. *Deduct Cost of Work Completed By Others.* The Engineer may proceed with adequate forces and equipment of its own or a third party contractor to implement or maintain the erosion and sediment control items necessary to bring the Project into compliance with the Contract documents.

   The entire cost to engage either a third party contractor or the Department’s Maintenance personnel, including administration costs, will be deducted from monies due the Contractor.
E. *Default of Contract.* More than one "Shut-Down" for erosion and sediment control noncompliance may be considered as a failure to perform the terms of the Contract and will be grounds for finding the Contractor in default of the Contract in accordance with Subsection 108.10. If the Contractor defaults on the erosion and sediment control provisions of the Contract, the Project will be referred to the DNREC for enforcement action.

110.23 Contractor Payment. Payment will be made at the unit prices bid for the quantities of the various erosion and sediment control items provided in the Contract that are installed by the Contractor and accepted by the Engineer. Approved changes to the Erosion and Sediment Control Plans shall be paid at the applicable unit bid prices. Any additional work or corrections brought about as a result of errors by the Contractor,

such as nonconformance with the Contract documents and the construction phasing, staging, or sequencing will be made at the Contractor's expense.

110.24 Fines Resulting from Non-Compliance. If the Department receives any fines from DNREC, the Army Corps of Engineers or the EPA as a direct result of the Contractor's refusal to implement and maintain the required erosion and sediment control, fails to supply a Site Reviewer, or fails to routinely perform E&S inspections, complete the E & S Reports and correct deficiencies identified in the E & S Reports, the Contractor will be responsible to pay the fines or the money will be deducted from monies due the contractor

SECTION 111 – DEWATERING OPERATIONS (6/23/2008)

Delete Section 110.13 in its entirety and add Section 111 as follows:

111.01 Permit Required. The State of Delaware, through the Department of Natural Resources and Environmental Control, Division of Water Resources, Water Supply Section regulates the pumping of ground water at depths, rates, and durations that have the potential to affect water supplies, and the pumping of surface water at rates and durations that have the potential to affect water supplies and aquatic environments.

A permit is required when the work described in the Plans requires the deliberate drawdown of the water table using well points, sump pits, or other similar dewatering devices to lower the water table below the work area.

A permit is required when the work described in the Plans requires pumping of water from an excavation and pumping at a rate exceeding 50,000 gallons per day.

111.02 Statewide Permitted Activities. A Statewide General Permit for Dewatering Activities on DelDOT projects has been approved via a memorandum of understanding between DNREC and DelDOT. The effective date of this general permit is June 1, 2008.

No individual dewatering permit shall be required when there is no withdrawal of ground water and pumping rates are less than 50,000 gallons per day.

For individual dewatering permits and Statewide General Permits pumping shall be metered using an instantaneous and totalizing flow meter accurate to within +/- 5%

For Statewide General Permits, DelDOT shall notify the Water Supply Section at (302) 739-9945 at the commencement of dewatering operations. For individual dewatering permits, the Contractor shall notify the Water Supply Section at (302) 739-9945, 48 hours in advance of starting dewatering operations.

The Contractor shall be aware that other State and Federal permits will be required for any entry into streams or wetlands. This Statewide General Permit for Dewatering

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STATE
OF
DELAWARE

Sediment & Stormwater Law
(with Amendments)

Effective Date: June 15, 1990

DELAWARE STATE SENATE
135TH GENERAL ASSEMBLY
SENATE BILL NO. 359
INTRODUCED: MAR 20, 1990
SIGNED: JUN 15, 1990

AN ACT TO AMEND CHAPTER 40, TITLE 7, DELAWARE CODE, RELATING TO EROSION AND SEDIMENTATION CONTROL AND STORMWATER MANAGEMENT.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF DELAWARE (Two-thirds of all members elected to each House thereof concurring therein):

Section 1. Amend Chapter 40, Title 7, Delaware Code by striking Chapter 40 in its entirety and by substituting in lieu thereof a new Chapter 40 to read as follows:

§4001. Legislative Findings and Statement Policy

(a) Legislative Findings. The General Assembly finds that erosion and sedimentation continue to present serious problems throughout the State, and that the removal of a stable ground cover in conjunction with the decrease in the infiltration capability of soils resulting form the creation of additional impervious areas such as roads and parking lots has accelerated the process of soil erosion and sediment deposition resulting in pollution of the waters of the State. This damages domestic, agricultural, industrial, recreational, fish and wildlife and other resource uses. The General Assembly further finds that accelerated stormwater runoff increases flood flows and velocities, contributes to erosion, sedimentation, and degradation of water quality, overtaxes the carrying capacity of streams and storm sewers, greatly increases the costs of public facilities in carrying and controlling stormwater, undermines flood plain management and flood control efforts in downstream communities, reduces groundwater recharge, and threatens public health, welfare, and safety.

(b) State of Policy. In consideration of these legislative findings, it is declared to be the policy of this Chapter to strengthen and extend the present erosion and sediment control activities and programs of this State for both rural and urban lands and to provide for control and management of stormwater runoff consistent with sound water and land use practices. These activities will reduce to the extent possible any adverse effects of stormwater runoff on the water and lands of the State, This policy, to be carried out by establishing and implementing the Department of Natural Resources and Environmental Control, hereinafter referred to as the 'Department', in cooperation with conservation districts, counties, municipalities and other local governments and subdivisions of this State, and other public and private entities, a statewide comprehensive and coordinated erosion and sediment control and stormwater management program to conserve and protect land, water, air and other resources of the State. This program shall be consistent with, and coordinated with other environmental programs implemented by the Department such as wetlands protection and groundwater protection.

§4002. Definitions. The following words, terms and phrases, when used in this Chapter, shall have the meanings ascribed to them in this Section, except where the context clearly indicates a different meaning:

(1) 'Certified Construction Reviewer' means an individual who has passed a departmental sponsored or approved training course and who provides on-site construction review for sediment control and stormwater management in accordance with regulations promulgated under this chapter.

(2) 'Designated Watershed or Subwatershed' means a watershed or subwatershed proposed by a conservation district, county, municipality, or State agency and approved by the

Department. The Department may establish additional requirements due to existing water quantity or water quality problems. These requirements shall be implemented on an overall watershed or subwatershed master plan developed for water quality and/or water quantity protection.

(3) 'Land Disturbing Activity' means any land change or construction activity for residential, commercial, silvicultural, industrial, and institutional land use which may result in soil erosion from water or wind or movement of sediments or pollutants into State waters or onto lands in the State, or which may result in accelerated stormwater runoff, including, but not limited to, clearing, grading, excavating, transporting and filling of land.

(4) 'Person' means any State or federal agency, individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private or public institution, utility, cooperative, municipality or other political subdivision of this State, any interstate body, or any other legal entity.

(5) 'Responsible Personnel' means any foreman or superintendent who is in charge of on-site clearing and land disturbing activities for sediment and stormwater control associated with a construction project.

(6) 'Sediment and Stormwater Management Plan' or 'plan' means a plan for the control of soil erosion, sedimentation, stormwater quantity, and water quality impacts which may result from any land disturbing activity.

(7) 'State Waters' means any and all waters, public or private, on the surface of the earth which are contained within, flow through or border upon the State of Delaware or any portion thereof.

(8) 'Stormwater' means the runoff of water from the surface of the land resulting from any form of precipitation and including snow or ice melt.

(9) 'Stormwater Management' means:

(a) for water quantity control, a system of vegetative, structural, and other measures that controls the volume and rate of stormwater runoff which may be caused by land disturbing activities upon the land; and

(b) for water quality control, a system of vegetative, structural, and other measures that controls adverse effects on water quality that may be caused by land disturbing activities upon the land.

(10) 'Stormwater Utility' means the establishment of an administrative organization that has been created for the purposes of funding sediment control, stormwater management or flood control planning, design, construction, maintenance, and overall resource needs by authorized and imposed charges.

§4003. <u>Duties of Persons Engaged in Land Disturbing Activities</u>

(a) After July 1, 1991, unless exempted, no person shall engage in land disturbing activities without submitting a sediment and stormwater management plan to the appropriate plan approval authority and obtaining a permit to proceed.

(b) Projects which do not alter stormwater runoff characteristics may be required to provide water quality enhancement even if the predevelopment runoff characteristics are unchanged. Criteria will be detailed in the regulations regarding level of water quality control and variance procedures.

(c) Each land developer shall certify, on the sediment an stormwater management plan submitted for approval, that all land clearing, construction, development, and drainage will be done according to the approved plan.

(d) All approved land disturbing activities shall have associated therein at least one individual who functions as responsible personnel.

§4004. Applicability

(a) The provisions of this Chapter shall not apply to agricultural land managements practices unless the conservation district of the Department determines that the land requires a new or updated soil an water conservation plan, and the owner or operator of the land has refused either to apply to a conservation district for the development of such a plan, or to implement a plan developed by a conservation district.

(b) Unless a waiver is granted the construction of agricultural structures such as broiler houses, machine sheds, repair shops, and other major buildings shall require approval of a sediment and stormwater management plan, by the appropriate plan approval agency, prior to the initiation of construction.

(c) Utility projects disturbing less the 5,000 square feet of land not subject to the provisions of this Chapter.

§4005. Program Funding and Financial Assistance

(a) The Department, conservation districts, counties, or municipalities are authorized to receive from federal, State, or other public or private sources financial, technical or other assistance for use in accomplishing the purposes of this Chapter. The Department may allocate, as necessary or desirable, any funds received to conservation districts, counties, or municipalities for the purpose of effectuating this Chapter.

(b) The conservation districts, counties, and municipalities shall have authority to adopt a fee system to help fund program implementation. That fee system shall be implemented by the designated plan approval agency to fund overall program management, plan review, construction review, enforcement needs, and maintenance responsibilities. In those situations where the Department may assess a plan review and inspection fee. That fee shall not exceed $80.00 per disturbed acre per project. There shall be no duplication of fees by the various implementing agencies for an individual land disturbing activity and the fee schedule shall be based upon the costs to the Department, conservation districts, counties, of municipalities to implement and administer the program.

(c) Authority is also granted to the Department, conservation districts, counties or municipalities to establish a stormwater utility as an alternative to total funding under the fee system. The stormwater utility shall be developed for the designated watersheds and may fund such activities as long range watershed master planning, watershed retrofitting, and facility maintenance. This fee system shall be reasonable and equitable so that each contributor of runoff to the system, including State agencies, shall pay toe the extent to which runoff is contributed. Criteria for the implementation of the stormwater utility shall be established in regulations promulgated under this Chapter. The implementation of a stormwater utility will necessitate the development of a local utility ordinance prior to its implementation.

§4006. State Management Program

(a) The Department shall, in cooperation with appropriate State and federal agencies, conservation districts, other governmental subdivisions of the State, and the regulated community develop a State Stormwater Management Program. This program shall take into consideration both quantity and quality of water, and shall be integrated with, and made a part of the amended State Erosion and Sediment Control Program to create a Sediment and Stormwater program.

(b) In carrying out this Act, the Department shall have the authority to:

(1) Provide technical and other assistance to districts, counties, municipalities, and State agencies in implementing this Chapter;

(2) Develop and publish, as regulation components, minimum standards, guide lines and criteria for delegation of sediment and stormwater program components, and model sediment and stormwater ordinances for use by Districts, counties, and municipalities;

(3) Review the implementation of all components of the statewide sediment and stormwater program that have been delegated to either the conservation districts, counties, municipalities, or other State agencies in reviews to be accomplished at least once every three (3) years;

(4) Require that appropriate sediment and stormwater management provisions be included in all new erosion and sediment control plans developed pursuant to this Chapter;

(5) Cooperate with appropriate agencies of the United States of other states or any interstate agency with respect to sediment control and stormwater management;

(6) Conduct studies and research regarding the causes, effects and hazards of stormwater and methods to control stormwater runoff;

(7) Conduct and supervise educational programs with respect to sediment control and stormwater management;

(8) Require the submission to the Department of records and periodic reports by conservation districts, tax ditch organization, county and municipal agencies as may be necessary to carry out this Act;

(9) Review and approve designated watersheds for the purpose of this Act;

(10) Establish a maximum life of three years for the validation of approved plans. The regulations shall specify variances which expand this time limitation in specific situation; and

(11) Establish a means of communication, such as a newsletter, so that information regarding program development and implementation can be distributed to interested individuals.

(c) The Department shall develop such regulations in conjunction with and with substantial concurrence of a regulatory advisory committee, appointed by the Secretary, which shall include representatives of the regulated community and others affected by this Act. The recommendations of this committee shall be presented at all public workshops and hearings related to the adoption of the regulations implementing this Act. Prior to final promulgations of regulations under this Act, the Secretary shall explain, in writing, any differences between the advisory committee recommendations and the final regulations. The regulations may include, but are not limited to, the following items:

(1) Criteria for the delegation of program elements;

(2) Types of activities that require a sediment and stormwater management permit;

(3) Waivers, exemptions, and variances:

(4) Sediment and stormwater plan approval fees and performance bonds;

(5) Criteria for distribution of funds collected by sediment and stormwater plan approval fees;

(6) Criteria for implementation of a stormwater runoff utility;

(7) Specific design criteria and minimum standards and specifications;

(8) Permit application and approval requirements;

(9) Criteria for approval of designated watersheds;

(10) Criteria regarding attendance and completion of departmental sponsored or approved training courses in sediment and stormwater control that will be required of certified construction reviewers and responsible personnel;

(11) Construction review; and

(12) Maintenance requirements for sediment control during construction and stormwater management structures after construction is completed.

(d) The Department may adopt, amend, modify, or repeal rules or regulations after public hearing to effectuate the policy and purposes of this Chapter. The conduct of all hearings conducted pursuant to this Chapter and the promulgation process shall be in accordance with the relevant provisions of Chapter 60 of this Title.

§4007. Local Sediment and Stormwater Programs

(a) Pursuant to regulations promulgated by the Department, each conservation district, county, municipality, or State agency may adopt, and submit to the Department for approval, one or more components of a sediment and stormwater program for the area within its jurisdiction.

(b) Requests for delegation of program elements shall be submitted within six months of the promulgation of State regulations, and by January 1 of subsequent years if delegation is desired at a future date. The Secretary shall grant or deny such a request on or before April 1 of the year for which delegation is sought.

(c) Delegation, once applied for, shall become effective on July 1 and shall not exceed (3) years, at which time delegation renewal is required.

(d) A district, county, municipality, or State agency may develop the program in cooperation with any other governmental subdivisions.

(e) Initial consideration regarding delegation of program elements shall be given to the conservation districts, since the conservation districts, having unique capabilities and areawide responsibilities, are in an ideal position to coordinate and implement local sediment and stormwater programs.

§4008. Interim Program

(a) Prior to July 1, 1991 requirements for sediment control shall be as provided in existing erosion and sediment control regulations promulgated September 26, 1980. Also, until July 1, 1991 any State or locally developed regulation or criterion for stormwater management shall remain in effect at the discretion of the implementing authority.

(b) Projects approved prior to July 1, 1991, but which are under construction after July 1, 1991, shall be subject to the penalty provisions contained in Section 4015 of this Chapter.

§4009. Failure of Conservation Districts, Counties, Municipalities, or State Agencies to Implement Delegated Program Elements

(a) If, at any time, the Department finds that a conservation district, county, municipality, or State agency has failed to implement program elements that the Department has delegated, the Department shall provide written notice of violation to the conservation district, county, municipality or State agency.

(b) Within 60 days of receipt of the notice of violation, the conservation district, county, municipality or State agency shall report to the Department the action which it has taken to comply with the requirements set forth in the violation notice.

(c) If after 120 days of receipt of the notice of violation, the conservation district, county, municipality, or State agency has failed to comply satisfactorily with requirements set forth in the notice of violation, the Department may suspend or revoke the delegated authority.

§4010. State and Federal Projects

After July 1, 1991 a State or federal agency may not undertake any land clearing, soil movement, or construction activity unless the agency has submitted a sediment and stormwater management plan to the Department and received its approval. The only variation to this requirement shall be when delegation of the plan approval process has been granted by the Department to a specific State of federal agency.

§4011. Designated Watersheds or Subwatersheds

(a) Watersheds or subwatersheds approved as designated watersheds or subwatersheds by the Department shall have the regulatory requirements clearly specified through a watershed approach to nonpoint pollution control or flood control. The watershed approach shall result in a specific plan, developed or approved by the Department, for the designated watershed or subwatershed that contains the following information:

(1) Stormwater quantity or quality problem identification;

(2) The overall needs of the watershed, not just the additional impacts of new development activities;

(3) Alternative approaches to address the existing and future problems;

(4) A defined approach which includes the overall costs and benefits;

(5) A schedule for implementation;

(6) Funding sources and amounts; and

(7) A public hearing process prior to departmental approval.

(b) Upon approval of the designated watershed or subwatershed plan, all projects undertaken in that watershed or subwatershed shall have stormwater requirements placed upon them that are consistent with the designated watershed or subwatershed plan.

§4012. Construction Review and Enforcement

(a) With respect to approved sediment and stormwater plans, the agency responsible for construction review during and after construction completion shall ensure that periodic reviews are undertaken, implementation is accomplished in accordance with the approved plans, and the required measures are functioning in an effective manner. Notice of such right of construction review shall be included in the sediment and stormwater management plan certification. The agency responsible for construction review may, in addition to local enforcement options, refer a site violation to the Department for additional action.

(b) Referral of a site violation to the Department may initiate a departmental construction review of the site to verify site conditions. That construction review may result in the following actions:

(1) Notification through appropriate means to the person engaged in a land disturbing activity and the contractor to comply with the approved plan within a specified time frame.

(2) Notification of plan inadequacy, with a time frame for the person engaged in a land disturbing activity to submit a revised sediment and stormwater plan to the appro priate plan approval agency and to receive its approval with respect thereto.

(c) Failure of the person engaged in the land disturbing activity or the contractor to comply with departmental requirements may result in the following actions in addition to other penalties as provided in this Chapter.

(1) The Department shall have the power to issue a cease and desist order to any person violating any provision of this Chapter by ordering such person to cease and desist from any site work activity other than those actions necessary to achieve compliance with any administrative order.

(2) The Department may request that the appropriate plan approval agency refrain from issuing any further building or grading permits to the person having outstanding violations until those violations have been remedied.

§4013. Approval of Certified Construction Reviewers

(a) Based on criteria established by the Department through regulation and any additional criteria established by the agency implementing the plan review and construction elements of the sediment and stormwater program, the person engaged in a land disturbing activity may be required to provide for construction review by a certified construction reviewer.

(b) Individuals functioning as certified construction reviewers must attend and pass a departmental sponsored or approved construction review training course. The Department will establish, through regulation, the length of time for which the certification will last and procedure for renewal. The construction reviewers shall also function under the direction of a registered professional engineer licensed to practice engineering in the State of Delaware.

(c) The responsibility of the certified construction reviewer will be to ensure the adequacy of construction pursuant to the sediment and stormwater management plan.

(d) The certified construction reviewer shall be responsible for the following items:

(1) Provision of a construction review of active construction sites on at least a weekly basis, as determined on a case-by-case basis by the plan review and construc tion review agencies, or as required by regulations promulgated pursuant to this Chapter;

(2) Within five calendar days, informing the person engaged in the land disturbing activity, and the contractor, by a written construction review report of any violations of the approved plan or inadequacies of the plan. The plan approval agency shall be informed, if the approved plan is inadequate, within five working days. In addition, the appropriate construction review agency shall receive copies of all construction review reports; and

(3) Referral of the project to the Department for appropriate enforcement action if the person engaged in the land disturbing activity fails to address the items contained in the land disturbing activity fails to address the items contained in the written construction review report. Verbal notice shall be made to the Department within two working days and written notice shall be provided to the Department within five working days.

(e) If the Secretary or his designee determines that a certified construction reviewer is not providing adequate site control or is not referring problem situations to the Department, the Secretary or his designee may suspend or revoke the certification of the construction reviewer.

(f) In any situation where a certified construction reviewer's approval is being suspended or revoked, an opportunity for hearing before the Secretary or his designee shall be provided. During any suspension or revocation, the certified construction reviewer shall not be allowed to provide construction reviews pursuant to this Chapter.

(g) The failure to assign a departmental approved certified construction reviewer to a land disturbing activity, when required by the approved plan, will place that project in violation of this Chapter and result in appropriate administrative and/or enforcement action.

§4014. Training of Responsible Personnel

After July 1, 1991, any applicant seeking sediment and stormwater plan approval shall certify to the appropriate approval agency that all responsible personnel involved in the construction project will have a certificate of attendance at a departmentally sponsored or approved training course for the control of sediment and stormwater before initiation of any land disturbing activity. The certificate of attendance shall be valid until the Department notifies the individual or announces in local newspapers that recertification is required due to a change in course content.

§4015. Penalties

(a) Any person who violates any rule, regulation, order, condition imposed in an approved plan or other provision of this Chapter shall be fined not less then $200 or more than $2,000 for each offense. Each day that the violation continues shall constitute a separate offense. The Justice of the Peace Courts shall have jurisdiction of offenses brought under this subsection.

(b) Any person who intentionally, knowingly, and after written notice to comply, violates or refuses to comply with any notice issued pursuant to Section 4013(2) of this Chapter shall be fined not less than $500 or more than $10,000 for each offense. Each day the violation continues shall constitute a separate offense. The Superior Court shall have jurisdiction of offenses brought under this subsection.

§4016. Injunctions

The Court of Chancery shall have jurisdiction to enjoin violations of this Chapter. The appropriate program element authority, the Department, or any aggrieved person who suffers damage or is likely to suffer damage because of a violation or threatened violation of this Chap-

ter may apply to the Chancery Court for injunctive relief. Among any other appropriate forms of relief, the Chancery Court may direct the violator to restore the affected land or water impacted area to its original condition."

SYNOPSIS

The intent of this legislation is to replace the existing sediment control law with new language that will strengthen that law. Additionally, in the same Chapter, a new statewide stormwater management program component is proposed that will reduce, to the extent possible, the adverse water quantity and water quality impacts of stormwater runoff after construction is completed.

The legislation improves upon existing criteria by including the ability to assess a permit fee to assist in program funding, a certification program for construction review (inspection), an educational program for contractors, regulation promulgation procedures that include input from the regulated community, and expanded delegation criteria that recognizes the importance of conservation district involvement while including counties, municipalities, and State agencies in program implementation.

The proposed stormwater management component will arrest the further decline of water quality, and reduce the increased potential of flooding on downstream properties that new development may exacerbate. The prevention of further decline will be accomplished through the imposition of stormwater control practices by individual land developers such as ponds and infiltration practices. A strategy is also presented that would provide for a watershed approach to stormwater management that would eventually improve water quatity and water quality conditons.

Placement of stormwater management legislation within the existing framework of the sediment control law reinforces the concept that these two programs are integrally related.

Author: Sen. Minner

DELAWARE STATE SENATE
137TH GENERAL ASSEMBLY
SENATE BILL NO. 388
INTRODUCED:
SIGNED: JUL 11, 1994

AN ACT TO AMEND TITLE 7 OF THE DELAWARE CODE RELATING TO STATE FORESTRY AND SEDIMENTATION AND EROSION CONTROL.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF DELAWARE :

Section 1. Amend Chapter 40, §4002(3), Title 7, Delaware Code by deleting the word "silvicultural" as it appears in that section.

Section 2. Amend Chapter 40, §4002 (3), Title 7, by adding a new final sentence to the section to read, "This subsection does not apply to commercial forestry practices."

Section 3. Amend Chapter 29, Title 7, of the Delaware Code by adding a new subchapter, designated as Subchapter VI, which subchapter shall read as follows:

"Subchapter VI. Water Quality as it relates to silvicultural systems and sedimentation and erosion control."

§2977. Findings; policy; purpose.

The Forestry Administrator shall provide for the protection of the waters of the state from pollution by sediment deposits resulting from silvicultural activities as provided in §2978 of this title. Through the adoption of this subchapter, the State of Delaware recognizes that water quality protection techniques for silvicultural practices are an integral component of properly managed forests. Further, the State of Delaware recognizes the positive benefits that properly mangaged forest systems have on the environment, water quality, and quality of life in Delaware.

§2978. Definitions

The following words, terms and phrases, as used in this Subchapter, shall have the following meaning ascribed to them except where the context clearly indicates a different meaning:

(1) 'Owner' shall mean any person that (a) owns or leases land on upon which silvicultural activity occurs or (b) owns timber on land which silvicultural activity occurs.

(2) 'Operator' shall mean any person that operates or exercises control over any silvicultural activity.

(3) 'Pollution' shall mean such alteration of the physical, chemical or biological properties of any waters of the state resulting from sediment deposition that will or is likely to create a nuisance or render such waters (a) harmful or detrimental or injurious to the public health, safety or welfare, or to the health of animals, fish or aquatic life; (b) unsuitable with reasonable treatment for use as present or possible future source of public water supply; or (c) unsuitable for recreational, commercial, industrial, agricultural, or other reasonable uses.

(4) 'Silvicultural activity' shall mean any forest management activity, including but not limited to the harvesting of timber, the construction of roads and trails for forest management purposes, and the preparation of property for reforestation.

(5) 'Reforestation' is the establishment of a tree crop on forest land.

(6) 'Special order' shall mean a special order or emergency special order issued under §2980.

§2979. Conduct of silvicultural activities.

If the Forestry Administrator or his or her designee determines that an owner or operator is conducting or allowing the conduct of any silvicultural activity in a manner which is causing or is likely to cause pollution, he or she may advise the owner of operator of corrective measures needed to prevent or cease the pollution. Failure of the Forestry Administrator, or his or her designee, to advise an owner or operator of such corrective meansures shall not impair the Forestry Administrator's authority to issue special orders.

§2980. Issuance of special orders.

Special orders can be issued if the Forestry Administrator, or his or her designee, finds that any owner or operator is conducting any silvicultural activity in a manner which is causing or is likely to cause alteration of physical, chemical or biological properties of any state water, resulting from sediment deposition presenting an imminent and substantial danger to (a) the public health, safety or welfare, or the health of animals, fish or aquatic life (a) a public water supply; or (c) recreational, commercial, industrial, agricultural or other reasonable uses. The Forestry Administrator, or his or her designee, shall have the authority to issue special orders to any owner or operator who is conducting any silvicultural activity in a manner which is causing or likely to cause pollution, to cease immediately all or part of the silvicultural activities on the site and to implement specified corrective measures within a stated period of time. Such special orders are to be issued only after a hearing with reasonable notice to the owner or operator, or both, of the time, place and purpose thereof, and shall become effective not less than five days after service as provided in this section. The commencement of proceedings by the Forestry Administrator for the issuance of a special order shall not impair the authority of the Forestry Administrator to issue an emergency special order pursuant to this subsection. The Forestry Administrator shall provide an opportunity for a hearing, after reasonable notice as to the time and place thereof to the owner or operator, to affirm, modify, amend or cancel such emergency special order. The Forestry Administrator shall not issue a special order to any owner or operator who has incorporated generally acceptable sediment control and stormwater management techniques and guidelines developed by the Forestry Administrator, which techniques have failed to prevent pollution. If the Forestry Administrator determines that the pollution is the direct result of unusual weather events which could not have been reasonably anticipated.

§2981. Hearings, notices

Any hearing required under this section shall follow Title 29, Chapter 101, of the Delaware code, the Administrative Procedures Act.

§2982. Civil penalties

Any owner or operator who violates, fails or refuses to obey any special order may be assessed a civil penalty by the Forestry Administrator. Such penalty shall not be less than $200.00 or more than $2,000.00 for each violation. Each day of a continuing violation may be deemed a separate violation for purposes of assessing penalties. The Superior Court shall have jurisdiction of the offenses brought under this subsection. In determining the amount of the penalty, consideration shall be given to the owner's or operator's history of noncompliance. the seriousness of the violation, including any irreparable harm to the environment, any hazards to the health or safety of the public, whether the owner or operator was negligent, and the demonstrated good faith of the owner or operator in reporting and remedying the pollution. A civil penalty may be assessed by the Superior Court only after the owner or operator has been given an opportunity for a hearing as specified under in §2981 of this Title. Any person who intentionally, knowingly and after written notice to comply, violates or refuses to comply with any notice issued pursuant to this chapter shall be fined not less than $500.00 or more than $10,000.00 for each offense. Each day the violation continues shall constitute a

separate offense. The Superior Court shall have jurisdiction of offenses brought under this subsection.

§2983. State program

In carrying out this chapter, the Forestry Administrator may, in cooperation with appropriate municipal, county, State and Federal agencies, and with representatives from operators and owners groups:

(1) Develop and publish sediment control and stormwater management techniques and guidelines for use by owners and operators;

(2) Provide technical and other assistance to owners and operators in the implementation of techniques and guidelines;

(3) Conduct and supervise educational programs for owners and operators with respect to sediment control and stormwater management techniques and guidelines;

(4) Conduct studies and research and publish the results regarding the causes, effects, and hazards of sediment and stormwater originating from silvicultural activities;

(5) Cooperate with appropriate agencies of the United States or other states or any Interstate agency with respect to silvicultural activities; and

(6) Establish a means of communication, such as a newsletter, so that information regarding program development and implementation can be distributed to interested owners and operators.

SYNOPSIS

This legislation amends Chapter 40, §4002 (3) Title 7, Delaware Code by deleting the word silvicultural. It also creates a new subchapter VI, Chapter 29, Title 7, placing the authority of protecting the state water's from pollution by sedimentation and erosion resulting from silvicultural activities under the Forestry Administrator.

Aurthor: Sen. Adams

DELAWARE STATE SENATE
137TH GENERAL ASSEMBLY
SENATE BILL NO. 395

INTRODUCED: JUN 14, 1994
SIGNED: JUL 11, 1994

AN ACT TO AMEND TITLE 7 OF THE DELAWARE CODE RELATING TO EROSION AND SEDIMENTATION CONTROL.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF DELAWARE :

Section 1. Amend §4015 of Title 7, Delaware Code by deleting the phrase "§4013(d)(2)" as it appears in said section and replacing said phrase with the phrase "§4012".

SYNOPSIS

This Bill would correct the reference in the penalties section of Chapter 40 of title 7 to the proper section.

Author: Sen. Adams

DELAWARE STATE
HOUSE OF REPRESENTATIVES
137TH GENERAL ASSEMBLY
HOUSE BILL NO. 268
AS AMENDED BY
HOUSE AMENDMENT NO. 1
INTRODUCED:
SIGNED: JUL 7,1995

AN ACT TO AMEND CHAPTER 40, TITLE 7 OF THE DELAWARE CODE RELATING TO STORM WATER PLAN APPROVALS FOR WORK ON OR ADJACENT TO A STATE RIGHT-OF-WAY.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF DELAWARE (three-fifths of all members elected to each house thereof concurring therein):

Section 1. Amend §4005(b) of Title 7, Delaware Code by adding the following after the last sentence thereof:

"In addition, the Department of Transportation is authorized to act as the designated plan approval agency in those situations where a public utility engages in land-disturbing activity for which a permit is required because of a project initiated by the Department of Transportation, subject to the following provisions:

(1) If the land-disturbing activity takes place on an existing right-of-way of the Department of Transportation, that Department is permitted to assess and collect a fee for this purpose which shall not exceed $125 per acre, with a $250 minimum.

(2) If the land-disturbing activity takes place adjacent to but not upon an existing right-of-way of the Department of Transportation, the fee contemplated in paragraph (1) above is waived."

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF WATERSHED STEWARDSHIP

5101 Sediment and Stormwater Regulations

1.0 General Provisions

1.1 Findings of Fact

1.1.1 It is determined that:

1.1.1.1 Erosion and sedimentation and delivery of other nonpoint source pollutants such as nutrients through stormwater runoff continue to present serious problems throughout the State.

1.1.1.2 The removal of a stable ground cover in conjunction with the decrease in the infiltration capability of soils resulting from the creation of additional impervious areas such as roads and parking lots has accelerated the process of soil erosion and sediment deposition and nonpoint source runoff of other pollutants resulting in pollution of waters of the State. This damages domestic, agricultural, industrial, recreational, fish and wildlife and other resource uses.

1.1.1.3 Accelerated stormwater runoff increases flood flows and velocities, contributes to erosion, sedimentation and degradation of water quality, overtaxes the carrying capacity of streams and storm sewers, greatly increases the cost of public facilities in carrying and controlling stormwater, undermines floodplain management and flood control efforts in downstream communities, reduces groundwater recharge, and threatens public health, welfare and safety.

1.1.2 The regulation of stormwater runoff from land development activities will control stormwater runoff, soil erosion and nonpoint source pollution and will mitigate the adverse effects of stormwater runoff from development and will reduce threats to public health and safety.

1.2 The purpose of this regulation is to enhance and extend the present erosion and sediment control activities and programs of the State for both rural and urban lands and to provide for control and management of stormwater runoff consistent with sound water and land use practices. These activities will reduce, to the maximum extent practicable, adverse effects of stormwater runoff on the water and lands of the State.

1.3 Applicability

1.3.1 On and after January 1, 2014, unless a particular activity is exempted by these regulations, a person shall not disturb land without an approved Sediment and Stormwater Management Plan from the Department or Delegated Agency. A Sediment and Stormwater Management Plan shall not be approved for a property unless it is consistent with the following items:

1.3.1.1 These regulations;

1.3.1.2 7 **Del.C.** Ch. 40, relating to erosion and sediment control and stormwater management;

1.3.1.3 7 **Del.C.** Ch. 60, relating to the development, utilization, and control of the land, water, underwater and air resources of the State, and;

1.3.1.4 *Regulations Governing the Control of Water Pollution*, Section 9.1.02, known as Special Conditions for Stormwater Discharges Associated with Construction Activities.

1.3.2 Applicability of these regulations for plans that have been approved to comply with previous regulations shall be consistent with the following:

1.3.2.1 Plans approved to comply with previous regulations where construction has not commenced on January 1, 2014 may have the plan approval extended under the requirements of the previous regulations in subsequent three-year approval periods. Any plan approved to comply with previous regulations must commence construction no later than December 31, 2019. A plan approved to comply with previous regulations where construction has not commenced by December 31, 2019 shall expire and a new plan in compliance with these regulations shall be submitted to the Department or Delegated Agency for review and approval before commencement of construction.

1.3.2.2 Plans approved to comply with previous regulations where construction has commenced may be extended based on the requirements in place at the time of original Plan approval.

1.3.2.3 In no case shall the plan extension supersede the sunset provisions of the county or local government.

1.3.2.4 Commencement of construction means that the construction of the approved Plan is visible with the construction of a structure or infrastructure, including but not limited to roads, water and sewer lines, and stormwater management systems. General earth moving is not considered commencement of construction.

1.4 The following activities are exempt from both sediment control and stormwater management requirements established by these regulations:

1.4.1 Agricultural land management practices having a soil and water conservation plan unless the Department or Delegated Agency determines that a new or updated soil and water conservation plan is required, and the Owner or operator of the land has refused either to apply to a Conservation District for the development of a conservation plan, or to implement a conservation plan developed by a Conservation District.

1.4.2 Developments or construction that disturbs less than 5,000 square feet. Individual disturbances of less than 5,000 square feet that accumulate to exceed 5,000 square feet are not exempt and may be subject to the provisions of these regulations as determined by the Department or Delegated Agency on a case-by-case basis.

1.4.3 With written agreement of the Department, land development activities which are regulated with respect to erosion and sediment control and stormwater management under other specific State or Federal laws.

1.4.4 Commercial forest harvesting operations that meet the requirements of the Department of Agriculture under 3 **Del.C.** Ch. 10, Subchapter VI.

1.4.5 Permitted land application of biosolids and residuals.

1.5 Variances

1.5.1 The Department may grant a variance from any requirement of these regulations in accordance with the provisions of 7 **Del.C.** §6011.

1.5.2 The Department may grant a temporary emergency variance from any requirement of these regulations in accordance with the provisions of 7 **Del.C.** §6012.

1.5.3 Excluding items covered by 1.7 Offset Provisions, the Department shall consider and decide applications for a variance from the provisions of these Regulations if all of the following are established by the applicant.

1.5.3.1 The variance sought will not be detrimental to the environment or contrary to law, or these Regulations.

1.5.3.2 Owing to special conditions or an unusual situation, a literal interpretation of these Regulations will result in hardship to the owner of the property in question.

1.5.3.3 If the variance were granted, the goals of these Regulations and the technical documents will be met with respect to the property in question.

1.5.4 The applicant must submit a request for a variance to the Sediment and Stormwater Program of the Department that sets forth and explains the need for the variance.

1.5.5 The Secretary or his designee shall publish his decision on the requested variance and the decision shall be effective immediately.

1.5.6 Any person whose interests are substantially affected may appeal to the Environmental Appeals Board within 15 days of publication of the Secretary's decision.

1.5.7 The variance shall be effective from the date of its approval until a final plan is approved unless the nature and scope of the project for which it was granted has changed.

1.6 Fees and Financial Guarantees

1.6.1 Fees

1.6.1.1 The Delegated Agency has the authority to require fees to support local program implementation, including overall program management, plan review, construction review, enforcement, and maintenance responsibilities. An Owner seeking approval of a Sediment and Stormwater Management Plan shall pay a fee as prescribed by the Department or Delegated Agency. When the Department is the approval agency, the fees shall not exceed $80.00 per disturbed acre per project.

1.6.1.2 The establishment of fees, not involving stormwater utilities, shall be in accordance with the following items:

1.6.1.2.1 The number of needed personnel and the direct and indirect expenses associated with those personnel shall be developed by the agencies requesting delegation in a specific jurisdiction in conjunction with and with the concurrence of the Department. Those expenses will then form the basis for determining plan review, construction review and maintenance review costs.

1.6.1.2.2 The fee schedule and revisions to the fee schedule of the Delegated Agency shall be subject to applicable State or local public notice requirements. State public notice requirements shall be governed by 7 **Del.C.** §6004.

1.6.2 Financial Guarantee

1.6.2.1 The Department or Delegated Agency may require and implement a financial guarantee for construction of the elements of the approved Sediment and Stormwater Management Plan. The Owner shall submit when required to the Department or Delegated Agency a financial guarantee before the onset of construction activities. The financial guarantee will ensure that action can be taken by the Department or Delegated Agency to complete required elements of the approved Sediment and Stormwater Management Plan, at the Owner's expense, should the Owner fail to initiate, complete, or maintain those measures identified in the approved Sediment and Stormwater Management Plan after being given proper notice and within a reasonable time specified by the Department or Delegated Agency.

1.6.2.2 Following approval of the Department, the financial guarantee provisions of the Delegated Agency shall be subject to applicable State or local public notice requirements. State public notice requirements shall be governed by 7 **Del.C.** §6004.

1.7 Offset Provisions

1.7.1 The Department may require an offset as an alternative to full or partial compliance with the Resource Protection Event requirements as provided in Sections 5.2 and 5.6.3 of these regulations.

1.7.2 Offset requirements shall be subject to Departmental review and approval as well as to the public notice requirements of 7 **Del.C.** §6004.

1.7.3 Procedures for determining offset options may be developed by the Department and published in the technical document supplement to these regulations.

1.8 These regulations are adopted pursuant to authority conferred by and in accordance with 7 **Del.C.** Ch. 40 and 7 **Del.C.** Ch. 60.

1.9 These regulations are not intended to interfere with, abrogate, or annul any other ordinance, rule or regulation, statute, or other provision of law. The requirements of these regulations should be considered minimum requirements, and where any provision of these regulations imposes restrictions different from those imposed by any other ordinance, rule or regulation, or other provision of law, whichever provisions are more restrictive or impose higher protective standards for human health or the environment shall be considered to take precedence.

1.10 If any section, subsection, sentence, clause, phrase or portion of these regulations is for any reason held invalid or unconstitutional by any court or competent jurisdiction, such provision and such holding shall not affect the validity of the remaining portions of these regulations.

1.11 Any person who undertakes or causes to be undertaken any land disturbing activities shall ensure that soil erosion, sedimentation, increased pollutant loads and changed water flow characteristics resulting from these activities are controlled so as to minimize pollution of state waters. The requirements of these regulations are minimum standards and a person's compliance shall not relieve the person from the duty of enacting all measures necessary to minimize pollution of, or detrimental impacts to state waters.

1.12 The conduct of all hearings conducted pursuant to these regulations shall be in accordance with the relevant provisions of 7 **Del.C.** Ch. 60.

1.13 The Department is responsible for the implementation and supervision of the sediment and stormwater program which is established by 7 **Del.C.** Ch. 40. The program shall be administered pursuant to these regulations. The Department may also develop and maintain a Technical Document to serve as a guide for the regulated community and Delegated Agencies in complying with Chapter 40 and these regulations.

1.14 Technical Document

1.14.1 The Technical Document may include policies, procedures, technical specifications and other advisory documents as deemed necessary by the Department to carry out implementation and supervision of the sediment and stormwater program.

1.14.2 The Technical Document, as well as any revisions or subsequent updates, shall be adopted following public notice requirements in accordance with 7 **Del.C.** §6004.

1.14.3 The Technical Document may be utilized as a reference for all activities subject to these regulations. Alternative measures that provide functional equivalency to the policies, procedures, technical specifications and other advisory provisions contained in the Technical Document and meet the provisions of these regulations may be considered on a case-by-case basis following Departmental review and approval.

18 DE Reg. 396 (11/01/14)

2.0 Definitions

The following words and terms, when used in this regulation, shall have the following meaning unless the context clearly indicates otherwise:

"Adequate conveyance" means any system having sufficient capacity to transport the runoff generated during the Resource Protection Event, Conveyance Event, and Flooding Event; functions and discharges in a non-erosive manner; and does not adversely impact any offsite properties, conveyance system, stormwater facility, or State Waters.

"Adverse impact" means a negative impact resulting from a construction or development activity. The negative impact may include, but is not limited to, increased risk of flooding; degradation of water quality; increased sedimentation; reduced groundwater recharge; negative impacts on aquatic habitat; or threatened public health and safety.

"Agricultural land management practices" means those methods and procedures generally accepted by the Conservation Districts and used in the cultivation of land in order to further crop and livestock production and conservation of related soil and water resources.

"Agricultural structure" means a structure on a farm used solely for agricultural purposes in which the use is exclusively in connection with the production, harvesting, storage, drying, or raising of agricultural commodities, including the raising of livestock. Structures used for human habitation, public use, or a place of employment where agricultural products are processed, treated, or packaged are not considered agriculture structures for the purposes of these regulations.

"Applicant" means a person who has requested approval of a Sediment and Stormwater Management Plan through submittal of an application in accordance with these regulations or who has requested permission to conduct any activity subject to these regulations.

"Best Available Technology (BAT)" means a level of technology based on the very best (state of the art) sediment and stormwater control and treatment measures that have been developed or are capable of being developed and that are economically achievable.

"Best Management Practices (BMPs)" means schedules of activities, prohibition of practices, maintenance procedures, and other management practices or measures to prevent or reduce the discharge of pollutants. BMPs include the following, among other practices and measures: structural and non-structural controls; treatment requirements; operating procedures and practices to control site runoff.

"Biosolids" means solid or semi-solid material obtained from treated wastewater or animal manure.

"Brownfield" means any vacant, abandoned or underutilized real property the development or redevelopment of which may be hindered by the reasonably held belief that the real property may be environmentally contaminated.

"Certified Construction Reviewer" or "CCR" means those individuals, having passed a Departmental sponsored or approved training course and holding current certification, which provide on-site construction review for sediment control and stormwater management in accordance with these regulations.

"Conservation plan" means a customized document that outlines the use and best management practices of the natural resources on a parcel of land.

"Conveyance Event" means the runoff event produced by a storm having an annual probability of occurrence of 10%.

"Conveyance Event Volume (Cv)" means the volume of runoff generated by the Conveyance Event that is not otherwise reduced for the Resource Protection Event.

"Dedication" means transferring ownership of a stormwater management system to a delegated agency, public utility, municipality, stormwater utility, or private entity, along with all associated easements, escrow funds, and maintenance responsibilities.

"Delegated Agency" means the Conservation District, county, municipality, or State agency that has accepted responsibility in a jurisdiction for implementation of one or more elements of the Sediment and Stormwater Program within that jurisdiction.

"Delegation" means the acceptance of responsibility by a Conservation District, county, municipality, or State agency for the implementation of the Sediment and Stormwater Program.

"Department" means the Department of Natural Resources and Environmental Control.

"Designated Watershed or Subwatershed" means a watershed or subwatershed proposed by a conservation district, county, municipality, or State agency and approved by the Department. The Department may establish additional requirements due to existing water quantity or water quality problems. These requirements shall be implemented on an overall watershed or subwatershed master plan developed for water quality or water quantity protection.

"Detailed plan" means a plan developed by a Licensed Professional in the State of Delaware which does not meet standard plan criteria.

"Drainage area" means that area contributing runoff to a single point measured in a horizontal plane, which is enclosed by a ridge line.

"Easement" means a grant or reservation by the Owner of land for the use of land by others for a specific purpose or purposes, and which must be included in the conveyance of land affected by the easement.

"Effective imperviousness", for the purposes of these Regulations, means the equivalent percentage of a site's impervious area that directly contributes stormwater runoff during the Resource Protection Event after all runoff reduction practices have been implemented.

"Erosion and sediment control" means the control of solid material, both mineral and organic, during a land disturbing activity, to prevent its transport out of the disturbed area by means of wind, water, gravity, or ice.

"**Final stabilization"** means that:

(1) All soil disturbing activities at the site have been completed and either of the two following criteria are met:
   (a) A uniform (e.g. evenly distributed, without large bare areas) perennial vegetative cover with a density of 70% of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or
   (b) Equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

(2) When background native vegetation will cover less than 100% of the ground (e.g., arid areas, beaches), the 70% coverage criteria is adjusted as follows: if the native vegetation covers 50% of the ground, 70% of 50% (0.70 X 0.50 = 0.35) would require 35% total coverage for final stabilization. On a beach with no natural vegetation, no stabilization is required.

(3) For individual lots in residential construction, final stabilization means that either:
   (a) The homebuilder has completed final stabilization as specified above, or
   (b) The homebuilder has established temporary stabilization including perimeter controls for an individual lot prior to occupation of the home by the homeowner and informing the homeowner of the need for, and benefits of, final stabilization.

(4) For construction projects on land used for agriculture purposes (e.g., pipelines across crop or range land, staging areas for highway construction, etc.) final stabilization may be accomplished by returning the disturbed land to its preconstruction agriculture use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to a "water of the United States" and areas which are not being returned to their preconstruction agricultural use must meet the final stabilization criteria (1) or (2) above.

"Financial guarantee" means a bond, security, letter of credit, etc. provided by the Owner to serve as a payment source should the Owner fail to meet the obligations and requirements of the approved Sediment and Stormwater Management Plan.

"Flooding Event" means the runoff event produced by a storm having an annual probability of occurrence of 1.0%.

"Flooding Event Volume (Fv)" means the volume of runoff generated by the Flooding Event that is not otherwise reduced for the Resource Protection Event and the Conveyance Event.

"Functional Equivalency" means alternative measures that are consistent with the policies, procedures, technical specifications, and advisory provisions found in the Technical Document, and which satisfy these Regulations.

"Impervious surface" means a surface which either prevents or retards the entry of water into the soil.

"Infiltration" means the passage or movement of water into the soil profile.

"Land disturbing activity" means a land change or construction activity for residential, commercial, industrial, and institutional land development which may result in soil erosion from water or wind, or the movement of sediments or pollutants into state waters or onto lands in the State; or which may result in accelerated stormwater runoff, including, but not limited to, clearing, grading, excavating, transporting and filling of land.

"Licensed Professional in the State of Delaware" means a design professional licensed under 24 **Del.C.** Ch. 2, 24 **Del.C.** Ch. 27, or 24 **Del.C.** Ch. 28.

"Maintenance" means the work of keeping stormwater management systems including access routes and appurtenances (grade surfaces, walls, drains, dams and structures, vegetation and other protective devices) in a safe and functioning condition as the system was designed. Routine or minor maintenance includes grass mowing and trimming, debris removal, minor sediment removal, filling eroded areas and animal burrows, and removal of trees and shrubs on embankments. Non-routine or major maintenance includes structural repair, major sediment removal and major erosion repair, and invasive aquatic vegetation removal.

"Maximum Extent Practicable" means, for the purpose of these Regulations, using stormwater management measures, techniques and methods that are available and capable of being implemented while taking into consideration cost, available technology, and project site constraints.

"Notice of Completion" means a document issued by the Department or Delegated Agency at the end of project construction when all items and conditions of the approved Sediment and Stormwater Management Plan have been satisfied, post construction verification documents demonstrate that the stormwater management systems have been constructed in accordance with the approved Sediment and Stormwater Management Plan, and final stabilization of disturbed areas on the site has been achieved.

"Offset" means an alternate to strict adherence to the regulations including, but not limited to trading, banking, fee-in-lieu, or other similar program that serves as compensation when the requirements of these regulations cannot be reasonably met on an individual project basis.

"Operation and Maintenance Plan" means the plan which identifies required maintenance for stormwater management systems.

"Owner" means a person who has a legal interest in lands of this State, or who has an equitable interest in lands of this State, except when a person holds an interest in those lands as a security interest, unless through foreclosure or other action the holder has taken possession of those lands, and who undertakes, or for whose benefit, activities subject to these regulations are commenced or carried out on those lands, or the person responsible for maintenance of stormwater management systems constructed to comply with these regulations on those lands.

"Performance-based approach" means a stormwater quantity management technique that utilizes an analytical process to determine compliance.

"Person" means a State or federal agency, individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, municipality or other political subdivision of this State, an interstate body or any other legal entity.

"Permanent stabilization" means the establishment of perennial vegetation by application of soil amendments, seed, and mulch in accordance with methods accepted by the Department on disturbed areas that have reached final grade in order to stabilize the soil, prevent erosion, and reduce sediment and runoff to downstream or offsite areas.

"Post construction verification documents" means a set of surveyed plans reflecting the as-built condition of stormwater management measures and may also include supporting computations and specifications as required by the Department or the Delegated Agency.

"Redevelopment", including brownfield development, means a construction, alteration or improvement, including but not limited to the demolition or building of structures, filling, grading, paving, or excavating, where existing land use is residential, commercial, industrial, or institutional. Ordinary maintenance activities, remodeling of existing buildings, resurfacing of paved areas, and exterior changes or improvements are typically not considered redevelopment activities for the purposes of these regulations.

"Resource Protection Event" means the runoff event produced by a storm having an annual probability of occurrence of 99%.

"Resource Protection Event Volume (RPv)" means the annualized volume of runoff generated by the Resource Protection Event.

"Responsible personnel" means a foreman or superintendent who is in charge of on-site clearing and land disturbing activities for sediment and stormwater control associated with a construction project.

"Runoff reduction practices" means stormwater best management practices that reduce total runoff volume from a developed site through canopy interception, surface recharge, evaporation, rainfall harvesting, engineered infiltration, or evapotranspiration and may include practices that delay the delivery of stormwater to a surface discharge.

"Sediment" means soils or other surficial materials transported or deposited by the action of wind, water, ice or gravity as a product of erosion.

"Sediment and Stormwater Management Plan" means a plan for the control of soil erosion, sedimentation, stormwater quantity, and water quality impacts resulting from a land disturbing activity, through both the construction and post construction phases of development.

"Standard plan" means 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.

"Standards-based approach" means a stormwater quantity management technique that utilizes a pre-determined discharge rate to determine compliance.

"State waters" means any and all waters, public or private, on the surface of the earth which are contained within, flow through or border upon the State or any portion thereof.

"Stormwater" means the runoff of water from the surface of the land resulting from precipitation, or snow or ice melt.

"Stormwater management" means:

(a) For water quantity control, a system of vegetative, structural, and other measures that controls the volume and rate of stormwater runoff which may be caused by land disturbing activities upon the land; and

(b) For water quality control, a system of vegetative, structural, and other measures that controls adverse effects on water quality that may be caused by land disturbing activities upon the land.

"Stormwater management system" means vegetative, structural, and other facilities or measures, singularly or in combination, that provide stormwater management.

"Stormwater utility" means an administrative organization that has been established for the purposes of funding sediment control, stormwater management or flood control planning, design, construction, maintenance, and overall resource needs by authorized and imposed charges.

"Temporary stabilization" means planting quick-growing vegetation and applying anchored straw mulch or other means to stabilize the soil and prevent erosion of a disturbed area until permanent vegetation or other stabilization measures can be established.

"Tidal waters" means any water that alternately rises and falls in a predictable and measurable rhythm or cycle due to the gravitational attraction of the moon and sun and is under the regulatory authority of 7 **Del.C.** Ch. 72.

"Transfer" means to convey responsibility for maintenance of a stormwater management system to a new Owner.

"Variance" means a permitted deviation from an established rule or regulation, or plan, or standard or procedure.

"Water quality" means those characteristics of stormwater runoff from a land disturbing activity that relate to the chemical, physical, biological, or radiological integrity of water.

"Water quantity" means those characteristics of stormwater runoff that relate to the rate, volume and duration of flow to downstream areas resulting from land disturbing activities.

"Watershed" means the drainage area contributing stormwater runoff to a single point.

"Watershed plan" means a comprehensive study of the activities and sources that contribute to water quality or water quantity problems and identifies the location of those problem areas within a specific watershed boundary. It also serves as a framework for how, where and what stormwater management tools will be applied to address those water quality or water quantity problems.

3.0 Plan Approval Procedures and Requirements

3.1 All projects requiring approval of a detailed Sediment and Stormwater Management Plan are subject to a three-step approval process. Step 1 of the plan approval process is scheduling and conducting the project application meeting. Step 2 of the plan approval process is submission of the preliminary Sediment and Stormwater Management Plan. Step 3 of the plan approval process is submission of the Sediment and Stormwater Management Plan.

3.1.1 Authorization from the Department or Delegated Agency is required to proceed from the current step to the subsequent step in the plan approval process.

3.1.2 If significant changes, as determined by the Department or Delegated Agency, are proposed on the subsequent submittal from the submittal that received authorization to proceed, the Owner may be required to repeat the previous step in the plan approval process.

3.2 Project Application Meeting

3.2.1 All Owners are required to hold a project application meeting with the Department or Delegated Agency, unless the requirement for a project application meeting is waived in writing by the Department or Delegated Agency as determined on a case-by-case basis.

3.2.2 Before scheduling the project application meeting, the Owner shall submit a Stormwater Assessment Study to the Department or Delegated Agency.

3.2.3 At the project application meeting the Stormwater Assessment Study will be reviewed as well as potential approaches for stormwater management and opportunities to reduce runoff rates, volumes, and pollutant loads.

3.2.4 A document listing the topics of discussion and items agreed upon will be developed during the meeting and concurred by all attendees.

3.2.5 A Stormwater Assessment Report will be completed by the Department or Delegated Agency based on the Stormwater Assessment Study and project application meeting discussion. The Stormwater Assessment Report will be submitted to the local land use approval agency.

3.3 Preliminary Sediment and Stormwater Management Plan

3.3.1 The preliminary Sediment and Stormwater Management Plan submittal shall include preliminary plans for the site, as well as the schematic erosion and sediment control plan, with supporting hydrologic and hydraulic calculations necessary for the Department or Delegated Agency to determine compliance with these regulations.

3.3.2 If significant changes are proposed on the preliminary Sediment and Stormwater Management Plan from the plan that was discussed at the project application meeting, such as a change in land use or changes that result in a different rating on the Stormwater Assessment Report, the Owner may be required to repeat the project application meeting step of the process.

3.4 Sediment and Stormwater Management Plan

3.4.1 The Sediment and Stormwater Management Plan submittal shall consist of the following elements: Construction Site Stormwater Management Plan, Post Construction Stormwater Management Plan, final hydrologic and hydraulic computations, Operation and Maintenance Plan, and a copy of the preliminary Record Plan as required by the local land use approval agency.

3.4.2 If significant changes are proposed on the Sediment and Stormwater Management Plan from the preliminary Sediment and Stormwater Management Plan, such as a change in the size or location of proposed BMPs, the Owner may be required to repeat the preliminary Sediment and Stormwater Plan step of the process.

3.4.3 Failure by the Owner to demonstrate that the Sediment and Stormwater Management Plan meets the requirements of these regulations, as determined by the Department or Delegated Agency, shall be reason to deny approval of the Sediment and Stormwater Management Plan.

3.5 Review Procedures for Plan Submittals

3.5.1 The Department or Delegated Agency shall have 30 calendar days from receipt of either the preliminary Sediment and Stormwater Management Plan or final Sediment and Stormwater Management Plan to complete the review and have either the approval or review comments transmitted to the Owner, unless the 30-calendar day period cannot be met, in which case the Department or Delegated Agency shall notify the Owner in writing of the reasons for delay, and an expected time period not to exceed an additional 30 calendar days, for when that review will be completed.

3.5.2 The Department or Delegated Agency shall have the right to reject an incomplete application at any time during the 30-calendar day review period. If an application is rejected for incompleteness, the Owner will be informed in writing of the information necessary to complete the application.

3.5.3 In cases where modifications are required to approve the plan, the Department or Delegated Agency shall have an additional 30 calendar days to review the revised plan from the initial and any subsequent resubmission dates.

3.5.4 The sediment and stormwater management plan shall not be considered approved without the inclusion of an original approval stamp on the plans with signature and date by the plan approval agency. If the plan is approved, a minimum of one (1) copy bearing the signed approval stamp shall be returned to the Owner or Owner's agent. If the plan is not approved, the Owner shall be notified in writing of the reasons.

3.5.5 No changes shall be made to an approved plan without review and written approval by the Department or Delegated Agency. The Department or Delegated Agency may request additional data with a plan amendment as may be necessary for a complete review of the plan and to ensure that changes to the plan will comply with the requirements of these regulations.

3.5.6 Administratively complete sediment and stormwater management plans, as determined by Department policy, that have been submitted for review and ultimate approval before January 1, 2014 shall be subject to the regulations in effect at the time that the plan was first submitted to the Department or Delegated Agency. Unless administratively extended by the Department, a plan undergoing the review process on January 1, 2014 but is not approved within eighteen months of January 1, 2014 shall be subject to these regulations.

3.6 Expiration of Plan Approval

3.6.1 Approved plans remain valid for 3 years from the date of an approval, unless specifically extended by the Department or Delegated Agency. The basis for extension may include, but is not limited to, the following items:

3.6.1.1 Failure to initiate the approved project for reasons acceptable to the Department or Delegated Agency such as funding or other agency permit delays; or

3.6.1.2 Time duration for a type of activity that typically exceeds three years.

3.6.2 The Department or Delegated Agency may extend plan approval following a written request for extension providing justification for the extension request. Plan approval extension may be granted no more than 90 days before plan expiration, and will be granted for a maximum extension of an additional 3 years. In no case shall the plan extension supersede the sunset provisions of the county or local government.

3.6.3 Plan extension requests for projects that have not commenced construction shall be granted for a maximum of one additional 3-year period.

3.6.4 Plan extension requests for projects that have commenced and have been actively under construction within the latest approval or extension period will not be limited in the number of extensions that may be approved.

3.7 Standard Plans

3.7.1 The Department may develop criteria for standard plans when a detailed plan is deemed not necessary. Project types that may qualify for a standard plan include, but are not limited to, individual parcel construction or improvements, tax ditch maintenance, minor linear disturbances, stormwater facility maintenance, agricultural structure construction, or other activities approved by the Department.

3.7.2 All standard plans shall contain standard conditions for construction site stormwater management and may contain standard conditions for post construction stormwater management.

3.7.3 The inclusion of an activity into the standard plan classification does not exclude that activity from the requirements of 7 **Del.C.** Ch. 40. Rather, the standard plan precludes that activity from the necessity of a detailed plan review for a qualifying project.

3.7.4 Failure to implement control practices pursuant to conditions included in the standard plan may necessitate appropriate enforcement action as provided in 7 **Del.C.** Ch. 40 and these regulations.

3.7.5 A detailed plan may be required for a site that would otherwise meet standard plan criteria as deemed appropriate by the Department or Delegated Agency on a case-by-case basis.

3.8 Plan Certifications

3.8.1 All detailed plans submitted for review shall be prepared, signed, dated, and sealed by a Licensed Professional in the State of Delaware. It is the obligation of the Licensed Professional in the State of Delaware to ensure that the design of construction site stormwater management best management

practices (BMPs) and post construction stormwater management systems meet the requirements in these regulations.

3.8.2 All Sediment and Stormwater Management Plans submitted for approval shall contain certification by the Owner stating that clearing, grading, construction, and development will be accomplished pursuant to the plan.

3.8.3 All Sediment and Stormwater Management Plans for projects having a land disturbance greater than or equal to one acre shall contain a certification by the Owner stating that responsible personnel involved in the land disturbance will have attended and successfully completed the Departmental-sponsored Contractor Training Program before initiation of the project.

3.8.4 All Sediment and Stormwater Management Plans shall contain certification by the Owner granting the right of either the Department or Delegated Agency or both to conduct on-site construction reviews.

3.9 Approvals issued in accordance with these regulations do not relieve the Owner of responsibility for obtaining other necessary permits or approvals from other federal, state, or local agencies. If the requirements of applicable federal, state, or local agencies vary, the most environmentally protective shall apply.

3.10 Before project completion the Owner shall submit a final post construction stormwater management Operation and Maintenance Plan for the entire stormwater management system. Operation and Maintenance Plans remain valid for the life of the stormwater management system.

3.11 Post construction verification documents shall be submitted to the Department or Delegated Agency within 60 calendar days of completion for stormwater management systems. The post construction verification documents shall compare the designed and constructed elements of the stormwater management system, and bear the seal of a Licensed Professional in the State of Delaware. A final construction review and approval by the Department or Delegated Agency is required before a financial guarantee shall be released, and before a Notice of Completion may be issued.

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4.0 Performance Criteria for Construction Site Stormwater Management

4.1 The Technical Document may be utilized as a reference for the design and preparation of construction site stormwater management plans. Alternative measures that provide functional equivalency may be considered on a case-by-case basis in accordance with Section 1.14 of these Regulations.

4.2 A sequence of construction shall be provided on plans describing the relationship between the implementation and maintenance of erosion and sediment controls, including permanent and temporary stabilization and the various stages or phases of earth disturbance and construction.

4.3 Best available technology (BAT) shall be employed to manage turbid discharges in accordance with requirements of 7 **Del.C.** Ch. 60, *Regulations Governing the Control of Water Pollution*, Section 9.1.02, known as Special Conditions for Stormwater Discharges Associated with Construction Activities, and Department policies, procedures, and guidance.

4.4 Limits on Land Disturbance

4.4.1 Use of standard details from the Delaware Erosion and Sediment Control Handbook for design of construction site stormwater management BMPs is limited to sites where no more than 20 acres draining to a common discharge point will be disturbed at one time.

4.4.2 Construction site stormwater management BMPs intended to manage areas greater than 20 acres shall have supporting design computations, including but not limited to storage, conveyance, stability, and treatment capabilities.

4.4.3 In no case shall the area of disturbance draining to a common discharge point exceed 20 acres. Grading of subsequent sections within that drainage area shall not proceed unless temporary or permanent stabilization has been accomplished such that the 20 acre limit of disturbance is maintained.

4.4.4 All plans shall include a limit of disturbance line (L.O.D.) establishing the maximum necessary extent of land disturbance required to implement and accomplish the permitted site construction for land disturbing activities subject to these Regulations.

4.5 Stabilization

4.5.1 Following soil disturbance or re-disturbance, Permanent or Temporary Stabilization shall be completed for perimeter sediment controls, topsoil stockpiles, and all other disturbed or graded areas on the project site within 14 calendar days unless more restrictive Federal requirements apply.

4.5.2 Documentation of soil testing and materials used for temporary or permanent stabilization including but not limited to soil test results, seed tags, soil amendment tags, etc. shall be provided to the Department or Delegated Agency to verify that the permanent or temporary stabilization has been completed in accordance with the approved plan.

4.5.3 The Department or Delegated Agency may require additional soil testing and reapplication of permanent or temporary stabilization in accordance with the specifications in the Delaware Erosion and Sediment Control Handbook, or alternative measures that provide functional equivalency.

4.5.4 Release of either a financial guarantee or issuance of Notice of Completion or both shall not occur until final stabilization of exposed areas is achieved.

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5.0 Performance Criteria for Post Construction Stormwater Management

5.1 The Technical Document may be utilized as a reference for the design and preparation of post construction stormwater management plans. Alternative measures that provide functional equivalency may be considered on a case-by-case basis in accordance with Section 1.14 of these Regulations.

5.1.1 Stormwater management designs shall reduce runoff, mimic natural watershed hydrologic processes, and cause no adverse impact to property. This shall be accomplished by treating runoff at the source, disconnecting impervious surfaces, preserving or enhancing natural flow paths and vegetative cover, conserving or enhancing natural open spaces and riparian areas, and other measures that simulate natural watershed hydrologic processes.

5.1.2 Residential, commercial, institutional or industrial developments shall apply these stormwater management criteria to land development as a whole. Smaller sites, such as individual residential lots in new subdivisions that are part of a larger, common plan of development or sale shall be subject to these requirements as part of that larger plan.

5.1.3 No portion of a stormwater system that is owned and maintained by a joint ownership such as a homeowner's association or maintenance corporation in a residential development shall be located on private property, except for those areas designated as common areas, community open space, community-owned property, jointly owned property, or within a recorded easement dedicated to public use. A stormwater system owned by a single Owner, as in the case of a commercial, institutional or industrial development, may be located on that Owner's private property.

5.1.4 If runoff from a land development will flow to a permitted or non-permitted municipal separate storm sewer system (MS4) or other drainage infrastructure, the land development applicant shall notify the system's owner of the intent to discharge into the system before plan approval. The Department, Delegated Agency, or system's owner may require the land development applicant to demonstrate that the system has adequate conveyance.

5.1.5 All applications that propose to use infiltration or natural recharge shall include a soils investigation to determine the appropriate design criteria.

5.1.6 Water quality and water quantity management shall be provided in accordance with the requirements set forth in this section unless the proposed project is limited to reconstruction of existing paved areas, re-grading and replacement of existing pervious areas, or rebuilding or repairing of structures damaged by fire, flood, wind, or other natural disaster and where the disturbed area will return to the original hydrologic condition and land cover at the conclusion of the project.

5.2 Resource Protection Event Criteria

5.2.1 The Resource Protection Event criteria provide runoff management measures to reduce the volume of stormwater runoff generated on a site, recharge groundwater, minimize impacts to downstream channels from runoff leaving the site, and reduce pollutant loads discharged into receiving waters.

5.2.2 The Resource Protection Event Volume (RPv) is the post-development annualized volume of runoff produced by the storm having a ninety-nine percent (99%) probability of occurrence, or the 1-year, 24-hour rainfall event.

5.2.3 Compliance with this section shall be accomplished to the maximum extent practicable through the following provisions:

5.2.3.1 Runoff from disturbed areas that were wooded or meadow in the pre-developed condition shall be reduced using runoff reduction practices to an equivalent wooded condition.

5.2.3.2 All remaining disturbed areas shall employ runoff reduction practices to achieve an equivalent 0% effective imperviousness. For those cases in which the minimum runoff reduction requirements are not met:

5.2.3.2.1 The allowable discharge for any remaining runoff shall not exceed the equivalent 24-hr detention time of the RPv, and

5.2.3.2.2 An offset shall be provided for the portion of the RPv that does not meet the minimum runoff reduction requirements.

5.2.3.3 Additional water quality treatment BMPs may be provided if the runoff reduction requirements of this section are not sufficient to meet Total Maximum Daily Load (TMDL) requirements for the receiving water. Pollutant reductions achieved through the use of these treatment BMPs may be used to partially reduce a runoff reduction offset requirement provided in accordance with Section 5.2.3.2.2 above.

5.2.4 Projects that qualify for and meet standard plan criteria developed by the Department shall be considered in compliance with the Resource Protection Event criteria.

5.3 Conveyance Event Criteria

5.3.1 The Conveyance Event criteria provide runoff management measures to minimize impacts to downstream properties, channels, and structures by optimizing watershed conveyance and hydrograph timing.

5.3.2 The Conveyance Event Volume (Cv) is the volume of runoff produced by the post-development storm having a ten percent (10%) annual probability of occurrence, or the 10-year, 24-hour rainfall event, less any volume reduction achieved for the RPv in accordance with Section 5.2.

5.3.3 Compliance with this section shall be accomplished through the following provisions:

5.3.3.1 The Cv shall be reduced to the maximum extent practicable using runoff reduction practices. For any portion of the Cv that is not reduced, quantity management shall be provided using either a standards-based or performance-based approach such that there is no adverse impact; or

5.3.3.2 Provisions will be made or exist for a non-erosive conveyance system to tidal waters by either a closed drainage system or by open channel flow that has adequate conveyance for the Cv; or

5.3.3.3 Demonstration that the location of a project within a watershed would aggravate flooding or channel erosion by the imposition of peak control requirements, as evidenced by a downstream analysis approved by the Department or Delegated Agency; or

5.3.3.4 The proposed project will generate only a de minimis discharge and will have no adverse impact on the receiving wetland, watercourse or downstream property as determined on a case-by-case basis.

5.3.4 Projects that qualify for and meet standard plan criteria developed by the Department shall be considered in compliance with the Conveyance Event criteria.

5.4 Flooding Event Criteria

5.4.1 The Flooding Event Criteria provide runoff management measures to reduce downstream flooding by optimizing watershed storage and hydrograph timing.

5.4.2 The Flooding Event Volume (Fv) is the volume of runoff produced by the post-development storm having a one percent (1%) probability of occurrence, or the 100-year, 24-hour rainfall event less any volume reduction achieved for the RPv and Cv in accordance with Sections 5.2 and 5.3.

5.4.3 Compliance with this section shall be accomplished through the following provisions:

5.4.3.1 The Fv shall be reduced to the maximum extent practicable using runoff reduction practices. For any portion of the Fv that is not reduced, quantity management shall be provided using either a standards-based or performance-based approach such that there is no adverse impact; or

5.4.3.2 Provisions will be made or exist for a non-erosive conveyance system to tidal waters by either a closed drainage system or by open channel flow that has adequate conveyance for the Fv; or

5.4.3.3 Demonstration that the location of a project within a watershed would aggravate downstream flooding or channel erosion by the imposition of peak control requirements, as evidenced by a downstream analysis approved by the Department or Delegated Agency; or

5.4.3.4 The proposed project will generate only a de minimis discharge and will have no adverse impact on the receiving wetland, watercourse, or downstream property as determined on a case-by-case basis.

5.4.4 Projects that qualify for and meet standard plan criteria developed by the Department shall be considered in compliance with the Flooding Event criteria.

5.5 Alternative Criteria

5.5.1 Land development that discharges to State Waters included in a Designated Watershed, or other watershed management plan approved in accordance with these Regulations, shall meet the alternative criteria identified in the approved watershed plan.

5.5.2 The Department or Delegated Agency, at its discretion, may require alternative stormwater treatment practices or criteria if a receiving waterbody has been identified as impaired, or designated with a specific pollutant reduction target necessary to meet State of Delaware water quality regulations.

5.5.3 The Department or Delegated Agency, at its discretion may require alternative stormwater treatment practices designed to reduce pollutant loading from a specific source.

5.6 Redevelopment Criteria

5.6.1 The Department recognizes the benefits of redevelopment. The requirements under this section are intended to encourage redevelopment while establishing compliance criteria that meet the overall goals and intent of these regulations.

5.6.2 In the case of development of a contaminated site or Brownfield, a remediation plan approved by the Department may meet the stormwater management goals and the intent of these regulations with prior consent and subsequent approval by the Department.

5.6.3 Compliance with the Resource Protection Event as defined in 5.2.2 shall be accomplished to the maximum extent practicable for redevelopment projects through the following provisions:

5.6.3.1 Runoff from redeveloped areas within the project limit of disturbance that were wooded or meadow in the existing condition shall be reduced to an equivalent wooded condition using runoff reduction practices.

5.6.3.2 All remaining redeveloped areas within the project limit of disturbance shall employ runoff reduction practices to achieve a 30% reduction in the effective imperviousness based on the existing condition. For those cases in which the minimum runoff reduction requirements are not met:

5.6.3.2.1 The allowable discharge for any remaining runoff shall not exceed the equivalent 24-hr detention time of the RPv, and

5.6.3.2.2 An offset shall be provided for any portion of the RPv that does not meet the minimum runoff reduction requirements.

5.6.3.3 Additional water quality treatment BMPs may be provided if the runoff reduction requirements of this section are not sufficient to meet Total Maximum Daily Load (TMDL) requirements for the receiving water. Pollutant reductions achieved through the use of these treatment BMPs may be used to partially reduce a runoff reduction offset requirement provided in accordance with Section 5.6.3.2.2 above.

5.6.4 Any redevelopment project that increases the rate, volume or duration of flow to a new or existing point of discharge during the Conveyance Event shall comply with the requirements of Section 5.3.

5.6.5 Any redevelopment project that increases the rate, volume or duration of flow to a new or existing point of discharge during the Flooding Event shall comply with the requirements of Section 5.4.

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6.0 Construction Review of Sediment and Stormwater Management Plan

6.1 Owner Responsibilities

6.1.1 The Owner shall ensure that all elements of the approved Sediment and Stormwater Management Plan are implemented and construction site stormwater management BMPs and post construction stormwater management systems are installed and maintained in accordance with that plan. All construction sites shall comply with these regulations.

6.1.2 The Owner may refer to the specifications contained in the Handbook or take functionally equivalent measures to install and maintain construction site stormwater management BMPs in accordance with the approved plan.

6.1.3 The Owner shall comply with the requirements contained in Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 **DE Admin. Code** 7201.

6.1.3.1 The Owner or Owner's representative shall conduct weekly construction reviews of the construction site stormwater management BMPs and post construction stormwater management systems.

6.1.3.2 The Owner or Owner's representative shall conduct construction reviews of the construction site stormwater management BMPs and post construction stormwater management systems following rainfall events producing runoff.

6.1.3.3 The Owner or Owner's representative shall maintain written records of all construction reviews at the construction site.

6.1.3.4 The Owner or Owner's representative shall maintain the approved Sediment and Stormwater Management Plan at the construction site.

6.1.4 The Department or Delegated Agency shall have the authority to require revisions to the approved Sediment and Stormwater Management Plan. The Owner is responsible for implementation of plan revisions when deficiencies are noted on the site by the Department or Delegated Agency construction reviewer.

6.1.5 The Owner shall certify to the Department or Delegated Agency that responsible personnel involved in the construction project have successfully completed the Contractor Training Program before initiation of a land disturbing activity. Responsible personnel shall implement the Sediment and Stormwater Management Plan fully through daily oversight of the construction site and guidance of construction personnel while a land disturbing activity is taking place.

6.1.6 For projects developing 20 acres or greater, and including those projects that require discharge monitoring for the maximum daily discharge limitation under Federal requirements, the Owner shall acquire the services of a Certified Construction Reviewer to perform weekly construction reviews of the approved Sediment and Stormwater Management Plan elements as well as construction reviews of installation of stormwater management systems. Any project, regardless of its size, may be required by the Department or Delegated Agency, to have a Certified Construction Reviewer on a case-by-case basis. Sediment and Stormwater Management Plans approved by the Department shall have a Certified Construction Reviewer. The Department or Delegated Agency may, at its discretion and following a written request, modify Certified Construction Reviewer reporting frequency for a particular site if site conditions warrant.

6.1.7 All costs and fees associated with the use of Certified Construction Reviewers shall be the responsibility of the Owner.

6.1.8 The Certified Construction Reviewer shall be responsible for reviewing construction activities and reporting on the adequacy of construction in accordance with the approved Sediment and Stormwater Management Plan, in addition to the following items:

6.1.8.1 Provision of a construction review on at least a weekly basis until released from review responsibility by the Department or Delegated Agency;

6.1.8.2 Provision of a construction review of stormwater management system construction at a frequency as needed to accurately complete the stormwater BMP construction checklist.

6.1.8.3 Inform the Department or Delegated Agency, the Owner, and the contractor, by a written construction review report of site conditions including any inconsistencies with or inadequacies of the approved plan within five calendar days of the construction review.

6.1.8.4 Referral of the project through the Delegated Agency to the Department for appropriate enforcement action if the Owner fails to address the items contained in the written construction review report. Verbal notice shall be made to the Department within two calendar days and written notice shall be provided to the Department within five calendar days.

6.1.9 The Owner shall notify the Department or Delegated Agency any time a new Certified Construction Reviewer begins providing construction review for the site.

6.1.10 Upon written notice by the Department, Delegated Agency, or Certified Construction Reviewer, any portion of the work which does not comply with the approved Sediment and Stormwater Management Plan or these regulations shall be corrected by the Owner within the time period specified in the written notice.

6.2 Contractor Training Program

6.2.1 A certificate of attendance shall be issued to Responsible Personnel who have attended and successfully completed the Contractor Training Program sponsored or approved by the Department.

6.2.2 Training shall be required of a foreperson or superintendent who is in charge of on-site clearing and land disturbing activities for construction projects subject to the requirements of these regulations.

6.2.3 The Contractor Training Program certification shall be valid until the Department notifies the individual or announces in local newspapers that additional training is required due to a change in course content.

6.2.4 The Department shall provide public notification of the date and location of training programs for attendance by responsible personnel and other interested persons.

6.2.5 Enrollment of existing and future responsible personnel is the responsibility of individuals or their employers.

6.3 Certified Construction Reviewer Requirements

6.3.1 The Certified Construction Reviewer shall function under the direction of a registered professional engineer licensed to practice engineering in the State of Delaware.

6.3.2 Certified Construction Reviewers shall attend and successfully complete the Departmental sponsored or approved Certified Construction Reviewer course. The Certified Construction Reviewer shall be responsible for reviewing construction activities and reporting on the adequacy of construction in accordance with the approved Sediment and Stormwater Management Plan, these regulations, and training received in the Certified Construction Reviewer training course.

6.3.3 Certification as a CCR shall be valid for five years. Recertification may extend certification for an additional five years.

6.3.4 A Certified Construction Reviewer who is not performing the duties prescribed by Section 6.1.8 of these regulations may be referred by the local Delegated Agency to the Department for action by providing written notification to the Department and supporting documentation.

6.3.5 In a situation where a Certified Construction Reviewer's certification is being suspended or revoked, an opportunity for hearing before the Secretary or his designee shall be provided. During a suspension, the Certified Construction Reviewer shall not be allowed to provide construction reviews in accordance with these regulations on any construction sites within the state.

6.4 Department or Delegated Agency Construction Reviews

6.4.1 The Department or Delegated Agency may, at a reasonable time, visit a site subject to these regulations to determine compliance with these regulations, including implementation of the Sediment and Stormwater Management Plan.

6.4.2 The Department or Delegated Agency shall conduct regular reviews of the construction site at a frequency to ensure that all elements of the approved Sediment and Stormwater Management Plan are implemented and all construction site stormwater management BMPs and post construction stormwater management systems are installed and maintained in accordance with that plan.

6.4.3 All Department or Delegated Agency construction reviews shall be documented in writing with a copy provided to the Owner. The review report shall document site conditions relevant to the Sediment and Stormwater Management Plan, identify deficiencies that warrant correction, and provide a time period for the Owner to take corrective action.

6.4.4 When the Department or Delegated Agency determines a deficiency in the approved Sediment and Stormwater Management Plan, a revision to the approved plans may be required. A change to the approved Sediment and Stormwater Management Plan shall be approved by the Department or Delegated Agency before construction.

6.5 Required Construction Reviews and Notification Steps

6.5.1 The Owner shall notify the Department or Delegated Agency in writing at least five calendar days before the initiation of construction. The notification shall include the contact information for the responsible person. The notification shall verify that the Sediment and Stormwater Management Plan for the project has been approved and that permit coverage for Storm Water Discharges Associated with Construction Activity has been gained through submittal of a Notice of Intent to the Department. If there is a Certified Construction Reviewer requirement for the site, the application for Certified Construction Reviewer shall be included with the notification.

6.5.2 A pre-construction meeting shall be required. The pre-construction meeting shall be held on site, unless another location is approved by the Department or Delegated Agency on a case-by-case basis.

6.5.3 The Department or Delegated Agency shall determine when Standard Plan applications require a pre-construction meeting and construction reviews based on the project type and land disturbance on a case-by-case basis.

6.5.4 Upon completion of installation of perimeter controls, the Department or Delegated Agency shall conduct a perimeter control review before commencement of bulk grading or other construction activities on the site.

6.5.5 All stormwater management systems shall be reviewed during construction with enough frequency to document that the system has been constructed in accordance with the approved Sediment and Stormwater Management Plan, the design specifications, and the appropriate stormwater management system construction checklist. The Owner shall provide adequate notice to the Department or Delegated Agency and Certified Construction Reviewer, if applicable, before initiating construction of stormwater management systems. The Department, Delegated Agency, or Certified Construction Reviewer shall be responsible for conducting and documenting these reviews, as required.

6.5.6 Upon project completion a final construction review shall be conducted by the Department or Delegated Agency to ensure compliance with the approved Sediment and Stormwater Management Plan. The Department or Delegated Agency shall issue a Notice of Completion for a project when all of the following criteria have been met:

6.5.6.1 All items and conditions of the approved Sediment and Stormwater Management Plan have been satisfied.

6.5.6.2 Post construction verification documents demonstrate that the stormwater management systems have been constructed in accordance with the approved Sediment and Stormwater Management Plan and accepted by the approving agency.

6.5.6.3 Operation and Maintenance Plan has been approved by the Department or Delegated Agency.

6.5.6.4 Final stabilization of disturbed areas on the site has been achieved.

6.5.6.5 A copy of the approved Record Plan showing easements or maintenance notes associated with the approved Sediment and Stormwater Management Plan has been submitted to the Department or Delegated Agency.

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7.0 Post Construction Maintenance of Stormwater Management Systems

7.1 Stormwater management systems constructed to comply with 7 **Del.C.** Ch. 40 and these regulations shall be maintained in accordance with the provisions of this section.

7.1.1 Maintenance responsibility lies with the Owner until the time that a legal transfer of ownership has been executed. Prior notice of the transfer shall be provided to the Department or Delegated Agency 30 business days before the transfer occurs.

7.1.2 The stormwater management system shall run with the land and be binding upon the landowner and any successors in interest. Maintenance of these systems shall ensure that the stormwater management system is performing in accordance with the approved engineered design, within the tolerances of the accepted post construction verification documents, and in compliance with these regulations.

7.1.3 The Owner of a stormwater management system established in accordance with these regulations may offer for dedication to a delegated agency, public entity, municipality, stormwater utility, or private entity, a stormwater management system, together with the easements and appurtenances as may be reasonably necessary for the proper functioning of the system.

7.2 Owner Responsibilities

7.2.1 The Owner shall conduct regular maintenance reviews of stormwater management systems to determine that routine maintenance obligations are being met. The frequency of the reviews will be contained in the Operation and Maintenance Plan.

7.2.2 The Owner shall ensure that the stormwater management system is functioning in accordance with the approved engineering design, within the tolerances of the accepted post construction verification documents, and in compliance with these regulations. The Owner will promptly repair and restore stormwater management systems.

7.2.2.1 Such repairs, restoration, or maintenance shall be conducted in accordance with the approved Sediment and Stormwater Management Plan, the Operation and Maintenance Plan, Standard Guidelines for Operation and Maintenance of Stormwater Management Systems, and directions provided by the Department or Delegated Agency.

7.2.2.2 When the Department or Delegated Agency gives direction for maintenance, those maintenance activities shall be conducted by the Owner within the time period established by the Department or Delegated Agency.

7.2.3 Any change made to the stormwater management system shall require the Owner to obtain approval of the Department or Delegated Agency, including updating of the Operation and Maintenance Plan as necessary.

7.2.4 The Owner shall submit a scope of work for non-routine maintenance to the Department or Delegated Agency for approval prior to implementation.

7.2.5 Maintenance responsibilities may be shared through a legal agreement between the Owner and another entity such as a delegated agency, public utility, municipality, stormwater utility, maintenance company, or other private entity. Responsibility for maintenance shall be joint and several among the parties to the agreement to share those responsibilities.

7.2.6 If the Sediment and Stormwater Management Plan includes structural or nonstructural stormwater management measures located within a tax ditch right-of-way the Owner shall enter into an agreement with the tax ditch organization for maintenance of those stormwater management measures.

7.3 Maintenance Reviews

7.3.1 The Department, Delegated Agency, or duly authorized agent shall conduct maintenance reviews of completed stormwater management systems. The Department, Delegated Agency, or duly authorized agent shall have the right of entry and access at reasonable times to perform stormwater management system maintenance reviews.

7.3.2 The maintenance review performed by the Department, Delegated Agency, or duly authorized agent shall document maintenance and repair needs and any discrepancies from the Operation and Maintenance Plan. A copy of the review shall be provided to the Owner.

7.3.3 The Owner of the stormwater management system shall comply with the conditions of the maintenance review within the timeframe specified by the Department or Delegated Agency.

7.4 Enforcement of Maintenance Responsibilities

7.4.1 The Department may seek enforcement action against an Owner deemed negligent in fulfilling the requirements of Section 7 of these regulations.

7.4.2 Enforcement will be conducted in accordance with Section 8 of these regulations.

8.0 Enforcement and Penalties

8.1 Any action or failure to act, which violates any of the following: the provisions of this regulation, the requirements of an approved Sediment and Stormwater Management Plan, permit, Notice of Intent, construction review report, notice of violation, or the requirements of a final Operation and Maintenance Plan, may be subject to the provisions of any of the following: 7 **Del.C.** §§4012, 4013, 4015, and 4016; 7 **Del.C.** §§6005, 6013, and 6018.

8.2 The Delegated Agency may, in addition to local enforcement options, refer a site violation to the Department for additional enforcement action. Referral of a site violation to the Department may initiate a Departmental construction review of the site to verify site conditions. That construction review may result in the following actions:

8.2.1 Notification through appropriate means to the Owner and the contractor to comply with the approved Sediment and Stormwater Management Plan within a specified time frame; or

8.2.2 Notification of plan inadequacy and the establishment of a date certain for the Owner to submit a revised Sediment and Stormwater Management Plan to the Department or Delegated Agency and to receive its approval with respect thereto. The Department shall notify the Delegated Agency in a timely manner of what enforcement action is taken on the site.

8.3 Failure of the person engaged in the land disturbing activity or the contractor to comply with Departmental requirements may result in the following actions in addition to other penalties as provide in Chapter 40 of Title 7 of the Delaware Code.

8.3.1 The Department shall have the power to issue a cease and desist order to a person violating any provision of Chapter 40 of Title 7 of the Delaware Code or these Regulations by ordering the person to cease and desist from any site work activity other than those actions necessary to achieve compliance with any administrative order.

8.3.2 The Department may request that the appropriate plan approval agency refrain from issuing any further building or grading permits to the person having outstanding violations until those violations have been remedied.

9.0 Delegation of Program Elements

9.1 The provisions of these regulations may be delegated to the Conservation Districts, counties, municipalities, or State agencies. Initial consideration regarding delegation of program elements shall be given to the Conservation Districts.

9.1.1 Program elements that are delegated shall be implemented according to Chapter 40 of Title 7 of the Delaware Code and these Regulations.

9.1.2 Any Delegated Agency may submit documentation to the Department for determination of functional equivalency to the requirements contained in these regulations.

9.2 A Conservation District, county, municipality, or State agency requesting or renewing delegation shall submit a written request to the Secretary on or before January 1 of the year immediately preceding the fiscal year for which delegation or renewal of delegation is sought. The request for delegation shall contain sufficient information to determine whether the agency may be considered capable of implementing program elements in accordance with Chapter 40 and these regulations. The Department shall provide guidance to agencies requesting delegation of program elements as to information that shall be submitted with the delegation request.

9.3 The Secretary shall grant delegation of program elements to a Conservation District, county, municipality, or State agency seeking delegation that is found capable of implementing program elements in accordance with Chapter 40 and these regulations.

9.4 The Secretary shall, in writing, grant or deny delegation on or before April 1 of the year during which delegation is sought. The Secretary shall not deny a request for delegation unless opportunity has been afforded to the appropriate officials from the agency requesting delegation to present arguments. Delegation shall be effective July 1 of that year and extend no more than three years, unless renewed. In the event that the Department does not act on the renewal request by April 1, the Delegated Agency submitting the request would be entitled to continue operating for a subsequent three year time period unless action is taken by the Department to suspend the program.

9.5 Delegation of program elements shall be granted for a maximum time period of three years. After three years a new application to the Department must be made. During the period for which delegation has been granted, the Department will evaluate delegation implementation, coordinate review findings with the Delegated Agency, and determine if the new delegation should be granted.

9.6 Based on the Department's evaluation of Delegated Agency performance, the Department may determine that re-delegation of program elements may be granted for a time period of less than three years. A delegation period of less than the maximum of three years shall be considered a probationary delegation and specific improvement items shall be provided to the Delegated Agency. If program implementation is not improved during the probationary delegation, delegation may not be renewed beyond the probationary delegation period.

9.7 A Delegated Agency may establish alternative requirements which are compatible with or are more stringent than Departmental requirements. These alternative requirements may be established through local ordinance or statutes. Alternative requirements that are not codified in local statute must have approval of the Department following compliance with the public notice of 7 **Del.C.** §6004.

9.8 A Delegated Agency may enter into a cooperative agreement or contract with a third party to assist with program implementation only after Departmental concurrence.

10.0 Criteria for Implementation of a Stormwater Utility

10.1 The implementation of a stormwater utility will necessitate the development of a local utility ordinance prior to its implementation.

10.2 The financing of a stormwater utility must be reasonable and equitable so that each user within the stormwater utility jurisdiction, including state agencies, contributes to the financing according to the users' pro rata share of runoff.

10.3 The intent of the utility must be clearly defined regarding program components that are to be funded through the utility. Those components may include but are not limited to the following: program administration, planning and engineering, maintenance operations, regulation and enforcement, and capital construction.

10.4 The authority for the creation of the stormwater utility and the imposition of charges to finance sediment and stormwater activities is conferred in 7 **Del.C.** Ch. 40. The implementation of a stormwater utility by means of a local ordinance shall not be deemed a limitation or repeal of any other powers granted by State statute.

7 DE Reg. 1147 (3/1/04)
8 DE Reg. 1172 (2/01/05)
10 DE Reg. 735 (10/01/06)
17 DE Reg. 240 (08/01/13)
18 DE Reg. 396 (11/01/14)

National Pollutant Discharge Elimination System (NPDES)

Conditions for Storm Water Discharges Associated with Construction Activities

Part 2 SPECIAL CONDITIONS FOR STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

§ 9.1.02.0 DEFINITIONS

As used in this Part, the following terms shall be defined as outlined herein:

(1) **Appropriate Plan Approval Agency**: means the Department, Conservation District, county, municipality, or State agency that is responsible for review and approval of the Sediment and Stormwater Plan.

(2) **Best Available Technology (BAT)**: means a level of technology based on the very best (State of the art) control and treatment measures that have been developed or are capable of being developed and that are economically achievable within the appropriate industrial category.

(3) **Best Management Practices (BMPs)**: means schedules of activities, prohibition of practices, maintenance procedures, and other management practices or measures to prevent or reduce the discharge of pollutants. BMPs include the following, among other practices and measures: structural and non-structural controls; treatment requirements; operating procedures and practices to control site runoff, or sludge disposal, or waste disposal, or spillage, or leaks, or drainage from raw materials storage.

(4) ***Certified Construction Reviewer***: means those individuals, having passed a Department-sponsored or approved training course, who provide on-site inspection for sediment control and storm water management in accordance with the *Delaware Sediment and Stormwater Regulations*.

(5) **C.F.R.**: means the Code of Federal Regulations.

(6) **Clean Water Act (Cwa)**: means 33 U.S.C. 1251 et seq. (formerly known as the Federal Water Pollution Control Act Amendment of 1972).

(7) **Co-permittee**: is a discharger of storm water associated with construction activity who is jointly and individually responsible for compliance with all conditions of this Part and applicable laws with another entity.

(8) **Construction Activity**: means clearing, grading and excavating activities that result in a land disturbance equal to or greater than one acre, including the disturbance of less than one acre of land that is part of a larger common plan of development or sale that will ultimately disturb more than one acre.

(9) **Department**: means the State of Delaware Department of Natural Resources and Environmental Control.

(10) **Discharge Of Storm Water Associated With Construction Activity**: means a discharge of storm water from areas where soil disturbing activities (e.g. clearing, grading, or excavations), construction materials or equipment storage or maintenance (e.g. fill piles, borrow areas, concrete truck washout, fueling), or other industrial storm water directly related to the construction process (e.g. concrete or asphalt batch plants) are located.

(11) **Effective Date**: means the date when these regulations have formally passed through a public comment period, a public hearing and have been formally adopted by the Department and become operative.

(12) **Facility**: means any building, any structure, any complex of buildings or structures, or any process, production, equipment, or machinery, which makes it possible for any activity to be conducted.

(13) **Final Stabilization**: means that:

a. All soil disturbing activities at the site have been completed and either of the two following criteria are met:

(1) A uniform (e.g. evenly distributed, without large bare areas) perennial vegetative cover with a density of 70% of the native background vegetative cover for the area has been established on all unpaved areas and Areas not covered by permanent structures, or

(2) Equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

b. When background native vegetation will cover less than 100% of the ground (e.g., arid areas, beaches), the 70% coverage criteria is adjusted as follows: if the native vegetation covers 50% of the ground, 70% of 50% (0.70 X 0.50 = 0.35) would require 35% total coverage for final stabilization. On a beach with no natural vegetation, no stabilization is required.

c. For individual lots in residential construction, final stabilization means that either:

(1) The homebuilder has completed final stabilization as specified above, or

(2) The homebuilder has established temporary stabilization including perimeter controls for an individual lot prior to occupation of the home by the homeowner and informing the homeowner of the need for, and benefits of, final stabilization.

d. For construction projects on land used for agriculture purposes (e.g., pipelines across crop or range land, staging areas for highway construction, etc.) final stabilization may be accomplished by returning the disturbed land to its preconstruction agriculture use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to "water of the United States" and areas which are not being returned to their preconstruction agricultural use must meet the final stabilization criteria (1) or (2) above.

(14) **Individual Permit**: means a permit which is written for one specific facility or site.

(15) **Municipal Separate Storm Water System (MS4)**: means a conveyance system which is not intended to convey anything but storm water and is owned by a municipal or public entity.

(16) **Notice Of Intent (NOI)**: serves as an application for NPDES permit coverage under this Part.

(12) **Notice Of Termination (NOT)**: serves as an application for termination of NPDES permit coverage under this Part.

(18) **NPDES (National Pollutant Discharge Elimination System):** means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits for the discharge of any pollutant or combination of pollutants and imposing and enforcing pretreatment and sludge requirements pursuant to Sections 307, 402, 318, and 405 of the Clean Water Act.

(19) **NPDES Permit**: means any permit authorizing the potential or actual point source discharge of pollutants to State waters, under prescribed conditions, pursuant to Section 6 of the State of Delaware "Regulations Governing the Control of Water Pollution."

(20) **Operational Control**: means the responsibility for managing a construction activity subject to the provisions of this Part.

(21) **Operator**: for the purpose of this Part, means any person associated with construction activity who has operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications.

(22) **Permit Coverage**: means an authorization granted to a category of storm water discharges pursuant to this Subsection.

(23) **Permittee**: is a discharger of storm water associated with construction activity who is responsible for compliance with all conditions of this part and to whom coverage under this Part has been granted.

(24) **Person**: means any individual, partnership, corporation, association, institution, enterprise, municipality, commission, political subdivision, or duly established entity.

(25) **Project Completion**: occurs when all items and conditions of the Plan have been satisfied, as-built documentation has been approved by the Plan approval agency, and final stabilization has been achieved in accordance with the definition in this document. It is at project completion that permit coverage is terminated.

(26) **Secretary**: means the Secretary of the State of Delaware Department of Natural Resources and Environmental Control or his duly authorized designee.

(27) **Sediment And Stormwater Plan**: means a plan for the control of soil erosion, sedimentation, storm water quantity, and water quality impacts resulting from construction activity. For the purposes of this Part, a Sediment and Stormwater Plan is a plan developed in accordance with the requirements of the *Delaware Sediment and Stormwater Law* and *Regulations*.

(28) **Storm Water**: means runon or runoff of water from the surface of the land resulting from precipitation or snow or ice melt.

(29) **These Regulations**: means the State of Delaware Special Conditions for Storm Water Discharges Associated with Construction Activity.

(30) **Total Maximum Daily Load or TMDL:** means the amount of a given pollutant that may be discharged to a waterbody from point, nonpoint and natural background sources and still allow attainment or maintenance of the applicable narrative and numerical water quality standards. A "TMDL" is the sum of the individual wasteload allocations or WLAs for point sources and load allocations or LAs for nonpoint sources of pollution and natural background. A “TMDL” may include a reasonable margin of safety (MOS) to account for uncertainties regarding the relationship between mass loading and resulting water quality. In simplistic terms, a "TMDL" attempts to match the strength, location and timing of pollution sources within a watershed with the inherent ability of the receiving water to assimilate the pollutant without adverse impact.

(31) **Transferee**: means the person who accepts permit responsibility from the original permittee.

(32) **Transfer Of Authorization**: means to transfer control of permitted construction activities to either a duly authorized person who will control the permitted activities, or a new owner/operator for the site for which the permit has been issued.

(33) **Transferor**: means the original permittee who transfers permit responsibility to another entity.

(34) **Waters Of The State**: means all water, on the surface and under the ground, wholly or partially within, or bordering the State of Delaware, or within its jurisdiction including but not limited to:

a. Waters which are subject to the ebb and flow of the tide including, but not limited to, estuaries,

bays and the Atlantic Ocean;

b. All interstate waters, including interstate wetlands;

c. All other waters of the State, such as lakes, rivers, streams (including intermittent and ephemeral streams), drainage ditches, tax ditches, creeks, mudflats, sandflats, wetlands, sloughs, or natural or impounded ponds;

d. All impoundments of waters otherwise defined as waters of the State under this definition; and

e. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in (a) – (d).

Waste and storm water treatment systems that would otherwise meet this definition are not "waters of the State."

§ 9.1.02.1 COVERAGE

A. Eligibility

The following discharges and activities are eligible for NPDES General Industrial Storm Water Permit coverage under this Part.

1. This Part covers all new and existing storm water discharges that are composed in whole or in part of discharges associated with construction activity [as defined by 40 Code of Federal Regulations (CFR), Section 122.26 (b)(14)(x), (15); see §9.1.02.0 DEFINITIONS]

2. Discharges from support activities (e.g., concrete or asphalt plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas) provided:

   a. The support activity is directly related to the construction site required to have NPDES permit coverage for discharges of storm water associated with construction activity;

   b. The support activity is not a commercial operation serving multiple unrelated construction projects by different operators, and does not operate beyond the completion of the construction activity it supports; and

   c. Appropriate controls and measures are identified in a Sediment and Stormwater Plan covering the discharges from the support activity areas.

3. Discharges composed of allowable discharges listed in 9.1.02.1.A and 9.1.02.6.B commingled with a discharge authorized by a different NPDES permit and/or a discharge that does not require NPDES permit authorization.

4. Storm water discharges associated with construction activity at facilities which have permit coverage for a discharge other than storm water can be covered by this Part, or at the discretion of the Secretary, an existing individual permit may be amended to cover storm water discharges associated with construction activities.

B. Limits on Eligibility

The following discharges and activities are not eligible for NPDES General Industrial Storm Water Permit coverage under this Subsection.

1. Discharges of storm water associated with industrial activity fully addressed by facilities with individual NPDES permits.

2. Discharges of pollutants occurring in watersheds for which there is a Total Maximum Daily Load (TMDL) allocation for associated water bodies are not eligible for coverage under this Part unless the facility has an approved Sediment and Stormwater Plan (Plan) that is shown to reduce pollutant loading to the level required by the TMDL or to the maximum extent practicable. To be eligible under this Part, the facility must incorporate into their Plan any conditions applicable to their discharges necessary for consistency with any TMDL implementation plan or plan for achieving State surface water quality standards. For discharges not eligible for coverage under this Part, the discharger must apply for and receive an individual NPDES permit.

3. Discharges of pollutants in quantities that would cause or contribute to an exceedance of any applicable surface water quality standard for the receiving waters, including:

   a. Discharges of substances or materials in amounts that are toxic, or that would be toxic to humans, fish, aquatic life, or wildlife;

   b. Discharges of floatable debris, oils, scum, foam, or grease in other than trace amounts. Excluded from this are naturally occurring substances such as leaves and twigs provided no person has placed such substances in or near the discharge; and

   c. Discharges that cause or contribute to degradation or loss of State designated beneficial uses of the receiving waters.

4. Discharges of materials other than storm water are prohibited and are not authorized by this Subsection.

5. Discharges of storm water from post-construction that originate from the site after project completion, including any temporary support activity.

6. Discharges mixed with non-storm water. This exclusion does not apply to discharges identified in 9.1.02.6(B).

7. Storm water discharges, allowable non-storm water discharges, and storm water discharge-related activities that are likely to jeopardize the continued existence of any species that are federally-listed as endangered or threatened ("listed") under the Endangered Species Act (ESA) or result in the adverse modification or destruction of habitat that is federally-designated as critical under the ESA ("critical habitat").

8. Storm water discharges, allowable non-storm water discharges, or storm water discharge-related activities that would cause a prohibited "take" of federally-listed endangered or threatened species (as defined under section 3 of the ESA and 50 CFR 17.3), unless such takes are authorized under sections 7 or 10 of the ESA.

9. Storm water discharges, allowable non-storm water discharges, or storm water discharge-related activities that would negatively affect a property that is listed or is eligible for listing in the National Historic Register.

C. Individual NPDES Permit Coverage

1. Any person covered by this Subsection may request to seek coverage under an individual permit by submitting an individual application (Form 1 and Form 2F[1]) as prescribed in Section 6 of the *Regulations Governing The Control of Water Pollution*. Coverage under this Subsection will continue until authorization for coverage under an individual permit has been issued to the person making the request.

2. The Secretary may require any person covered by this Subsection to submit an application and seek coverage under an individual NPDES permit.

   a. The Secretary shall notify a person in writing when an individual permit application is required. The notice shall include a brief statement of the reasons for the decision, an application, and a statement setting a deadline for the person to file the application. The Secretary shall notify the person in writing that permit coverage under this Subsection shall automatically terminate on the effective date of the individual NPDES permit that is issued to the person.

   b. If a person fails to submit an individual permit application in compliance with a notice from the Secretary, the applicability of this Subsection to the person shall automatically terminate at the end of the day specified for application or NOI submittal.

3. When an individual NPDES permit is issued to a person for discharges otherwise covered by this Subsection, the applicability of this Subsection is automatically terminated on the effective date of the individual NPDES permit.

D. Authorization

To be authorized to discharge storm water under this Part, a person planning a construction activity must submit, in accordance with the requirements of §9.1.02.3, an NOI form prior to commencement of any construction activities. Unless notified by the Secretary to the contrary, persons who submit such notification and have either obtained approved Sediment and Stormwater Plans or have been deemed exempt in accordance with the *Delaware Sediment and Stormwater Law* and *Regulations*, are authorized to discharge storm water associated with construction activity under the terms and conditions of this Part.

E. Transfer of Authorization

1. Transfer of control of permitted activities at the site.

   A person submitting an NOI who does not intend to control the permitted activities on the site shall transfer authorization under this Part, at least ten (10) days prior to any land disturbing activities, to a duly authorized person who will control the permitted activities. To transfer authorization under this Part, the facility must submit and receive written Department approval of a completed Transfer of Authorization form, signed by both the transferor and transferee.

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[1] Form 1: NPDES permit application containing general information about the applicant and facility. This form must accompany the NPDES permit application, Form 2F.

Form 2F: NPDES permit application to discharge storm water associated with industrial activity.

2. Transfer of property to a new owner.

   A permittee/transferor may transfer coverage under this Part to a new owner should ownership change during the construction period. To transfer authorization under this Part, the facility must submit and receive written Department approval of a completed Transfer of Authorization form, signed by both the transferor and transferee.

3. Obligations of the permittee/transferor.

   The permittee/transferor must familiarize the person who is assuming control of the permitted activities, the transferee or new owner, with the program and provide the transferee/new owner with a copy of the Sediment and Stormwater Plan as required in §9.1.02.5. All conditions and obligations outlined in this Part will apply to the transferee/new owner upon transfer.

4. The Department will maintain guidance related to Transfer of Authorization.

F. Shared Operational Control (Co-Permittee Status)

1. Construction activities at a permitted site may become the responsibility of multiple persons when more than one person has operational control (see §9.1.02.0 Definitions) of the site. When multiple persons maintain operational control, all are considered co-permittees of the site.

2. A person submitting an NOI who will share control of the permitted activities on the site shall require a duly authorized person to submit to the Department a Co-Permittee form. The co-permittee condition shall become effective upon receipt and written Department approval of a completed Co-Permittee form, signed by both the original and subsequent co-permittee. If operational control will be shared by more than one additional co-permittee, a Co-Permittee form shall be submitted for all subsequent co-permittees.

3. The original permittee must familiarize the subsequent co-permittees with the program and provide the subsequent co-permittees with a copy of the Sediment and Stormwater Plan as required in §9.1.02.5. All conditions and obligations outlined in this Part will apply to the co-permittees upon completion of the Co-Permittee form.

4. The Department will maintain guidance related to Co-Permittees.

§ 9.1.02.2 STANDARD CONDITIONS

A. Entry and Inspection

Any person subject to this Subsection shall allow the Department to:

1. enter the facility subject to this Subsection during standard business hours;

2. inspect and copy at reasonable times, any records that must be kept under the conditions of this Subsection;

3. inspect at reasonable times any facilities or equipment; and

4. perform sampling of the storm water discharges from the site.

B. Signature Requirements

1. All Notice Of Intent (NOI) Forms shall be signed by:

   a. a president, vicepresident, secretary or treasurer for a corporation; or

   b. a general partner or proprietor for a partnership or sole proprietorship; or

   c. a principal executive officer or ranking official for a municipality or public agency.

2. All other reports or information required by this Subsection shall be signed by a person described above or by a duly authorized representative. A person is a duly authorized representative only if the authorization is made in writing by the person described above and is submitted to the Department.

3. Any person signing documents in accordance with this Subsection shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations."; and

   "I certify under penalty of law that I understand the terms and conditions of the Delaware National Pollutant Discharge Elimination System (NPDES) Special Conditions for Storm Water Discharges Associated with Construction Activities."

C. Proper Procedures

Any person subject to this Subsection shall at all times properly operate and maintain all facilities, systems and practices of pollution control which are installed, or implemented to achieve compliance with the requirements of this Subsection and with the measures of the Sediment and Stormwater Plan.

D. Duty to Mitigate

Any person subject to this Subsection shall take all reasonable steps to minimize or prevent any discharge of pollutants in violation of this Subsection.

E. Adverse Impacts

Any person subject to the requirements of this Subsection shall take all reasonable steps to minimize any adverse impact to State waters, including such accelerated or additional monitoring as necessary to determine the nature and extent of the non-complying discharge.

F. Transfers

Coverage under this Part is transferable. Coverage under this Part shall be transferred in accordance with the provisions outlined in §9.1.02.1.E.

G. Continuation of Expired Coverage

The requirements of this Part shall continue in force and effect until this Part is re-promulgated.

H. Other State or Federal Laws

Nothing in this Subsection shall be construed to preclude the institution of any legal action or relieve any person subject to this regulation from any responsibilities, liabilities, or penalties established pursuant to any applicable State or Federal law or regulation.

I. Penalties for Violations

Any person who violates conditions of this Subsection may be subject to penalties in accordance with 7 Del. C. Chapter 60. Violation of this Subsection is also a violation of the Clean Water Act and may be subject to penalties established under that statute.

J. Oil and Hazardous Substance Liability

Nothing in this Subsection shall preclude the institution of any legal action or relieve any person from any responsibilities, liabilities, or penalties to which a person is or may be subject under 40 C.F.R. Part 117 or 7 **Del.C.** Chapters 60, 62 or 63.

K. Need to Halt or Reduce Activity Not a Defense

Persons subject to this Part may not use as a defense in an enforcement action that it would have been necessary to halt or reduce the construction activity subject to this Part to maintain compliance with the conditions of this Part.

L. Property Rights

The issuance of a permit under the requirements of this Part does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

M. Severability

The provisions of this Part are severable, and if any provision of this Part, or the application of any provision of this Part to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this Part shall not be affected thereby.

§ 9.1.02.3 NOTIFICATION

A. Deadlines

1. New Projects

Any person who intends to obtain coverage under this Part for storm water discharges associated with construction activity, commencing after the effective date of this Part, must submit a Notice of Intent (NOI) Form in accordance with this Part prior to the onset of construction as a condition of approval of the Sediment and Stormwater Plan.

2. Permitted Ongoing Projects

   a. Any person who has or had permit coverage for storm water discharges associated with construction activity immediately prior to the effective date of this Part, who wishes to continue coverage must submit a new Notice of Intent (NOI) within 90 days of re-promulgation of this Part.

   b. Any person who has or had permit coverage for storm water discharges associated with construction activity prior to the effective date of this Part, and meets the termination of coverage requirements in accordance with § 9.1.02.7.B must submit a Notice of Termination (NOT) within 90 days of re-promulgation of this Part.

3. Unpermitted Ongoing Projects

   For any person subject to this Part who has or had not obtained permit coverage for storm water discharges associated with construction activity taking place prior to the effective date of this Part, authorization to discharge under the renewed Part occurs at the time that the NOI is submitted. The Department reserves the right to seek enforcement action for any unpermitted discharges or noncompliance that occurs between commencement of construction and discharge authorization.

4. Late Notification

   Any person subject to this Part is not precluded from submitting an NOI in accordance with the requirements of this Part after initiating construction activities. Authorization to discharge occurs at the time that the NOI is submitted. The Department reserves the right to seek enforcement action for any unpermitted discharges or noncompliance that occurs between commencement of construction and discharge authorization.

B. Contents of the Notice of Intent (NOI) Form

The Notice of Intent (NOI) shall be submitted on a form provided by the Department. The NOI shall include, at a minimum, the following information.

1. Applicant information including the operator name, contact person, mailing address, and telephone number;

2. Project information including the project name, location, county, and municipality, if applicable;

3. The project type and proposed methods of permanent storm water management;

4. The latitude and longitude of the facility;

5. The name of the receiving waters or municipal separate storm water system;

6. The plan approval agency name;

7. The total land area and the estimated area to be disturbed; and

8. The estimated construction start and project completion dates.

C. Additional Information

When any person subject to this Part becomes aware that any relevant facts were omitted or submitted incorrectly on the NOI Form, or any other records required by this Part, that person shall promptly submit such corrected information to the Department.

D. Where to Submit

Persons intending to obtain permit coverage under this Part must submit an NOI Form to the following address:

The Department of Natural Resources and
Environmental Control
Division of Watershed Stewardship
Sediment and Stormwater Program
89 Kings HighwayDover, DE 19901

E. Fees

The completed NOI Form must be accompanied by the appropriate fee required by the Department and established by the State regulations to be considered complete.

F. Failure to Notify

Persons who discharge storm water associated with construction activity, who fail to notify the Department of their intent to be covered under this Part, and who discharge to waters of the State without an individual NPDES permit, are in violation of 7 **Del.C.** Chapter 60 and the federal Clean Water Act and may be subject to penalties.

§ 9.1.02.4 MONITORING

A. Effluent Limitations

The Department has not established specific effluent limitations for storm water discharges associated with construction activity. Therefore, this Part establishes effluent limitations in terms of performance standards established with the Best Available Technology (BAT) for erosion and sediment control and storm water management. Compliance with BAT associated with the *Delaware Sediment and Stormwater Regulations,* and/or Sediment and Stormwater Program standards and specifications, guidance, and policy will constitute compliance with effluent limitations for storm water discharges associated with construction activity.

B. For the purposes of monitoring, persons subject to this Part must:

1. During construction, maintain at the site the approved Sediment and Stormwater Plan (see §9.1.02.5).

2. Conduct the following:

   a. weekly maintenance inspections of erosion and sediment controls, and constructed storm water management measures; and

   b. inspections of erosion and sediment controls and storm water management practices the next business day after a rainfall event that results in runoff.

C. Record Keeping

1. During construction, persons subject to this Part must maintain at the site, written reports of all inspections conducted in accordance with item B above, that include:

   a. the date and time of the inspection;

   b. the name(s) of the individual(s) who performed the inspection;

   c. as assessment of the condition of erosion and sediment controls, and constructed storm water management measures;

   d. a description of any erosion and sediment control and storm water management measures construction or implementation and maintenance performed on those measures; and

   e. a description of the site's present phase of construction.

2. Persons subject to this Part shall maintain all inspection reports, notices of violations, enforcement actions, and correspondence issued by the Department, its authorized agents, the appropriate plan approval agency, or a required Certified Construction Reviewer.

3. Reporting Requirements

   Persons subject to this Part must retain the records described in §9.1.02.4, B(1), and §9.1.02.4.C and submit the information upon request to the Department at the following address:

   The Department of Natural Resources and Environmental Control
   Division of Watershed Stewardship
   Sediment and Stormwater Program
   89 Kings Highway
   Dover, DE 19901

D. Additional Monitoring

The Secretary may provide written notification to any facility, requiring additional monitoring.

§ 9.1.02.5 SEDIMENT AND STORMWATER PLAN

A. Persons covered by this Part shall develop, fully implement, and maintain at the site, the approved Sediment and Stormwater Plan (Plan) and any other records that are required in accordance with 7 **Del.C.** Chapter 40 and the *Delaware Sediment and Stormwater Regulations*. The Plan shall cover all site activities from the date of initiation of construction activity to the date of project completion. Pollution prevention measures, in accordance with Delaware Erosion and Sediment Control Handbook standard and specification for Construction Site Pollution Prevention, shall be incorporated into the Plan for construction activity.

B. The Plan shall be signed in accordance with this Part and kept at the facility.

C. Persons covered by this Part shall retain records of all information required by the Plan for a minimum of five (5) years.

D. Keeping the Plan Current

1. Persons covered by this Part shall amend the Plan whenever:

   a. There is a change in the design, construction, operation, or maintenance of erosion and sediment controls or storm water management measures on the site; or

   b. The Plan proves to be ineffective in eliminating or significantly minimizing the discharge of pollutants, or in otherwise achieving the general objectives of controlling pollutants in storm water discharges associated with construction activity; or

   c. To address any sources or potential sources of pollution identified as a result of a site inspection pursuant to §9.1.02.4.B.; or

   d. Upon notification by the Department or the appropriate plan approval agency that the Plan does not adequately address the requirements of this Part. The notification from the Department or the appropriate plan approval agency shall list and describe the deficiencies of the Plan.

2. Persons subject to §9.1.02.5.D.1.(a) shall amend the Plan and submit these amendments to the Department or appropriate plan approval agency and receive approval for the amendments prior to construction or modification of the erosion and sediment controls or storm water management measures on the site.

3. Persons subject to Part §9.1.02.5.D.1.(b), (c), and (d) shall amend the Plan and submit these amendments to the Department or appropriate plan approval agency and receive approval for the amendments within 30 days of notification by the persons subject to this Part, inspector, Certified Construction Reviewer, Department, or appropriate plan approval agency that the current Plan is inadequate. The Department may grant additional time for amending the Plan. A written request for an extension shall be made by the person subject to this Part to the Department.

4. Under the requirements of the *Delaware Sediment and Stormwater Law* and *Regulations*, the Plan remains valid for three (3) years following the date of approval. If construction continues beyond that three-year time period, an extension or renewal of the Plan may be granted by the Department or the appropriate plan approval agency. Unless the plan is extended or renewed, the plan is considered expired and any construction activity that occurs after the expiration date occurs in violation of the *Delaware Sediment and Stormwater Law* and *Regulations* and this Part. For the purposes of this Part, permit coverage is only valid within the three (3) year period as long as construction activity is taking place.

E. Failure to Prepare or Amend Plan

In no event shall failure to complete or update a Plan in accordance with this Part relieve any persons covered under this Part of responsibility to implement actions required to protect the waters of the State, complete any actions that would have been required by such Plan, and to comply with all conditions of this Part.

F. Sediment and Stormwater Plan Deadlines

The Plan must be approved, and the NOI Form submitted to the Department, prior to the onset of construction activity at the site for which coverage has been granted. Failure to obtain an approved Plan prior to construction activity constitutes a violation of the *Delaware Sediment and Stormwater Law* and *Regulations* and this Part.

§ 9.1.02.6 NON-STORM WATER DISCHARGES

A. Discharges to a storm water system of anything other than storm water, except those discharges described in subparagraph (B) below, shall either be eliminated or in compliance with an appropriate individual NPDES permit.

B. Industrial facilities that qualify for coverage under this Subsection may discharge the following non-storm water discharges, through outfalls identified in the Plan:

1. discharges from fire fighting activities and fire hydrant flushings;

2. uncontaminated potable water sources including waterline flushings;

3. lawn watering and similar irrigation drainage;

4. water from the routine external washing of buildings, conducted without the use of detergents or other chemicals;

5. water from the routine washing of pavement conducted without the use of detergents or other chemicals and where spills or leaks or toxic or hazardous materials have not occurred (unless a spilled material has been removed);

6. uncontaminated air conditioner condensate, compressor condensate, and condensate that externally forms
on steam lines;

7. water from foundation or footing drains where flows are not contaminated with pollutants (e.g. process materials, solvents, and other pollutants);

8. springs and other uncontaminated ground water; and

9. mist discharges which originate from cooling towers (as long as the discharge has been evaluated for contaminated chemicals used in the cooling tower and determined that the levels of such chemicals in discharges would not cause or contribute a violation of applicable water quality standards).

§ 9.1.02.7 EFFECTIVE DATE OF COVERAGE

A. Commencement of Coverage

Coverage under this Part begins when the Department has been notified pursuant to the provisions outlined in §9.1.02.3 of this Part.

B. Termination of Coverage

Coverage under this Part continues until a completed Notice of Termination (NOT) form has been submitted to the Department or appropriate plan approval agency and it is determined by the Department or appropriate plan approval agency that:

1. All items and conditions of the Plan have been satisfied in accordance with the *Delaware Sediment and Stormwater Regulations*;

2. As-built documentation verifies that the permanent stormwater management measures have been constructed in accordance with the approved Plan and the *Delaware Sediment and Stormwater Regulations*, and

3. Final stabilization has been achieved.

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Guidance Document to Support:

The Regulations Governing Storm Water Discharges Associated with Industrial Activity
Part 2 – Special Conditions for Storm Water Discharges Associated with Construction Activities

I. Background

The EPA can authorize any state to operate the National Pollutant Discharge Elimination System (NPDES) program. Delaware received this authority in April, 1974. The 1987 amendments to the Clean Water Act require national regulations to be issued to address the control of pollutants entrained in storm water discharges.

Under the provisions of the Clean Water Act, as amended, (33 U.S.C. 1251 et.seq.; the Act), except as provided by Part I.B.3 of the permit, Federal law prohibits discharges of pollutants in storm water from construction activities without an NPDES Permit. A General Permit, as defined by federal law in 40 C.F.R. §122.28, authorizes the discharge of storm water associated with industrial activity from sources within a defined area or sources that share certain similarities.

In 1993, Section 9 (The General Permit Program) of the State of Delaware, Department of Natural Resources and Environmental Control (DNREC), Regulations Governing the Control of Water Pollution was issued. Subsection 1 of the General Permits Program contains The Regulations Governing Storm Water Discharges Associated with Industrial Activity and are referred to as the "General NPDES Storm Water Permit Program". In order to obtain coverage through the General NPDES Storm Water Permit Program, persons will be required to file a Notice of Intent (NOI) with DNREC. The NOI requirement is in accordance with 40 C.F.R. §122.28(b)(2) of the USEPA NPDES Program. The NOI is the equivalent of an NPDES permit application for General NPDES Storm Water Permit coverage.

II. Requirement to Obtain Permit Coverage

In Delaware, any land disturbing activity exceeding 5,000 square feet is required to obtain an approved Sediment and Stormwater Plan prior to the initiation of land disturbance, or construction activities. All projects requiring a detailed Sediment and Stormwater Plan must also submit the Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity Under a NPDES General Permit (FORM 1). Submittal of the NOI together with approval of the detailed Sediment and Stormwater Plan provide the site with permit coverage to be authorized to discharge storm water associated with construction activity.

As a matter of practice, the NOI must be submitted to DNREC prior to approval of the Sediment and Stormwater Plan by the local plan approval agency. Projects eligible for Sediment and Stormwater Plan approval through a Standard Plan, where the total limits of disturbance do not exceed one (1) acre, are not required to submit the NOI.

III. Who is Responsible?

Persons with "operational control" of the site activities manage and have control of the construction activity, construction plans and specifications, and have the ability to make modifications to the plans and specifications. Any modification to the plans and/or specifications will require an approval of the modification by the local plan approval agency. It is the person with operational control, or the operator, who must sign the certification on the NOI. By signing the certification, the signatory agrees to fully comply with the *Special Conditions for Storm Water Discharges Associated with Construction Activities*.

Persons with operational control may include:

- owners,
- developers, and
- homebuilders in residential development projects.

A general and/or site contractor who is under contract with the owner, developer, and/or homebuilder is not considered to be an operator when they are acting at the direction of the owner, developer and/or homebuilder, when they do not have the authority to make modifications to the plans and specifications without the consent of the owner, developer and/or homebuilder. The land development plan consultant, engineer, surveyor, landscape architect, or architect is not considered to be an operator, and NOIs submitted under the signature of those individuals will be returned for a proper owner certification signature. The certification shall be signed as follows:

- For a corporation: by a responsible corporate officer which means: (I) president, secretary, treasurer, vice-president of the corporation in charge of a principal business function, or any person who performs similar policy or decision making function, or (ii) the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

- For a partnership or sole proprietorship: by a general partner of the proprietor; or

- For a municipality, state, federal, or other public facility: by either a principal executive or ranking elected official.

For Delaware businesses, the form certification shall be signed as follows:

- For a Corporation: by an Authorized Officer (8 Del. C., Chapter 1),
- For a Limited Liability Company: by an Authorized Person (6 Del C., Chapter 18),
- For a Limited Partnership: by a General Partner (6 Del C., Chapter 17),
- For a General Partnership: by a Partner or Authorized Person (6 Del. C., Chapter 15),
- For a Limited Liability Partnership: by a Partner or Authorized Person (6 Del. C., Chapter 15), or
- For a Statutory Trust: by a Trustee (12 Del. C., Chapter 38).

Reference the Delaware Code as listed for definitions of the individuals who may sign for the various business entities.

Transfer of Authorization

There are two different conditions whereby authorization to discharge may be transferred to another permittee who agrees to comply with the requirements of Special Conditions for Storm Water Discharges Associated with Construction Activities:

A. Transfer of Control of Permitted Activities

If an owner who submitted the NOI prior to approval of the Sediment and Stormwater Plan does not intend to manage or control the permitted activities during construction, that owner may choose to transfer authorization to discharge to a duly authorized person by submitting a Transfer of Authorization form (FORM 3). By transferring control of permitted activities, the original permittee relinquishes their own responsibility under the permit. The duly authorized person accepts all responsibility for compliance with the permit conditions. A general and/or site

contractor who is under contract with the owner, developer, and/or homebuilder and has the authority to make modifications to the plans and specifications without the consent of the owner, developer and/or homebuilder may be considered to have operational control and authorization to discharge may be transferred to that general and/or site contractor.

The Transfer of Authorization form (FORM 3) must be submitted to DNREC no less than ten (10) days prior to beginning construction activities. Transfer of Authorization, except in the case of an ownership change, may not take place once construction activities have commenced. After construction begins, if the original permittee wishes to share authorization to discharge with a duly authorized person, the original permittee and the duly authorized person may share operational control through submittal of the Co-Permittee Application [FORM 4, See C. Shared Operational Control (Co-Permittees)]. The Transfer Agreement on the Transfer of Authorization form must provide effective dates of the transfer and be signed by both the original permittee and the duly authorized person, or transferee. The Transfer of Authorization form includes the NOI Certification that must be signed by the transferee. By signing the certification, the transferee agrees to fully comply with the *Special Conditions for Storm Water Discharges Associated with Construction Activities*.

It is the responsibility of the original permittee, not the local plan approval agency, to provide the transferee with the current approved Sediment and Stormwater Plan.

B. New Owner

Should ownership of the project change after submittal of the NOI, either before or during the construction period, the original permittee must transfer authorization to discharge to the new owner by completing the Transfer of Authorization form (FORM 3). The Transfer Agreement on the Transfer of Authorization form must provide effective dates of the transfer and be signed by both the original permittee and the new owner. The Transfer of Authorization form includes the NOI Certification that must be signed by the new owner. By signing the certification, the new owner agrees to fully comply with the *Special Conditions for Storm Water Discharges Associated with Construction Activities*.

In addition to submitting the Transfer of Authorization form to DNREC, the new owner must submit required documentation of the ownership change to the local plan approval agency for the purpose of updating the agency's owner contact information. At a minimum, the Owner's Certification as required by the *Delaware Sediment and Stormwater Regulations* must bear the original signature of the new owner; this may be accomplished through submittal of a revised Sediment and Stormwater Plan. The new owner should contact the local plan approval agency to determine what additional documentation will be required.

It is the responsibility of the original owner, not the local plan approval agency, to provide the new owner with the current approved Sediment and Stormwater Plan.

Shared Operational Control (Co-Permittees)

A single project may have multiple persons with operational control. Examples of this condition include:

- A residential development project with an original developer who is responsible for construction of roads, utility infrastructure, open spaces, and stormwater management components, and one or more homebuilders responsible for home construction and having operational control on individual residential lots.

- An office or business park complex having an original developer who is responsible for construction of roads, utility infrastructure, open spaces, and stormwater management components, while individual lots each have individual owners with operational control on those lots.

In these cases, each of those individual entities will be "co-permittees" under the original NOI for the site. Multiple NOIs are not required and will not be accepted for individual lots within the limits of a project already receiving permit coverage through submittal of an NOI. Should the original permittee sell one or more lots to another person or persons during the construction period, the original permittee must share operational control with each new owner by completing the Co-Permittee Application form (FORM 4). The Shared Operational Control Agreement on the Co-Permittee Application form must provide effective dates of shared operational control and be signed by both the original permittee and the new co-permittee. The Co-Permittee Application form includes the NOI Certification that must be signed by the new co-permittee. By signing the certification, the co-permittee agrees to fully comply with the *Special Conditions for Storm Water Discharges Associated with Construction Activities*. If more than one co-permittee is added for permit coverage under the same NOI, a separate Co-Permittee Application must be submitted for each additional co-permittee.

DNREC and/or its delegated agency will not be responsible for dictating when additional co-permittees must be added to the NOI to gain permit coverage for their construction activities. DNREC recommends that when individual lots are conveyed to new owners (homebuilders or pad site owners, for example), the new owner will at that time become a co-permittee for the overall site with the original permittee as a condition of the sale of property.

It is the responsibility of the original permittee, not the local plan approval agency, to provide the new co-permittee with the current approved Sediment and Stormwater Plan. The Sediment and Stormwater Plan should include a plan sheet that further defines the responsibilities of the co-permittee(s). That plan sheet, titled, "Individual Lot Erosion and Sediment Control Plan", shall include, at a minimum, the following information:

- For residential development projects, Standard Detail No. DE-ESC-3.7.1 titled ESC for Minor Development,
- A separate sequence of construction for individual lot construction if not included in the Standard Detail, and
- Notes defining who is responsible for cleanup of transported sediment and maintenance of sediment and stormwater best management practices (BMPs) during the lot construction phase

The Erosion and Sediment Controls Operations and Maintenance Responsibilities matrix attached to this Guidance Document as Appendix A should be used as a guide to define items that require maintenance throughout the construction phase. Construction, operation, or maintenance of each of these items must be assigned to one or more permittee for the site and defined in an agreement to accompany the co-permittee form when it is submitted to DNREC.

Adding a co-permittee on the original NOI does not relieve the original permittee from responsibility for compliance with the permit. If the original permittee makes changes to the Plan without notification to the co-permittees, that original permittee assumes full responsibility for implementation of the Plan. In enforcement action the original permittee, or overall owner/developer, will be held jointly responsible for any violations of the Plan or permit with any of the subsequent co-permittees. Individual co-permittees, such as individual lot developers, will be responsible in an enforcement action only for construction activities that have occurred on their lot(s), or for violations and/or damages that have occurred as a result of construction activities that have occurred on their lot(s).

IV. Termination of Coverage

Individuals who submit for coverage under the permit must terminate coverage once construction activities have been completed. The original permittee or the transferee must submit the Notice of Termination (NOT) form (FORM 2) to DNREC; individual co-permittees need not submit individual NOTs (see below for termination of individual coverage for co-permittees). The NOT should not be submitted until the following conditions have been met, as determined by the local plan approval agency:

- All items and condition of the Plan have been satisfied in accordance with the Delaware Sediment and Stormwater Regulations,
- As-built documentation verifies that the permanent stormwater management measures have been constructed in accordance with the approved Plan and the Regulations, and
- Final stabilization of the site has been achieved in accordance with the definition in Section 9.1.02.0.

Following final inspection, the local plan approval agency will notify the permittee when they consider the project to be complete and recommend submittal of the NOT to DNREC. When DNREC receives the NOT form from the permittee, DNREC will await verification from the local plan approval agency that the project has indeed met all of the above conditions before terminating permit coverage. Individual delegated agencies will agree with DNREC on the best way to provide this verification (ie. final inspection report, closeout letter, etc.). It is noted that permit coverage in multi-lot projects, such as residential development projects, may not be terminated until construction of each individual lot has been completed.

When a co-permittee has met all of the termination of coverage conditions for their individual lots within the total project site, the co-permittee shall submit to DNREC a Notice of Termination of Shared Operational Control form (FORM 5). For example, a homebuilder owning a block of 25 lots within a residential development of greater than 25 lots may submit a Notice of Termination of Shared Operational Control to DNREC when each of those 25 lots has been built out, Certificates of Occupancy have been issued, and final stabilization has been achieved in accordance with the definition in Section 9.1.02.0. Once the NOT of Shared Operational Control form is submitted to and accepted by DNREC through verification with the local plan approval agency, the co-permittee is relieved of his responsibility under the permit and will no longer share operational control with the other co-permittees of the site.

V. Fees

Until permit coverage is terminated, the original permittee will be assessed an annual NOI permit fee of $195. The permittee will be notified to submit the fee to DNREC twice, after which a Notice of Violation will be issued and enforcement action will proceed.

Clarifications:

During the public review period, comments were received requesting clarification of the term "larger common plan of development or sale" used in the definition of Construction Activity. EPA's Fact Sheet on NPDES General Permit for Storm Water Discharges from Construction Activities uses the term "common plan" as follows:

> *Any construction activity that will, or is part of a "common plan" of development or sale that will, disturb one or more acres and has the potential to have a discharge of storm water to a water of the United States must either have a permit OR have qualified for a waiver. These regulated discharges are broken into two categories: "Large" and "Small". A large construction activity is one that will disturb, or is part of a "common plan" that will cumulatively disturb, five or more acres. A small construction activity is one that will disturb, or is part of a "common plan" that will cumulatively disturb, one or more acres.*

In Delaware, land development projects such as residential subdivisions and business or industrial park complexes would include lots and construction activities that may be part of a larger "common plan". An individual residential lot that is less than one acre in size, but is part of a land development project such as a subdivision of one (1) acre or more, is not precluded from permit coverage because it is part of that larger "common plan". Individual residential or commercial lots that fall within a larger "common plan" that has already gained permit coverage through approval of the Sediment and Stormwater Plan and submittal of the NOI will also have permit coverage under that Plan and NOI. If the ownership or operator of the individual parcel is different than the ownership or operator of the larger "common plan", a Co-permittee Form must be filed to allow for Shared Operational Control of the parcel.

Definitions:

"Standard Plan" means a set of pre-defined standards and/or specification for minor land disturbing activities that may preclude the preparation of a detailed plan under specific conditions.

Appendix A.

Erosion and Sediment Control
Operations and Maintenance Responsibilities

Prior To Bulk Grading	Bulk Grading And Infrastructure	Home Building Phase	Post Home Building Phase
Stabilized Construction Entrance	Maintenance of SCE Road Stabilization	Lot Silt Fence	Clean Sediment out of Pipes and Drainage
Dikes, Berms, Diversions	Swales, Berms, Diversions, Tracking	Lot Stabilized Driveway Entrance	Other Repairs to Stormwater Conveyance
Sediment Basins, Traps	Maintenance of Traps and Basins	Maintain Perimeter Controls/Traps/Basins	Remove other E&S Controls
Silt Fence	Maintenance of Silt Fence	Maintain Inlet Protection	Sediment Basin Conversion
	Temporary Stabilization of Bulk Fill Areas	Downspout Slope Drains	As-Builts
	Stone Check Dams	Permanent Lot Stabilization	
	Inlet Protection	Street Cleaning/Sweeping	
	Stabilization of the Lot Areas		

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4.02
Enforcement and Penalties

Site Violations
Whenever the Department or Delegated Agency discovers noncompliance with **7 Del. C.,** Ch. 40 (Delaware Sediment and Stormwater Law and/or *Delaware Sediment and Stormwater Regulations*) and **7 Del. C.,** Ch. 60 (Federal National Pollutant Discharge Elimination System (NPDES) requirements) enforcement action may be taken. Site violations can be generated through the following ways: 1) no plan violations; 2) the construction and maintenance review process; and 3) referrals from delegated agencies.

No Plan Violations
If a site has no plan and the disturbance is greater than 5,000 square feet the Department or Delegated Agency will issue a letter requiring the owner to submit specified information within a specified deadline to gain compliance. If the owner does not submit the required information within the specified deadline a Notice of Violation will be issued and may result in the Department seeking additional enforcement action.

Construction Review and Maintenance
Non-compliances will be documented in the construction review reports or maintenance review reports and include a reasonable deadline for compliance. If the site deficiencies have not been corrected a Notice of Violation will be sent to the owner by the Department or Delegated Agency. The Department may seek additional enforcement action.

Referral of a Site Violation to the Department
When a Delegated Agency cannot obtain compliance on a site they may use local enforcement options, as well as referring a site to the Department for enforcement action. The Department may request of the local permitting agency that no building permits be issued, pursue criminal and/or administrative penalties and other enforcement actions, such as a Cease and Desist Order.

4.02.1
COMPLIANCE ASSISTANCE POLICY

Section I. Introduction

This policy establishes a formal procedure to be followed by the Department of Natural Resources and Environmental Control (DNREC) Sediment and Stormwater Program and their Delegated Agencies ("Agency") to address noncompliance with the State's Sediment and Stormwater Law and Regulations and the Federal National Pollutant Discharge Elimination System (NPDES) requirements.

Noncompliance cases can be generated in any of the six ways:

(1) through the construction review process;

(2) through referrals from an Agency;

(3) through Sediment and Stormwater Plan violations;

(4) through violations of the NPDES General Permit Regulations for Construction Activities;

(5) through no plan violations; and

(6) through citizen concerns of individuals, groups, etc.

Section II. Construction Review

Whenever the Agency discovers noncompliance(s), the noncompliance(s) will be addressed by an appropriate enforcement response, which will, at a minimum:

1. Document the noncompliance(s) in the Agency construction review reports and provide a reasonable deadline for achieving or restoring compliance. The Agency should notify DNREC in writing on significant noncompliance issues such as discharge of sediment to a water body, pumping without a dirt bag, disturbance of greater than 20 acres and inadequate pollution prevention practices that involve hazardous substances.

2. If noncompliance(s) have been corrected, it should be documented in the Agency construction review reports.

3. If noncompliance(s) have not been corrected in accordance with the Agency construction review reports the following process should occur:

- The Agency will issue a notice of non-compliance (NON) to the owner/developer or authorized agent.
- The NON should include the following:

    1) The date and time of the construction review;
    2) the noncompliance(s);
    3) the corrective measures to be taken;
    4) deadline to complete the work
    5) require an on-site meeting with an owner's representative, the responsible person(s), the and a representative from DNREC.

- The NON shall be sent to the owner/developer. A copy shall also be sent to the responsible person(s) on site and DNREC.

4. Compliance Review

At the end of the time period specified in the NON, a follow-up construction review shall take place to determine whether compliance has been achieved. Depending on that determination, the following actions may occur:

a. Noncompliance(s) Corrected:
If all previous noncompliance(s) have been corrected, the site reviewer shall issue a return to compliance letter specifying compliance and the site shall be returned to a normal Construction Review status.

b. Noncompliance(s) Not Corrected:
If all previous noncompliance(s) have not been satisfactorily corrected, the site should be referred to DNREC as outlined in Section III.

Section III. Referrals

Referrals from an Agency will be handled in the following manner:

1) In the event when the Agency has followed the steps in Section II and noncompliance(s) persist, cases will be referred directly to the DNREC, Sediment and Stormwater Program, by way of a referral package.

The referral package should contain the following:

- a referral letter from the Agency documenting why the case is being referred along with a brief history;
- the current owner/developer information;
- tax parcel ID for the site;
- the Notice of Intent number associated with the site and confirmation that the owner on the NOI is current;
- contact information for the CCR, design engineer, project manager, and site contractor;
- the approved plan expiration date;
- previous Agency construction review reports and Certified Construction Reviewer (CCR) reports for the last six (6) months;
- the NON letter sent to the owner/developer;
- and the approved Sediment and Stormwater Management plan.

Site conditions will be verified by DNREC Sediment and Stormwater Program.

At the point of referral DNREC Sediment and Stormwater Program will be the lead agency for the project. DNREC Sediment and Stormwater Program will keep the Agency apprised of the project status, will coordinate all plan reviews with them, and will copy them on all correspondence. Agencies may assume plan review or construction review responsibilities at the request of DNREC.

2) DNREC Sediment and Stormwater Program will issue a Notice of Violation (NOV) letter to the owner/developer specifying the following:

- the regulatory requirements with which the owner/developer failed to comply;

- occasion(s) on which the violation was observed or discovered by the Agency or DNREC Sediment and Stormwater Program;

- a reasonable deadline or deadlines by which the owner/developer is required to come into compliance with the requirement(s) described in the NOV.

- DNREC may assess criminal or civil/administrative penalties under Chapter 40 and/or Chapter 60.

3) At the end of the specified time frame on the NOV, DNREC Sediment and Stormwater Program will review the site for compliance. If all work has been satisfactorily completed DNREC Sediment and Stormwater Program will:

- conduct a joint construction review between DNREC Sediment and Stormwater Program, the Agency, and the owner/developer;

- provide a letter from the DNREC Sediment and Stormwater Program, referring the project back to the Agency for Plan and construction review responsibilities;

- issue a Return to Compliance letter to the owner/developer and furnish a copy to the Agency;

- return all approved plans and pertinent correspondence to the Agency.

Section IV. No Plan Violations

If unlawful land disturbing activity is alleged at a site, the Agencies will request a site review through a letter to the land owner in order to verify how much land disturbance has occurred.

1) If the land disturbance is greater than 5000 square feet and less than one (1) acre, the Agency will issue a NON letter requiring the owner/developer to submit a standard plan within a stated deadline. The letter will enumerate all the requirements to bring the site into compliance with the Sediment and Stormwater Regulations and the Federal NPDES or,

2) If the land disturbance is greater than one (1) acre the Agency will issue a NON letter requiring the owner/developer to submit a detailed Sediment and Stormwater Management Plan to the Agency. The letter will also instruct the owner/developer to submit a Notice of Intent with a stated deadline and requirements to bring the site into compliance with the Sediment and Stormwater Regulations and the Federal NPDES. A copy of the owner/developer's NON letter must be furnished to the DNREC Sediment and Stormwater Program.

3) If the owner/developer does not meet the required deadline set by the Agency, the Agency shall notify DNREC in writing (email will suffice) with the following:

    - the current owner/developer information;
    - tax parcel ID for the site;
    - and copies of all correspondence to the owner/developer.

4) DNREC Sediment and Stormwater Program will issue a Notice of Violation (NOV) letter to the owner/developer specifying the following:

- the regulatory requirements with which the owner/developer failed to comply;
- occasion(s) on which the violation(s) was observed or discovered by the Agency or DNREC Sediment and Stormwater Program;
- a reasonable deadline or deadlines by which the owner/developer is required to come into compliance with the requirement(s) described in the NOV.
- DNREC may assess criminal or civil/administrative penalties under Chapter 40 and/or Chapter 60.

Section V. Citizen Concerns

Citizen Concerns will be handled in the following manner:

1) All concerns will be entered into the Drainage and Stormwater Assistance database and then assigned to its respective program.

2) Each Agency should then investigate the concern and document the resolution in the Drainage and Stormwater Assistance database.

3) In some cases, DNREC may coordinate an on-site meeting with the Agency and the concerned citizen.

Section VI. Enforcement Options for Failure to Comply

1) DNREC may issue a cease and desist order to any persons violating any provision of Chapter 40, and/or the Regulations by ordering that all site work stop except that necessary to comply with any administrative order.

2) DNREC may request withholding any further building or grading permits until outstanding violations have been remedied.

3) DNREC may initiate criminal or civil/administrative penalties under Chapter 40 and/or Chapter 60. Complete information concerning enforcement and penalties is contained in Chapter 40 Title 7 of the Delaware Code and the Delaware Sediment and Stormwater Regulations.

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Chapter 2

Background Information on Hydraulics, Hydrology, and Soils Engineering

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Rainfall Depths for Delaware* ***(NRCS Type II, 24-Hour Duration)***			
	County		
Storm Event	*Kent*	*New Castle*	*Sussex*
Latitude	39.070 N	39.547 N	38.673 N
Longitude	75.602 W	75.681 W	75.417 W
WQ	2.0	2.0	2.0
1-YR	2.7	2.7	2.8
2-YR	3.3	3.2	3.4
5-YR	4.3	4.1	4.4
10-YR	5.2	4.8	5.3
25-YR	6.5	6.0	6.7
50-YR	7.6	6.9	7.9
100-YR	8.9	8.0	9.2
500-YR	12.6	10.9	13.0

* Ref: NOAA Atlas 14 Volume 2, Version 3

EFFECTIVE DATE: January 1, 2007

Appendix B Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

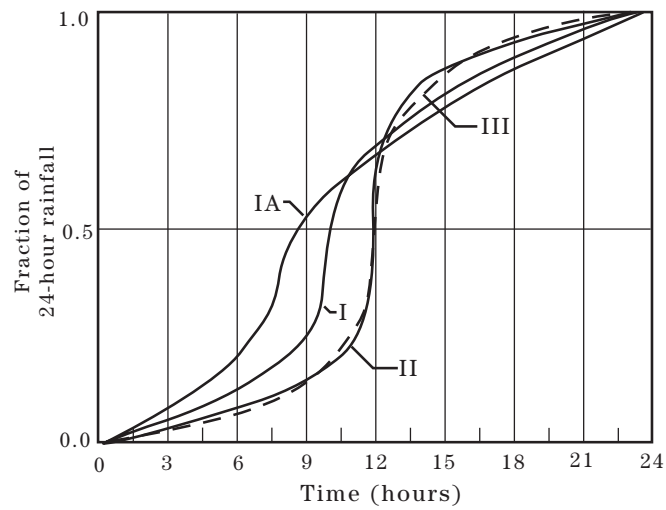
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c. For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c.

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having "nested" rainfall intensities was developed. The set "maximizes" the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

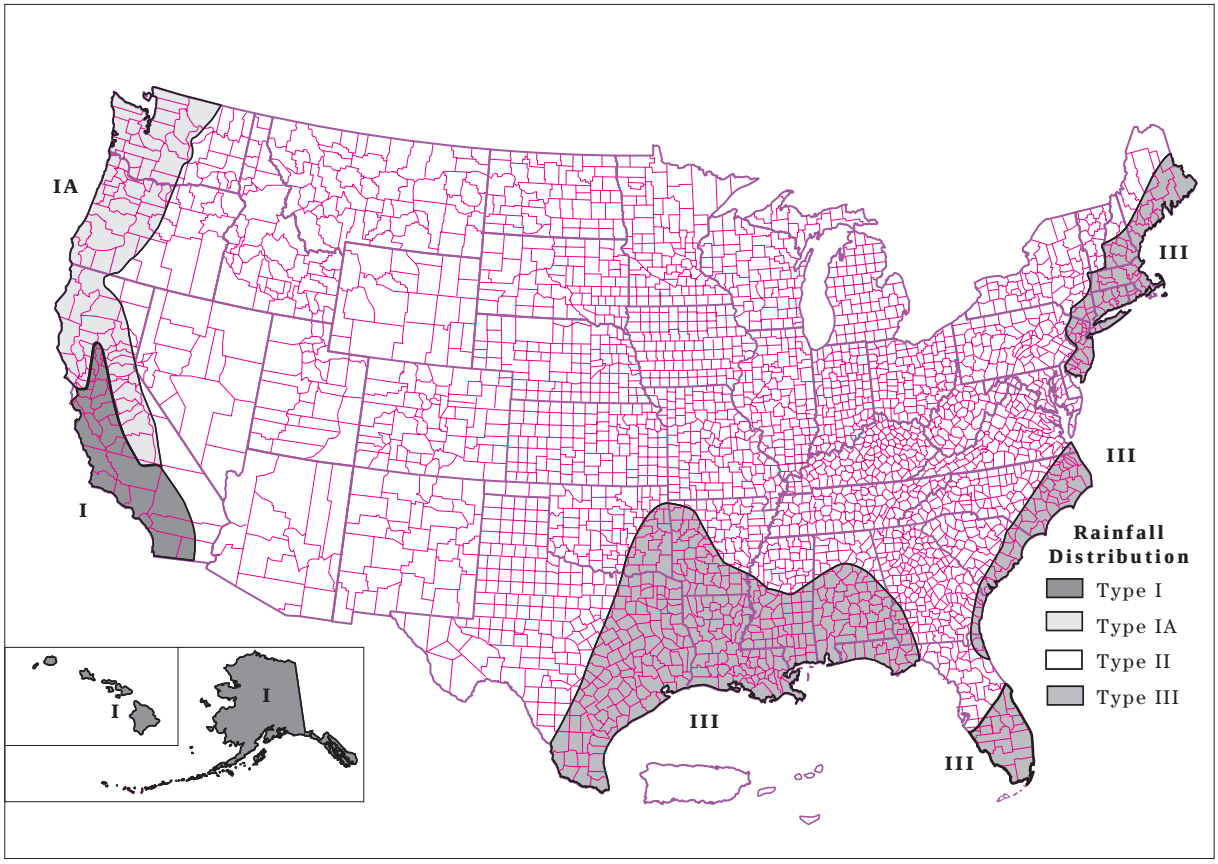
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061; Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Figure B-3 2-year, 24-hr rainfall

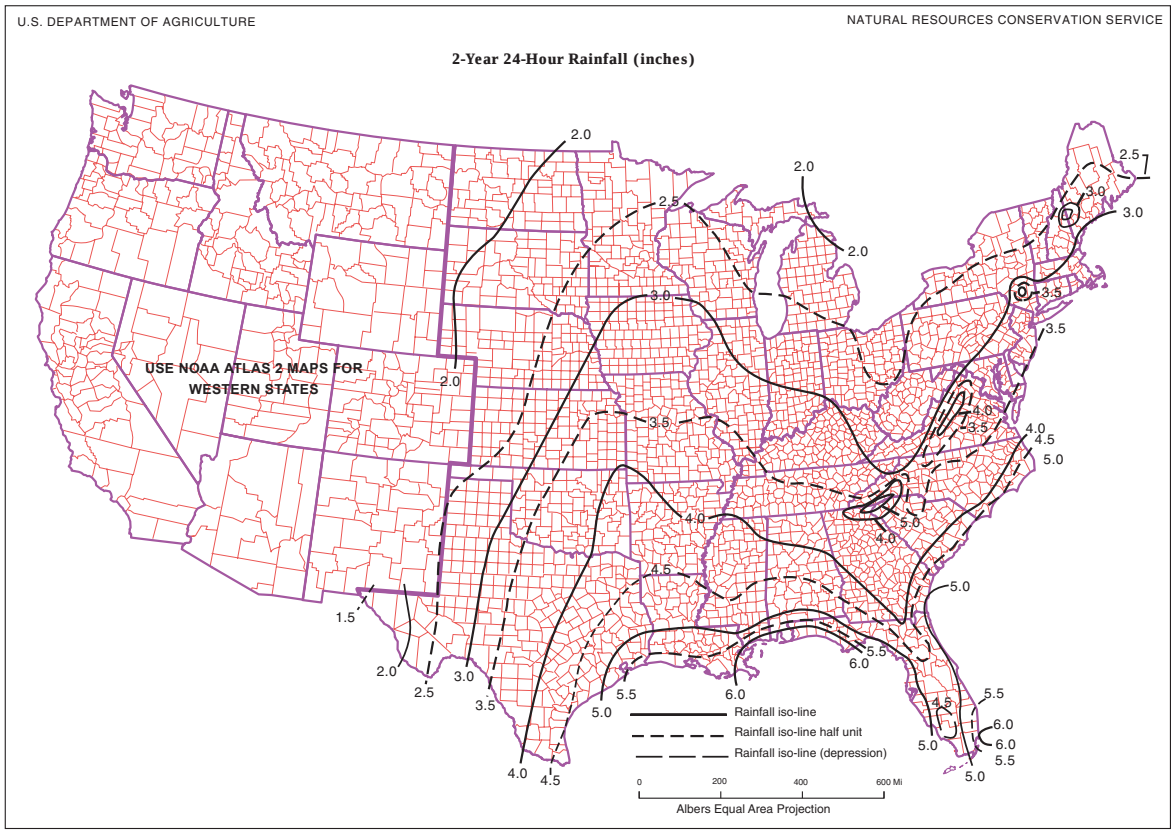


Figure B-4 5-year, 24-hour rainfall

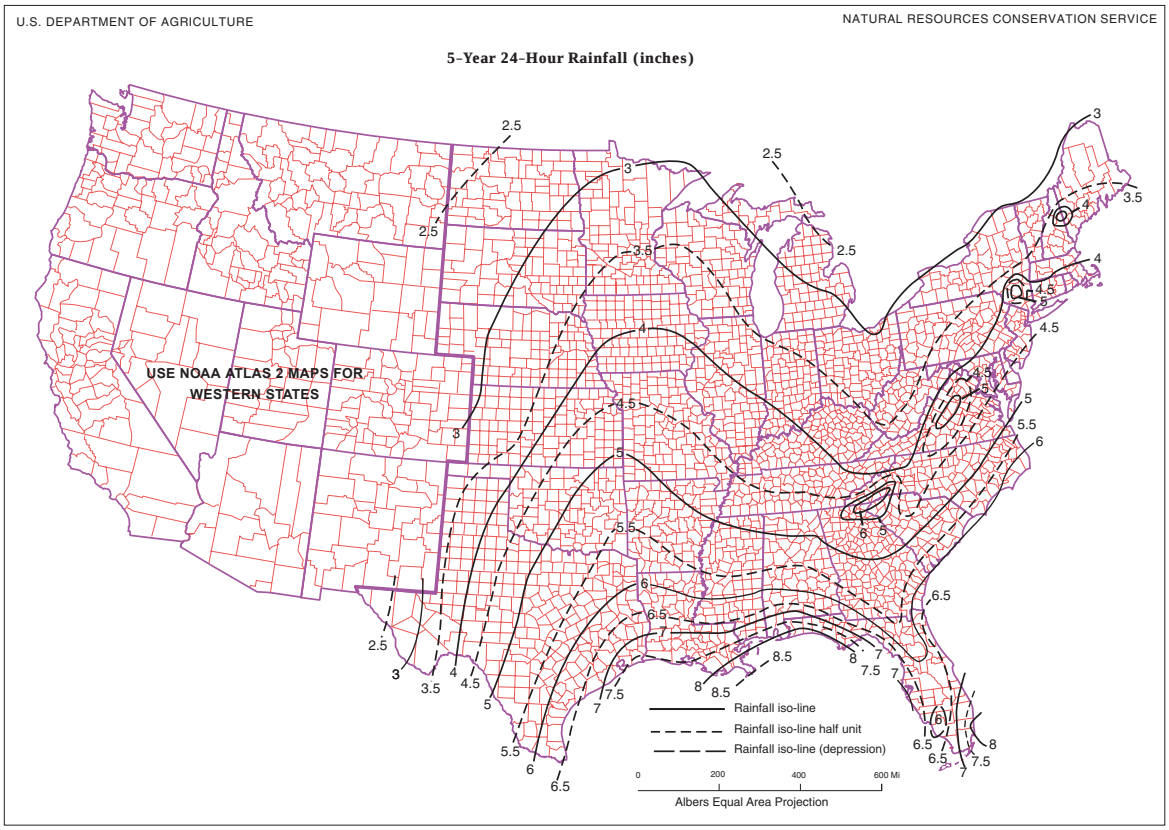


Figure B-5 10-year, 24-hour rainfall

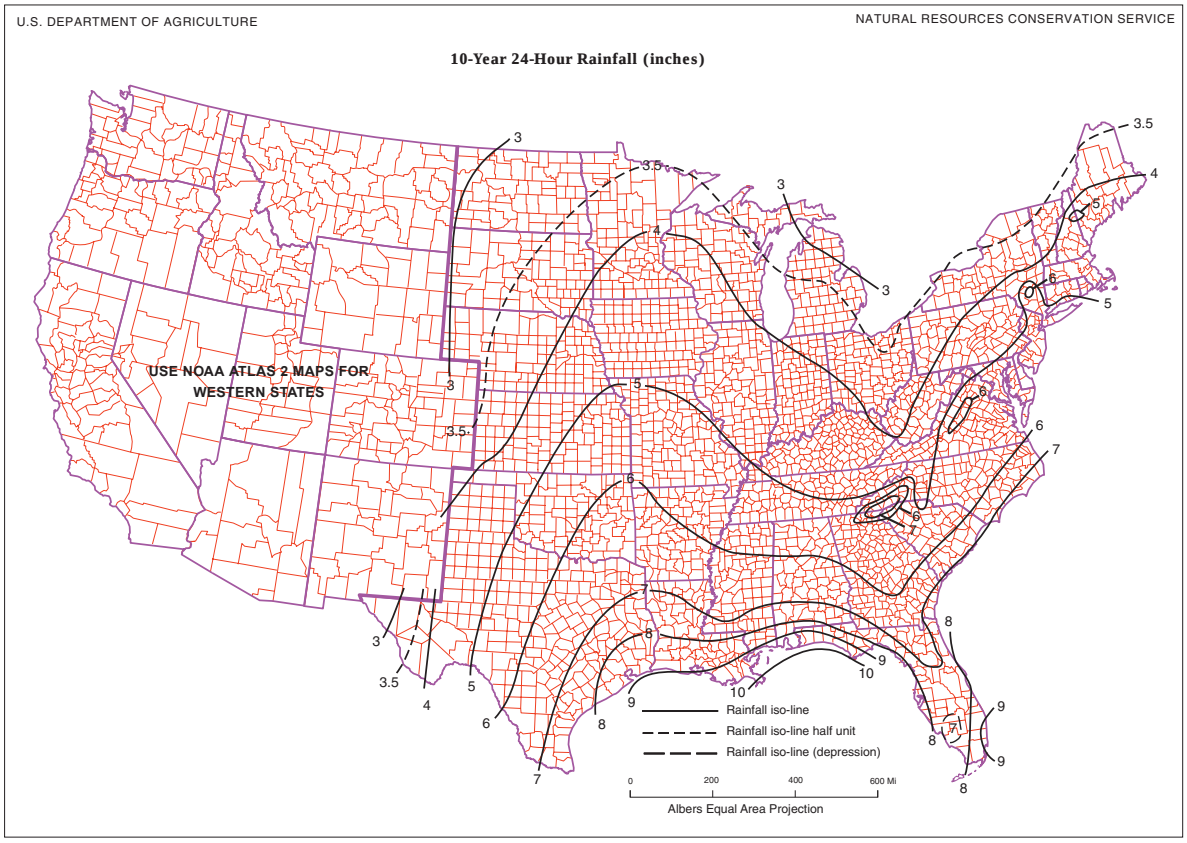


Figure B-6 25-year, 24-hour rainfall

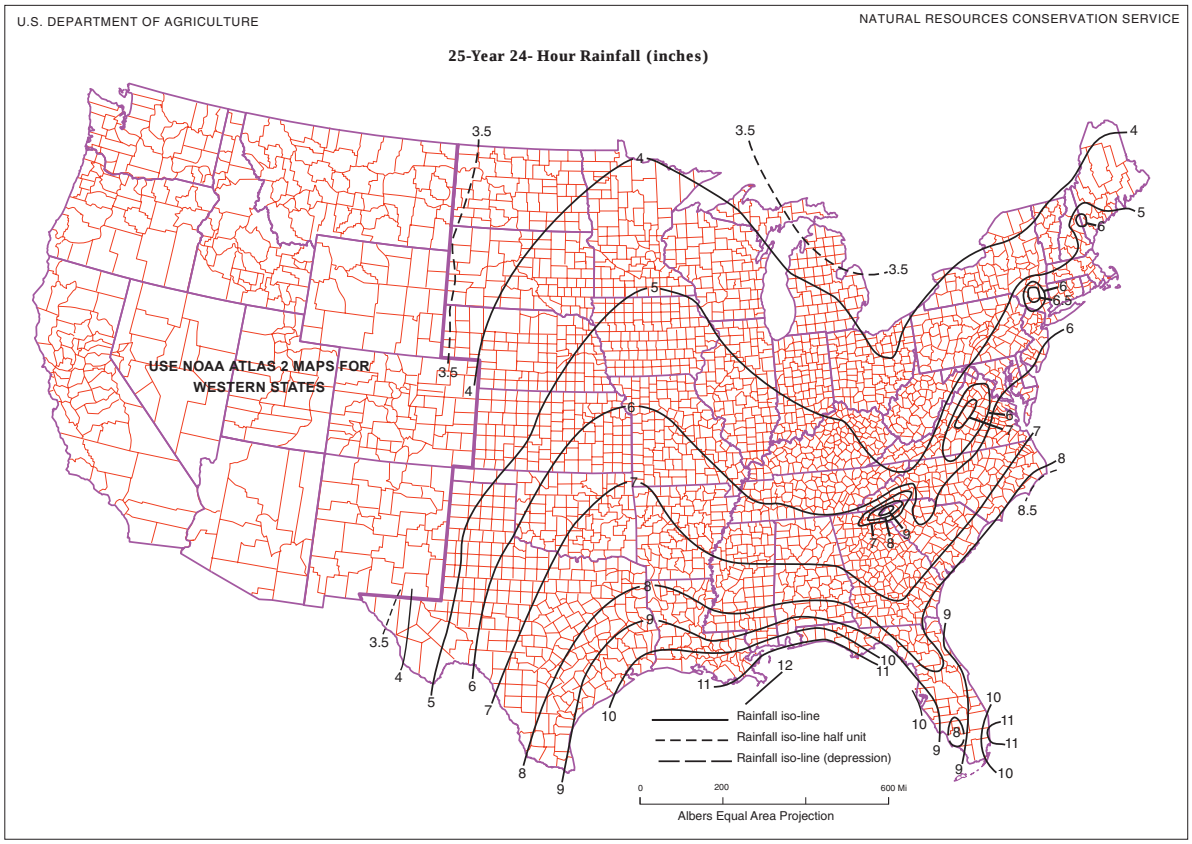


Figure B-7 50-year, 24-hour rainfall

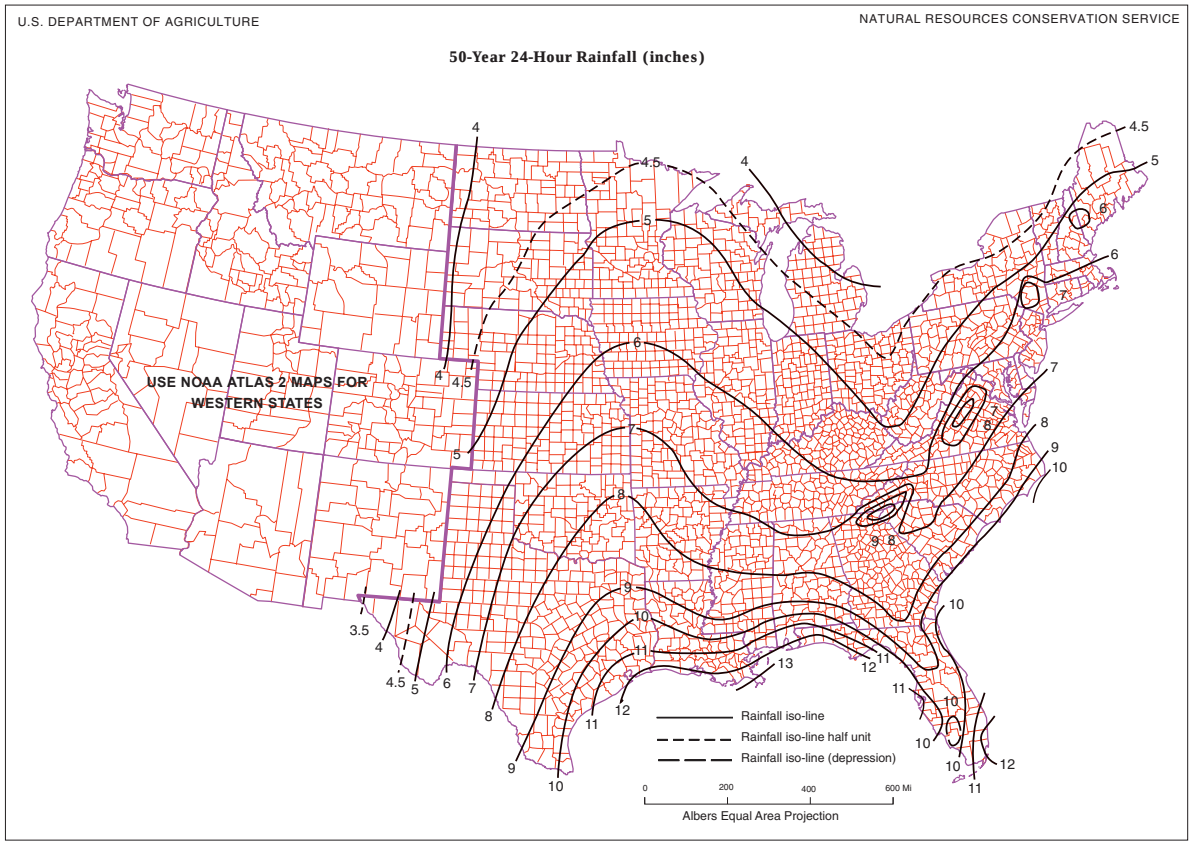
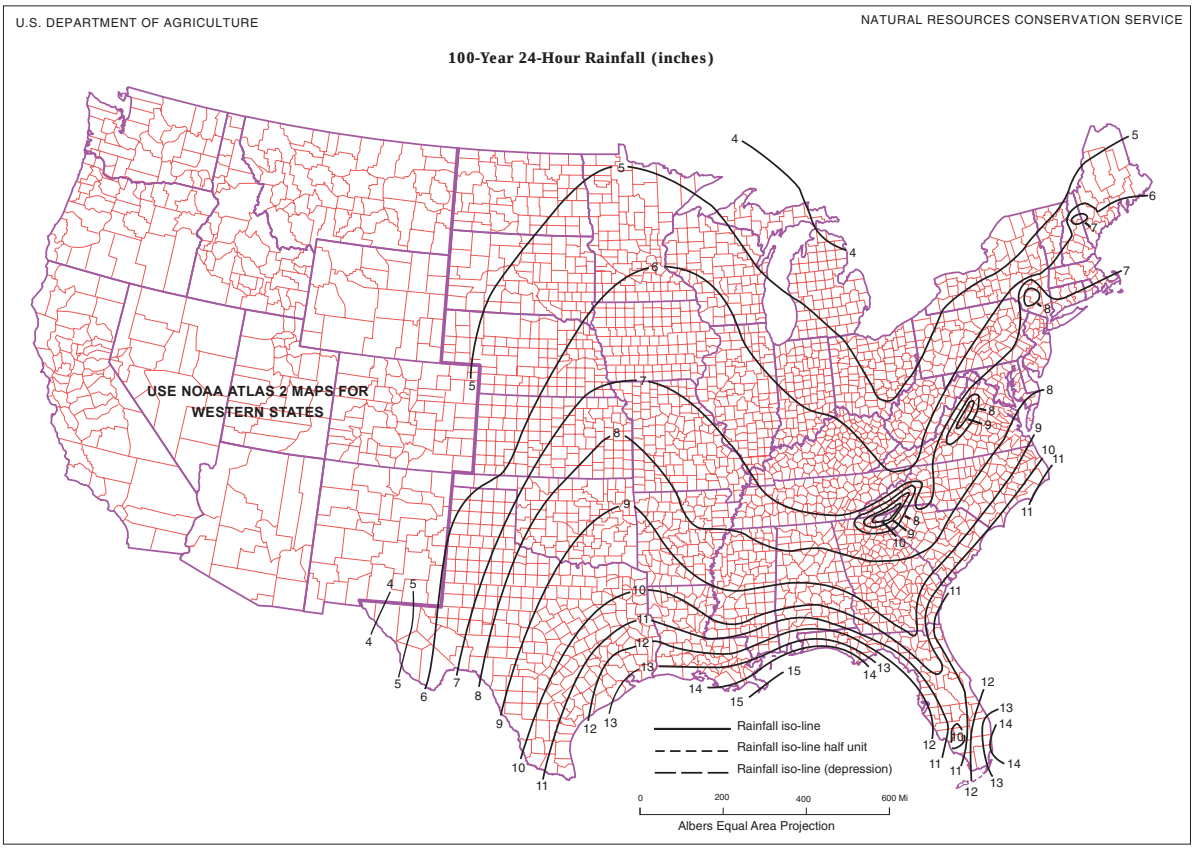


Figure B-8 100-year, 24-hour rainfall



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Flooding in Delaware and the Eastern Shore of Maryland From Hurricane Floyd, September 1999

by Anthony J. Tallman and Gary T. Fisher

Location of Delaware and the Eastern Shore of Maryland

Summary of Flooding

• Record floods as a result of Hurricane Floyd reached 100-year discharge on many streams, and floods on several streams reached the 500-year discharge.

• Major flooding was confined to the central and northern areas of the Delmarva Peninsula.

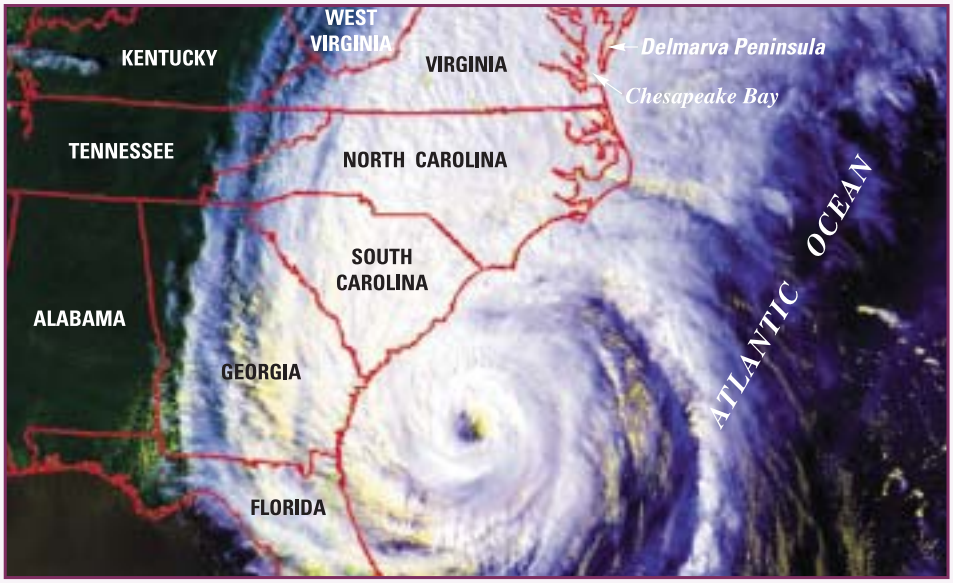
• Two children in Delaware were swept away and drowned by rapidly rising floodwaters, and 7 other people throughout the region were injured as a result of the flooding.

• Property damage reached $14.75 million on the Eastern Shore of Maryland and $8.37 million in Delaware.

Rainfall Data

Heavy rainfall associated with Hurricane Floyd began early on September 16, 1999, and continued late into the night. The amount of rainfall was highly variable over the region; some areas received more than 10 inches of rain while other areas received only 5 inches or less. Rainfall was heaviest in the central parts of the Eastern Shore of Maryland, with a maximum of 12.59 inches reported at Chestertown, Maryland.

Hurricane Floyd entered the lower half of Maryland's Eastern Shore and followed a northeasterly track over the lower part of the Delmarva Peninsula (fig. 1). As the storm crossed over the southern end of the Delmarva Peninsula, the heaviest rainfall was on the northwestern side of the storm, where it collided with a stationary front that moved into the area from the northwest. Because of the interaction of the two air masses, the heaviest rainfalls were in New Castle County in Delaware, and Kent, Cecil, and Queen Annes Counties in Maryland.



Multi-spectral false color image of Hurricane Floyd, September 15, 1999, from the National Oceanic and Atmospheric Administration (NOAA).

Peak Streamflows

Peak-flow data for the storm of September 16-17, 1999, and peak-flow data from the highest previous floods are presented in table 1. Information from active stream-gaging stations and discontinued stations is included in the table, and is listed in downstream order by U.S. Geological Survey (USGS) station number. USGS personnel surveyed high-water marks to determine peak stages for the storm at discontinued stations.

Flood-frequency analysis is a statistical technique that is used to estimate the probability, or chance, that an annual peak-flow value will be equaled or exceeded in any given year. A related statistic, the recurrence interval, is the average period of time between peak flows that are equal to or greater than a specified peak flow. For example, a peak flow that has a 1-percent chance of being equaled or exceeded in any given year will have an estimated recurrence interval of 100 years.

Peak flows in White Clay Creek in New Castle County, Delaware; Unicorn Branch in Queen Annes County, Maryland; Morgan Creek in Kent

County, Maryland; and Little Elk Creek and Northeast Creek in Cecil County, Maryland, reached or exceeded calculated 500-year recurrence intervals. Christina River and Red Clay Creek in New Castle County, Delaware, exceeded 100-year recurrence intervals.

Flooding in Delaware

Record flooding in Delaware was confined mainly to the Christina River Basin in northern New Castle County, where most gaged streams reached record levels and discharges. Damage from the storm reached [illegible].7 million, with [illegible] million alone in New Castle County as a result of the flooding (National Climatic Data Center, 2001). Two children were swept away and drowned by rapidly rising waters in northern Delaware and two other people in the State were injured. Although heavy rain fell over the entire State, flooding in the south was less severe. Recurrence intervals ranged from greater than 500 years in the northern part of the State to about 2 years in the southernmost areas.

The Christina River Basin, the largest river basin in New Castle County, includes the drainage areas of White Clay Creek, Red Clay Creek, and Brandywine Creek. Discharges during the storm of September 16, 1999, reached peaks up to and exceeding the calculated 500-year recurrence intervals. Peak flows in the Christina River, White Clay Creek, and Red Clay Creek exceeded the highest levels previously recorded for the periods of record at these stations.

Before the peak on September 16, 1999, the highest discharge measured at the Christina River gaging station was 5,5[illegible]0 ft[illegible]s (cubic feet per second) on July 5, 19[illegible]9, at a recorded stage of 1[illegible]12 ft (feet). The peak of September 16 reached a recorded stage of 1[illegible]92 ft and a discharge of 7,050 ft[illegible]s, surpassing the 100-year flood discharge of 5,[illegible]70 ft[illegible]s.

Stages and discharges at the three gaging stations on White Clay Creek also exceeded the highest previously recorded levels. Discharge at the gaging station near Newark reached a peak of 19,600 ft[illegible]s, surpassing the previous record discharge by [illegible],000 ft[illegible]s. Discharge at the discontinued station above Newark was 16,[illegible]00 ft[illegible]s, and exceeded the previous record by 6,100 ft[illegible]s. Discharge at

Figure 1. Location of active and inactive streamflow-gaging stations in Delaware and the Eastern Shore of Maryland, rainfall distribution, and track and direction of Hurricane Floyd, 1999.

Table 1. *Peak stages and discharges for previous flood of record and flood of September 1999*

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; >, greater than; <, less than]

GAGING STATION (Location shown in figure 1)				PREVIOUS FLOOD OF RECORD			FLOOD OF SEPTEMBER 1999		
Number	Name	Drainage Area (mi^2)	Period of Record (water years[1])	Date	Stage (ft)	Peak Discharge (ft^3/s)	Stage (ft)	Peak Discharge (ft^3/s)	Recurrence Interval (years)[3]
01477800	Shellpot Creek at Wilmington, DE	7.46	1945-99	7/05/89	13.76	8,040	8.95	4,460	10
01478000	Christina River at Coochs Bridge, DE	20.5	1943-99	7/05/89	13.12	5,530	13.92	7,050	>100
01478500	White Clay Creek above Newark, DE	66.7	1952-59 1962-80	6/22/72	13.77	10,200	15.14	16,300	500
01478650	White Clay Creek at Newark, DE	69.0	1994-99	1/19/96	13.35	7,540	17.13	16,800	500
01479000	White Clay Creek near Newark, DE	89.1	1931-36 1943-57 1959-99	7/05/89	16.55	11,600	17.57	19,600	>500
01480000	Red Clay Creek at Wooddale, DE	47.0	1943-99	7/21/75	10.32	5,010	13.93	7,650	>100
01480015	Red Clay Creek near Stanton, DE	52.4	1988-99	1/19/96	19.38	5,330	23.54	8,260	>25
01481500	Brandywine Creek at Wilmington, DE	314	1946-99	6/23/72	15.49	29,000	15.43	28,700	>50
01483200	Blackbird Creek at Blackbird, DE	3.85	1956-99	6/22/72	5.04	712	6.47	789	150
01483700	St. Jones River at Dover, DE	31.9	1958-99	9/13/60	9.45	1,900	6.60	756	4
01484000	Murderkill River near Felton, DE	13.6	1931-33 1952-85 1996-99	8/04/67	8.83	2,090	6.00	380	4
01484100	Beaverdam Branch at Houston, DE	2.83	1959-99	9/12/60	5.55	176	3.84	54	2
01484500	Stockley Branch at Stockley, DE	5.24	1943-99	3/03/94	5.52	303	3.58	73	>2
01485000	Pocomoke River near Willards, MD	60.5	1949-99	8/20/89	15.41	2,820	7.53	265	<2
01485500	Nassawango Creek near Snow Hill, MD	44.9	1949-99	8/19/89	9.07	3,930	5.23	267	<2
01486000	Manokin Branch near Princess Anne, MD	4.80	1951-74 1974-99	8/20/69	5.44	547	4.61	257	<2
01487000	Nanticoke River near Bridgeville, DE	75.4	1943-99	2/26/79	10.31	3,020	9.19	1,760	>10
01488500	Marshyhope Creek near Adamsville, DE	43.9	1943-69 1971-99	7/13/75	13.19	3,700	12.92	3,340	25
01491000	Choptank River near Greensboro, MD	113	1948-99	8/04/67	14.47	6,970	13.92	6,420	40
01493000	Unicorn Branch near Millington, MD	19.7	1948-99	12/14/96	6.09	1,160	9.40	2,600	>500
01493112	Chesterville Branch near Crumpton, MD	6.12	1996-99	6/13/98	5.35	83.0	10.22	3,220	Unknown
01493500	Morgan Creek near Kennedyville, MD	12.7	1951-99	6/22/72	13.07	7,500	15.03	11,200	>500
01495000	Big Elk Creek at Elk Mills, MD	52.6	1884 1932-99	6/1884[2] 7/5/37	19 14.50	18,000 10,600	14.53	9,780	30
01495500	Little Elk Creek at Childs, MD	26.8	1949-58	8/12/55	8.37	5,400	11.19	8,700	500
01496000	Northeast Creek at Leslie, MD	24.3	1949-84	6/22/72	8.41	4,800	11.50	9,000	500
01496200	Principio Creek near Principio Furnace, MD	9.03	1967-92	8/04/69	9.26	7,060	8.64	3,430	10
01579000	Basin Run at Liberty Grove, MD	5.31	1949-58 1965-76	7/04/51	6.06	1,440	6.20	1,940	10
01578500	Octoraro Creek near Rising Sun, MD	193	1932-58 1969-77	8/09/42	17.57	35,000	17.10	24,650	15

[1] *A "water year" is the 12-month period from October 1 through September 30. It is designated by the calendar year in which it ends.*

[2] *Stage from information by local residents. Peak discharge is approximate.*

[3] *Recurrence-interval estimates are based on peak-discharge data prior to September 1999.*

Newark reached a peak of 16,700 ft□s, and was the peak of record; however, the station has been in operation only since 199□.

Stages and discharges in Red Clay Creek also reached record levels as a result of Hurricane Floyd. Peak discharge at Wooddale for the storm reached 7,650 ft□s, surpassing the 100-year flood discharge. A peak discharge of □,620 ft□s was recorded on Red Clay Creek near Stanton, surpassing the previous peak discharge of 5,□□0 ft□s. The estimated recurrence interval for the peak at Stanton only exceeded the 25-year flood discharge, because the station has been in operation only since 19□□, and statistical computations are less reliable than those from stations that have been operating for longer periods of time.

Brandywine Creek at Wilmington reached a peak discharge of 2□,700 ft□s, which is greater than the 50-year flood discharge. The peak discharge of September 1999 was only slightly lower than the record peak of 29,000 ft□s, which occurred on □une 22, 1972, as a result of Tropical Storm Agnes.

Flooding in Maryland

Record flooding associated with Hurricane Floyd was confined mainly to the central and northern parts of the Eastern Shore and northeastern Cecil County. Damage from the storm reached □1□75 million (National Climatic Data Center, 2001) as a result of the flooding. Five people throughout the State were in□ured as a result of the floodwaters. Flooding was less severe in the southern and extreme northwestern parts of the area.

Elk River Basin, in the northern part of the Eastern Shore of Maryland, includes the drainage areas of Big Elk Creek and □ittle Elk Creek. Flooding in this river basin reached record or near-record levels as a result of Hurricane Floyd.

Big Elk Creek reached a stage of 1□5□ft, □ust surpassing the previous recorded peak of 1□50 ft, and the peak discharge was 9,7□0 ft□s. The discharge in 1999 was less than the previous peak of record, however, as a result of changes in the stream channel. The recurrence

Brandywine Creek gage house (September 17, 1999)

Brandywine Creek at Wilmington, Delaware

Looking downstream from Rising Sun bridge (September 17, 1999)

Chesterville Branch near Crumpton, Maryland

Looking downstream from Route 291 bridge (September 16, 1999)

Upstream vortex on Chesterville Branch

interval of the flood discharge was estimated to be only 10 years, because a flood in 1[illegible] was reported to have reached a peak stage of about 19 ft, with an estimated discharge of about 1[illegible],000 ft³/s.

Little Elk Creek near the town of Childs reached a record stage of 11.19 ft, with an associated discharge of [illegible],700 ft³/s. Flooding in this basin reached the estimated 500-year flood discharge. The previous record flood occurred on August 12, 1955, when the creek reached a stage of [illegible]7 ft, with an associated discharge of 5,[illegible]00 ft³/s. Other storm peaks have been observed since the station was discontinued in 195[illegible], but none of those reached the level of the peak in 1955.

Northeast Creek, in the north-central part of Cecil County, also experienced record flows. The peak discharge associated with Hurricane Floyd was 9,000 ft³/s (stage 11.50 ft), surpassing the previous record of [illegible],[illegible]00 ft³/s (stage [illegible].[illegible] ft) that occurred on June 22, 1972, as a result of Tropical Storm Agnes.

Except for Little Elk Creek and Northeast Creek, the flooding in the northwestern part of the upper Eastern Shore was less severe than in the eastern areas, probably because the storm moved along a northeasterly track away from the region. Recurrence intervals ranged from 10 to [illegible]0 years.

The Chester River Basin, in the central part of the Eastern Shore of Maryland, includes the drainage areas of Morgan Creek, Unicorn Branch, and Chesterville Branch. Flooding from Hurricane Floyd exceeded the estimated 500-year recurrence interval on Morgan Creek and Unicorn Branch. The recurrence interval on Chesterville Branch was not computed because the gaging station has not been in operation long enough to provide the data needed to produce meaningful statistics.

The flood level on Morgan Creek, located east of Kennedyville, exceeded the stage experienced in 1972, when Tropical Storm Agnes hit the region. The peak stage of September 1999, 15.0[illegible] ft, exceeded the previous record of 1972 by almost 2 ft; the calculated peak discharge was 11,200 ft³/s.

The stage of Unicorn Branch, located near Millington, reached a new record level of 9.[illegible]0 ft, with an associated peak discharge of 2,600 ft³/s. The previous record peak was on December 1[illegible], 1996, when the stream reached a stage of 6.09 ft, with an associated peak discharge of 1,160 ft³/s.

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_____ **2000**, Storm data[illegible] Asheville, North Carolina, U.S. Department of Commerce, National Climatic Data Center, v. [illegible]1, no. 9.

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Urban Soil Primer

For homeowners and renters, local planning boards, property managers, students, and educators

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Cover: Urban scenes and soil profiles from across the United States.

Preface

The *Urban Soil Primer* is intended to give planning officials and people who live in urban areas an introduction to soils. It provides information important in planning and managing land resources in a manner that helps to prevent or mitigate problems associated with sedimentation, contamination, runoff, and structural failure. In nontechnical language, this publication describes the basic processes and functions common to all soils. Much of the complexity of soil science is simplified, and many sensitive issues are discussed only in passing.

This primer lists many affordable resources available to people seeking information about soils in urban areas. These resources include government agencies, such as the Environmental Protection Agency (www.epa.gov), which provides information about contamination, and the Natural Resources Conservation Service (www.nrcs.usda.gov), which provides assistance with conservation planning and implementation through local field offices. The Natural Resources Conservation Service (NRCS) provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment. Other resources include universities, private consultants, and nonprofit groups experienced with soils in urban areas.

This primer provides the basic vocabulary and key concepts needed for further explorations in urban soil survey and for the development of interpretive guidelines for specific local uses by soil type. Many of the terms used in this publication are defined in the Glossary. The primer was produced by staff at the NRCS National Soil Survey Center with assistance from a cadre of NRCS field soil scientists. It is available as a printed booklet and as a compact disc (CD), or it may be downloaded from the NRCS Web site (http://soils.usda.gov/use).

Contact your State or local office of the Natural Resources Conservation Service for more information. Visit http://offices.usda.gov/scripts/ndCGI.exe/oip_public/USA_map to find the NRCS field office near you.

Welcome to the fascinating field of urban soils.

Photo Credits

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Figure—	*Used by permission of—*
2.1 and 4.5	Dr. Ann Kennedy, USDA, Agricultural Research Service
3.1, 4.1, 5.1a, 5.1b, and 6.1	Laszlo Falvay, artist, Green Pac Program
4.8	Dr. Samantha Langley-Turnbaugh
6.6	USDI, United States Geologic Survey

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Chapter 1: Introduction

Soil is an amazing, mostly natural material that covers nearly all of the land surface of the earth. Soil, along with water and air, provides the basis for human existence. It is the interface between the earth's atmosphere and bedrock or ground water. It has either formed in place or has been transported to its present location by wind, water, ice, gravity, or humans. Soils may have been deposited thousands or millions of years ago by volcanoes, glaciers, floods, or other processes or were delivered to the site by truck or other mechanical device an hour ago, a week ago, or several months ago. These facts illustrate why soils are very complex. Soil functions, as part of a natural ecosystem, are also very complex and diverse. Basic knowledge about soil allows us to use it wisely.

The primary goal of this publication is to help people who live in cities understand soil and to help them know where and how to get information about soil. Knowing about soil and its potentials and limitations helps urban planners and those living in urban areas to make good decisions about using their soil as a basic and valuable resource. Soil is the basic raw material and common link to all projects whether one wants to build a park, a street, a golf course, or a large building, landscape a yard, or just plant a backyard garden. Soil lies beneath each activity!

Figure 1.1: Urban garden.

Figure 1.2: Playground.

Figure 1.3: City skyline.

Urban project managers and homeowners can predict a soil's behavior under similar situations when they know how soil responds to the same use in other locations. Similar kinds of soil tend to behave in the same ways. There are more than 22,000 different soils identified and mapped in the United States. Some States recognize more than 1,000 different kinds of soil. Knowing soil responses to specific uses allows engineers and others to design projects that will not require high maintenance costs, will last a long time, will not harm individuals, society, or ecosystems, and will not fail and/or require expensive repair and/or removal costs.

Figure 1.4: Urban development.

Growth Trends in Urban Areas

Figure 1.5 demonstrates that urban areas are expanding at a rapid rate within the United States. Urbanization is also a worldwide issue. Soils that are best suited to other uses, such as providing food and fiber for our Nation, are commonly the easiest to use as sites for homes and cities. Urban areas often expand into surrounding forestland, rangeland, or agricultural land areas because these areas are adjacent to existing urban areas. Prime farmland is vanishing at a alarming rate in certain regions of the United States because of urban expansion and development (figure 1.6). We must balance the increasing size of urban areas with our need for food and fiber.

Urban areas occur all across the USA, from coastal areas to areas high in the mountains, and soils occur in such areas as parks, playgrounds, lawns, and gardens. These soils are similar in some ways to soils in rural areas, but in other ways they are very different. A basic understanding of urban soils will help you learn more about this valuable resource. As urban areas grow and change, so must the management of natural resources surrounding and within those areas.

We invite you to continue to explore the complex, fascinating, and fun science of urban soils.

Figure 1.5: Land converted to urban development from 1982 through 1997 (NRCS, NRI).

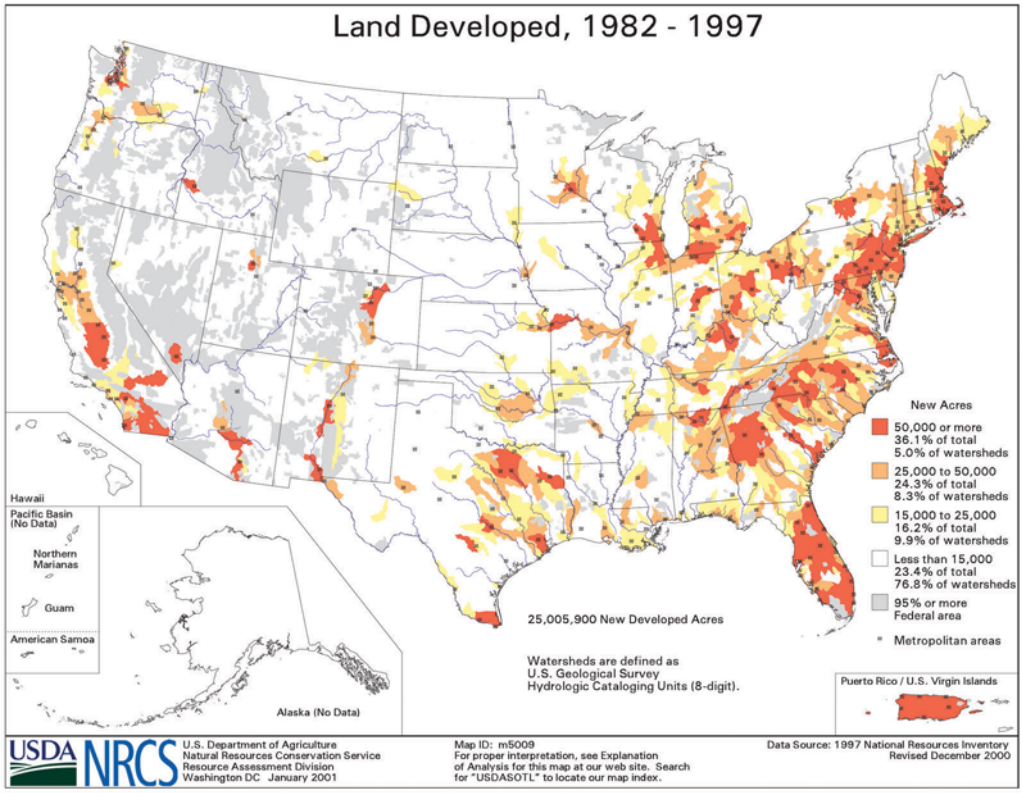

Figure 1.6: Annual rate of urban development from 1982 through 1997 (NRCS, NRI).

Chapter 2: Basic Soil Properties

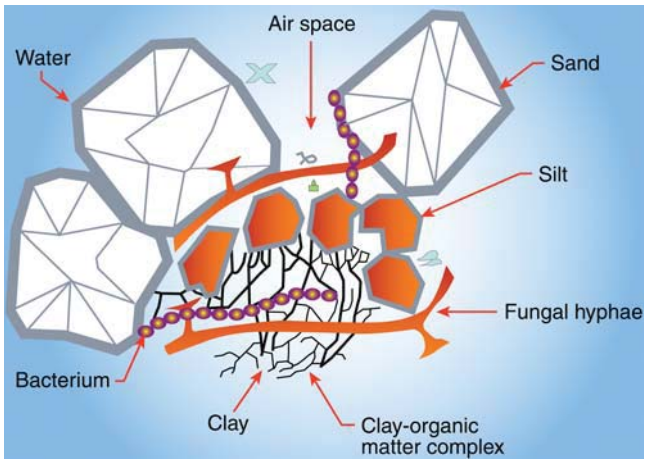

Figure 2.1

Soils in an urban area may share some properties with soils in forests, pastures, cotton fields, or even other urban areas. There are large differences in soils as they naturally occur in forests, farmed fields, and grazing land areas, and these differences are changed when an area is converted to an urban area. Soil scientists have developed conventions and language to communicate among themselves. It is important that we share scientific information with everyone, not just other scientists and professionals. Soil properties, such as soil texture and structure, particle-size distribution, soil reaction, and bulk density, help us to understand and predict how soils react and respond to different uses. Construction activities, compaction, and surface sealing dramatically change soil properties and can sometimes result in a reduced ability to perform the critical functions or activities of natural soil.

Topics in this chapter:

- **Soil variation**
- **Soil components**
- **Soil-forming processes**
- **Soil horizons**
- **Measuring and monitoring soil properties**

Soil Variation

What is soil and why is soil important to each of us? Traditionally, soil is defined as a dynamic natural body that is made up solids, liquids, and gases, occurs on the earth's surface, contains living matter, and supports or is capable of supporting plants. Bockheim (1974) defines urban soil as "soil material having a non-agricultural, man-made surface layer more than 50 cm (20 inches) thick that has been produced by

mixing, filling, or by contamination of land surface in urban and suburban areas." In some important ways, soils of urban areas differ from soils of other areas.

Differences in urban soils have been observed and recorded by scientists, engineers, equipment operators, and construction workers for a long time. Even within urban areas, there is a multiplicity of soil conditions, ranging from "natural" soils that are relatively undisturbed to soils in which the natural materials have been mixed or truncated, to soils that formed in added materials, or fill, of varying thickness. Each of these areas, in turn, can be subject to different types of use and management, which can further affect their soil properties. Soils in urban areas can be divided into two general types: *natural* soils, which formed in material naturally deposited by water, wind, or ice or in material weathered from the underlying bedrock, and *anthropogenic* soils, which formed in human-deposited material, or fill (table 2.1). Anthropogenic soils are almost anywhere in the urban environment. The purpose of adding fill to an area may be to alleviate undesirable soil properties or to modify the urban landscape for specific activities.

Table 2.1: Examples of Fill Material in Urban Soils

- Natural soil materials that have been moved around by humans
- Construction debris
- Materials dredged from waterways
- Coal ash
- Municipal solid waste
- A combination of any or all of the above

Characteristics of soil in any urban area depend on many things. They depend on how deep the site has been excavated during construction and if new materials were brought in and mixed with the original soil materials. They depend on the properties of the original natural soil and the past uses of the site. Many times topsoil is removed from the site prior to construction and may or may not be returned to the site. After excavation, subsoil may be placed as fill over topsoil. Changing the order of the soil layers or mixing the topsoil and subsoil can alter soil properties. These variables make predicting soil behavior difficult in urban areas.

Soil Components

All soil is made up of air, water, numerous kinds of living and/or dead organisms (organic matter), and mineral matter (sand, silt, and clay). In the urban arena, it includes many manmade materials. The amount of each of these soil components varies from one place to another in the world or from one kind of soil to another. Soil components can vary dramatically within distances of only a few feet on the same landscape.

Soil composition can be dramatically changed by pedestrian or vehicular traffic, especially when the soil is wet. The soil components most easily changed are the amounts of soil air and water. Imagine the change in soil composition at construction sites after large trucks and heavy construction equipment drive over a soil and compact it. Imagine people walking and playing on wet soils in city parks and recreation areas or yards. Note the differences in percent of soil air and soil water in figures 2.2 and 2.3. Figure 2.2 illustrates the general composition of a natural soil. Figure 2.3 illustrates the general composition of a soil that has been compacted by heavy traffic. As soil particles are squeezed together, pores for air and water are reduced in size and number (figure 2.4). The reduced pore space changes the way a soil handles water intake and water movement throughout its layers, or horizons.

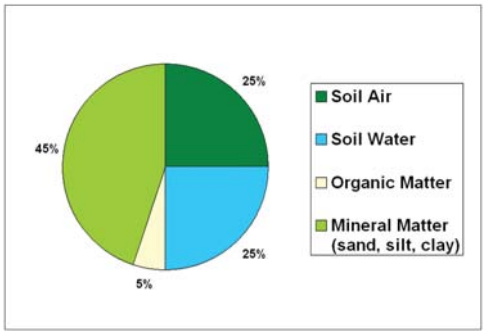

Figure 2.2: Composition of a natural soil, by weight.

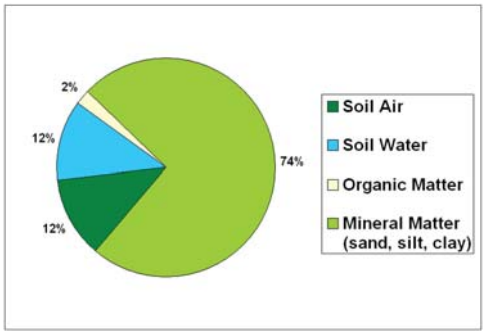

Figure 2.3: Composition of a compacted soil, by weight.

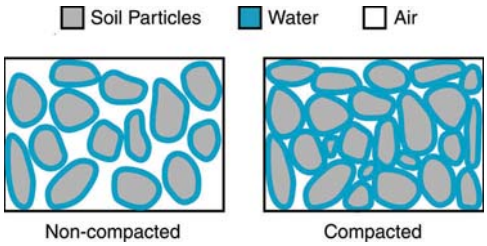

Figure 2.4: Soil pore space.

Soil-Forming Processes

Soils form through a group of processes no matter where they are located or what they are used for. All soils form because of four processes operating along with five basic soil-forming factors. The four processes that operate on soil material are additions, transformations, translocations, and losses (figure 2.5). We are able to map, classify, and interpret soil because a given set of environmental factors produces a predictable kind of soil.

The soil-forming factors are parent material, climate, living and dead organisms, time, and landscape position. When all soil-forming factors are similar, a similar soil is produced. If we change one or more of the soil-forming factors significantly, then a different soil is produced.

Additions to soil generally include organic matter, fertilizer, pollutants, and deposits of soil material. All of the additions change a soil and how it functions. In urban areas new soil material is sometimes added on top of an existing soil. If thick enough, the new layer or layers can change the way the soil develops. When a layer of concrete or asphalt is added to the top of a soil in areas where streets, parking lots, or driveways are built, additions to the soil are suddenly altered, restricted, or even stopped.

Transformations are changes that take place within a soil. In figure 2.5, transformations are illustrated by the letters x and y and the arrows that connect them. During transformation processes, material does not leave the soil but is simply changed from one form to another or from one compound to another. Micro-organisms and earthworms play an important role in soil transformations. Earthworms eat soil and plant materials and transform them into organic material that provides

food for plants and other organisms. Chemical weathering changes parent material, such as rocks and sand grains, and creates new minerals and/or smaller particles. Rocks are transformed into sand grains, and sand grains are transformed into silt and clay particles over time. As iron particles change form, they change soil colors from gray to brown or to red and yellow. Applying too much fertilizer of certain kinds can transform a soil into one that is too acidic for plants to grow.

Translocations are movements of soil components from one place to another in the soil. Translocations can move materials from one soil layer to another and can even move the materials completely out of a soil. Water moves through a soil profile and carries clay particles, soluble salts, organic matter, and chemical compounds downward into the soil. Translocations can also be upward or horizontal. As soil dries and water evaporates from the soil surface, minerals and salts may move back toward the soil surface. In dry areas translocations are restricted because there is less water to carry compounds and materials deep into the soil. Compounds and minerals can move only as deep as water moves into a soil. Concentrations of soluble material generally are closer to the surface in dry areas than in other areas. Windthrow and the activity of animals (i.e., ants, termites, groundhogs, and worms) also can move soil components upward.

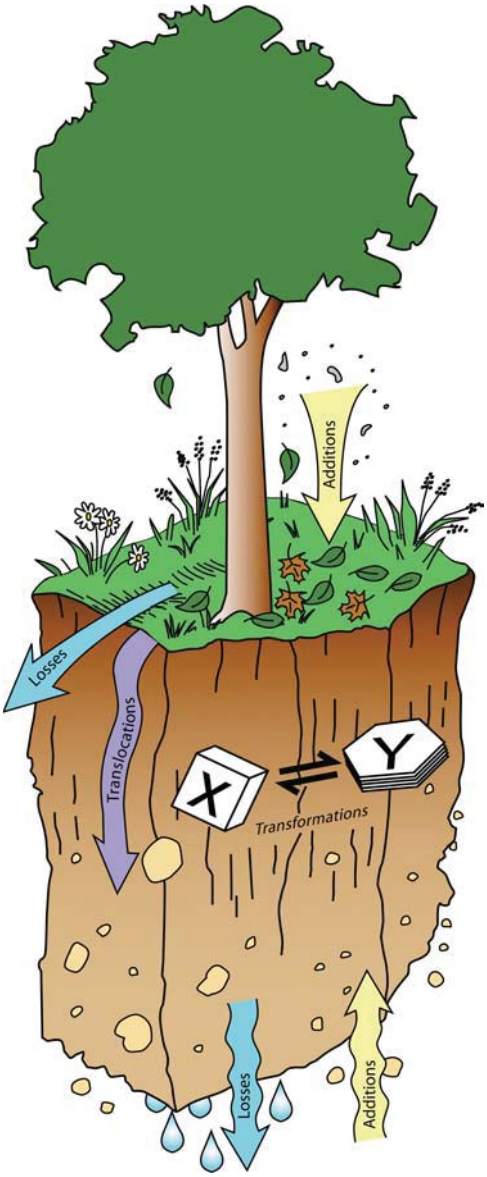

Figure 2.5: Soil-forming processes.

Losses occur when water moves material through and out of a soil profile. If enough water is available, soluble materials, such as sodium and calcium, are removed early in the process of soil formation. Lawn and garden fertilizers are relatively soluble and may be removed from a soil when too much water is applied. Ground-water pollution can occur if too much water is added to a soil that contains contaminates. Erosion by wind or water removes the soil particles and compounds needed for plant growth. Topsoil removed through water erosion in a given area can improve the soil in the area where the sediments are deposited.

Soil Horizons

Soils are made up of soil horizons, or layers, that form as the result of five soil-forming factors. The six major kinds of soil horizons are designated as O, A, E, B, C, and R (figure 2.6). All six of these horizons are not always evident in every soil profile.

For example, most agricultural soils do not have an O horizon because organic horizons are usually mixed with A horizons during tillage. Also, a soil has an R horizon only if bedrock is close to the surface.

O horizons are generally the uppermost layers and form on top of mineral horizons where they occur. They are formed by the accumulation of fresh and decaying plant parts, such as leaves, grass, needles, and twigs. O horizons are dark colored (mainly black or brown) because decomposing plant and animal materials produce humus. They are generally in forested or wet areas.

A horizons are below O horizons and are made up mostly of mineral material. They are characterized by the loss of iron, clay, and aluminum and the addition of organic matter by soil organisms. Hence, they are dark colored in most areas, except for extremely dry areas. A horizons are commonly referred to as topsoil.

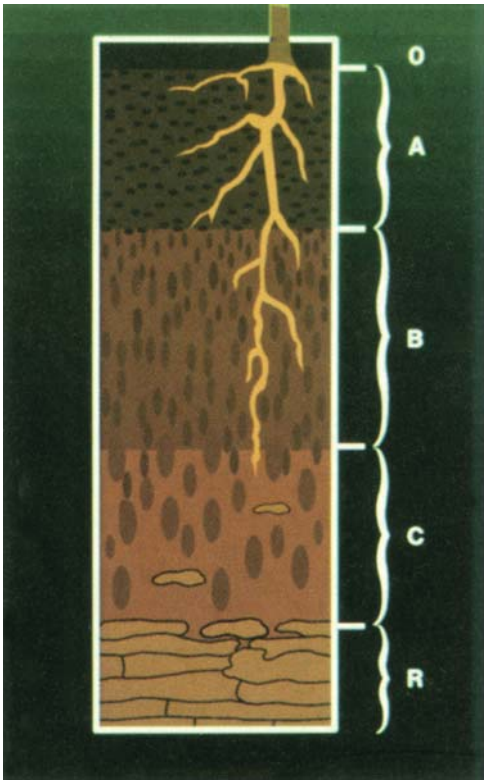

Figure 2.6:Natural soil profile with major horizons.

E horizon*s* are commonly in forested areas. The "E" stands for eluvial, which means that clay, iron, organic matter, and other minerals have been removed from this horizon. E horizons commonly appear white or lighter in color than the horizons above and below them.

B horizons are below A or E horizons and are characterized by the accumulation of iron, clay, aluminum, and other compounds. B horizons are commonly referred to as subsoil.

C horizons are below B horizons and are commonly referred to as the substratum. They are made up mainly of partially weathered or disintegrated parent material, but soft bedrock can also occur. Because C horizons are deeper in the profile, the effects of the soil-forming factors are less pronounced than the effects in the overlying A and B horizons.

R horizons are made up of bedrock. The bedrock can be far below or just a few inches below the surface.

Horizons in urban soils may not be fully related to the natural soil-forming factors but instead may be manmade layers formed by the deposition of dredge, fill, and/or mixed materials. Human artifacts, such as bricks, bottles, pieces of concrete, plastics, glass, pesticides, petroleum products, pollutants, garbage, and disposable diapers, are often components of urban soils. Manmade materials may be added to raise a landscape to a higher level, backfill ditches or foundation walls, or construct berms. In urban areas, human activity is often the predominant activity in making soil instead of the action of the natural agents of wind, water, ice, gravity, and heat.

Urban soils differ from natural soils because they have been altered to some degree. They have been excavated, compacted, disturbed, and mixed and may no longer possess their natural soil properties and features. Many highly disturbed soils in urban areas or on construction sites have not been in place long enough for soil-forming factors to significantly change them and to form soil horizons. In areas where

Figure 2.7: Urban soil profile.

fill materials have been in place for a considerable time (e.g., 50 years or so), the formation of A horizons and sometimes weakly expressed B horizons has been documented. Figures 2.7 and 2.8 show soil horizons in urban and natural soil profiles.

Measuring and Monitoring Soil Properties

Soil properties are measured at specific sites or sampled for laboratory analysis. The properties that can be described in the field include horizonation and layering, color, texture, structure, consistence, depth to bedrock, and drainage class. The properties that generally are measured in the laboratory include content of organic matter, particle-size distribution, clay mineralogy, reaction, exchangeable cations, and concentrations of contaminants. The soil characteristics that are estimated or calculated from the measured properties include engineering classification and erodibility.

Physical Soil Properties

Soil is a mixture of mineral matter, organic material, air, and water. The texture of a mineral soil is based on the amounts of sand, silt, and clay in the soil. Sand, silt, and clay are defined on the basis of the size of each individual soil particle. These size

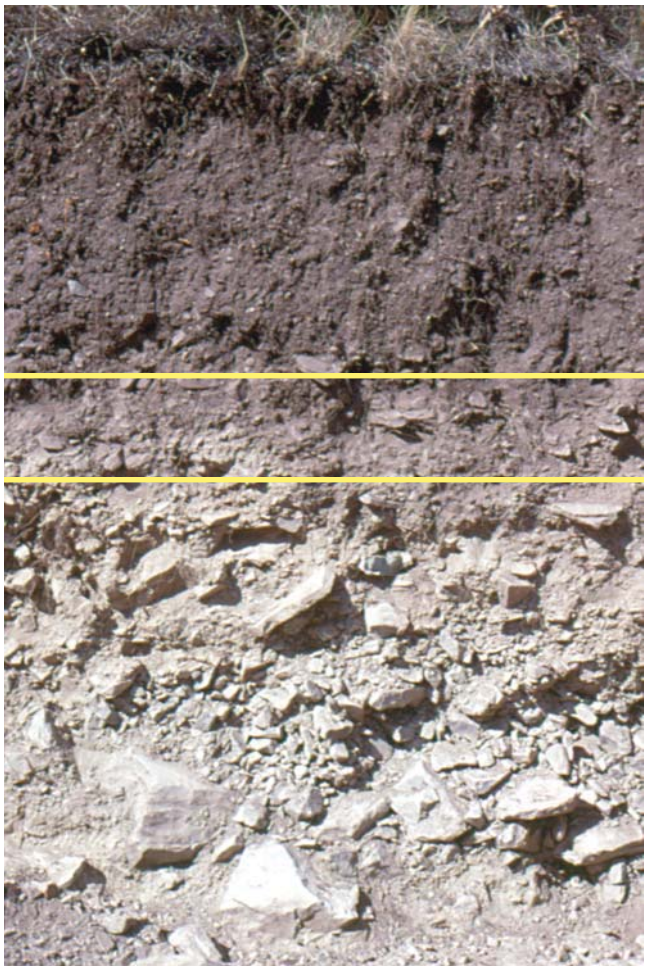

Figure 2.8: Natural soil profile.

relationships can be demonstrated by imagining that a sand particle is the size of a basketball, a silt particle is the size of a baseball, and a clay is the size of an aspirin tablet (figure 2.9).

Soil texture and other soil properties vary significantly within short distances on urban or natural landscapes. This variation is caused by the movement and mixing of soil materials during construction activities or changes in any of the soil-forming

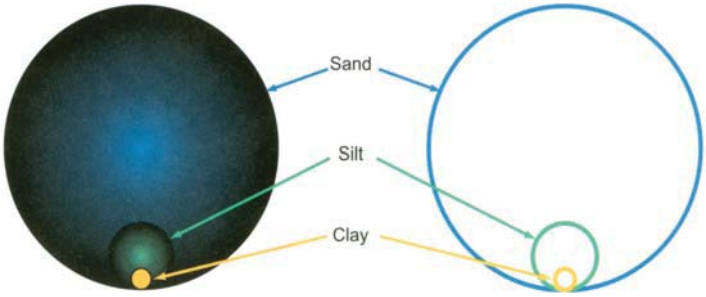

Figure 2.9: Relative sizes of sand, silt, and clay particles.

factors. The combinations of different textures may improve or limit the soil for a specific use.

Soil texture affects water and air movement through the soil as particles of different sizes pack together and thus determine the size and spacing of pores and channels. Sand particles have the largest pore spaces and allow water to drain through the pores most freely. Silt particles have smaller pore spaces, so water moves through them more slowly. Clay particles have very small pores, and so they tend to adsorb and hold more water. The mixture of particle sizes affects water, nutrient, and contaminant absorption. The specific type of mineral influences engineering properties, such as shrink-swell potential and excavation difficulty, especially in expanding clays (smectite), which behave like plastics.

The soil textural triangle (figure 2.10) can be used to determine soil texture from the relative amounts of particles of any two sizes. For example, a clay percentage of 15 with a silt percentage of 70 gives a soil texture of silt loam.

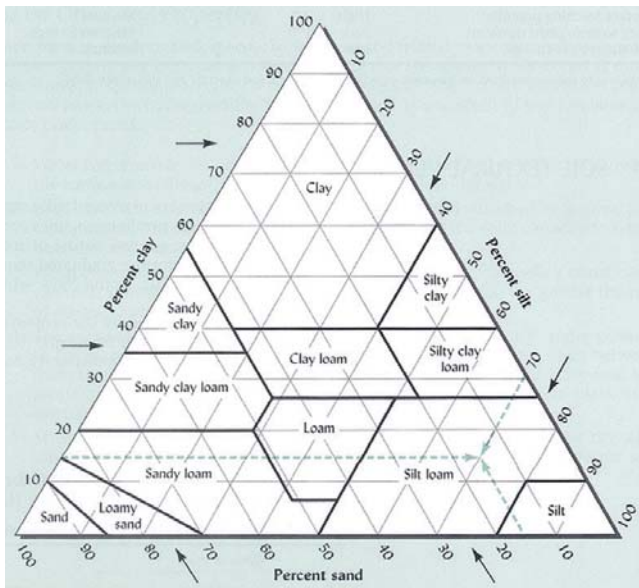

Figure 2.10: Soil textural triangle.

Measures of Water Movement

Water movement in urban soils is described in three ways (figure 2.11):

- infiltration into the soil surface, especially from rainfall
- percolation within the soil drain lines from septic systems, which is especially important in the soil below the drain line and above a restrictive layer
- permeability within the soil from the surface to a restrictive layer

Key terms in understanding water movement in soils are “restrictive layer” and “water table.” Restrictive layers have high density (high weight in a given volume of soil) and low porosity (limited space between particles), so that water cannot flow into or through them. Restrictive layers at the surface can cause surface sealing and limit

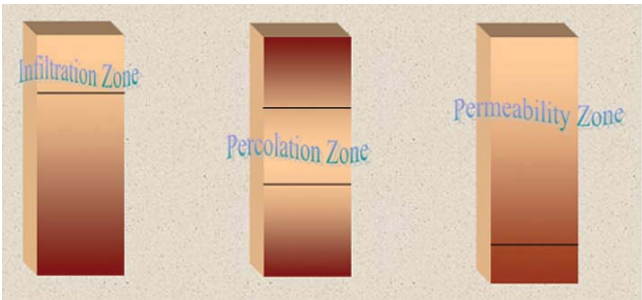

Figure 2.11: Comparison of descriptive terms for water movement in soils.

infiltration of water into the soil. Restrictive layers within the percolation zone reduce the drainage rate of fluids in septic drain lines and can cause septic systems to back up and fail. Compaction of soil materials can occur if heavy weight is on the surface when the soil is wet, resulting in dense restrictive layers below the surface.

A "perched" water table occurs when a restrictive layer anywhere in the soil limits waterflow deeper into the soil. Water drains down from the soil surface and builds up, or "perches," above the restrictive layer and above the expected water table depth. An "apparent" water table is fed from below by ground water, streamflow, or subsurface lateral flow as water moves across a restrictive layer below the soil surface.

Soil Color

Soil color differences in a profile reflect soil-forming processes and can be an indicator of soil wetness. These differences help to distinguish fill from natural soil. Important coloring agents in soil include parent (geologic) material, soil wetness, extent of leaching, content of organic matter, and the chemical form and content of iron.

Organic matter darkens the soil to a degree, depending on the content and the extent of decomposition. *Iron* gives soil a brown, yellow, or red color. Shades of blue or green may also appear, depending on iron amount, oxidation state, and hydration state. When soil is saturated, iron can become soluble and can be removed, leaving the soil with "mottled" brown and gray colors or completely gray colors, depending on the extent of the wetness.

Soil Structure

Soil structure is the combination or arrangement of primary soil particles into secondary units or aggregates. Organic materials and clay are important binding agents. Wetting and drying cycles are important in creating structure. Soil structure influences pore space and water movement in soils.

The principal forms of soil structure are—*granular* (roughly spherical)*; platy* (laminated); *angular or subangular blocky* (roughly cube shaped, with more-or-less flat surfaces); *prismatic* (vertical axis of aggregates longer than horizontal); and *columnar* (prisms with rounded tops). See figures 2.12 to 2.15.

Structureless soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Figure 2.12: Granular structure.

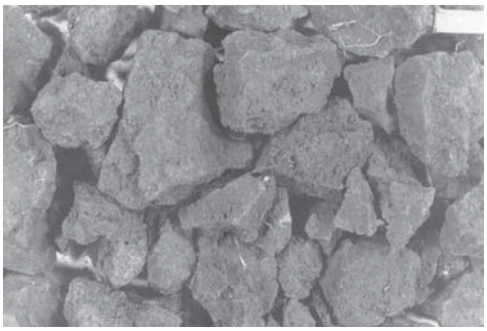

Figure 2.13: Blocky structure.

Figure 2.14: Prismatic structure.

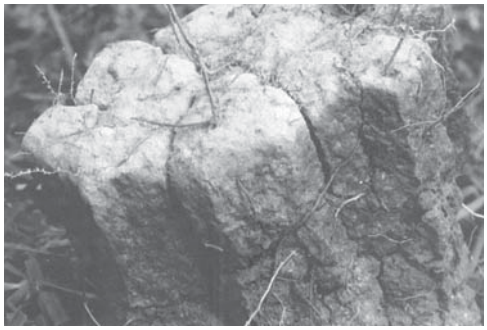

Figure 2.15: Columnar structure.

Chapter 3: Soils Regulate, Partition, and Filter Air and Water

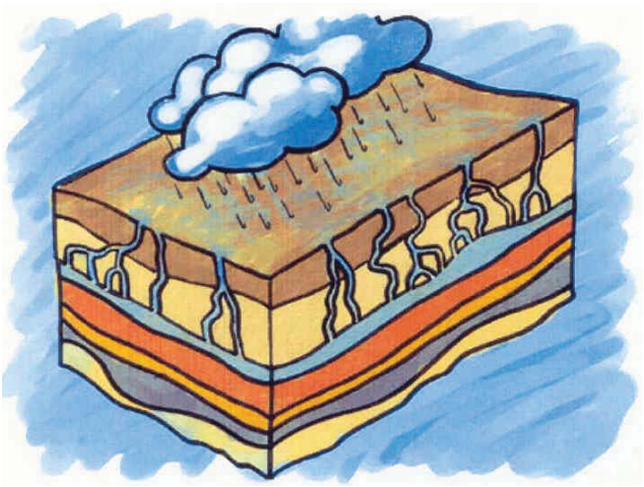

Figure 3.1

Soils play a very important role in storing, regulating, and filtering both air and water resources. As rainwater falls onto the soil surface, it may percolate into the soil or run off the surface, depending on soil properties. Soil particles may hold chemicals and nutrients, making them available for plant roots and keeping them from moving into lakes and streams or entering the ground water. Soil pores that hold and transmit air and water play an important role in the health of the soil environment. All living organisms need both air and water. If all soil pores are filled with water or compacted, then less air is available to plant roots. After site preparation or manipulation, the properties of urban soils differ from those of natural soils and the soil air and water react much differently.

Topics in this chapter:

- **Soil functions**
- **Urban landscapes**
- **Soil and water interactions**
- **Soil temperature**
- **Stream corridors**
- **Storm water management**
- **Urban wind erosion**

Soil Functions

The kinds of activities that soils perform are called soil functions. Soil functions help us sort the extremely complex soil system into smaller parts that can be studied and understood. We depend on soil for more than just producing food. Other soil functions include a) providing building materials and support for structures; b) preserving natural

and cultural history; c) regulating, partitioning, and filtering air and water; d) sustaining biological diversity and productivity; e) trapping pollutants; and f) providing sites for recreation. Soils perform specific critical functions no matter where they are located, and they perform more than one function at a time (table 3.1).

Table 3.1: Five Concurrent Soil Functions

- Soils act like *sponges,* soaking up rainwater and limiting runoff. Soils also impact ground-water recharge and flood-control potentials in urban areas.
- Soils act like *faucets,* storing and releasing water and air for plants and animals to use.
- Soils act like *supermarkets,* providing valuable nutrients and air and water to plants and animals. Soils also store carbon and prevent its loss into the atmosphere.
- Soils act like *strainers or filters,* filtering and purifying water and air that flow through them.
- Soils buffer, degrade, immobilize, detoxify, and *trap* pollutants, such as oil, pesticides, herbicides, and heavy metals, and keep them from entering ground-water supplies. Soils also store nutrients for future use by plants and animals above ground and by microbes within the soils.

Soil functions occur in spite of the land use. Rainwater must be dispersed or regulated in urban areas, and landscaping plant roots must have air available for growth. When areas are paved over, plans must be in place to handle rainwater. Buildings constructed on fill material must still be supported by the materials on the site. Soils perform the same or similar functions in all areas, including urban ones.

An important task is convincing people living in the urban environment to consider soil information and data before urban projects begin. This information must be part of the planning process for all urban projects. As soil properties change because of construction or other disturbances, major changes occur in the capacity of a soil to function, as predicted by engineering properties. The ability of a soil to support buildings and other structures changes when the soil is disturbed and/or mixed with other materials. Soil materials placed on top of garbage cannot support large buildings and certain other structures. Thus, it is important to know ahead of time what functional changes are expected to result from soil disturbance. Soil maps and soil profile descriptions can help us to understand how the soil at the building site will respond to project management.

Urban Landscapes

Landscapes in urban areas are controlled by underlying geologic landforms; by human activities, such as excavation or other disturbances and removal of water, oil, or minerals; and by microrelief in small areas. Soil movement can result from hazards, such as the formation of sinkholes, soil settling, decomposition of buried trees or landfills, and landslides. Some of these hazards are natural in the environment, and others are caused by human activities, such as excavation and filling for building. These impacts are secondary to the intended soil use. Old geologic formations, such as lava flows and lava tubes, collapse and unexpectedly create large holes. Knowing the underlying geologic formations before building can eliminate the need for costly repairs.

Urban planning for landscape changes requires consideration of fill consistency, soil porosity, internal water movement, surface drainage, and the increased water retention as organic matter is added to the soil. Knowledge of landforms helps us to understand water movement and storage whether the landforms were created by geologic forces or human construction. Some human-constructed soil layers dramatically impact water movement in soils. Geologic landforms lie beneath areas of urban development and may not be visible on the landscape (figure 3.2).

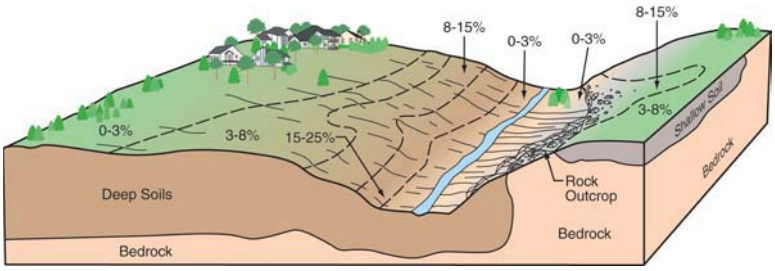

Figure 3.2: Soil slope and underlying geology.

Table 3.2: Summary of Inputs Useful in Identifying Urban Soil-Landscape Units

• Infrastructure	Storm drains, building heights, housing density, and road types
• Soil catenas	Interrelated drainage, soil texture, soil depth, and geologic deposits
• Block diagrams	Geologic material, relief, and spatial patterns of cuts and fills
• Site data	Measured erosion, infiltration, streamflow, and waste filtration
• Soil science	Chemical, physical, and biological interactions and discontinuities
• Vegetation	Seasonal variation, opportunistic species, and adapted physiology

Soil and Water Interactions

Maps with contour lines, called topographic maps, show the direction of waterflow from landforms (figure 3.3). The contour lines are drawn around landforms. Each line represents the same elevation. Contour lines generally show 10- or 20-foot intervals. They run side by side across a slope, and water moves perpendicularly (at a right angle) to the lines to get downhill. The contour lines are closest together where the slope, or downhill gradient, is steepest.

When contour lines form a V shape and elevation increases as you follow the point of the V, the V points upstream. The lines for flat areas or gentle slopes are spaced farther apart than the lines for steeper areas. A closed circle indicates a hilltop or knoll. A closed circle with hatch lines inside indicates a closed depression or sinkhole at the lowest point on a landscape. Map unit symbols on soil survey maps commonly

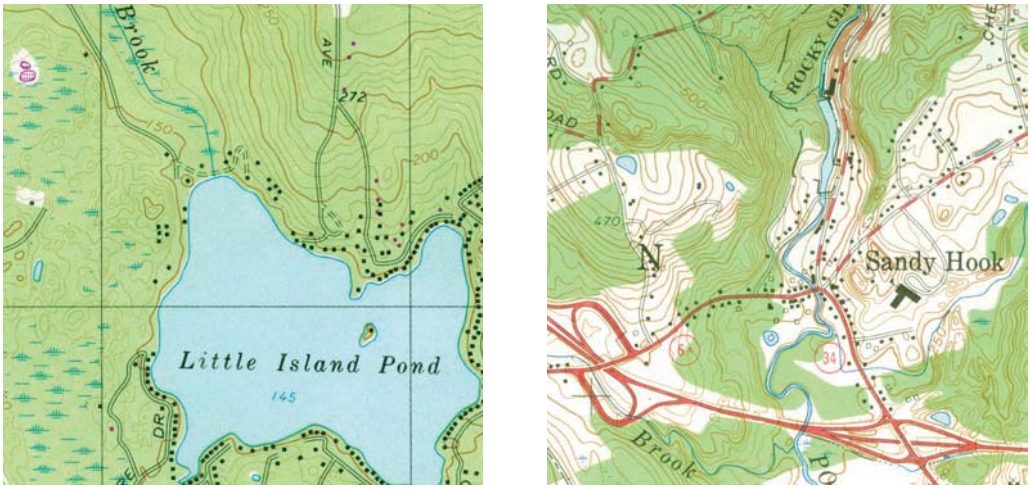

Figure 3.3: Topographic map detail.

indicate the relative steepness of slope. They tie the map unit delineation in soil survey reports to the name of the soil, the texture of its surface layer, and its slope. An example is Ridgebury loam, 3 to 8 percent slopes.

Water tables are underground supplies of water that generally occur closer to the surface during wet periods and are deeper during dry periods. Land use impacts water tables and runoff. An area of wetland may occur where the land surface slopes to an elevation below the water table. Where the underground water does not rise to the surface, it is called an aquifer. Water tables can be identified by observing and recording soil color and soil wetness in urban project excavations or in test holes.

The movement of water into a soil depends heavily on soil texture, soil structure, slope, bulk density, compaction, surface loading, and vegetation. Figures 3.4 and 3.5 demonstrate that more water moves into the soil on natural landscapes than on

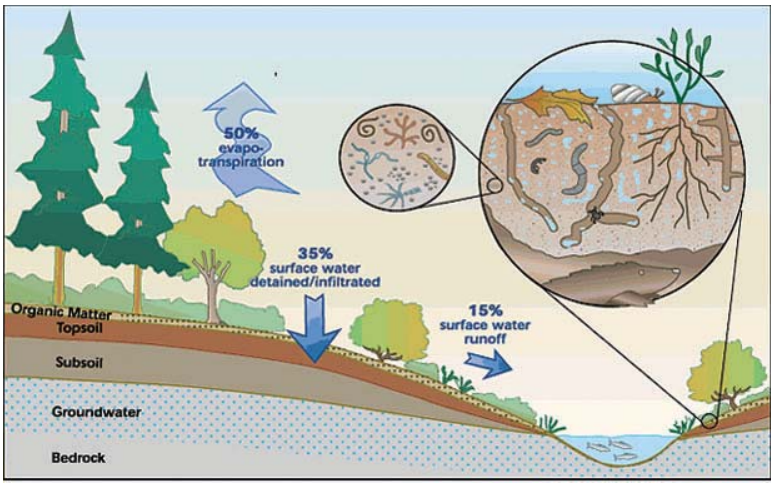

Figure 3.4: Water movement on a natural landscape with a plant cover. This landscape is in a humid area. In the drier regions, the stream level is higher than the surrounding land.

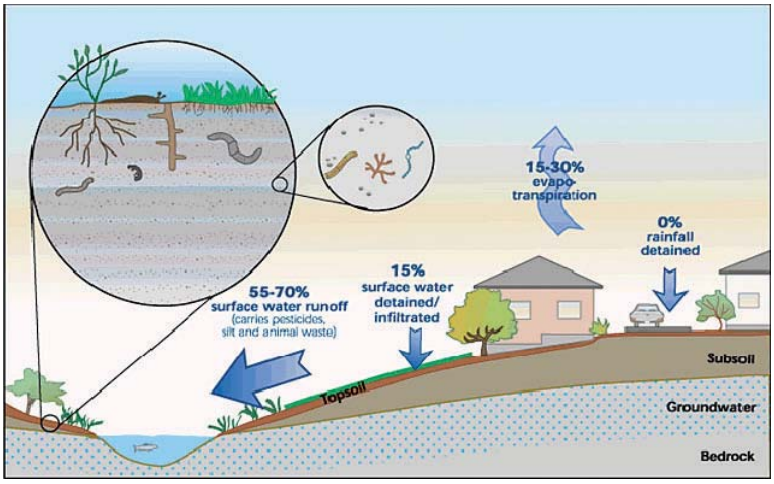

Figure 3.5: Water movement on a disturbed urban landscape with limited vegetation and impervious surfaces. This landscape is in a humid area. In the drier regions, the stream level is higher than the surrounding land.

disturbed landscapes, such as those in urban areas. More water evaporates into the air on natural landscapes than in areas covered by streets, roads, homes, garages, and other buildings. More water runs off urban areas because of the impervious nature of pavement, compacted soil layers, and urban buildings. Water containing sediment clogs lakes and reservoirs. Removing this sediment is costly (figure 3.6).

Figure 3.6: Removing sediment from a flood-control lake. A dam is in the background.

Oil, gas, lawn fertilizer, pesticides, and other pollutants often run off from urban areas and into lakes, streams, or reservoirs and reduce water quality. Some of the fertilizer, pesticides, and herbicides can run through the soil and into ground water, also impacting urban water quality.

Geologic formations, the kinds of rocks that occur below soils, affect water movement in soils and their landscapes. An example of an unstable geologic formation is a shale bed, which is prone to slippage and landslides (figures 3.7 and 3.8). The weight of excess water in the soil can reduce slope and soil stability, especially in urban areas where expensive urban projects are built.

Figure 3.7: A home damaged by slippage of shale beds.

Soil Temperature

Soil temperature may be higher in urban areas than in the surrounding forests and fields. Heat islands form where extensive pavement and large buildings absorb and return heat and restrict airflow within a city. The water supply may be limited in the heat islands as roof runoff and rainwater are piped to storm drains in the streets. Heat stress can occur in plants in excessively dry soils. Soil water and microbial activity within the soil have a significant impact on subsurface soil temperature (figure 3.9).

Figure 3.8: Soil slump on a steep slope below a mall.

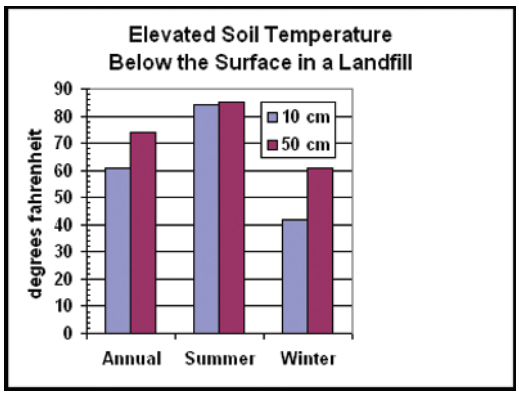

Figure 3.9: Increased microbial activity results in elevated soil temperature in a landfill.

Stream Corridors

Stream corridors provide opportunities for recreational green space, flood control, and wildlife habitat in urban areas. Urban and suburban soil ecosystems are similar to rural ones but have the added dynamics of heat islands, channeled storm water, and transportation systems for urban residents. In some areas, streets interrupt normal surface drainage and ponds or lakes form. Many urban projects restore streams that were piped underground in the past and create riparian stream corridors. These areas may connect with retrofitted parking lots of porous pavement, so that more rainwater eventually returns to the ground water or surface rivers and lakes.

The filtering function of soils is critical in areas within stream corridors and under parking areas. Soils require an active biological community for the chemical reactions that draw toxic materials out of runoff water and hold them in less reactive forms within the soils.

Because of a high population density and the resulting intensive land use, urban soils commonly are disturbed. This disturbance can be small and involve only the soil profile. Examples are mixing of soil horizons, removal of topsoil, and additions of soil material for plant growth. Other disturbances, such as shaping and grading activities, can be more dramatic and can change the shape of the landscape itself. Cutting and

filling activities change the surface characteristics that impact water movement into and through soil, site erosion characteristics, and soil fertility. Shaping and grading activities may improve a project site, but they may also change the direction and flow of water, causing problems on adjacent sites. Planning is required prior to construction to minimize the problems in adjacent areas and the impacts on ground water, erosion, and sedimentation. Silt fences can keep sediment from reaching streams and other water bodies (figure 3.10).

Figure 3.10: Silt fences collect sediment and keep it from reaching water bodies near construction sites. Construction is just starting on this site.

Watersheds in urban areas can be defined by the type of boundary between landscape features that forces water to move in a different direction. We can differentiate between an urban watershed, or “sewer shed” (defined by storm drains), and a “natural” watershed, defined by topographic watershed divides.

Landscape disturbance may also have positive effects. It sometimes introduces additional plant and animal species or helps to minimize the effects of the less favorable traits of natural landscapes. Soil reconstruction can take advantage of different soil textures and boundary conditions between soil layers to manage waterflow, structural stability, and nutrient storage.

Storm Water Management

Construction activities can be major contributors to poor water quality from sedimentation and dust in urban areas. Changes in water quality in adjacent streams and wetlands commonly indicate poor management of urban soils. For example, a lower abundance of organisms, such as crayfish and dragonflies, in streams can be an indicator of poorly managed urban soils nearby.

Runoff is water that cannot infiltrate the soil and flows across the land surface, picking up soil particles and any other objects that can be moved as sediment during rainstorms and periods of flooding (figure 3.11). Sediment can clog streets and storm drains with mud, and floodwater can carry excess phosphorus, nitrogen, and other contaminants to streams or lakes. Excess nutrients, attached to soil particles in sediment, may cause algae blooms and poor underwater visibility. Algae blooms are sometimes health hazards and impact swimming and fishing. Algae blooms and sedimentation also decrease water quality, usually by reducing the oxygen content.

Figure 3.11: Street flooding submerges cars.

Erosion- and sediment-control plans are used where large land areas are to be disturbed or where activity is expected to last through a number of rainfall or windstorm events. Two major components of these plans are control of runoff and windblown dust and maintenance of the flow rate and amount of water (hydrology) at preconstruction levels. Preventative measures that slow the flow of sediment to waterways include silt fences staked on contours across hillsides and hay bales anchored at intervals within runoff ditches.

Some urban areas have rapid soil infiltration rates of approximately 2.5 inches per hour. A negative effect of the high infiltration rate is that if fertilizer is applied immediately before a severe thunderstorm, then a great deal of the fertilizer may be leached through the soil into ground water or washed directly into the storm drains. Soil scientists have called these nutrient-rich storm drains human-made wormholes. Wormholes in the soil fulfill a similar function of carrying nutrients rapidly to distant places in the soil.

More often, storm water management in highly developed areas is needed to prevent flooding and emergency discharge of untreated sewage into rivers (figure 3.12). The amount and flow of storm water depend on how much rainfall can infiltrate into the soil. The amount of rainfall varies greatly in urban areas across the Nation. Construction practices that disturb the soil may differ from one State to another because of local and State ordinances. Increased runoff resulting from decreased water infiltration (from compaction or land shaping) is a high priority in urban planning.

"Urban Hydrology for Small Watersheds" (Technical Release 55, USDA, NRCS, 1986) is still widely used as a tool for planning and monitoring water movement, especially in urban areas where soils have been disturbed. Water infiltration plays a critical role in the calculation of the amount of water that will flow from a site in a certain amount of time. Relative infiltration rates for different housing densities and varying degrees of lawn vigor are expressed as runoff curve numbers (RCN) in TR-55 (table 3.3). The hydrologic soil group (HSG), which is an indicator of infiltration, is predetermined for each soil. The letter A indicates rapid infiltration, and the letter D indicates that rainwater generally runs off the surface. Soil management in urban areas can focus on decreasing runoff (RCN) by increasing the area of "good" open lawn, where more than 75 percent of the surface is covered with grass. Each addition of pavement will increase the amount and speed of water leaving the site.

Figure 3.12: A flooded parking lot and street.

Table 3.3: TR-55 Runoff Curve Numbers by Housing Density and Vigor of Cover

Cover type	Increasing runoff (RCN) by decreasing infiltration (HSG)				Soil condition
	A	B	C	D	
Paved driveway	98	98	98	98	impervious
Commercial district	89	92	94	95	85% impervious
Newly graded area	77	86	91	94	no vegetation
Housing lot <1/8 acre	77	85	90	92	65% impervious
Housing lot 1/4 acre	61	75	83	87	38% impervious
Housing lot 1/2 acre	54	70	80	85	25% impervious
Housing lot 2 acres	46	65	77	82	12% impervious
“Poor” open lawn	68	79	86	89	<50% grassed
“Good” open lawn	39	61	74	80	>75% grassed

Excerpt from table 2.2a in TR-55, “Urban Hydrology for Small Watersheds.” RCN is the runoff curve number (30-98). The number 30 indicates the least runoff. HSG is hydrologic soil group (A-D). Group A consists of soils characterized by rapid infiltration.

Urban Wind Erosion

Wind erosion is the movement of soil particles by wind. It occurs when land surfaces lack vegetation and the soil dries out. Windspeeds must reach a certain velocity (in most cases more than 12 miles per hour at 1 foot above the land surface) to move soil particles, depending on the size of the particles. The smaller soil particles (silt and clay) require lower windspeeds, and individual particles of organic matter move most easily and with the lowest windspeeds because of their low weight. "PM-2.5" dust refers to soil particles less than 2.5 microns in size. It can enter human lungs and cause respiratory problems. These small particles form when construction vehicles pulverize soil under dry and windy conditions. There is a high potential for dust blowing on large construction sites and in other disturbed areas (figures 3.13 and 3.14).

Figure 3.13: A cut on a construction site. This site is subject to wnd erosion.

Figure 3.14: A dust cloud along a highway. Windblown particles are measured by the meter in the foreground.

There are three kinds of wind erosion based on particle size and weight (figure 3.15). “Soil creep” occurs when very high wind moves coarse sand particles by rolling them along the soil surface. “Saltation” occurs when wind moves soil particles by bouncing them along the soil surface. Medium-sized sand particles usually are moved by this process. A “dust storm” occurs when wind detaches small soil particles from the land surface and suspends them in the air. Wind erosion is most visible during the suspension stage of dust storms.

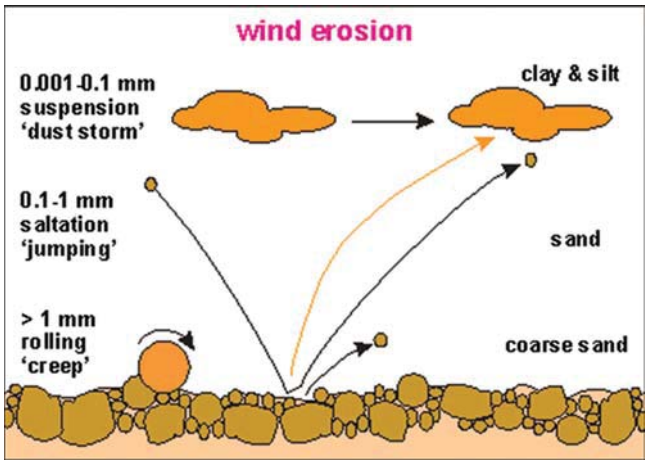

Figure 3.15: Process of wind erosion.

Flat areas in dry climates are likely to have serious wind erosion problems. Certain areas of the United States are more prone to high-velocity winds than others. Construction activities usually disturb the land surface by removing plants and pulverizing soil aggregates, making the site more likely to dry out. Reducing traffic over the land surface, keeping the surface rough by maintaining soil clods or aggregates, watering construction site surfaces, applying mulch to disturbed sites, and maintaining windbreaks or barriers reduce the risk of urban wind erosion. Establishing grasses and other plants as soon as possible after construction is completed also helps to control wind erosion.

Chapter 4: Soils Sustain Plant and Animal Diversity and Productivity

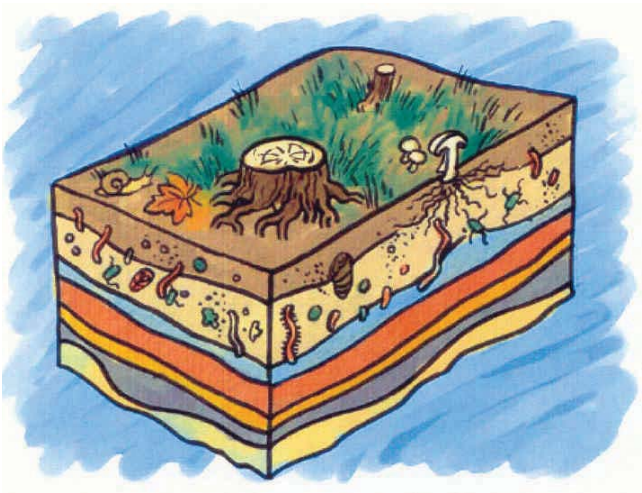

Figure 4.1

Whether they are in urban or natural areas, soils provide living space and supply air, water, and nutrients for micro-organisms, plants, animals, and humans. In most areas, soil properties determine which plants and animals can live in and on the soil. Urban soils that have been disturbed and mixed may no longer possess the natural characteristics needed to support life. Soil amendments may be required to reestablish plants. In many urban areas, the remaining soil materials must be modified before they can support plant and animal life.

Topics in this chapter:

- **Soil fertility and plant nutrition**
- **Soil acidity**
- **Soil organisms and biochemistry**
- **Soil as a filter and buffer for waste**
- **Identifying problem sites from historical records**
- **Identifying problem sites by visual clues**
- **Precautions for community gardens, playgrounds, and parks**
- **Historical tidbits on waste management**

Soil Fertility and Plant Nutrition

Management of urban soils for productive gardens requires a basic understanding of physical and chemical soil properties. Local sampling and testing can help gardeners to determine the suitability of urban soils for certain plants and the need for fertilizer, or plant food (table 4.1).

Table 4.1: Examples of the Factors That May Affect the Productivity of Urban Soil

- Little or no addition of organic matter
- Artifacts that disrupt water movement
- Elevated salt content
- Interrupted nutrient cycling and modified activity of micro-organisms
- High soil temperatures that increase the rate of chemical reactions
- Generally higher pH values resulting from additions of cement, plaster, and road salts
- Lateral (sideways) subsurface waterflow resulting from compacted layers

Meeting the nutritional needs of urban plants requires consideration of soil moisture and temperature as well as the chemicals and biological organisms needed to convert fertilizers into useful nutrients. Plant selection may vary according to the grower's nutritional needs, cultural traditions, soil conditions, and the space available. Plants common in different ethnic diets can be successfully grown in urban areas (figures 4.2 and 4.3). Attention must be paid to different plant tolerances for metals and to drainage, the growing season, and weed control.

Figure 4.2: Produce from a Vietnamese home garden.

Figure 4.3: Intensive Vietnamese home garden in an urban area.

Plant growth and nutrition are closely linked to soil properties. The ability of soil particles to hold and release nutrients for plants and micro-organisms to use is called the cation-exchange capacity (CEC). This capacity determines which nutrients stay in solution and are available for uptake by plant roots and which nutrients are moved through the soil and thus are not available for plant and microbe use. Cations in the soil are positively charged nutrients, such as nitrogen, sodium, calcium, and potassium. Different plants and microbes require different kinds and amounts of nutrients. Trace metals also are nutrients in the soil. They generally are used in very small amounts. Such trace metals as iron and manganese are necessary for plant growth. Also, they help plants to fight diseases. Metal mobility and potential toxicity in soil occur at the lower pH levels and depend on metal binding through cation exchange.

Various kinds of clay in the soil attract and hold cations onto negatively charged parts of their surfaces. Certain clays internally bind some chemicals very tightly. As a result, it is difficult for plants to obtain the necessary nutrients from the soil solution. In areas of these highly active clays, we often add lime (calcium carbonate) to reduce the acidity of the soils and facilitate release of the nutrients from the clays into soil solution.

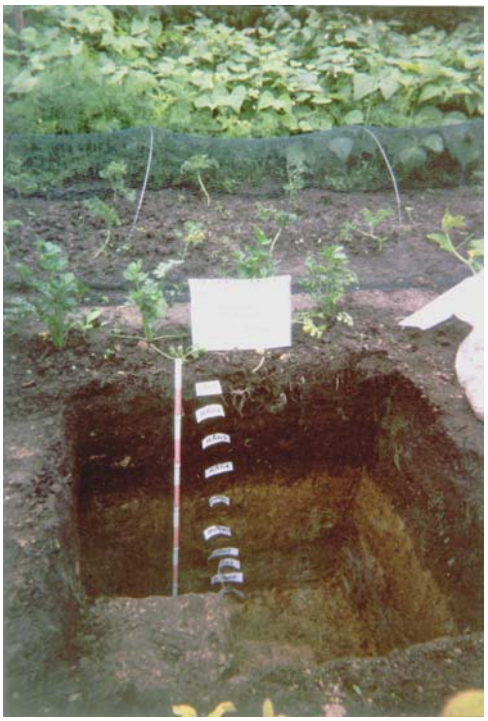

Figure 4.4 Soil profile in a long-term garden.

Organic matter has many active sites that bind chemicals in a manner similar to the way clay particles bind the chemicals in the soil. Organic matter is often visible in a thick, dark surface layer, in which plants begin to grow and take up nutrients. Clays and other soil materials are mixed with the organic matter in each soil layer to form a chemical system. Intensive vegetable gardening over many years during which unused plant materials and organic waste are returned to the soil can produce a thick, dark surface layer of organic matter. The color of the resulting dark surface layer may contrast with the color of the underlying soil, as is shown in figure 4.4, which pictures a 100-year-old continuous vegetable garden.

Soil Acidity

An acid is a substance that has a positive charge and usually yields hydrogen ions when dissolved in water. Hydrogen ions are positively charged. The stronger the acid, the better it dissolves in water. The pH scale (1-14) is a common measure of soil reaction. The lower the number, the greater the acidity. The midpoint of the pH scale is neutral (7.0), a good level for the growth of most plants.

Changes in soil reaction, as measured by pH, have significant effects on metals in soil. Metal toxicity to plants and animals increases in strongly acid soils with a low pH (3.5). Metals in these soils are released from negative sites back into soil solution. At a higher pH (8.5), the metals often are sequestered in the soil. The term “sequestered” indicates that the positively charged metal ions are bound tightly to

negatively charged sites in the soil. These sites may be on clays, mineral compounds, or organic matter, including the surfaces of some micro-organisms. These strong, tight bonds restrict the availability of metals for plant uptake and reduce the risk of animal consumption or human skin contact.

Soil Organisms and Biochemistry

Soil is made up of mineral particles and organic matter, the decomposed remains of living things. Bacteria, fungi, and other micro-organisms are largely responsible for breaking down dead plants and animals in the soil. Small organisms (microbes) have negatively charged sites where soil nutrients and metals can bind to form soil aggregates and compounds. Earthworms and larger animals eat and digest organic materials and minerals, transform them into soil aggregates, and deposit them as waste. Soil aggregates are loose groupings of many different soil components in a structure allowing water and air movement as well as biochemical reactions for energy production and nutrient cycling (figure 4.5).

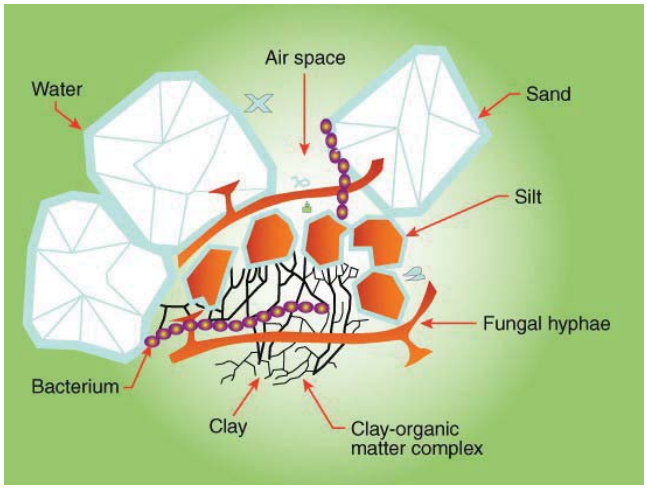

Figure 4.5 : Soil components at a microbial scale.

Soil as a Filter and Buffer for Waste

Managing compost and organic waste is important for plant nutrition and for the biological degradation and conversion of contaminants into inactive forms in the soil. Two key ways to manage waste are filtering and buffering. Waste is filtered when it flows through the soil and is slowly trapped and bound to soil particles. Soil buffering traps waste particles and transforms them into inactive forms.

Composting and using septic systems are examples of waste management in urban soils. Organic materials are needed to hold water and nutrients in the soil for plant growth. In urban parks and community gardens, as well as suburban home gardens and yards, composting can recycle most of the leaves and grass clippings (figure 4.6). This management alternative provides inexpensive soil conditioner that increases porosity and improves the rooting environment for plants.

The major considerations in applying yard and garden waste after composting are plant nutritional needs and the potential of the compost to contain weed seeds or contaminants. Existing resources from the Cooperative Extension Service provide guidelines for managing compost in a manner that maximizes the nutrient content and minimizes the transfer of diseases or contaminants. The same practices work for

Figure 4.6: Composting barrels or traditional fenced piles fit different management intensities in home gardens.

organic waste whether from urban or agricultural sources, and the economic benefits of recycling apply to both.

Understanding the role of soils in septic systems helps residents of small towns or remote housing developments to manage the return of some nutrients to the soil. The liquid septic effluent can provide nitrogen and phosphorus for use by the roots of lawn grasses. Lawn areas receiving liquid drainage from poorly designed or failing septic systems may appear darker green and have thicker grass than surrounding lawn areas. Lakes surrounded by intensive development using septic systems may have water-quality problems, such as algae blooms or high phosphorus levels, if the systems become overloaded.

Conversion of summer cottages to year-round homes may lead to septic system failure or excessive drainage of nutrient-rich septic effluent to lakes or streams. Upgrades, cleanouts, and enlargements of septic systems are needed to accommodate the amount of human waste produced and to make sure that the waste does not pollute surface water or the ground-water supply for wells. Soil properties affecting septic system design and installation include slope, depth to bedrock, permeability, depth to the water table, plasticity of the soil (possible expansion when the soil is wetted and then dried), soil texture and structure, and potential for corrosion of steel or concrete pipe.

Identifying Problem Sites From Historical Records

Metals in soils come from various sources. They may have been present in the geologic rock, or they may occur as atmospheric additions of copper, mercury, lead, and zinc. Metals also may have been deposited by past industrial activities, such as battery production, brass and steel manufacturing, mining, and many different processes involving nickel, cadmium, copper, and lead. Lead is especially evident near roadways because of automobile emissions before the availability of unleaded gasoline, and automobile demolition areas may contain a variety of metals that were commonly used in older cars. As lead paints and some window blinds and soldered pipes used in houses before 1978 wear out and deteriorate, they add lead to nearby soils.

Other ongoing sources of metals and organic waste material are landfills and dump areas that are poorly maintained or unregulated. Landfill materials eventually decompose and form a highly variable type of urban soil. The volunteer vegetation may be dominated by phragmites, as is shown in figure 4.7. These sites can be reclaimed for limited recreational or industrial use.

Figure 4.7: An older landfill with phragmites.

Areas affected by city fires may have concentrated metals buried in the soils. These concentrations are discovered only by referring to historical records or by digging into the soils (figure 4.8). Major fires may leave surface residue high in contaminants. A variety of plants may still grow well, but careful evaluation of each site is needed to determine the risk to human health.

Marine sediments may be dredged and used as fill in low-lying urban areas. Contaminants in the dredged material may be moved onto a site. Other problems with water movement and root resistance may result from compaction of a subsurface layer of very fine sand.

Figure 4.8: Soil profile with a buried layer of ash and refuse. This site was burned by a city fire.

Identifying Problem Sites by Visual Clues

Metal contamination on a site may be evidenced by plant growth, animal behavior, or paint flecks containing lead from older buildings. Many plants simply cannot grow where the level of certain metals is high. Other plants grow well in contaminated soil but fail to set seed or do not grow as well as expected. Absence of any plant growth is a warning sign that a site may be severely contaminated. Caution during sampling is needed.

Metals may be present at a site but not be a high risk for gardening or recreation, depending on the soil properties, drainage, and vegetation at the site. A human health risk from mosquitoes can occur not only in areas of standing water but also in any areas near homes or on city streets with stagnant water. Compaction is often the main problem causing water to pool on the surface without infiltrating into the soil. Mixing the soil when it is just a little moist can increase the porosity (air space between particles) and allow water to soak in. Other options are to divert the water away from low spots and to create channels for storm water to flow around the site or in specific streams or ditches across the site.

Precautions for Community Gardens, Playgrounds, and Parks

Outdoor recreation and gardening are popular activities on urban soils. The risk to human health varies among the sites used for these activities and even between the soils on the same site. A careful study of the area and consideration of key soil properties are needed (table 4.2)

Community and home gardens on contaminated soils may not be a health risk if the garden vegetables supply a very small proportion of the vegetables in the overall human diet. Caution is advised, however, when produce grown in contaminated soils is eaten. Often, the garden supplements the produce bought at grocery stores and for most of the year the nutritional needs of the growers are met elsewhere. Buying vegetables at farmer's markets or school fundraising gardens is another way to dilute the dietary intake of contaminated plants by any one person

Caution is needed in areas of bare ground or leaking water near past industrial sites, dumps, or older homes. Gloves should be worn during soil sampling. Dust from contaminated sites may be dangerous if inhaled by humans or animals. Extended skin contact or hand-to-mouth activities may allow metals to enter children's bodies and interfere with growth and mental development. Pets may collect contaminated dust or mud and carry it into the home.

Prolonged skin contact with contaminated gardens can endanger young children. Raised bed gardens built with a liner on the soil surface and carefully selected fill materials provide a relatively safe and productive alternative. For many residents of urban areas, a community garden is a desirable opportunity for physical exercise, visiting with neighbors, supplementing vegetables, and relaxation.

Table 4.2: Human Health Risks

potential health risks

- **dust inhaled**
- **soluble lead for plant intake**
- **mud puddles that attract children and increase skin contact**

soil chemical properties influencing relative risks

- **strongly bound and insoluble forms of contaminants**
- **prevalence of active clay surfaces for binding**
- **organic carbon in various active forms for binding**
- **other cations, electrical conductivity, pH, and salts**

soil physical properties influencing relative risk

- **drainage**
- **infiltration and permeability**
- **erosion potential for runoff and sediment loss**
- **particle sizes and water in soil pore space**

Historical Tidbits on Waste Management

Night soil was a traditional material in monasteries and in urban areas without sewer systems. Human waste was recycled into gardens and agricultural areas as fertilizer. It was usually emptied from storage pots each morning. Thus, it was called "night soil."

Kitchen gardens were located near cooking areas to provide vegetables and herbs convenient for food preparation. These often were fertilized with night soil. Many historical discard areas are uncovered by the efforts of archaeology and give us insight into the foods people ate, the cooking vessels they used, and the ways they recycled waste materials.

Chapter 5: Soils as Building Material and Structural Support

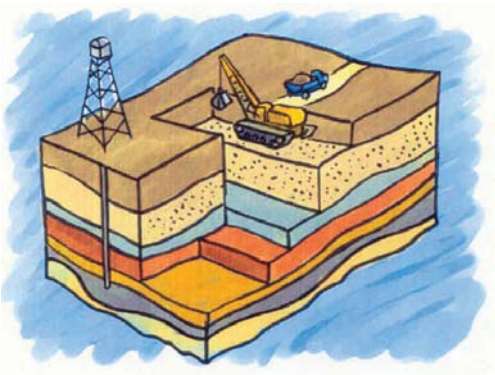

Figure 5.1a

Figure 5.1b

Soil is used as raw material in urban construction activities. Sand, gravel, and clay are mined and used as important materials for many purposes, such as constructing foundations and roadbeds, leveling and filling building sites, and lining ponds and lakes where porous materials require sealing. Soil provides structural support for the houses, schools, shopping malls, churches, industrial parks, and parks and recreation fields that are part of urban areas. Not all kinds of soil are suitable for the many urban uses that are required. Sandy soils are better drained than clayey soils, and some soil layers that are exposed during construction have low strength and are easily compacted. When exposed, bedrock and hardpans are difficult to manage. Knowledge of the soils on the site is needed prior to construction.

Topics in this chapter:

- **Site preparation**
- **What happens when soil is disturbed?**
- **Management after disturbance**
- **Special care of plants in islands within paved areas**
- **Sinkholes**
- **Artificial landscapes**
- **Building material**
- **Materials that allow water to infiltrate**
- **Open space in planned developments**
- **Reclaiming contaminated sites and vacant lots**

Site Preparation

One goal of construction activities in urban areas is to provide material that supports buildings, streets and roads, ballfields, tennis courts, golf courses, parks, and gardens. Another goal is to use soil and other land resources wisely. Each construction site has different needs from the standpoint of supporting structures to be

built and then providing materials for landscaping the site after construction is completed. Some sites are left in their natural condition, but many are leveled, drained, shaped, and compacted. These activities help to overcome the engineering and construction limitations affecting building foundations or concrete slabs for building floors, parking lots, athletic fields, or other uses. Soil or even bedrock must be moved or removed when a construction site is leveled or graded. When bedrock or hardpans are involved, drilling and blasting may be needed to loosen the materials. Large machinery, such as an earthmover (figure 5.2), is used to move soil material from one place to another on the site.

Figure 5.2: An example of construction machinery.

Soil materials that are moved from one construction site to another or to a different location on the same site must be compacted if they are to support the weight of buildings. Machinery is used to reduce the number and size of soil pores and increase soil strength (figure 5.3). When soils are not compacted or when sites are unstable, project failures occur. Figure 5.4 shows a house foundation that is unstable. The electric meter was torn from the house as the soil next to the foundation settled. In figure 5.5 settling around a house has torn the outside step away from the patio doors. The red line on the foundation is the original level of the patio. Figure 5.6 shows damage to a road built on an unstable soil.

Soil compaction often occurs in areas where sidewalks were not built along the preferred footpaths (figure 5.7). This compaction is unintentionally caused by people after construction is completed. Because of soil sealing at the surface, vegetation cannot grow in compacted areas. Compaction below the surface may be evidenced by puddles on the surface or trees that are blown over by heavy winds because of shallow root systems. Compaction often is caused by the heavy machinery used by builders and contractors (figure 5.8). The use of large machinery to move materials around on a building site when the soil is wet compacts surface and subsurface horizons in the soil. These compacted horizons, which are characterized by reduced pore space and increased density, alter soil drainage, root penetration, and even microbial communities on the site.

Unintentional soil compaction is a symptom of soil mismanagement and can be a cause of excessive runoff, with or without sedimentation. Compaction occurs when soil particles are packed tightly together as heavy forces (including vehicles, foot traffic, or even glaciers) are applied to wet soils. Compaction is reflected in decreased

Figure 5.3: Sheepsfoot rollers compact soil.

Figure 5.4: An electrical service box torn from a home because of soil settling.

Figure 5.5: A home damaged by soil settling.

Figure 5.6: A road constructed on an unstable soil.

Figure 5.7: Compaction in a footpath.

Figure 5.8: Compaction caused by the use of heavy machinery during wet periods.

water infiltration, limited internal water movement, and the inability of plant roots to grow through a restrictive soil layer.

After soils are modified and used for urban projects, the landscape must still function as a natural system. In other words, the soils must still regulate, partition, and filter air and water; sustain biological diversity and productivity; and support structures. This is the challenge. Soils in densely populated urban areas are dramatically different from soils naturally occurring in forests, on rangeland, in agricultural areas, or at the urban fringe. The functions of urban soils often are modified (figure 5.9), sometimes in a positive way and sometimes in a negative way.

Urban soils range from slightly disturbed to completely manmade. Natural soils can occur in urban areas where site preparation has not been extensive. Urban soils present unique challenges to landscape architects, horticulturalists, engineers, and urban planners. The general types of soil disturbance in urban areas include intentional cutting and filling; vehicular or foot traffic, which can cause compaction; introduction of manufactured soils for raised bed gardens and containerized plantings; and special preparation of sites for parks, gardens (figure 5.10), athletic fields, and golf courses (figure 5.11). Large-scale soil disturbance includes leveling through cutting

Figure 5.9: A modified urban landscape.

Figure 5.10: A garden near a home foundation.

Figure 5.11: Golf course.

and filling or through grading in certain areas, such as sites for buildings or athletic fields; filling of wet areas or areas that have undesirable soil characteristics; and filling of unused or abandoned areas in preparation for waste disposal.

Disturbed soils differ from soils in natural areas because their horizons have been mixed, destroyed, or removed; natural soil structure has been destroyed; compaction has occurred because of heavy machinery use; water transmission rates have probably been reduced because of soil compaction and loss of soil structure; and runoff and soil erosion rates typically have been increased.

What Happens When Soil is Disturbed?

Humans are probably the most important organisms of the soil-forming factors in urban areas. Urban soils have been disturbed by human activity in some manner and to some degree. This disturbance has changed the properties of the soils, and the soils should now be managed in a different manner. Mixing different parts of more than one soil can result in a new soil that may be better suited to a certain use than the original soils. Some soils have to be altered before they are suitable for certain uses. An example is a soil in an area where preparing a roadbed requires mixing and

deliberately compacting soil material. Topsoil commonly is piled up and then spread on top of the altered soil after construction. In some strongly sloping areas, soil may be moved from one area to another to fill low-lying areas and level the site for construction. In some areas soil material is created on the site by mixing manmade and/or natural materials from various sources. The materials may be mixed as they are moved by heavy construction equipment.

Soils in urban areas are used for many purposes even if they are compacted and/or contaminated. Contaminated soil material is sometimes buried because of the need to protect those who work or play on the site. This contaminated material may be exposed during construction activities. Old dump sites for petroleum and chemicals are now being exposed as urban redevelopment occurs in many cities. The buried materials have leached into other soil layers or even into the ground water, and cleanup coasts are extremely high. In some areas cleanup may be impossible. Some soils are unintentionally compacted prior to their use. This compaction causes problems after construction. Soils that have been compacted or contaminated create special problems for certain uses or for the people who live or work on them. A soil scientist and specialists in other disciplines can provide valuable information to help people use soils properly and to address existing problems in urban areas. It is important to get advice and help from soil scientists before projects are started.

These facts help us begin to understand that urban soils are very different from soils in natural areas. Even in undisturbed areas, no two soils are exactly alike. Thus, it is important to know all one can about a soil before it is used for any purpose, including urban projects. Most soil-related limitations can be overcome if enough money is available to correctly design, install, and maintain a project. Costs to overcome project errors are often higher than the original project costs.

Management After Disturbance

After disturbance, the surface layer of urban soils should have the characteristics needed for good plant growth. Management includes overcoming physical and chemical root restrictions, providing nutrients by managing soil fertility and acidity (pH), and reducing the likelihood of contamination or disease problems. In areas where the climate is dry, a water supply for the site also is needed.

Special Care of Plants in Islands Within Paved Areas

Urban plants may grow on small islands within disturbed or paved areas. Overland waterflow to the vegetation is limited on these islands. Large soil pores that connect to the surface are critical if water is to move to the deep roots of the plants. The soil in the island of vegetation should extend below the pavement and should provide enough volume for root growth in proportion to the above-ground height of the trees and shrubs. Trees and flowerbeds along streets may require more frequent applications of fertilizer and water than backyards or gardens.

Sinkholes

Sinkholes severely limit urban uses. They form where water has been pumped from underlying geologic formations, leaving the surface soil without support; where limestone bedrock is dissolved in water and removed below the soil during geologic weathering; and where underground volcanic lava tubes collapse after geologic weathering (figure 5.12).

Figure 5.12: A sinkhole where a lava tube has collapsed.

Artificial Landscapes

Many urban parks were once deep ravines. These ravines were filled with construction materials and refuse during the process of land leveling. Examining a pit dug into the soil under the vegetation helps soil scientists to determine the soil properties controlling the way water moves through the soil and the way nutrients are released to plants (figure 5.13).

Figure 5.13: Soil scientists examining urban soils.

Building Material

Soils in urban areas are more often the recipients of excavated and dredged materials than the source of those materials. Some areas do have large deposits of sand or gravel that can easily mined and transported to other areas. The pits left behind when quarries in urban areas are closed are sometimes used for water-based recreation or are refilled with other material, such as garbage or road debris.

Fill material can be natural soil (derived locally or moved onsite), waste (e.g., coal ash, dredged spoil, and construction debris), or a mixture of both (figure 5.14). Soils in urban areas may have cultural artifacts (garbage), construction debris, and various waste products.

Figure 5.14: A filled area excavated for a home foundation.

Soil material is sometimes made on a site by mixing manufactured materials with natural materials from various sources as both of the materials are moved around by heavy construction equipment. This process may result in hardpans or compacted layers that impede foundation drainage under extensive fill material added for home construction. The potential problems associated with disturbed urban soils include a scarcity of organic material for plant nutrition and biological soil-building reactions, the presence of artifacts that damage construction equipment or release contaminants, and significant variability between soil layers. The variability between the soil layers affects water movement and the stability of the soil under weight.

Materials That Allow Water To Infiltrate

Urban renewal may include removing old culverts and pipes and thus restoring a natural stream, as in a park with trees and picnic areas. Restoration of stream corridors for recreation, flood control, and wildlife may require rebuilding of streambanks with such material as rock or gabions (rock baskets, as shown in figure 5.15) that can withstand the erosive force of floodwater (FISRWG, 1998). Pavement may be removed from parking lots near the reconstructed stream so that more water can infiltrate into the soil and thus raise the stream level. Porous building materials may be added to the surface of streets (figure 5.16), parking lots, or sloping areas that require greater stability. The porous materials permit water to move into the soil instead of running off the site. Also, plants growing through the materials help to control erosion (figure 5.17).

Figure 5.15: Rock baskets.

Figure 5.16: Brick street in an historic district.

Figure 5.17: Soil surfaces may be covered with products that provide strength for slope stability and still allow water to infiltrate and plants to grow.

Open Space in Planned Developments

Planting beds may be constructed in parking lots, around playgrounds, and near nature trails to allow a wider variety of plants to flourish with frequent watering and intensive fertilizing. Urban planning can combine housing and open space needs for a community through consideration of the soil resources of the larger urban area (figures 5.18 and 5.19).

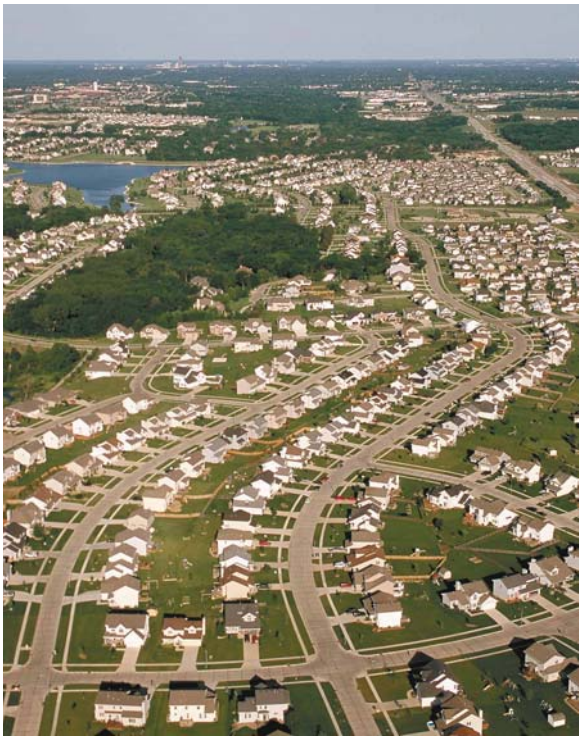

Figure 5.18: Aerial view of planned development.

Figure 5.19: A subdivision.

Building suburban houses on slight or moderate slopes and establishing lawns minimize erosion. The houses generally have gutters that channel runoff from roofs into storm drains. Very little space is left between houses, but larger lawn areas are in the backyards, where mowing and fertilizing can be coordinated among suburban owners. The soils around the houses should be characterized by good infiltration. They should slope away from the foundation, so that basements are not flooded. A level soil with moderate infiltration and good drainage is desirable in areas near swimming pools and play structures.

Reclaiming Contaminated Sites and Vacant Lots

In the more densely populated urban areas, a vacant lot may be the only site available for recreation and gardening. This restriction forces residents to use soils that may be compacted and contaminated or filled with unknown materials. Reclaimed mine areas provide land for urban housing and recreation after soil reconstruction measures are applied for water movement, structural stability, and plant growth. Raised bed gardens built with composted leaves and grass provide a plant rooting space of minimal risk to children and adults in many urban areas (figure 5.20).

Figure 5.20: A raised bed garden.

Chapter 6: Soils Preserve Natural and Cultural History

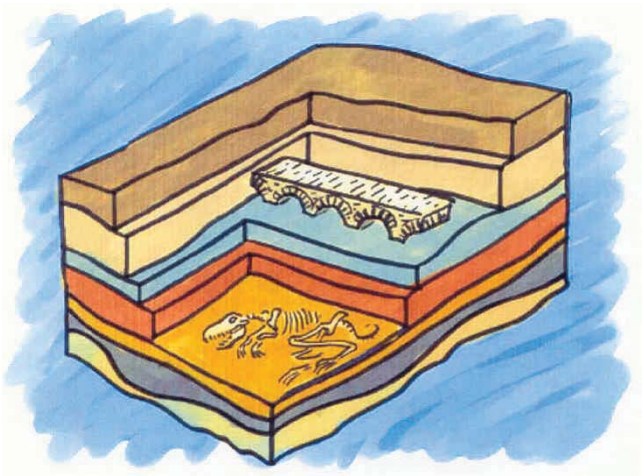

Figure 6.1

Soils can tell us much about our past. They are derived from a variety of parent materials and are transported by wind, water, ice, gravity, or humans. Soil material has been transported to its present location over very long to very short periods of time. What occurs in or under a soil can indicate how old a buried soil layer is and even how it got to its present location. For example, glaciers from the Canadian ice sheets moved down into the northern part of the United States about 12,000 to 15,000 years ago. Rocks otherwise found only in Canada are within the soils impacted by these glacial events. Soils can be dated by the plant pollen or artifacts within them. Layers of garbage or dredge material also can indicate the age of the soils. In addition, they help to preserve artifacts of culture and history.

Topics in this chapter:

- **Urban site preparation**
- **Intentional burial**
- **Catastrophic events**

Urban Site Preparation

When most sites for urban projects are prepared, soil excavation is required to allow the construction of building foundations, roads, and streets and to shape the lot for construction activities. Excavations vary in depth and size, depending on the building project. Very deep excavations are required when skyscrapers or other large buildings are constructed or when roads and streets are built on strongly sloping land. As soil material is removed by excavation, objects that have been buried, either by natural

processes or by humans, are sometimes uncovered and must be dealt with before construction begins.

The objects that are discovered in the soils during excavation may have been accidentally lost, intentionally discarded or buried, or buried by catastrophic events. Coins and jewelry are examples of the buried items that are discovered. Old dumps, hazardous materials, fossils, or artifacts of past civilizations also may be exposed during site preparation.

Intentional Burial

Landfills and garbage dumps are examples of intentional burial sites (figure 6.2). Construction debris, garbage, and other items are often placed in dumps or low-lying areas and then covered by soil or dredge materials. Operators of most landfills are required to cover each layer of garbage with a layer of soil on a daily basis. When old landfills are discovered during project excavations, the content may appear to be a stack of debris and soil in layers. In the past, old dumpsites and burial areas were not marked on maps. Radioactive materials or carcinogens may have been buried in some areas before landfill regulations were in place. These areas can be avoided if their location is known, but the location is not always known. The buried materials can be very dangerous when exposed during construction activities. If areas such as these are discovered on a homesite or building lot, the discovery should be reported to the proper authorities.

Figure 6.2: Bulldozers working in a landfill.

Liquid materials, such as oil and oil products, pesticides, and other pollutants also have been placed in landfills and garbage dumps. These materials are in various kinds of containers that eventually corrode, degrade, and begin to leak (figure 6.3). The pollutants may leak into the ground water or out onto the surface in areas downslope from the landfill or dumpsite. In our Nation's past, dumpsites in many rural areas were unregulated. Toxic or hazardous waste material was deposited on these sites along with household garbage. As towns and cities grow and expand, these sites are often uncovered and must be cleaned up before use.

Small towns or a few buildings are sometimes intentionally covered by water impounded by large dams. Over time, sediment that settles out of the water buries the buildings and streets. The dam may be filled with sediment and abandoned. If the site is later used for another purpose, the buildings and debris material may be exposed during site preparation.

Figure 6.3: Barrels containing hazardous material.

Current technology helps us to design safe dumps and landfills. Liners made of impervious materials are now used under garbage and waste materials in dumps to contain the waste materials and keep the by-products of decomposition from leaving the site and leaking into ground water. Cover material placed on top of the garbage can keep odors and hazardous gases from escaping into the atmosphere. Most dumps now require permits. Strict monitoring helps to ensure that hazardous material is not deposited in the dumps. When dumps and landfills are closed, monitoring plans require that the sites be checked on a regular basis.

Catastrophic Events

Catastrophic events, such as earthquakes, volcanoes, landslides, dust storms, and large floods, bury objects unintentionally (figures 6.4, 6.5, and 6.6). An object discovered during urban development is sometimes a surprise. The exposed objects may be skeletons of prehistoric plants and animals, old buildings, human artifacts from earlier civilizations, footprints, leaf imprints, or even pollutants and contaminants that were buried during past disposal activities. Some project sites must be altered when pollutants or contaminants are exposed during excavation. On other sites, changes in project and/or construction plans are needed because of artifacts or hazardous materials uncovered during construction.

Figure 6.4: Human artifacts buried by windblown dust.

Soil horizons are important time markers and are used to help date items discovered when sites for urban projects are excavated. Newspaper articles tell of human and animal bones that were disturbed during excavations in urban areas. In some areas excavation is stopped until the bones can be identified so that the remains of members of ancient civilizations are not disturbed prior to study and cataloging. When the conditions and soil properties are right, buried artifacts and remains are well preserved for long periods of time. Not all kinds of soil, however, preserve artifacts and plant and animal remains. Some soils are so acid that they dissolve the buried materials. In some areas of wet soils, organisms living in the water consume the buried materials as food.

Figure 6.5: Animal skeletons buried by volcanic ash.

Figure 6.6: 1994 landslide (USGS photo).

Locating existing information about a site before site preparation begins can save the owner a great deal of time and expense. Soil survey reports commonly provide information about historic sites and past land use activities as well as information about soils. Soil survey information regarding slope stability, restrictive layers in the soils, and water transmission rates can help builders and landowners to avoid problems and save money. The costs of repairing, rebuilding, or relocating structures can be avoided, and the life expectancy of projects can be enhanced.

Chapter 7: Soil Management for Recreation and Renewal

Many cities and towns maintain botanical gardens or arboretums for use by their citizens and visitors. Some of these gardens and arboretums are very well known and draw people from all over the United States and the world. Some are used for large gatherings of people celebrating special community or holiday events. Unmanaged use of parks, gardens, and arboretums can cause damage to plants and severe soil compaction, which restricts the movement of water into the soil. The result is increased soil erosion, poor plant vigor and growth, increased runoff and offsite sedimentation, and renovation costs.

The most common kinds of urban parks and gardens are meditation gardens, rooftop gardens, rain gardens, butterfly gardens, outdoor classrooms, desert gardens, kitchen gardens, victory gardens, pocket parks, riverfront parks, green space, open space, medicine circles, labyrinths, and peace parks (figures 7.1, 7.2, 7.3, 7.4, and 7.5). The kinds of plants in these areas vary because of differences in soil properties. Additions of special types of nutrients (plant foods or soil conditioners) to the soil or containers in which the plants can grow may be needed.

Figure 7.1: Butterfly garden at an elementary school.

Schoolyards are ideal spots for building butterfly gardens and outdoor classrooms. These areas can also serve as small neighborhood parks. The soil and site history in the areas can show whether contamination is likely and whether protective measures are needed to minimize exposure. Soil testing is needed before the projects begin.

Applications of basic environmental science in urban areas can quickly become complicated and may require special contributions from scientists in many fields. A garden site surrounded by buildings may be hotter and drier than expected because rainwater is channeled in roof gutters and street drains away from the site, nearby concrete walls and streets stay hot longer, and the buildings cut off breezes. In some parts of the country, the added heat can extend the short growing season for

Figure 7.2: An urban pocket park under development.

Figure 7.3: A developed urban pocket park.

Figure 7.4: An urban riverfront park.

Figure 7.5: Intensively managed ballfields after soil reconstruction.

vegetables, but in the warmer regions, it can make a garden site undesirable for some plants.

Careful planning of lawns and picnic areas is needed because of the possibility of heavy foot traffic during wet periods. Urban parks commonly have a combination of paved areas and manufactured soils that can withstand trampling.

Conversion of a vacant lot into a ballfield or picnic area may be delayed if the site was used in the past as a garbage dump. Soil contamination, bad smells, uneven ground surfaces, and other problems may be caused by buried garbage that is slowly decomposing. Some former landfills provide space for parks and ballfields, but they must be carefully planned and managed for intensive use by many people in variable weather.

A few basic soil management practices can help to maintain existing parks or reclaimed recreation areas over time. A soil-based site management plan might include ways to balance water content and movement. Compost leaves and grass add organic materials and thus increase the supply of plant nutrients. Also, they help to maintain soil porosity and thus reduce the likelihood of compaction. In general, gardens and parks in urban areas require careful initial site selection followed by intensive maintenance of the vegetation in lawns and landscaped areas. A soil scientist may need to dig a pit so that the soil properties that affect management can be investigated (figures 7.6 and 7.7).

Figure 7.6: A backhoe used for digging a soil pit.

Figure 7.7: Human artifacts buried in a soil pit.

Schools, parks and recreation departments, and garden centers often employ people with training in soils and landscaping. Many recreation areas and parks are heavily used for more than one purpose throughout the year (figure 7.8). Maintenance plans are needed in these areas. These plans can be used as templates for planning smaller pocket parks and gardens that comply with local regulations.

Figure 7.8: High school playing fields are used for sports and for band and music competitions or performances.

Chapter 8: Help Is Nearby

Many of the conservation practices used in agricultural and forested areas can be adapted to work in urban areas or small towns. The Backyard Conservation Program of the Natural Resources Conservation Service (NRCS) helps urban people to plan, establish, and maintain simple waterways and plantings around homes, schools, and small parks. Team-building skills across disciplines, among generations, and among cultural groups are essential for successful urban conservation programs. These skills have been combined with the science behind NRCS field-office conservation planning. The Backyard Conservation Program has improved the ability of NRCS to serve customers using ecosystem concepts in urban areas.

Topics in this chapter:

- **Soil surveys in urban areas**
- **Naming soil series and soil map units**
- **Help in evaluating your soil and urban site**

Soil Surveys in Urban Areas

The program responsible for mapping all soils in the United States is called the National Cooperative Soil Survey (NCSS). It has been ongoing for more than 100 years. The NCSS is a partnership that combines the resources of Federal agencies, including the Natural Resources Conservation Service (NRCS), the U.S. Forest Service (USFS), the National Park Service (NPS), and the Bureau of Land Management (BLM), and the resources of State and local agencies and universities. In the earliest years of the soil survey program, soil surveys were focused on lands that were or could be important for agriculture. At that time, urban areas were broadly mapped or sometimes even ignored as soil surveys were completed.

The NCSS program has nearly completed the initial mapping of all nonurban land within the Nation and is now turning its attention to updating and maintaining existing soil survey data, to mapping lands managed by certain Federal and State agencies, and to mapping urban areas. Some urban areas have already been mapped, while others are just beginning soil surveys. Table 8.1 lists several completed and published

Table 8.1: Examples of Soil Surveys in Urban Areas

Soil Survey of the San Diego Area, California, 1973
Soil Survey of Suffolk County (Long Island), New York, 1975
Soil Survey of Washington, District of Columbia, 1976
Soil Survey of St. Louis County and St. Louis City, Missouri, 1982
Soil Survey of Charlotte County, Florida, 1984
Soil Survey of Cumberland and Hoke Counties, North Carolina, 1984
Soil Survey of Montgomery County, Maryland, 1985
Soil Survey of Nassau County (Long Island), New York, 1987
Soil Survey of South LaTourette Park, Staten Island, New York,1997
Soil Survey of Baltimore City, Maryland, 1998

soil surveys of urban areas. Soil survey activities currently are either planned or underway in several other urban areas.

Mapping urban areas can be difficult because the present land use restricts the access to sites needed for observation of soil profiles and because land use can quickly change. Observing the soils in these areas is difficult because impervious layers of concrete and asphalt are commonly on the surface and because most people do not want holes dug in their yards or gardens.

An urban soil classification scheme based mostly on the use or intended use of the soils could be developed. Urban soils can be investigated for commercial, residential, industrial, and greenbelt uses. For a satisfactory design of each use, there are key soil properties that must be known and understood. The NCSS program maps and classifies soils according to National standards and collects soil property data to be used in developing soil interpretations helpful in wise land use planning.

The emphasis on mapping urban areas results from the increasing size and density of the urban areas, a more environmentally aware clientele, the fact that nearly all rural areas have already been mapped once, and the need for more and better land resource data within and adjacent to urban areas.

NCSS soil survey information is useful for general planning activities. Because of the map scale, however, this information is not adequate for most site-specific activities. Most activities in urban areas are site specific, apply to areas of land smaller than those generally shown on soil maps, and involve highly intensive uses. Site-specific examinations are needed to provide the accurate and detailed data needed for most urban projects.

Naming Soil Series and Soil Map Units

Table 8.2 lists some soil series in urban areas and the type of material in the upper part of the soils and in the underlying substratum. Each soil that is mapped in the NCSS program is given a name that distinguishes it from other soils. Each has a set of chemical and physical soil properties that are different from those of other soils. Groups of soils having profiles that are almost alike, except for differences in the

Table 8.2: Examples of Urban Soil Series

Series	Survey area	Depth and type of surface fill	Substratum
Harvester	St. Louis, MO	12-40" fill or reworked loess	< 20% glass, brick
Fishpot	St. Louis, MO	up to 48" fill or reworked loess	< 20% glass, brick
Matlacha	Charlotte Co., FL	35" dredge spoil	natural sand
St. Augustine	Charlotte Co., FL	30" dredge spoil	natural sand
Bragg	Cumberland and Hoke Cos., NC	20-81" sandy clay loam fill	buried loamy sand
Greatkills	Staten Island, NY	7-24" mod. coarse texture	garbage
Canarsie	Staten Island, NY	10-39" mod. coarse texture	dense glacial till
Foresthills	Staten Island, NY	10-39" mod. coarse texture	buried soil
Greenbelt	Staten Island, NY	40-80" mod. coarse texture	same fill
Centralpark	Staten Island, NY	40-80" very gravelly material	same fill

texture of the surface layer, are called soil series. For example, the soils of one series may have bedrock or a layer of garbage at a depth of 24 inches, while the soils of another series may have bedrock or a layer of garbage at a depth of 75 inches. Other soil series are separated on the basis of chemical properties or, more often, on the basis of a combination of physical and chemical properties. Soils usually are named by the soil scientists who map them. Most are named after landmarks, geographic areas, rivers, mountain peaks, cities, or towns. Examples are the Centralpark series (named after Central Park in New York City) and the Seattle series (named after Seattle, Washington). In a few instances, the names are simply made up.

Urban soils form in different types of human-deposited material, including a) loamy fill over natural sand, b) dredged spoil, c) coal ash, and d) construction debris (figures 8.1a, 8.1b, 8.1c, and 8.1d).

Nonsoil areas are given such names as Rock outcrop, Urban land, Dumps, Water, and Rubble land. Urban land is defined as areas with a specific percentage of pavement, driveways, and buildings (impervious cover). Collectively, nonsoil areas are classified as miscellaneous areas.

Soils are mapped either as a single soil series or a group of soil series and/or miscellaneous areas. For example, one group could be mapped as “Urban land-Charlton complex, 2 to 8 percent slopes.” A single soil map unit could be mapped as “Seattle loam, 1 to 3 percent slopes.” The end of this soil name (“2 to 8 percent slopes”) is an example of additional information called “soil phase” criteria. Soil phase criteria may be related to such characteristics as slope, texture of the surface layer (e.g., loam), and flooding.

Figure 8.1a: Profile of a Verrazano soil, which formed in loamy fill over natural sand.

Figure 8.1b: Profile of a Big Apple soil, which formed in dredged spoil.

Figure 8.1c: Profile of a Riker soil, which formed in coal ash.

Figure 8.1d: Profile of an Inwood soil, which formed in construction debris.

Soil maps are usually made with aerial photographs as the background. Figure 8.2 is an example of a soil map of a dominantly urban area. By carefully examining the background aerial photograph, one can observe the streets and buildings of the urban area. The light blue areas are lakes or reservoirs. The soils delineated on the map have been separated from one another by black lines. Every delineation on the map has a set of letters that identifies the map unit. Examples of these map symbols are Ur, Urb, UpC, and CrC. The list of map unit symbols and map unit names is called a legend. The legend is very important because it can be used as a link to information or data about the map units. Those who need soil information must have the soil map, the legend, and the soil data or interpretations to make effective use of the soil information in planning onsite investigations for specific projects at the proper scale.

Help Evaluating in Your Soil and Urban Site

Local resource information can be obtained from soil scientists, professional gardeners or garden clubs, science teachers, city planners and planning boards, Master Gardeners, landscape contractors, private soil consultants, and local people with expertise gained through work on schools, outdoor worship areas, and parks. A field tour that involves a combination of these experts can be an effective learning experience (figure 8.3).

Local resource specialists can better assist you when you know some of the vocabulary that applies to urban soils, such as the terms used in this primer. Questions about site planning, landscaping, composting, and urban waste management may lead to a search of city laws and regulations including scientific terms. Management intended to reduce the risk to human health may require micro-engineering for urban sites and selection of certain plants that can grow well on the sites.

Figure 8.2: A map of dominantly urban soils.

Figure 8.3: A stop on a field tour of soils in Central Park, New York City.

The local Cooperative Extension Service provides brochures explaining how you can collect samples for soil testing and can help you to locate the nearest public university offering soil fertility tests at a low cost. The Cooperative Extension Service also trains Master Gardeners, local volunteers who can help you to manage garden plants and related insects and diseases (figure 8.4).

Figure 8.4: Adult working in a community garden plot.

The Urban Soil Quality Card includes some basic soil tests that you can perform before you plant a garden or vegetation in a park. The card was developed in Connecticut by local community groups with assistance from NRCS soil scientists and community planners. It is designed to be printed and used as written or with changes that you make to help you evaluate your specific site. It is available on the Internet (http://soils.usda.gov/sqi/soil_quality/assessment/cardguide.html).

Other sources of local soil expertise and assistance are youth program leaders and handbooks from organizations, such as Girl Scouts, Boy Scouts, 4H Clubs, Envirothon teams, the Science Bowl, school science fairs, the National Science Teacher's Association, the Future Farmers of America, and Vocational Agriculture Curriculum (figures 8.5, 8.6, and 8.7). Many of these resources are listed under the heading "References and Resources" in this primer.

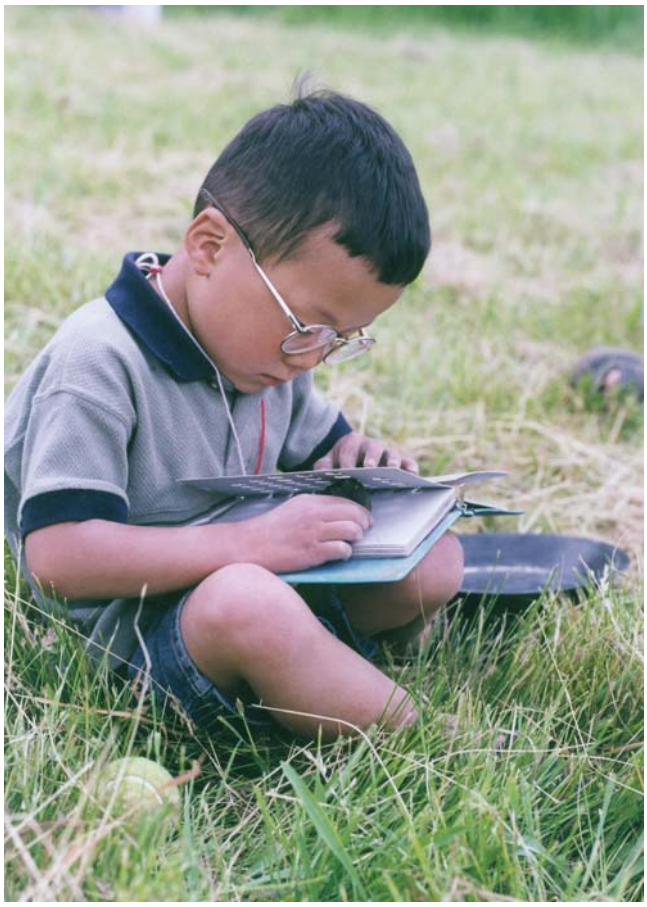

Figure 8.5: A boy with a soil color book.

Figure 8.6: Boys and girls testing soil.

Figure 8.7: Preliminary examination of soil in a backyard.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Compaction. Creation of dense soil layers when the soil is subject to the heavy weight of machinery or foot traffic, especially during wet periods.

Composting. Managing the decomposition of organic materials, such as leaves, grass, and garden waste.

Container gardens. Gardens planted in pots, concrete boxes, brick or stone basins, or other isolated rooting areas within paved areas.

Contaminated soil. A soil that has high concentrations of trace metals or organic waste that is toxic or a high risk to people or animals.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Heat islands. Small areas of artificially drained urban soils surrounded by tall buildings that change soil temperature and moisture patterns. May also refer to an entire city with an artificial microclimate.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Hydrologic unit or watershed. In urban areas, a catchment area with an outlet in or affecting a densely populated area.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Percolation. The movement of water through the soil.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as "saturated hydraulic conductivity."

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Pocket park. A relatively small area reserved for recreation or gardening and surrounded by streets or buildings.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Raised bed gardens. Gardens that are planted in boxes made of wood or other materials and have the rooting area above the ground surface. The boxes may be filled with composted materials mixed with uncontaminated soil.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline.

Relief. The elevations or inequalities of a land surface, considered collectively.

Restrictive layer. A compact, dense layer in a soil that impedes the movement of water and the growth of roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sealed soil. Soil that is covered with buildings, pavement, asphalt, or other material. Water and air do not enter the soil from the surface.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell potential. The potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Sinkhole. A depression in the landscape where limestone has been dissolved or lava tubes have collapsed.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil-forming factors. Five factors responsible for the formation of the soil from the unconsolidated parent material. The factors are time, climate, parent material, living organisms (including humans), and relief.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are platy, prismatic, columnar, blocky, and granular. Structureless soils are either single grained or massive.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Topographic maps (USGS). Maps that show terrain, ridges, waterways, contours, elevations, and geographic locations. Also may show roads and buildings.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

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Unified Classification and Properties of Soils

SOURCE: USDA/Soil Conservation Service
Engineering Field Manual
Chapter 4, Elementary Soil Engineering

Figure 4–I4.—**Unified classification and properties of soils.**

Typical Names	IMPORTANT PROPERTIES						Unified Soil Classes
	Shear Strength	Compress-ibility	Workability as Construction Material	Permeability			
				When Compacted	K Cm. Per Sec.	K Ft. Per Day	
Well graded gravels, gravel-sand mixtures, little or no fines.	Excellent	Negligible	Excellent	Pervious	$K > 10^{-2}$	$K > 30$	GW
Poorly graded gravels, gravel-sand mixtures, little or no fines.	Good	Negligible	Good	Very Pervious	$K > 10^{-2}$	$K > 30$	GP
Silty gravels, gravel-sand-silt mixtures.	Good to Fair	Negligible	Good	Semi-pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}	GM
Clayey gravels, gravel-sand-clay mixtures.	Good	Very Low	Good	Impervious	$K - 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	GC
Well graded sands, gravelly sands, little or no fines.	Excellent	Negligible	Excellent	Pervious	$K > 10^{-3}$	$K > 3$	SW
Poorly graded sands, gravelly sands, little or no fines.	Good	Very Low	Fair	Pervious	$K > 10^{-3}$	$K > 3$	SP
Silty sands, sand-silt mixtures.	Good to Fair	Low	Fair	Semi-pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}	SM
Clayey sands, sand-clay mixtures.	Good to Fair	Low	Good	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	SC
Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	Fair	Medium to High	Fair	Semi-pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}	ML
Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Fair	Medium	Good to Fair	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	CL
Organic silts and organic silty clays of low plasticity.	Poor	Medium	Fair	Semi-pervious to Impervious	$K = 10^{-4}$ to 10^{-6}	$K = 3 \times 10^{-3}$ to 3×10^{-3}	OL
Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Fair to Poor	High	Poor	Semi-pervious to Impervious	$K = 10^{-4}$ to 10^{-6}	$K = 3 \times 10^{-1}$ to 3×10^{-3}	MH
Inorganic clays of high plasticity, fat clays.	Poor	High to Very High	Poor	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	CH
Organic clays of medium to high plasticity, organic silts.	Poor	High	Poor	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	OH
Peat and other highly organic soils	Not Suitable for Construction						Pt

Figure 4–I4.—**Unified classification and properties of soils — Continued.**

EMBANKMENTS								
Compaction Characteristics	Standard Procter Unit Density (Lbs. per cu. ft.)	Type of Roller Desirable	Relative Characteristics: Permeability	Relative Characteristics: Compressibility	Resistance to Piping	Ability to Take Plastic Deformation Under Load Without Shearing	General Description & Use	Unified Soil Classes
Good	125-135	Crawler tractor or steel wheeled & vibratory	High	Very Slight	Good	None	Very stable, pervious shells of dikes and dams.	GW
Good	115-125	Crawler tractor or steel wheeled & vibratory	High	Very Slight	Good	None	Reasonably stable, pervious shells of dikes and dams.	GP
Good with close control	120-135	Rubber-tired or sheepsfoot	Medium	Slight	Poor	Poor	Reasonably stable, not well suited to shells but may be used for impervious cores or blankets.	GM
Good	115-130	Sheepsfoot or rubber-tired	Low	Slight	Good	Fair	Fairly stable, may be used for impervious core.	GC
Good	110-130	Crawler tractor & vibratory or steel wheeled	High	Very Slight	Fair	None	Very stable, pervious sections, slope protection required.	SW
Good	100-120	Crawler tractor & vibratory or steel wheeled	High	Very Slight	Fair to Poor	None	Reasonably stable, may be used in dike with flat slopes.	SP
Good with close control	110-125	Rubber-tired or sheepsfoot	Medium	Slight	Poor to Very Poor	Poor	Fairly stable, not well suited to shells, but may be used for impervious cores or dikes.	SM
Good	105-125	Sheepsfoot or rubber-tired	Low	Slight	Good	Fair	Fairly stable, use for impervious core for flood control structures.	SC
Good to Poor. Close control essential	95-120	Sheepsfoot	Medium	Medium	Poor to Very Poor	Very Poor	Poor stability, may be used for embankments with proper control. *Varies with water content.	ML
Fair to Good	95-120	Sheepsfoot	Medium	Medium	Good to Fair	Good to Poor	Stable, impervious cores and blankets.	CL
Fair to Poor	80-100	sheepsfoot	Medium to Low	Medium to High	Good to Poor	Fair	Not suitable for embankments.	OL
Poor to Very Poor	70-95	Sheepsfoot	Medium to Low	Very High	Good to Poor	Good	Poor stability, core of hydraulic fill dam, not desirable in rolled fill construction.	MH
Fair to Poor	75-105	Sheepsfoot	Low	High	Excellent	Excellent	Fair stability with flat slopes, thin cores, blanket & dike sections.	CH
Poor to Very Poor	65-100	Sheepsfoot	Medium to Low	Very High	Good to Poor	Good	Not suitable for embankments.	OH
Do Not Use for Embankment Construction								Pt

Figure 4–14.—**Unified classification and properties of soils — Continued.**

TENTATIVE FOR TRIAL USE ONLY							
CHANNELS Long duration to constant flows.		FOUNDATION Foundation soils, being undisturbed, are influenced to a great degree by their geologic origin. Judgment and testing must be used in addition to these generalizations.					
RELATIVE DESIRABILITY		RELATIVE DESIRABILITY					Unified Soil Classes
Erosion Resistance	Compacted Earth Lining	Bearing Value	Seepage Important	Seepage Not Important	Requirements for Seepage Control: Permanent Reservoir	Requirements for Seepage Control: Floodwater Retarding	
1	—	Good	—	1	Positive cutoff or blanket	Control only within volume acceptable plus pressure relief if required.	GW
2	—	Good	—	3	Positive cutoff or blanket	Control only within volume acceptable plus pressure relief if required.	GP
4	4	Good	2	4	Core trench to none	None	GM
3	1	Good	1	6	None	None	GC
6	—	Good	—	2	Positive cutoff or upstream blanket & toe drains or wells	Control only within volume acceptable plus pressure relief if required.	SW
7 if gravelly	—	Good to poor depending upon density	—	5	Positive cutoff or upstream blanket & toe drains or wells	Control only within volume acceptable plus pressure relief if required.	SP
8 if gravelly	5 erosion critical	Good to Poor depending upon density	4	7	Upstream blanket & toe drains or wells	Sufficient control to prevent dangerous seepage piping.	SM
5	2	Good to Poor	3	8	None	None	SC
—	6 erosion critical	Very Poor; susceptible to liquefication	6, if saturated or pre-wetted	9	Positive cutoff or upstream blanket & toe drains or wells	Sufficient control to prevent dangerous seepage piping.	ML
9	3	Good to Poor	5	10	None	None	CL
—	7 erosion critical	Fair to Poor; may have excessive settlement	7	11	None	None	OL
—	—	Poor	8	12	None	None	MH
10	8 volume change critical	Fair to Poor	9	13	None	None	CH
—	—	Very Poor	10	14	None	None	OH
—	—	REMOVE FROM FOUNDATION					Pt

Soil Compaction Guidelines

Source: USDA/Soil Conservation Service
Soil Mechanics Training Series
Module 5, Compaction

ACTIVITY 7
Summary of Compaction Characteristics of Unified Soil Classes

USCS CLASS	RELATIVE EASE OF COMPACTION	BEST SUITED EQUIPMENT	COMPACTED LIFT THICKNESS	IMPORTANCE OF WATER CONTENT CONTROL
GW	Very Easy	Vibratory Roller Crawler Tractor	10 -12 Inches	Either Dry Or Saturated
GP	Good To Excellent	Vibratory Roller Crawler Tractor	10 - 12 Inches	Either Dry Or Saturated
GM	Good With Close Control	Rubber-Tired Or Tamping Roller	6 - 8 Inches	Fairly Important
GC	Good	Tamping Or Rubber-Tired Roller	6 Inches	Very Important
SW	Excellent	Crawler Tractor Vibratory Roller	10 - 12 Inches	Either Dry Or Saturated
SP	Fair	Crawler Tractor Vibratory Roller	10 - 12 Inches	Either Dry Or Saturated
SM	Fair	Rubber-Tired Or Tamping Roller	6 - 8 Inches	Important
SC	Good	Tamping Or Rubber-Tired Roller	6 Inches	Very Important

Continued to next page

ACTIVITY 7 (continued)
Summary of Compaction Characteristics of Unified Soil Classes

USCS CLASS	RELATIVE EASE OF COMPACTION	BEST SUITED EQUIPMENT	COMPACTED LIFT THICKNESS	IMPORTANCE OF WATER CONTENT CONTROL
ML	Fair	Tamping Roller	6 Inches	Important
CL	Good To Fair	Tamping Roller	6 Inches	Very Important
OL	Fair	Tamping Roller	6 Inches	Important
MH	Poor	Tamping Roller	6 Inches	Very Important
CH	Very Poor	Tamping Roller	6 Inches	Critical
OH	Very Poor	Tamping Roller	6 Inches	Important
Pt	Not Suitable			

ACTIVITY 7 Summary of Compaction Characteristics of Unified Soil Classes				
UNIFIED CLASS	PREFERRED TYPE OF EQUIPMENT	NUMBER OF PASSES	TYPICAL DRY UNIT WEIGHTS (PFC)	TYPICAL WATER CONTENTS (%)
GW	Crawler Tractor Vibratory Roller	3-4	125-135	9-12
GP	Crawler Tractor Vibratory Roller	3-4	115-125	12-16
GM	Rubber-Tired Tamping Roller	3-5	120-135	8-13
GC	Tamping Roller Rubber-Tired	6-8	115-130	9-14
SW	Crawler Tractor Vibratory Roller	3-4	110-130	10-18
SP	Crawler Tractor Vibratory Roller	3-4	100-120	13-22
SM	Rubber-Tired Tamping Roller	6-8	110-125	10-16
SC	Tamping Roller Rubber-Tired	4-6	105-125	10-18
ML	Tamping Roller	4-6	95-120	12-22
CL	Tamping Roller	4-6	95-120	12-22
MH	Tamping Roller	4-6	70-95	22-40

Continue to next page

ACTIVITY 7 (continued) Summary of Compaction Characteristics of Unified Soil Classes				
UNIFIED CLASS	PREFERRED TYPE OF EQUIPMENT	NUMBER OF PASSES	TYPICAL DRY UNIT WEIGHTS (PFC)	TYPICAL WATER CONTENTS (%)
CH	Tamping Roller	4-6	75-105	20-40
OL	Tamping Roller	4-6	80-100	20-32
OH	Tamping Roller	4-6	65-100	20-45
Pt	Not suitable for most fills - usually placed with draglines and little compaction			

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Colorado Master Gardener[sm] Program
Colorado Gardener Certificate Training
Colorado State University Extension

GardenNotes #214

Estimating Soil Texture

Sandy, Loamy or Clayey?

Outline:

Sand, silt, and clay, page 1
Soil texture triangle, page 2
Identifying soil texture by feel, page 3
Identifying soil texture by measurement, page 5

Note: For additional information on managing soils refer to CMG GardenNotes #213, *Managing Soil Tilth*.

Sand, Silt and Clay

Texture refers to the size of the particles that make up the soil. The terms ***sand***, ***silt***, and ***clay*** refer to relative sizes of the soil particles. Sand, being the larger size of particles, feels gritty. Clay, being the smaller size of particles, feels sticky. It takes 12,000 clay particles lined up to measure one inch. Silt, being moderate in size, has a smooth or floury texture. [Table 1 and Figure 1]

Table 1. The Size of Sand, Silt and Clay

Name	particle diameter
Very coarse sand	2.0 to 1.0 millimeters
Coarse sand	1.0 to 0.5 millimeters
Medium sand	0.5 to .25 millimeters
Fine sand	0.25 to 0.10 millimeters
Very fine sand	0.10 to 0.05 millimeters
Silt	0.05 to 0.002 millimeters
Clay	below 0.002 millimeters

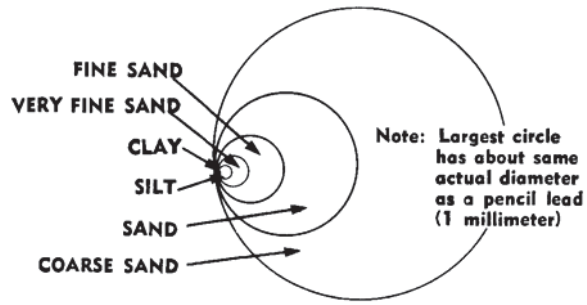
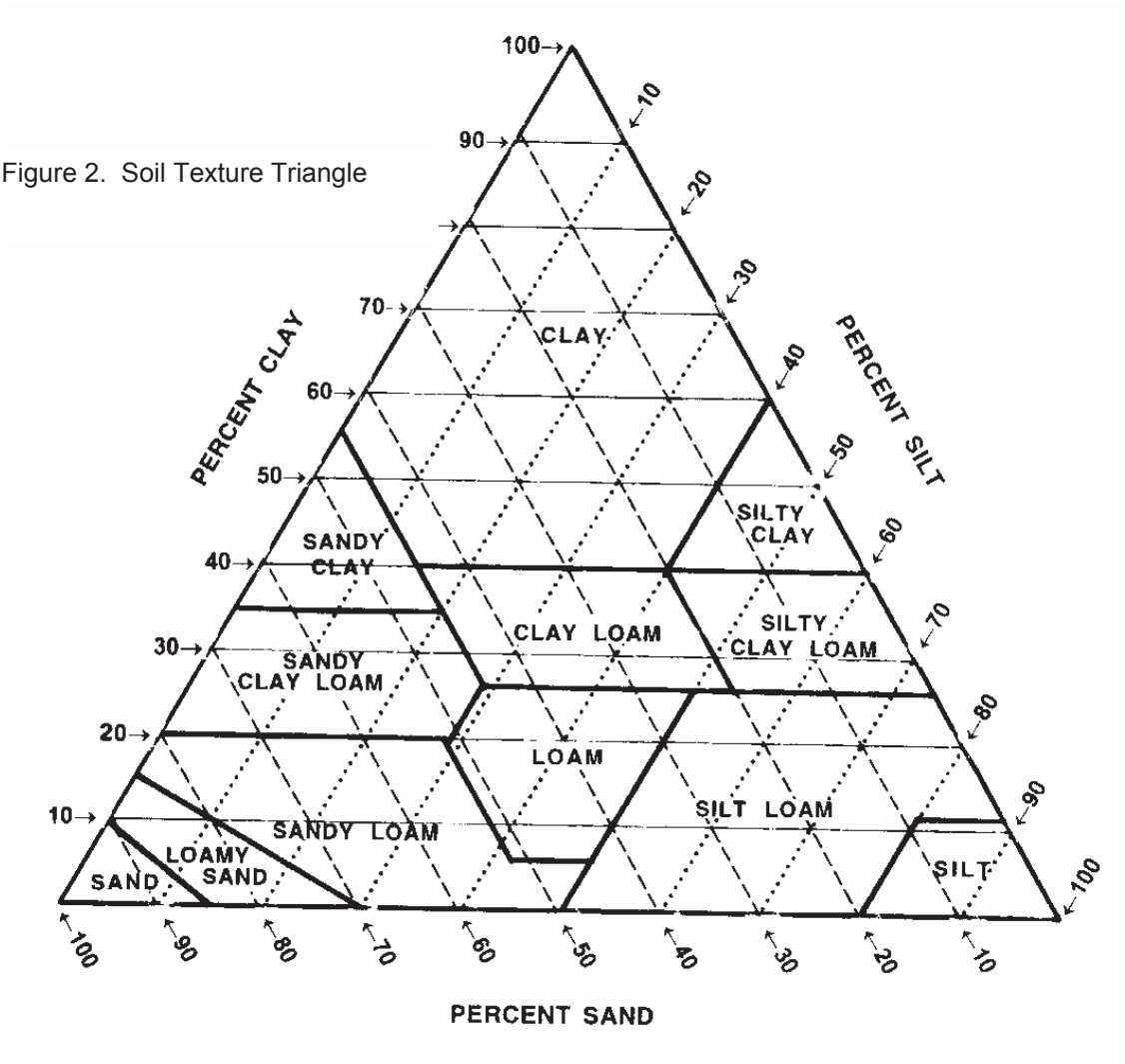


Figure 1. Comparative size of sands, silt and clay

Soil Texture Triangle

The ***soil texture triangle*** gives names associated with various combinations of sand, silt and clay. A ***coarse-textured*** or ***sandy*** soil is one comprised primarily of medium to coarse size sand particles. A ***fine-textured*** or ***clayey*** soil is one dominated by tiny clay particles. Due to the strong physical properties of clay, a soil with only 20% clay particles behaves as sticky, gummy clayey soil. The term ***loam*** refers to a soil with a combination of sand, silt, and clay sized particles. For example, a soil with 30% clay, 50% sand, and 20% silt is called a *sandy clay loam.* [Figure 2]

Figure 2. Soil Texture Triangle



Identifying Texture by Feel

Feel test – Rub some moist soil between fingers

- Sand feels gritty
- Silt feels smooth
- Clays feel sticky

Ball squeeze test – Squeeze a moistened ball of soil in the hand

- Coarse textures (sand or sandy loam) soils break with slight pressure
- Sandy loams and silt loams stay together but change shape easily
- Fine textured (clayey or clayey loam) soils resist breaking

Ribbon test – Squeeze a moistened ball of soil out between thumb and fingers

- Sandy or sandy soils won't ribbon
- Loam, silt, silty clay loam or clay loam soil ribbons less than 1 inch
- Sandy clay loam, silty clay loam or clay loam ribbons 1 to 2 inches
- Sandy clay, silty clay, or clay soil ribbons more than 2 inches

Note: A soil with as little as 20% clay may behave as a heavy clayey soil. A soil needs 45% to over 60% sand to behave as a sandy soil.

Soil Texture by Feel

Start: Place soil in palm of hand. Add water drop-wise and knead the soil into a smooth and plastic consistency, like moist putty.
Does the soil remain in a ball when squeezed?

- Yes → Place ball of soil between thumb and forefinger
- No → Is the soil too dry?
  - Yes → Add more water → Is the soil too dry?
  - No → Is the soil too wet?
    - Yes → Add dry soil → Is the soil too wet?
    - No → **Sand**

Place ball of soil between thumb and forefinger, gently pushing the soil between with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow ribbon to emerge and extend over the forefinger, breaking from its own weight.
Does the soil form a ribbon?

- Yes → What kind of ribbon does it form?
- No → **Loamy Sand**

What kind of ribbon does it form?

Moisten a pinch of soil in palm and rub with forefinger

	Forms a weak ribbon less than 1" before breaking **LOAM**	Forms a ribbon 1-2" before breaking **CLAY LOAM**	Forms a ribbon 2" or longer before breaking **CLAY**
Does it feel very gritty? Yes	**Sandy Loam**	**Sandy Clay Loam**	**Sandy Clay**
Does it feel equally gritty and smooth? Yes	**Loam**	**Clay Loam**	**Clay**
Does it feel very smooth? Yes	**Silt Loam**	**Silty Clay Loam**	**Silty Clay**

Identifying Soil Texture by Measurement

1. Spread soil on a newspaper to dry. Remove all rocks, trash, roots, etc. Crush lumps and clods.
2. Finely pulverize the soil.
3. Fill a tall, slender jar (like a quart jar) ¼ full of soil.
4. Add water until the jar is ¾ full.
5. Add a teaspoon of powdered, non-foaming dishwasher detergent.
6. Put on a tight fitting lid and shake hard for 10 to 15 minutes. This shaking breaks apart the soil aggregates and separates the soil into individual mineral particles.
7. Set the jar where it will not be disturbed for 2-3 days.

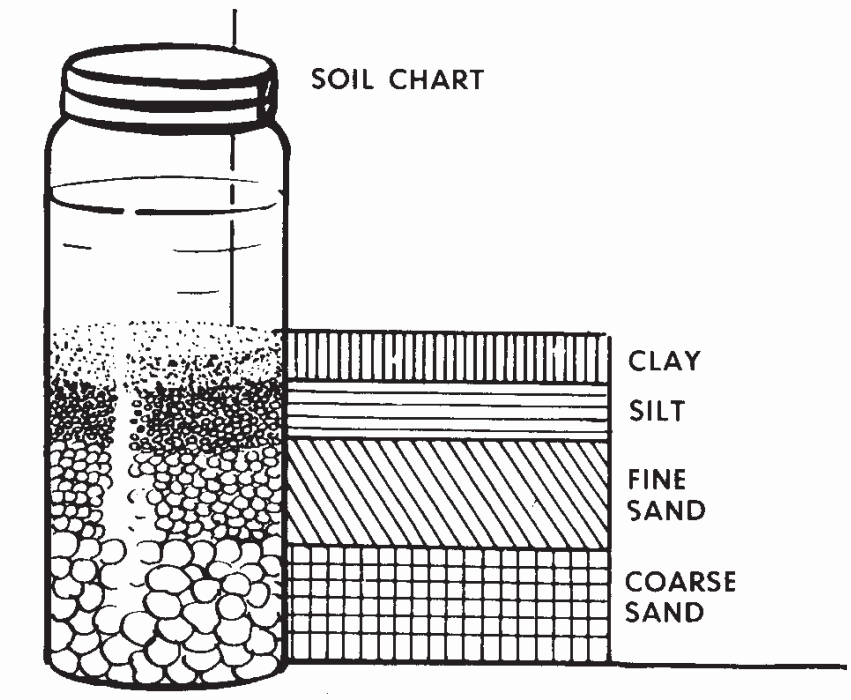
8. Soil particles will settle out according to size. **After 1 minute,** mark on the jar the depth of the sand.

9. **After 2 hours,** mark on the jar the depth of the silt

10. **When the water clears** mark on the jar the clay level. This typically takes 1 to 3 days, but with some soils it may take weeks.

11. Measure the thickness of the sand, silt, and clay layers.
    a. Thickness of sand deposit ____
    b. Thickness of silt deposit ____
    c. Thickness of clay deposit ____
    d. Thickness of total deposit ____

12. Calculate the percentage of sand, silt, and clay.



[clay thickness]
---------- = ___ percent clay
[total thickness]

[silt thickness]
---------- = ___ percent silt
[total thickness]

[sand thickness]
---------- = ___ percent sand
[total thickness]

13. Turn to the soil texture triangle and look up the soil texture class.

Additional Information – *CMG GardenNotes* on Soils, Fertilizers and Soil Amendments:

#211 The Living Soil
#212 Earthworms
#213 Managing Soil Tilth
#214 Estimating Soil Texture
#215 Soil Compaction
#216 Mulching with Wood/Bark Chips, Grass Clippings and Rock
#217 Soil Drainage
#221 Soil Tests
#222 Soil pH
#223 Iron Chlorosis
#224 Saline Soils
#231 Plant Nutrition
#232 Understanding Fertilizers
#233 Calculating Fertilizer Rates
#234 Organic Fertilizers
#241 Soil Amendments
#242 Using Manure
#243 Using Compost
#244 Cover Crops and Green Manure Crops

Authors: David Whiting, Adrian Card and Carl Wilson: Colorado State University Cooperative Extension

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Colorado Master Gardener

Revised December 2006

Chapter 3

Erosion and Sediment Control Plans & Conducting the Site Review

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STANDARD AND SPECIFICATIONS FOR ESC FOR MINOR DEVELOPMENT

Definition: Guidelines for controlling erosion and sediment during the development of relatively small sites.

Purpose: To prevent soil from eroding from a site and damaging adjacent properties or degrading nearby watercourses.

Conditions Where Practice Applies: This standard was primarily developed for sites that qualify for the issuance of a Standard Plan and which therefore lack detailed Erosion & Sediment Control Plans. However, the guidelines may also be applicable for controlling individual lots within larger sites having such plans.

Planning Considerations:

Erosion control is important on any building site regardless of its size. Usually, the principles and methods for controlling erosion and reducing off-site sedimentation are relatively simple and inexpensive. The following are four basics to be followed when developing a building site.

1. **Evaluate the site.** Inventory and evaluate the resources on the lot before building. Location of structures should be based, in large part, on the lot's natural features. Identify trees that you want to save and vegetation that will remain during construction. Also identify areas where you want to limit construction traffic. Wherever possible, preserve existing vegetation to help control erosion and off-site sedimentation.

2. **Select and install erosion/sediment control practices.** Determine the specific ones needed, and install them before clearing the site. Among the more commonly used practices are vegetative stabilization, silt fence, stabilized construction entrances, and runoff inlet protection.

3. **Develop a practice maintenance program.** Maintenance of all practices is essential for them to function properly. They should be inspected twice a week and after each rainfall event. When a problem is identified, repair the practice immediately. Also, any sediment that is tracked onto the street must be scraped and deposited in a stable area. Do not flush sediment from the street with water.

4. **Revegetate the site.** Do so as soon as possible. A well-maintained lot has a higher sale potential.

Guidelines for Building Lot Drainage

The best time to provide for adequate lot drainage is before construction begins. With proper planning, most drainage problems can be avoided. Correcting a problem after it occurs is usually much more difficult and costly. The following are some guidelines to ensure good lot surface and subsurface drainage.

1. Surface drainage

a. Position the structure a minimum of 18 inches above street level.

b. Divert storm water runoff away from the structure by grading the lawn in accordance with local building code requirements.

c. Construct side and rear yard swales to take surface water away from the structure.

d. Avoid filling in existing drainage channels and roadside ditches, since that could result in wetness problems on someone else's property and/or damage to adjacent road surfaces.

2. Subsurface drainage

a. Provide an outlet for foundation or footer drains and for general lot drainage by using storm sewers (where allowed), or obtain drainage easements if you must cross adjoining properties.

b. If an existing field drainage tile is accidentally cut, assume that it carries water even if currently dry; therefore, reroute it (using the equivalent pipe size) around the structure or septic field, then reconnect it.

Construction Sequence for Building Site Erosion Control Practices

It is important to note that the following construction sequence is meant to be for illustrative purposes only and may not be applicable for all building lots. An individual plan should be developed for specific site conditions which preclude the use of this standard.

1. Evaluate the site.

Before construction, evaluate the entire site, marking for protection any important trees and associated rooting zones, unique areas to be preserved, on-site septic system absorption fields, and vegetation suitable for filter strips, especially in perimeter areas.

a. *Identify vegetation to be saved*

Select and identify the trees, shrubs, and other vegetation that you want to save (see "Vegetative Filter Strips" under Step 2).

b. *Protect trees and sensitive areas*

To prevent root damage, do not grade, burn, place soil piles, or park vehicles near trees or in areas marked for preservation. Place plastic mesh or snow fence barriers around the trees' dripline to protect the area below their branches. Place a physical barrier, such as plastic fencing, around the area designated for a septic system absorption field (if applicable).

2. Install perimeter erosion and sediment controls.

Identify the areas where sediment-laden runoff could leave the construction site, and install perimeter controls to minimize the potential for off-site sedimentation. It's important that perimeter controls are in place before any other earth-moving activities begin.

a. Protect down-slope areas with vegetative filter strips. On slopes of less than 6 percent, preserve a 20 to 30 foot wide vegetative buffer strip around the perimeter of the property, and use it as a filter strip for trapping sediment. Do not mow filter strip vegetation shorter than 4 inches.

b. Protect down-slope areas with silt fence. Use silt fencing along the perimeter of the lot's downslope side(s) to trap sediment.

c. Restrict all lot access to a stabilized entrance to prevent vehicles from tracking mud onto roadways.

d. Protect storm drain inlets. Install inlet protection on nearby storm drain inlets.

3. Prepare the site for construction.

Prepare the site for construction and for installation of utilities. Make sure all contractors (especially the excavating contractor) are aware of areas to be protected.

4. Salvage and stockpile the topsoil/subsoil

Remove topsoil (typically the upper 4 to 6 inches of soil material) and stockpile. Remove subsoil and stockpile separately from the topsoil. Locate the stockpiles away from any downslope street, driveway, stream, lake, wetland, ditch, or drainageway. Immediately after stockpiling, temporary-seed the stockpiles with annual rye and/or place silt fence around the perimeter of the piles.

5. Build the structure(s) and install the utilities.

Construct the home and install the utilities; also install the sewage disposal system and drill the water well (if applicable); then consider the following.

6. Install downspout extenders

Downspout extenders are highly recommended as a means of preventing lot erosion from roof runoff. Add the extenders as soon as the gutters and downspouts are installed. Be sure the extenders have a stable outlet, such as the street, sidewalk, or a well vegetated area.

7. Maintain the control practices.

a. Maintain all erosion and sediment control practices until construction is completed and the lot is stabilized.

b. Inspect the control practices a minimum of twice a week and after each storm event, making any needed repairs immediately. Toward the end of each work day, sweep or scrape up any soil tracked onto roadways. Do not flush areas with water. By the end of the next work day after a storm event, clean up any soil washed off-site.

8. Revegetate the building site.

Immediately after all outside construction activities are completed, stabilize the lot with sod or seed and straw mulch.

a. *Redistribute the stockpiled subsoil and topsoil.*

Spread the stockpiled subsoil to rough grade. Spread the stockpiled topsoil to a depth of 4 to 6 inches over roughgraded areas. Fertilize and lime according to soil test results or recommendations of a seed supplier or a professional landscaping contractor.

b. *Seed or sod bare areas.*

Contact local seed suppliers or professional landscaping contractors for recommended seeding mixtures and rates. Follow recommendations of a professional landscaping contractor for installation of sod. Water newly seeded/sodded areas every day or two to keep the soil moist. Less watering is needed once grass is 2 inches tall.

c. *Mulch newly seeded areas.*

Spread straw mulch on newly seeded areas, using 1 to 2 bales of straw per 1,000 square feet. On flat or gently sloping land, anchor the mulch by crimping it 2 to 4 inches into the soil or use a tackifer (adhesive binder). On steep slopes, anchor the mulch with netting or tackifiers. An alternative to anchored mulch would be the use of erosion control blankets.

9. Remove remaining temporary control measures.

Once the sod and/or vegetation is well established, remove any remaining temporary erosion and sediment control practices, such as:

a. *Downspout extenders.* (Or shorten to outlet onto the vegetated areas, allowing for maximum infiltration).

b. *Storm drain inlet protection measures.*

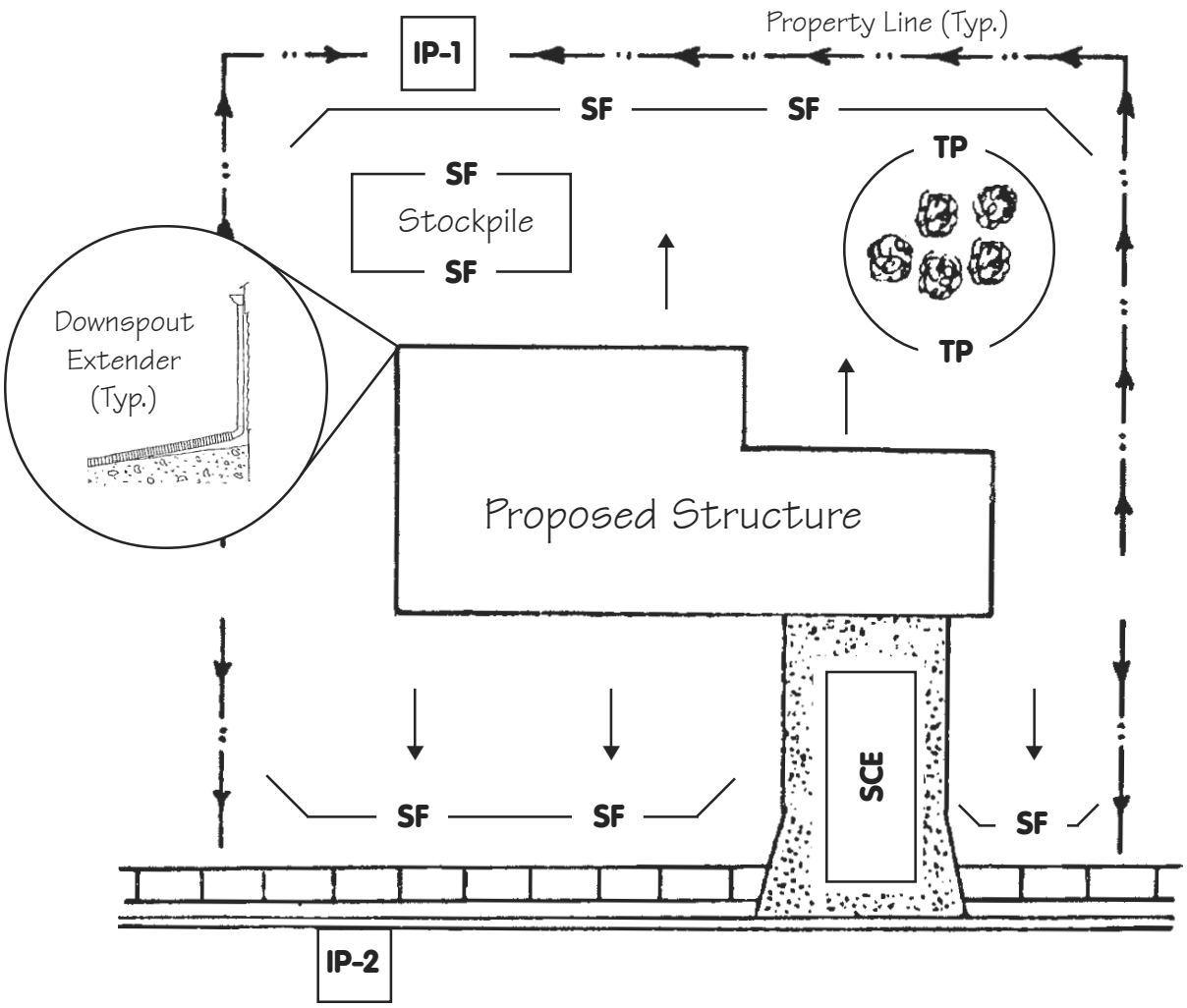
c. *Silt fence.*

Reference:

Indiana Dept. of Natural Resources, Division of Soil Conservation, *"Erosion Control for the Home Builder"* (1/96)

Standard Detail & Specifications

ESC for Minor Development



LEGEND

Flow	→	Inlet protection - Type 1	IP-1
Silt Fence	SF		
Tree Protection	TP		
Stabilized Construction Entrance	SCE	Inlet Protection - Type 2	IP-2

Source:	Symbol:	Detail No.
Adapted from IN DNR, "Erosion Control for the Home Builder"		**DE-ESC-3.7.1** Sheet 1 of 2 Date: 12/03

ESC for Minor Development

Construction Notes:

1. Evaluate the Site.
   a. Identify Vegetation To Be Saved
   b. Protect Trees and Sensitive Areas
2. Install Perimeter Erosion And Sediment Controls.
   a. Protect down-slope areas with vegetative filter strips.
   b. Protect down-slope areas with silt fence.
   c. Restrict all lot access to stabilized construction entrance to prevent vehicles from tracking mud onto roadways.
   d. Install inlet protection on nearby storm drain inlets.
3. Prepare the Site for Construction.
4. Salvage and Stockpile the Topsoil/Subsoil
5. Build the Structure(s) and Install the Utilities.
6. Install Downspout Extenders
7. Maintain the Control Practices.
   a. Maintain all erosion and sediment control practices until construction is completed and the lot is stabilized.
   b. Inspect the control practices a minimum of twice a week and after each storm event, making any needed repairs immediately.
8. Revegetate the Building Site.
   a. Redistribute the stockpiled subsoil and topsoil.
   b. Seed or sod bare areas.
   c. Mulch newly seeded areas.
9. Remove Remaining Temporary Control Measures.

Source:	Symbol:	Detail No.
Adapted from IN DNR, "Erosion Control for the Home Builder"		**DE-ESC-3.7.1** Sheet 2 of 2 Date: 12/03

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READING AND INTERPRETING EROSION AND SEDIMENT CONTROL PLANS

COMPONENTS OF AN EROSION AND SEDIMENT CONTROL PLAN

An erosion and sediment control plan is a document which (1) describes the potential for erosion and sedimentation problems on a construction project, and (2) explains and illustrates the measures to be used to prevent or control those problems.

An erosion and sediment control plan is composed of two parts; a narrative and a site plan. The narrative is a written document explaining site conditions, erosion and sediment control decisions and the justifications for those decisions. The site plan is a map that visually documents the site conditions and the locations and details of selected control practices.

The narrative is important because it identifies problems and provides information not apparent from the site plan. It should answer most questions raised in reference to the sit plan. Although not commonly referred to by construction personnel, the narrative can be very useful to a job superintendent who may have questions about the plan. Inspectors will also want to have a copy of the narrative to ensure that they fully understand all the concerns and requirements of the plan.

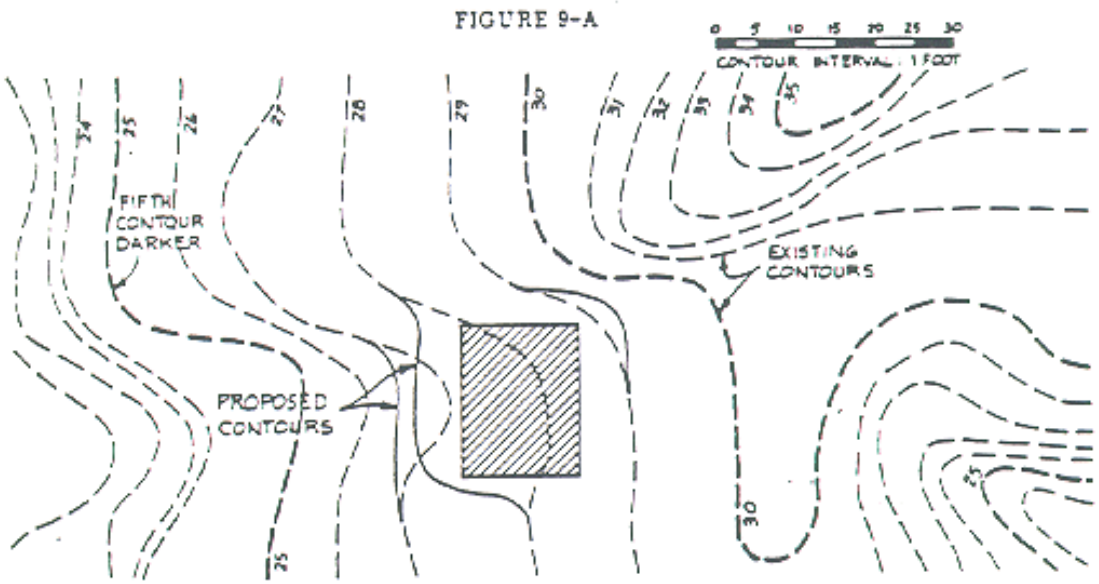
INTERPRETING CONTOUR LINES (from Grad Easy, by Untermann)

A contour line is a line drawn on a plan which connects all points of equal elevation above or below a known or assumed reference point or plane (usually mean se level). Contour lines show land forms; i.e., a hill, a valley, a ridge line, etc. They also show the relationships of land forms – this hill to that valley, to this stream and ultimately to the ocean, etc. Changing contour lines results in a change of land form. To "move" a contour line half an inch on a plan may mean in reality moving a ton of earth 50 feet.

As contours are shown two-dimensionally (on the map), the scaled distance between them is exactly the same as in the field. All grading plans have a vertical contour interval which should remain the same over the entire drawing. This interval stands for the vertical distance between contours, and is always indicated somewhere on the plan. In an area of slight relief or generally flat and level country, the vertical interval may be as slow as one foot, whereas in steep terrain, it may be as large as 50 to 100 feet or more.

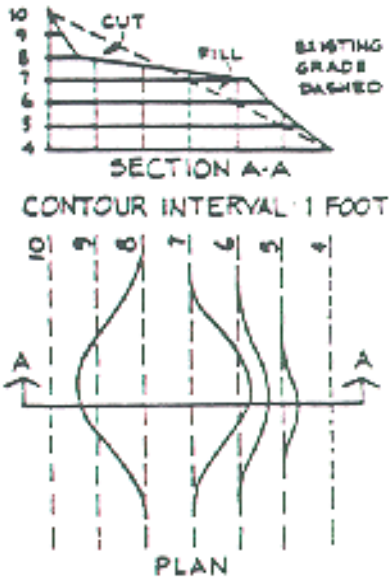
Proposed and existing contours are both shown on the same drawing. By showing both on the same drawing, it is possible to understand the exact location of work to be performed and the exact amount of work to be done (see Figure 9-A). Existing contours are shown by a light dashed line (usually ¼" long, spaced about 1/16" apart). Every fifth contour is shown slightly darker for easy legibility. Proposed contours are shown as a solid light line. This solid line begins where you propose to make a grading change, and moves away from the existing (dashed) contour, returning to the existing (dashed) contour at the end of the proposed grading change. It is therefore possible to "read" the change by studying the area between proposed contours and existing contours.

FIGURE 9-A



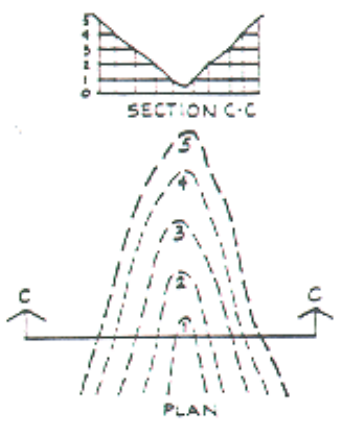
"Reading" changes in contours is tricky, but c
mastered with practice. Basically, proposed g
changes either add earth (called filling) or remove
(called cutting). A proposed contour which moves
direction of a lower contour is adding earth (filling
instance (See Figure 9-B), proposed Contour 7 mo
the direction of a lower contour (6) and indicates
Conversely, a proposed contour which moves
direction of a higher contour is removing earth (cu
This can be seen where Contour 8 moves in the dir
of Contour 9 and is removing earth (cutting).
amount of earth to be added or removed c
determined by comparing the proposed contour w
existing contours it crosses.

FIGURE 9-B



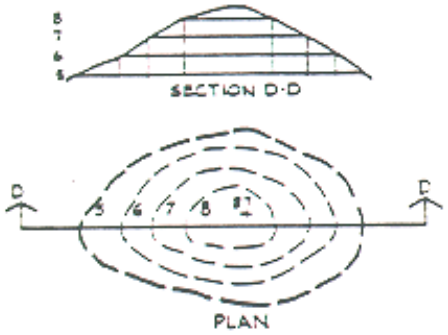
Profiles or cross-sections can be constructed from contours and conversely, contour locations can be determined from profiles. A freehand construction of a cross-section is the best way to understand what the contours are doing. The following are most typical forms found in grading:

FIGURE 9-C



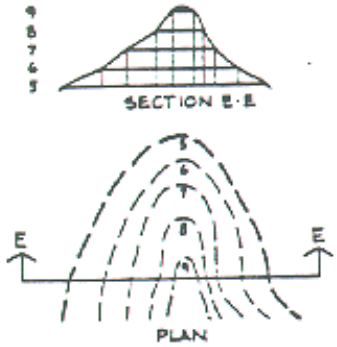
A Valley or swale is represented by contours which point toward the higher numbers. To construct the section, draw first the place where the section is to be taken (labeled 'A'), then project up, parallel lines at each place a contour crosses 'A'. Somewhere above, draw lines parallel to 'A' and scaled according to the contour interval. Where the two lines cross becomes the section line, and one has only to connect these points to complete the section.

FIGURE 9-D

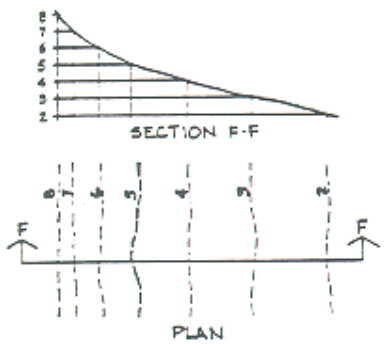


A Summit is indicated by concentric closed contours, and adequate contour labeling to distinguish it from a depression. Depressions are often labeled with hachures and both forms should include spot elevations at the highest or lowest point.

FIGURE 9-E

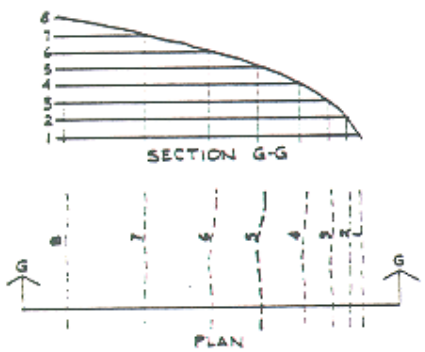


A Ridge is shown similar to a valley, but with the contours pointing toward the lower numbers (note carefully the contour labeling for this is the easiest way to determine if it is a ridge or valley). Ridges and valleys often are very wide and difficult to distinguish on a large scale map.



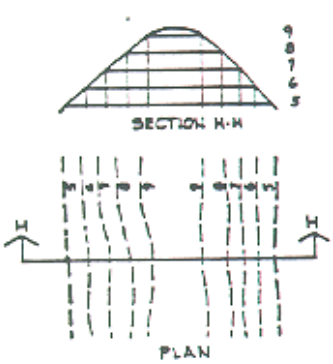
A Concave Slope is shown with parallel contours, each spaced farther apart starting with the closely spaced contours at the top.

FIGURE 9-G



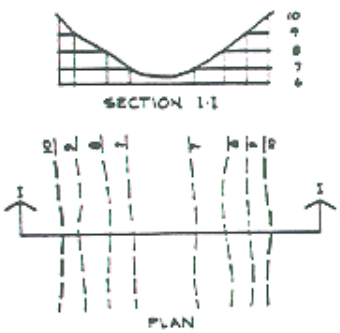
Conversely,
A Convex Slope is shown with parallel contours, each spaced farther apart with the closer contours at the lower elevations. Convex and concave landforms are the most common forms found in nature and should be well understood by plan preparers and plan reviewers.

FIGURE 9-H



Two Adjacent Contours with same numbers indicate either top of a ridge (left) or the bo of a valley (right). Again, numbering indicates which it i check carefully.

FIGURE 9-I



Drainage always occurs perpendicular (at right angles) to the contours. The perpendicular line is the shortest distance between contours, and hence the steepest route (see Figure 9-J). Water naturally seeks the easiest (steepest) route as it travels downhill in runoff. Channels, ditches and valleys are indicated by contours which point uphill and are sometimes made obvious by drawing an arrow in the direction of drainage, or labeling it as SWALE. (Figure 9-K)

FIGURE 9-J

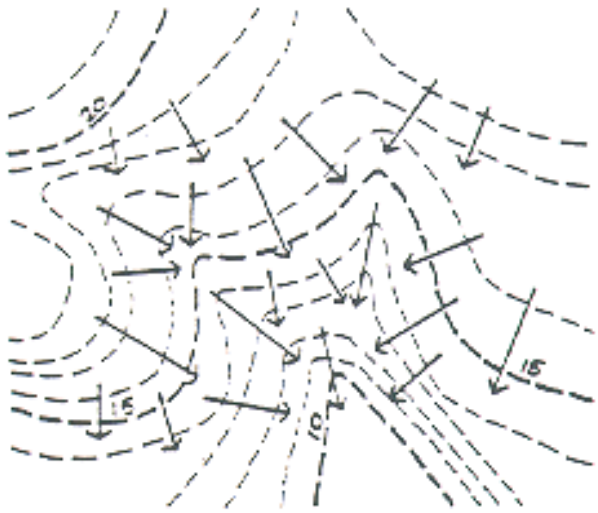
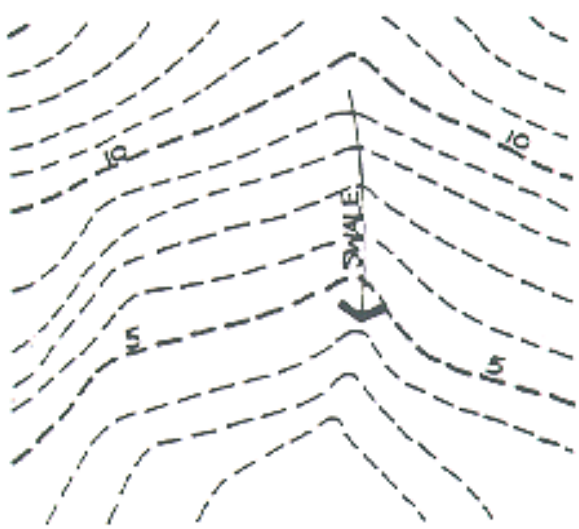


FIGURE 9-K



CHARACTERISTICS OF CONTOURS (See Figure9-L for clarification)

1. All points on a contour line have the same elevation. A contour line connects points of equal elevation.

2. Every contour closes on itself within or beyond the limits of the map. In the latter case, the contour will not end on the map but will run to the edges.

3. A contour which closes on itself within the limits of a map is either a summit or a depression. A depression is usually indicated by the elevation at the lowest point, a spot elevation or the letter 'D' placed there. A depression is also indicated by placing short hachure marks on the low side of the contour line (see No. 3 for depression and 3a. for summit).

4. Contour lines never cross other contours except where there is an over-hanging cliff, natural bridge or pierced or arched rock.

5. Contours which are equally spaced indicate a uniform sloping surface (see No. 5)

6. On a convex slope, contours are spaced at increasing intervals going up a hill: higher contours are spaced farther apart than the lower contour lines (see No. 6).

7. On a concave slope, the contours are spaced at increasing intervals with the lower contour lines spaced farther apart than the higher ones (see No. 7).

8. Valleys are indicated by contours pointing uphill (see No. 8). In crossing a valley, the contour lines run up the valley on one side, turn at the stream and run back the other side.

9. Generally, contours which are close together indicate a steep slope (see No. 9).

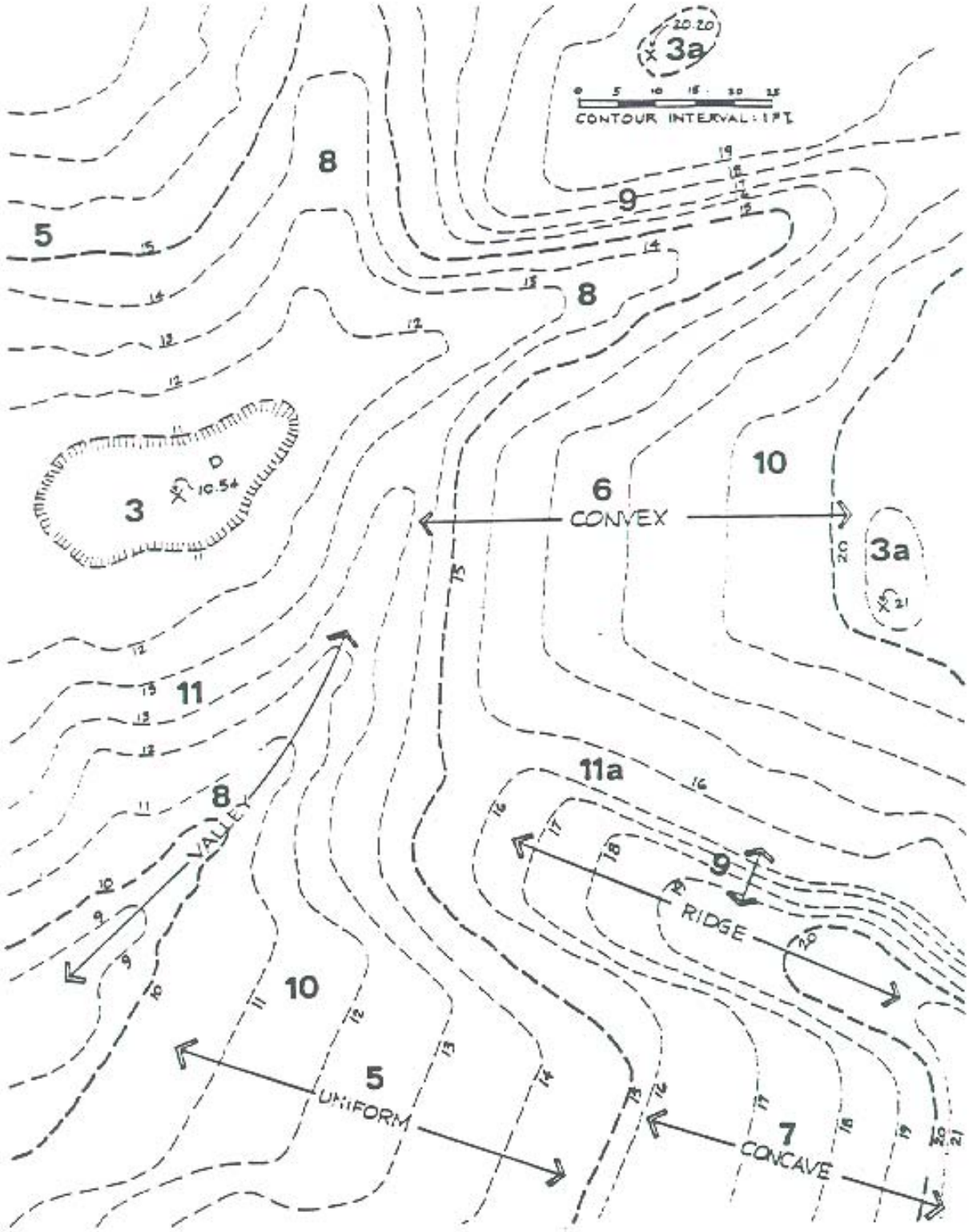
10. Contours which are spaced far apart indicate a relatively level or slight grade (see No. 10).

11. Contours never split; however, you will occasionally see two contours numbered the same and side by side. This indicates either a high area, or a low area. It will be high if the flanking contours are lower elevations (see No. 11), and low if the flanking contours are higher (see No. 11a).

12. The steepest area of a slope runs perpendicular to the contours (water also drains this way).

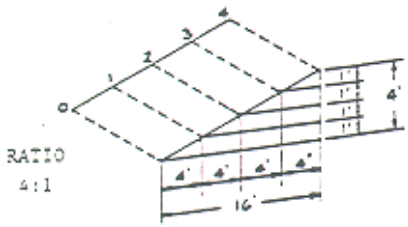
FIGURE 9-L

4/85



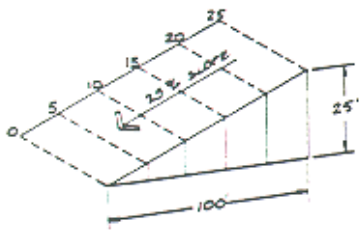
In discussing topography and earthwork, slopes are often referred to with number ratios or percentages. Angles are seldom used since mathematical conversion of ratios to angles is difficult.

FIGURE 9-M



When ratios are used, the slopes are referred to as 2 to 1 (2:1), 3 to 1 (3:1), 4 to 1 (4:1) or whatever the case may be. By 4:1, we mean four feet of horizontal space is required for each one foot of vertical change in elevation. As contours are shown on the plan, a 4:1 slope (assuming a 1' contour interval) would have contour lines spaced 4 feet apart (to scale.)

FIGURE 9-N

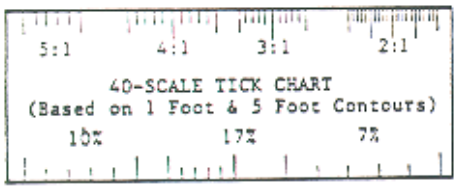


PERCENTAGE 25%

When expressed in percentages, a 3:1 slope becomes 33 1/3%, a 4:1 becomes 15%, etc. Percentage slope is easiest to understand if you think of the slope being 100-feet long (measure horizontally). Then the vertical distance becomes the percent. To determine the percentage of any slope, divide the vertical distance by the horizontal distance (a 3:1 slope would be 1/3 or 33 1/3%).

$$\frac{\textbf{VD}}{\textbf{HD}} = \frac{\textbf{Vertical Distance}}{\textbf{Horizontal Distance}}$$

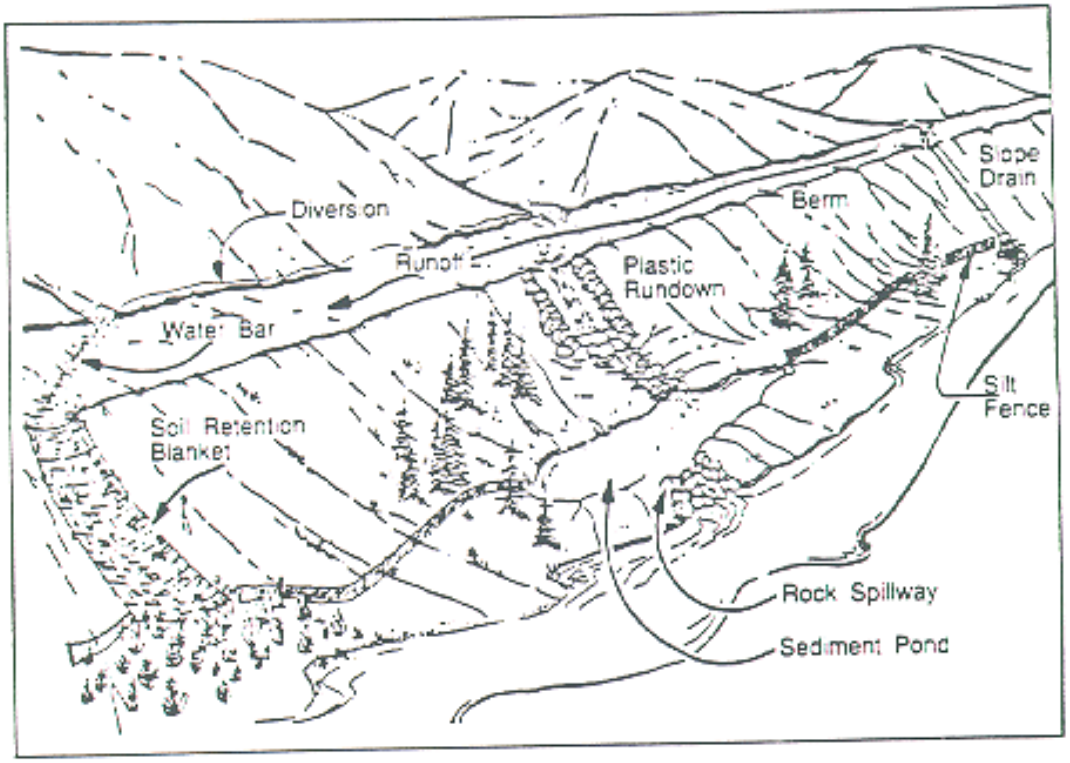
FIGURE 9-P



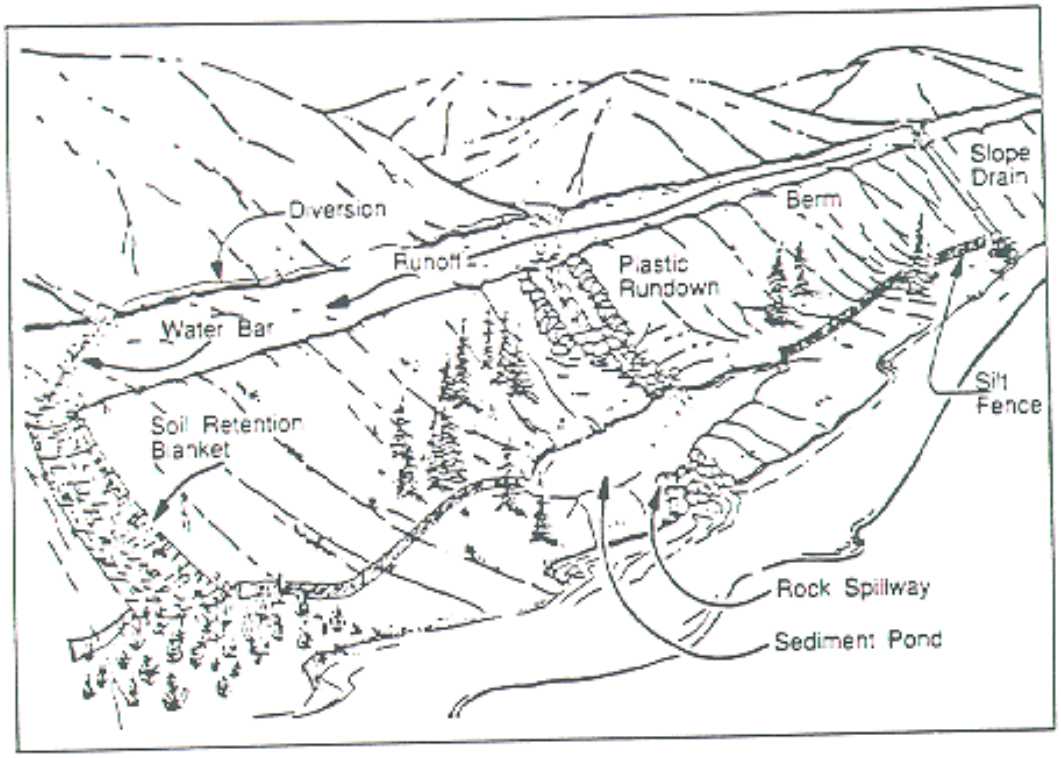
A tick chart (Figure 9-P) may be a useful tool for checking proper spacing of contour lines. Such tick charts can be made at any scale. These charts are easy to use and save much time.

THE UNIFORM PRACTICE CODING SYSTEM

To promote uniformity in the specification and presentation of conservation practices on erosion and sediment control plans, a standards practice numbering and coding system has been developed. Each practice has been assigned a specific number, code and graphic symbol. Assigned numbers should be used to identify practices on the map or site plan. If this system becomes widely used, erosion and sediment control plans will become more uniform and understandable on a statewide basis.



From: Colorado Department of Highways, 1978



From: Colorado Department of Highways, 1978

LEGEND

Earth Dike……..

Straw Bale Dike ……

Silt Fence……..

Temporary Swale ……

Pipe Drop Structure (Flexible)…….

Pipe Drop Structure (Rigid)…….

Perimeter Dike/Swale……..

Swale Inlet Protection ……

Curb Inlet Protection …….

Limits of Disturbance……..

Existing Topography …….

Proposed Topography ……..

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Construction Site Stormwater Management
Review Report

Date:_____ Time Arrived:_____

Time Left:_____

Project / Site Name:_____

NOI # _____(http://apps.dnrec.state.de.us/noi/) Plan Expiration Date: _____

Owner/Developer:_____

New Owner? ___Yes ___No (if yes, contact approval agency)

Location:_____

Weather Conditions:_____

Site Status (Active / Inactive / Completed):_____

Date of Last Site Review:_____

Site Compliance: Compliance Non-Compliance

[N/A] Not Applicable

[S] Satisfactory

[U] Unsatisfactory (include written comments)

1. Stabilized Construction Entrance (SCE) _____
2. Earth Berms/Dikes/Swales _____
3. Inlet Protection (IP) _____
4. Vegetative Stabilization _____
5. Stormwater Management Facilities _____ (Attach completed pond construction checklist)
6. Silt Fence (SF) _____
7. Sediment Traps/Basins _____
8. Outlet Protection _____
9. Stone Check Dams (SCD) _____
10. Pollution Prevention (P2) _____

Written Comments:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

CC:

Action to be taken:

Continue Routine Site Reviews_____

Correct Noted Deficiencies_____ Completion Date: _____

Other: _____

_____

Printed Name: _____ Email Address: _____

Certified Construction Reviewer CCR #_____

_____

Printed Name:_____

Delaware Licensed P.E. #_____

Your Company Information/Logo

Construction Site Stormwater Management Review Report

Date: 12 March 2014 Time Arrived: 9:45 am

Time Left: 11:10 am

Project / Site Name: Sweetbriar High School 2011-001

NOI # 6393 (http://apps.dnrec.state.de.us/noi/) Plan Expiration Date 1 / 4/ 2016

Owner/Developer: Developer Associates, LLC

New Owner? ___Yes _X_No (if yes, contact approval agency)

Location: 1500 Sweetbriar Road, Middletown DE 19709

Weather Conditions: Sunny and Cold 35 F

Site Status (Active / Inactive / Completed): Active

Date of Last Site Review: 5 March 2014

Site Compliance: Compliance Non-Compliance

[N/A] Not Applicable

[S] Satisfactory

[U] Unsatisfactory (include written comments)

1. Stabilized Construction Entrance (SCE) U
2. Earth Berms/Dikes/Swales NA
3. Inlet Protection (IP) U
4. Vegetative Stabilization U
5. Stormwater Management Facilities _____ (Attach completed pond construction checklist)
6. Silt Fence (SF) S
7. Sediment Traps/Basins U
8. Outlet Protection S
9. Stone Check Dams (SCD) NA
10. Pollution Prevention (P2) U

Written Comments:

1. Stabilized Construction Entrance:

a. The stabilized construction entrance is laden with sediment and there is tracking out onto the roadway. **[Corrective Action]** Rough the existing stone to loosen the sediment and refresh the entrance with more DE #3 stone. Sweep the sediment off the roadway and return the sediment to the site. Maintain the roadway with regular street sweeping.

2. Earth Berms/Dikes/Swales: No issues

3. Inlet Protection:

a. The inlets are inundated with straw from the stabilizing efforts and are threatened with sediment. Inlet protection has been removed without approval from the delegated agency. **[Corrective Action]** Remove all straw and sediment from the inlet boxes. Install the silt bags in the inlets and continue to maintain the silt bags. Removal of the inlet protection is only permitted upon the approval of the delegated agency.

4. Vegetative Stabilization:

a. The stabilization that was applied in the fall 2013 has taken well in some locations. There are some significant areas that will require additional stabilizing to achieve the 70% uniform cover. **[Corrective Action]** Loosen compacted areas of the soil and apply stabilization as per the vegetative specifications on the approved plan, page C-5.

5. Stormwater Management Facilities: no items

6. Silt Fence:

a. The super silt fence along the east side of the site is properly installed and functioning well. The addition of the stone at the base of the fence has resolved the previous scour problem. **[No Action]**

7. Sediment Traps/Basins:

a. **[Repeat Observation]** There is significant gullying near the basin headwall. The gullying has worsened since this observation was first reported. The initial stabilization applied to the basin banks has not become established. **[Corrective Action]** Repair the gullies by filling and compacting the base soils. Leave the top 6" of soil loose and well fertilized. Apply erosion blanket and seed to these critical areas to allow the grass to establish. Reduce the concentrated flow at the top of the basin bank by applying a straw wattle, turned upward toward the stormwater flow to avoid abrupt ends, until the soil is stabilized.

8. Outlet Protection:

a. The outfall protection has been installed as per the approved plan and the 6" rip rap has been underlain with the Mirafi 600X fabric. The area around the outlet has been seeded and the ECSC-2B erosion blanket has been installed. **[No Action]**

9. Stone Check Dams: no items

10. Pollution Prevention:

a. It appears that the painting trades are washing their equipment in the loading dock area by the catch basin. **[Corrective Action]** This is a violation to wash hazardous substances into a catch basin. I spoke with the site superintendent and directed him to stop the tradesmen from washing in this area and we discussed another location on site where the wash water can be captured.

b. The loading dock area is inundated with trash and sediment. **[Corrective Action]** Remove the trash from this area and provide trash receptacles. Flat shovel the sediment and return it to a controlled area.

c. All fueling operations are within controlled areas and containers are properly stored. **[No Action]**

From previous reports:

3. Inlet Protection:

a. [Previous Item 2/29/14] The inlet at the entrance is unprotected and there is sediment around the inlet. [Corrective Action] Place a Typ-2 inlet protection in the CB and clean the sediment off the impervious around the grate. **Completed.**

b. [Previous Item 1/18/14] The inlet at the southeast side of the school is not protected and there is sediment around the inlet. **[Corrective Action]** Place Typ-2 inlet protection in the CB and clean the sediment off the surfaces around the inlets. **Incomplete.**

4. Sediment Traps/Basins:

a. [Previous Item 1/18/14] A large gully has formed around sediment trap #3. [Corrective Action] Repair the gully and stabilize all open areas. In areas of concentrated flow entering the sediment trap, place straw wattles upland to reduce the SW velocity. **Completed.**

b. [Previous Item 2/29/14] A large gully has formed at the south side of sediment trap #1**.** [Corrective Action] Repair the gully and stabilize all upland areas. **Incomplete.**

CC:

Im. A. Developer	iadeveloper@develop-usa.com	Developer Associates
Harvey Haddix	Hhaddix@aol.com	Project Manager Enterprises
Honas Wagner	Honas.Wagner@enginnering-usa.com	Engineering USA
Billy Pierce	302-422-0990	Project Manager Enterprises
Milt Wilcox	302-376-0440	Site Contractors
Tommy Bridges	Tbridges@CCRsRUs.com	CCRs R Us
Dave Stieb	Dave.Stieb@state.de.us	Delegated Agency

Action to be taken:

Continue Routine Site Reviews _X_____

Correct Noted Deficiencies_____X_____ Completion Date: _____3/19/14_____

Other _____

Signature Required

_____

Cheryl L. Gmuer, Certified Construction Reviewer # 2013/03/29-053
Cheryl.Gmuer@state.de.us

Signature Required

_____

Larry Hagman, Delaware Professional Engineer
Larry.Hagman@engineering-firm.com

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Delaware

Sediment and Stormwater Program

Technical Document

Article 4.

Construction Review and Compliance

4.01

Construction Review Guidelines

Construction Site Stormwater Management (CSSWM) Pre-Construction Meeting

A written notification must be submitted to the review agency five days in advance of requesting a pre-construction meeting and the notification must be accompanied by the Certified Construction Reviewer (CCR) Application form. A construction site stormwater management pre-construction meeting must be held before any land disturbing activity may occur. The pre-construction meeting should always be held at the proposed site unless the Delegated Agency approves of another location. While at the meeting, attendees review the sequence of construction, the anticipated work area in conjunction with any site concerns or questions.

A pre-construction meeting must be held for all projects that require a detailed plan. For Standard Plan applications, the Delegated Agency determines whether a pre-construction meeting is required. The required attendees for a pre-construction meeting are the owner (or owner's representative), the site project manager, site contractor, Certified Construction Reviewer (if required), the Responsible Person (Blue Card Holder), and the Delegated Agency site reviewer. The essential items that must be covered at the pre-construction meeting are listed in the Pre-Construction Meeting Check List at Appendix 4.01.1. While on the site, review the site to locate all existing drainage inlets and check the inlets against those noted on the approved Plan. Review the construction site access and confirm that the access is suitable for construction vehicles.

Perimeter Control Review (PCR)

The Department requires the installation and review of the perimeter construction site stormwater management (CSSWM) practices before any land disturbing activity commences. The perimeter controls are contained on the approved Sediment and Stormwater Plan and their installation and review are included in the Sequence of

Construction. The review must be conducted by DNREC or the Delegated Agency prior to proceeding with bulk grading or other construction activities on the construction site. In some cases where perimeter controls that require land disturbance such as berms, dikes, swales and traps are not started until after the initial perimeter control review. Upon completion of the berms, dikes, swales, and traps another review may be required by DNREC or the Delegated Agency. These site review timeframes will be established at the pre-construction meeting.

Pollution Prevention Review

The pollution prevention details on the Delaware approved Sediment and Stormwater Plan are required elements for compliance with Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 Del. Admin. Code 7201 and the EPA Stormwater Pollution Prevention Plan (SWPPP). The construction site pollution prevention best management practices (reference the Delaware Erosion and Sediment Control Handbook) must be reviewed and documented in the CSSWM report.

Construction Site Stormwater Management Review by the Delegated Agency:

The Department requires regular construction site reviews to be conducted such that the local Delegated Agency is overseeing and verifying that the requirements of the Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 Del. Admin. Code 7201 are met which includes the implementation of the Sediment and Stormwater Plan. The regular review should verify that a Responsible Person is on site daily during construction site work that involves any land disturbing activity, which includes fine grading and utility work that could impact CSSWM practices.

- Each time a site is visited there must be documentation of the visit.

- The site reviewer should verify that the approved Sediment and Stormwater Plan is on site.
- Each time a construction review is conducted, a CSSWM report must be written.
    - The report must be provided to the owner, construction manager, and CCR (if applicable) as a minimum.
    - The report describes items in compliance with the approved Plan and any deficiencies.
    - The report contains the prescribed action to correct deficiencies.
    - The report must be kept digitally or a paper copy in the project file.
- Any field modifications that affect the stormwater management system design must be communicated to the owner/developer through the Delegated Agency. When a revision is necessary, the Delegated Agency will instruct the owner/developer to submit a Plan revision for review.
- In the case where the Delegated Agency is the responsible party for review of the stormwater management facilities, the construction reviewer must be present on the site to observe the facility construction to the extent that the stormwater facility construction checklist can be filled out for each facility.
- If a violation is observed on site, the owner/developer of the project must be notified in writing of the nature of the violation, the corrective action, and a timeframe for violation correction.
- At the completion of a project, the Delegated Agency can require a vacuuming of the entire storm system.
- Refer to the technical document entitled Article 4.05 Project Completion for guidance on project completion and Construction General Permit termination.

Construction Site Stormwater Management Review by a CCR:

The Department requires regular construction site reviews to be conducted such that the approved Sediment and Stormwater Plan is fully implemented and the requirements of the Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 Del. Admin. Code 7201 are met. The Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 Del. Admin. Code 7201 contains monitoring requirements that must be fulfilled by the owner, and often times, a CCR is obtained to fulfill this requirement. When the owner employs a CCR to perform construction review, the CCR must fill out the CCR Application and provide the original to the Delegated Agency prior to land disturbing activity. The details of who will be performing the construction reviews are discussed with the Delegated Agency at the pre-construction meeting.

- A CSSWM report must be written and provided to the owner, construction manager, and Delegated Agency as a minimum. The report is prepared and provided in a way that meets the performance standards of a CCR.
- The pollution prevention practices must be reviewed and documented in the CSSWM report. The standard detail and specifications for Site Pollution Prevention are contained on the Sediment and Stormwater Plan details sheet.
- The CCR must utilize the most current version of the Delaware Erosion and Sediment Control Handbook as a reference for installation, specifications, and maintenance of erosion and sediment control best management practices.
- When the CCR is the responsible party for review of the stormwater management facilities, the CCR must be present on the site to observe the facility construction to the extent that the stormwater facility construction checklist can be filled out for each facility.
- Any CSSWM practices that are not capable of controlling the sediment may have to be improved or revised. Any changes must be reviewed by the Delegated

Agency. Allow the Delegated Agency to determine whether the resolution is a field change or whether it necessitates a revised Sediment and Stormwater Plan. The Delegated Agency will guide the process of contacting the owner and how to proceed toward a resolution to the site issue. Once the resolution is approved by the Delegated Agency, field changes are annotated on the approved set of plans; whereby a revision to the plan will usually require a new set of engineered-stamped plans. Changes need to be documented on the next CCR and Delegated Agency CSSWM report.

- The report should contain a reasonable deadline for all CSSWM items to be corrected.
- Follow-up the site review with a written CSSWM report within the timeframe set forth by the local Delegated Agency; not to exceed 7 calendar days. It is the CCR's responsibility to ensure that the local Delegated Agency is receiving the reports signed by the CCR and the Signing Professional Engineer (PE).
- At the completion of a project, the Delegated Agency can require a vacuuming of the entire stormwater management system. The vacuuming of the system must be reviewed by the CCR or the Delegated Agency to observe that the sediment removal is satisfactorily completed.

Construction Site Stormwater Management (CSSWM) Report:

The construction site stormwater management report is the means of communicating construction site observations to the project owner. The CCR has received training through the Department's CCR course and re-certification course on the report content requirements. A CCR must adhere to the local agency reporting requirements. In addition, some agencies may require digital report submissions instead of facsimiles and hardcopies; again, the site reviewer must adopt the accepted submission format of the local Delegated Agency. The CSSWM report form is located on the Department website.

Indicating Site Compliance on the CSSWM Report:

In general, site compliance is determined by the observations of the site reviewer at the time of the review and any outstanding CSSWM issues from the previous report(s). The three nomenclatures used on the CSSWM report to describe the condition of a specific CSSWM practice are (S) for satisfactory, (U) for unsatisfactory, and (NA) for not applicable to the site. In some cases, a CSSWM item may be reported as **NA** because that item has not been implemented on the site yet; for instance a stone check dam or outlet protection. Once the CSSWM practice is installed it will be reported as a **U** or **S**. Likewise, when construction is coming to a conclusion some CSSWM practices will be removed upon the direction of the local agency; those practices can then be reflected as **NA**. The report narrative must support the **NA** nomenclature by stating that the practice had been removed.

If a CSSWM practice receives an unsatisfactory, the narrative portion of the report must provide the reviewer's observations and corrective action. An overall rating of compliance or non-compliance must be placed on the CSSWM report.

Stormwater Facility Installation and Review:

When stormwater facilities are being installed on a construction site, the site reviewer must have the required Department construction checklist for that specific facility. The construction checklists for each stormwater facility are contained in Appendix 4.01.2 entitled BMP Construction Checklists. The designated person, either the CCR or a Delegated Agency representative, conducting the stormwater facility review is determined at the pre-construction meeting and all the construction principals are informed that the reviewer must be on site when installation is occurring. All aspects of the construction must be documented; especially with underground systems that include stormwater pond outfall pipe, bioretention area, infiltration trench, manifold systems, level spreaders, and underdrains. Photographic documentation of underground systems is required. The site reviewer must verify that all the elements on the Sediment and Stormwater Plan are being implemented for each stormwater facility. Any deviation

from the plan must be discussed with the Delegated Agency and project manager; then follow up with a notation on the plan and in the CSSWM report.

Once the stormwater facility is installed, the owner will submit the stormwater facility post construction verification document within 60 days. Appendix 4.01.3 contains the Post Construction Verification Document checklist. Before project close out, the stormwater facilities must be converted to permanent use and post construction verification documents submitted again to the Delegated Agency.

Releasing the CCR Review Requirement

As a construction project is applying stabilization by hard surfacing, stone, vegetation, and landscaping; the amount of disturbed soils is being reduced. The owner (or the CCR) can contact the local Delegated Agency and request a site review to determine whether the CCR reviews are still required. Only the local agency reviewer can release the CCR from the construction reviews if it is determined that the CCR is no longer required. The owner must continue to adhere to the requirements under the *Delaware Regulations Governing the Control of Water Pollution*, *Section 9.1.02, Monitoring* until project termination.

Site Construction Inactivity

At times during construction, a site may become inactive due to a variety of circumstances. Some circumstances may be due to irregular funding, reduced housing demand, change of phases, change of contractor, change in owner, a lapse between remediation activities and construction, etc. Site activity, circumstances, and requirements shall comply with Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 Del. Admin. Code 7201.

Pre-Construction Meeting Check List

- ☐ The sign in sheet has the following items for contact information
  - ☐ Name
  - ☐ Company name, address, telephone numbers (office, fax, cell phone)
  - ☐ E-mail address

- ☐ Request business cards for the project file
- ☐ When is the anticipated start and end of construction?
- ☐ How will the construction vehicles access the site?
- ☐ How will the personal vehicles be handled in and around the construction site?
- ☐ Method for sending and receiving reports (e-mail, fax, or hard copy).
- ☐ Determine who the responsible person is, Blue Card Holder, and request to see the Blue Card to verify the card is current. Record their card number on the sign-in sheet. Go over the Blue Card responsibilities while there is site activity.
- ☐ Determine who will be performing the CCR duties, and request to see the CCR Card to verify the card is current. Record their card number on the sign-in sheet.
- ☐ Provide the CCR Application to the CCR and begin the process of filing it out is all parties are available. (No land disturbing activity begins until the CCR Application form has been received by the plan review agency)
- ☐ Requirement to have the approved plan on site at all times.
- ☐ Requirement to have a copy of the Notice of Intent on site at all times.
- ☐ NPDES requirements during construction activity
  - ☐ Weekly site reviews of the erosion and sediment controls
  - ☐ Reviews of erosion and sediment controls after a rain event that produces runoff
  - ☐ Maintaining the erosion and sediment control reviews on site in a log
  - ☐ Discuss if stormwater monitoring is a requirement, and if so, the monitoring log to be on site

Sequence of Construction and Construction General Notes

- ☐ Read through and discuss the Sequence of Construction. Discuss all General Construction Notes that are pertinent.
- ☐ Go over pollution prevention details as they pertain to this project.
- ☐ Discuss setting up the required perimeter control review (PCR) and define which controls must be installed. Discuss what the PCR will entail.
- ☐ Discuss the requirement for all stormwater conveyance channels and swales to have erosion control matting installed. If matting is not on the approved sediment and stormwater plan, contact the design engineer for the appropriate product.
- ☐ Discuss stockpiling of material on site. Discuss exporting of material off-site, the intended location of the materials and necessary E&S controls if operation of stockpiling is over 5000 sqft.

- It is required for the owner of a site to have a Nutrient Management Plan for the use of fertilizers on the construction site when more than 10 acres of fertilizers are being applied and the fertilizer must be applied by a certified nutrient applier.

Stormwater Facility

- Discuss whether a pre-construction meeting is necessary prior to pond or bioretention installation
- Provide the stormwater facility construction check lists to the CCR for the pertinent facilities to be installed. Tell the CCR that the construction check lists must be submitted to the local agency reviewer and the local agency stormwater engineer that will be reviewing the post construction verification documents (PCVD).
- Provide the post construction verification document check lists to the project manager that will order the PCV surveys.
- Discuss the requirement of the CCR being on site for all aspects of the stormwater facility installation and the CCR must be notified at least 72 hours in advance of the construction start. For bioretention areas, the CCR must receive a copy of the delivery tickets for the biosoil.
- (If applicable) Discuss soil compaction and cordoning off areas of proposed stormwater facilities that rely on infiltration. If compaction during construction is suspect, the delegated agency can require new infiltration testing prior to the stormwater facility being installed to verify infiltration.

Project Termination

- Sediment removal from the stormwater facility is required before project termination.
- CCR must receive the permanent seed mix tags from the bags. If there is a specific mix called for on the approved sediment and stormwater plan, the tags must match the designed mix.
- Discuss the NPDES General Permit coverage termination requirements with the owner
- (If applicable) Discuss when stormwater facility PCV surveys will be done (after installation and at project completion). Provide the CCR with the appropriate stormwater facility construction checklists. Construction check list must be submitted to the delegated agency site reviewer and submitted with the PCVDs to the delegated agency.

    - Releasing the CCR/converting to weekly reviews by the owner must be approved by the delegated agency.
    - 70 % germination of permanent seed is required for project termination. The delegated agency can grant a temporary certificate of occupancy for a period of up to six (6) months while vegetative growth is establishing.
    - Discuss the requirement that all elements on the approved sediment and stormwater plan have been met.
    - (If applicable) Discuss stormwater management system maintenance requirements

Periods of Site Inactivity

- If for any reason a construction site becomes inactive, the local delegated agency must be contacted.

4.04
Certified Construction Reviewer (CCR)

CCR & Applicability

A Certified Construction Reviewer (CCR) is a private reviewer of sediment and stormwater controls who is hired by an owner/developer. The primary role of a CCR is to determine conformance with Delaware's Sediment and Stormwater Regulations and the approved Sediment and Stormwater Plan by reviewing the on-site construction activities in conjunction with the Department or Delegated Agency construction reviewer. The CCR produces a Construction Site Stormwater Management (CSSWM) Report which contains the CCR's observations and the report is submitted to the owner/developer and the appropriate Delegated Agency.

All Department- approved construction projects require a CCR. A CCR is required on all projects 20 acres or greater and sites that require discharge monitoring for the maximum daily discharge limitation under Federal requirements. For projects approved through a delegated agency, the delegated agency's CCR policy may be more stringent and the CCR must conform to that policy. In extenuating circumstances, the Department or the Delegated Agency has the authority to tailor the frequency of CCR review to ensure construction overview and documenting site compliance.

CCR Certification Requirements

The CCR course offers detailed information on sediment control and stormwater management practices, and is provided as training to individuals who wish to qualify as CCRs as specified in the Delaware Sediment and Stormwater Regulations. In addition, the course benefits anyone in the government, engineering, consulting, contracting, or land development professions that work in the field of sediment and stormwater management. Certification is valid for five years. In order to attain certification, the CCR candidate must attend all sessions of the Department-sponsored CCR course and pass a written comprehensive exam.

CCR Re-Certification Requirements

The CCR Re-certification course is offered for those individuals who are already CCR certified and want to maintain continuous certification for a subsequent five year period. This course highlights any changes in the regulations, along with any new policies, best management practices, and approaches to stormwater management.

CCR Course

Course topics may include but will not be limited to:

- CCR responsibilities
- Laws and regulations
- Erosion and sediment control practices
- Basic hydrology and hydraulics
- Basics in soils and establishment of vegetation
- Stabilization products and applications
- Stormwater management best management practices
- The Sediment and Stormwater Plan
- CCR site review and Construction Site Stormwater Management (CSSWM) Report writing
- Federal and state enforcement options

CCR Responsibilities

The CCR shall function under the direction of a professional engineer (PE) registered in the State of Delaware, where the PE will be responsible for signing all CCR reports. When conducting a review and writing the report, the facts are to be noted and reported completely, accurately, and objectively. If a site review that a particular sediment or erosion control measure is not properly functioning, it is the CCR's responsibility to contact the appropriate Delegated Agency and report the site observations.

The CCR shall be responsible for the following:

- Ensure that CCR certification is up-to-date throughout the project duration.
- Complete the CCR application form for each site being reviewed and provide the copy with "live" signatures to the local delegated agency.
- Review construction sites weekly and submit reports
- Review active construction sites after rain events resulting in runoff.
- Assist the property owner/developer with technical assistance for erosion and sediment controls, Best Management Practices, and following the sequence of construction on the Sediment and Stormwater Plans. Though the CCR can provide technical assistance, the CCR cannot make changes to the approved plan, only the design engineer or delegated agency has the authority to do so.

Professional Engineer (PE) Responsibilities

The PE is responsible for overseeing and verifying the accuracy of the CCR review, and for signing the CCR reports. The PE must maintain an ongoing knowledge of the site conditions, through periodic site visits and/or discussions with the CCR. The PE shall only sign CCR reports that were prepared under their direct supervision, for sites where the PE has knowledge of the site conditions. The PE's involvement in the CCR process should be guided by the Delaware Association of Professional Engineers (DAPE) Code of Ethics.

CCR Reporting Requirements

Generally, CCR reviews are required once every seven days during active construction, and within 24 hours after a rainfall event that results in runoff. The local Delegated Agency may have more stringent requirements whereby the local policies must be adhered to. The CCR is required to review the installation of all stormwater facilities, photo document the activity, and complete the construction checklist for each installed element of the facility. Photo documentation and construction checklists must be submitted to the owner/developer and the local Delegated Agency as each stormwater facility is completed in the field.

In any event that results in the CCR halting reporting activities; the CCR must contact the local Delegated Agency and inform them of the circumstances. In the same vein, if the CCR anticipates a short absence from the construction site, such as vacation or sick leave, the CCR must arrange coverage of the weekly site reviews by another CCR.

If the construction site activity subsides and the CCR requests to reduce the weekly reporting; the local delegated agency <u>must</u> be notified of the intent. The local Delegated Agency will then give guidance to the owner/developer on how to proceed with site reviews to ensure compliance with Federal site monitoring requirements.

The Construction Site Stormwater Management (CSSWM) review report submitted by the CCR must have the CCR's company letterhead, not the letterhead of DNREC or the Delegated Agency. CSSWM review reports must be submitted to the local Delegated Agency, owner/developer, contractor, and other interested parties, and be signed by the CCR and professional engineer. Digital submission of the CSSWM review reports is encouraged along with photo documentation to ensure quick communication. The method of submitting reports may be more stringent at the local delegated agency and those methods must be adhered to.

All the elements of the CSSWM review report, an example report, a blank report, and construction site review are contained in the Site Review Section of these technical documents.

CCR Certification Revocation

A CCR who is not performing at an acceptable level as compared to the Delaware Sediment and Stormwater Regulations, the CCR Performance Standards, and CCR Course training will be notified by the local plan approval agency; the delegated agency or DNREC. The Delegated Agency or DNREC will state the corrective action for the delinquencies. If the CCR continues to be delinquent in the CCR responsibilities, the Delegated Agency may refer the CCR to DNREC for certification revocation. At that time DNREC will review the CCR and the signing PE performances. Based on the DNREC review and documentation from the Delegated Agency, DNREC will determination whether to (1) revoke the CCR certification and/or (2) report the delinquencies of the PE to the Delaware Association of Professional Engineers. Official proceedings under Chapter 60 will be followed if any of the parties involved seek to appear before the Environmental Appeals Board.

4.05
Project Completion

Project Completion Guidelines

The termination of the Federal National Pollution Discharge Elimination System (NPDES) General Permit for Construction Activities is required at the end of all construction projects that are functioning under the NPDES Notice of Intent. The following items must be accomplished before the project can be deemed complete and thus terminate the NPDES General Construction Permit:

- Conversion of temporary stormwater facilities into the permanent configurations as per the approved Sediment and Stormwater Plan
- Completion of the stormwater system vacuuming out of sediment, when required by the delegated agency
- Post construction verification documents for all stormwater facilities have been received and accepted by the local delegated agency
- Post construction verification documents for all stormwater facilities have been incorporated onto the Operation and Maintenance Plan
- A final construction site stormwater management site review report from the local delegated agency stating:
    - that all elements of the approved Sediment and Stormwater Plan have been implemented
    - all disturbed areas associated with the construction project meet the definition of final stabilization as contained in the NPDES General Construction Permit
    - all the temporary erosion and sediment controls have been removed and properly stabilized
- Acceptance of the maintenance responsibilities as outlined in the Operation and Maintenance Plan contained in the approved Sediment and Stormwater Plan

A Notice of Completion letter will be sent to the owner of the project after the construction verification documents have been received and accepted. The Notice of Completion will indicate the name of the project to be terminated and it will contain the following enclosures:

- The Notice of Termination instructions and form
- The local delegated agency final construction site stormwater management review report
- Declaration of the stormwater facility maintenance responsibilities on the Maintenance Obligation, if stormwater facilities were constructed
- Recommendations for routine stormwater facility maintenance, if stormwater facilities were constructed

Once the Notice of Termination has been sent to the Department Sediment and Stormwater Program, the local Delegated Agency places the completed site into the Stormwater Maintenance database held locally at each Delegated Agency. The local Delegated Agency will perform regular reviews of the stormwater management systems as outlined under Article 5 entitled Maintenance of Permanent Stormwater Management Systems.

Chapter 4

Erosion and Sediment Control Practices & Stabilization Techniques

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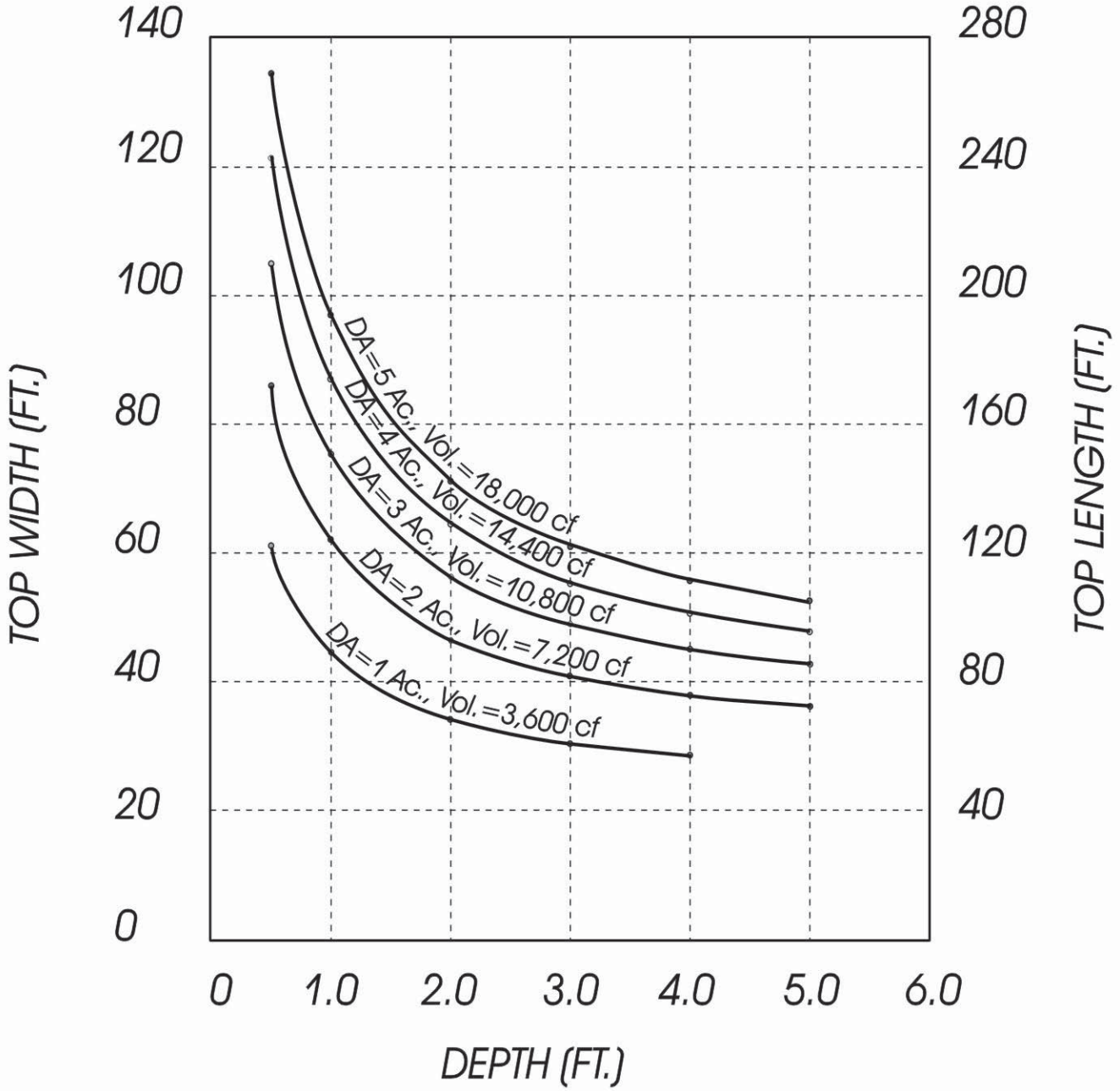
SEDIMENT TRAP SIZING CHART

LENGTH TO WIDTH RATIO OF 2:1

SIDE SLOPES OF 3:1



McCleary 8/92

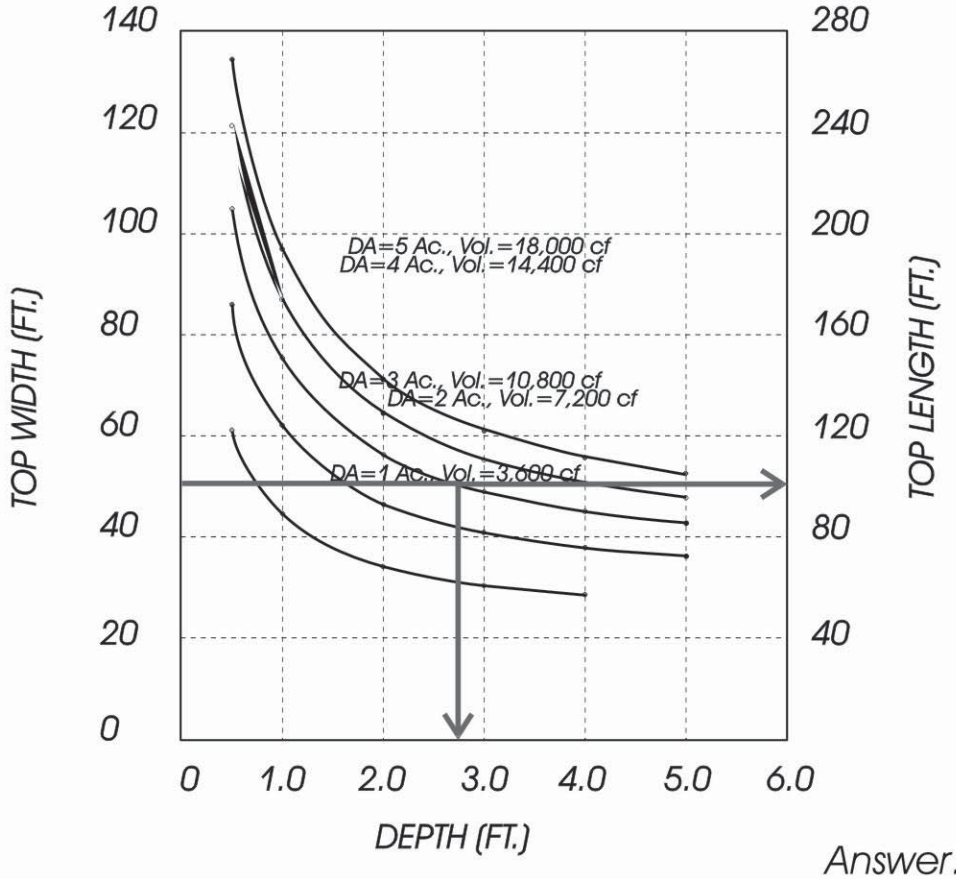
Example Problem:

Modifications during construction necessitates the relocation of a sediment trap. The drainage area to the trap is 3 acres. There is an area available to place the trap 50' wide x 150' long. Will a trap of sufficient size fit into this area and if so what are Adequate dimensions?

SEDIMENT TRAP SIZING CHART

LENGTH TO WIDTH RATIO OF 2:1

SIDE SLOPES OF 3:1



Answer:
yes
50'x100'x2.8'

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Estimating Seeding Rates of Surface Applied Grass Seed

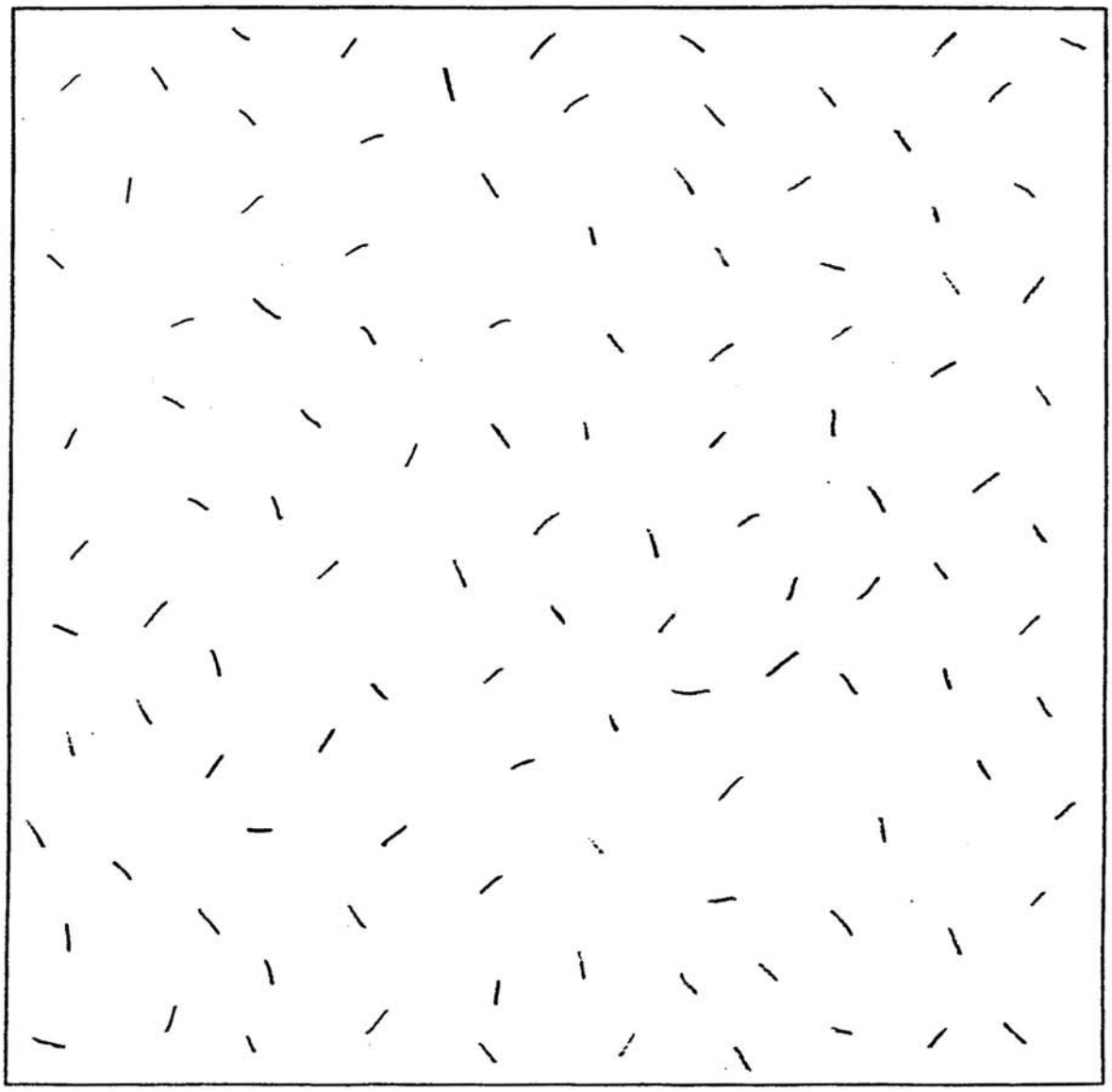
Example: *Estimating the minimum number of seeds in a 6" X 6" sample block in order to comply with the Temporary Seeding specification for 100 lbs. per acre of 50/50 of K-31 Tall Fescue and Annual Ryegrass.*

We know that there are approximately 200,000 seeds per pound in each one of these species of grass. If we multiply this by 100 lbs., we now know that we need 20,000,000 seeds per acre.

We know that there are 43,560 sq. ft. in an acre multiply this figure by 144 (because there are 144 square inches per square foot) and we now know that there are 6,272,640 sq. inches per acre.

Divide 20,000,000 (number of seeds desired per acre) by 6,272,640 (the number of square inches per acre) and we get 3.1 seeds per square inch.

If our sample size is a 6" X 6" square block, (this is 36 square inches) multiply by 3.1 (the number of seeds per square inch) you get approximately 112 seed per sample block.



ADDITIONAL STANDARD AND SPECIFICATIONS FOR TEMPORARY STABILIZATION

Definition: The planting of quick growing vegetation to provide temporary stabilization on disturbed areas.

Purpose: To temporarily stabilize the soil, reduce damage from sediment and runoff to downstream or off-site areas, and to provide protection to disturbed areas until permanent vegetation or other erosion control measures can be established.

Conditions Where Practice Applies
Graded or cleared areas which are subject to erosion for a period of 14 days or more.

Specifications

1. Site Preparation

   a. Prior to seeding, install needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, grassed waterways, and sediment basins.

   b. Final grading and shaping is not necessary for temporary seedings.

2. Seedbed Preparation

   It is important to prepare a good seedbed to insure the success of establishing vegetation. The seedbed should be well prepared, loose, uniform, and free of large clods, rocks, and other objectionable material. The soil surface should not be compacted or crusted.

3. Soil Amendments - Soil amendments are not typically required for temporary stabilization. However, in some cases soil conditions may be so poor that amendments are needed to establish even a temporary vegetative cover. Under these extreme conditions, the following guidelines should be used:

   a. Lime - Apply liming materials based on the recommendations of a soil test in accordance with the approved nutrient management plan. If a nutrient management plan is not required, apply dolomitic limestone at the rate of 1 to 2 tons per acre. Apply limestone uniformly and incorporate into the top 4 to 6 inches of soil. For additional information, see **Section 3.4.3.1, Additional Standards and Specifications for Soil Testing**.

   b. Fertilizer - Apply fertilizer based on the recommendations of a soil test in accordance with the approved nutrient management plan. If a nutrient management plan is not required, apply a formulation of 10-10-10 at the rate of 600 pounds per acre. Apply fertilizer uniformly and incorporate into the top 4 to 6 inches of soils. For additional information, see **Section 3.4.3.1, Additional Standards and Specifications for Soil Testing**.

4. Seeding

   a. Select a mixture from **Figure 3.4.3.2a**.

   b. Apply seed uniformly with a broadcast seeder, drill, cultipacker seeder or hydroseeder. All seed will be applied at the recommended rate and planting depth.

   c. Seed that has been broadcast should be covered by raking or dragging and then lightly tamped into place using a roller or cultipacker. If hydroseeding is used and the seed and fertilizer is mixed, they will be mixed on site and the seeding shall be done immediately and without interruption.

5. Mulching

   All mulching shall be done in accordance with **Section 3.4.5, Standard and Specifications for Mulching**.

TEMPORARY SEEDING BY RATES, DEPTHS AND DATES

Mix #	Species[6]	Seeding Rate		Optimum Seeding Dates [1] O = Optimum Planting Period; A = Acceptable Planting Period							Planting Depth[3]
				Coastal Plain			Piedmont			All	
	Certified Seed	lb/Ac[.5]	lb/1000 sq.ft.	2/1-4/30	[2] 5/1-8/14	8/15-10/31	3/1-4/30	[2] 5/1-7/31	8/1-10/31	10/31-2/1	
1	Barley	125	4	O	A	O	O	A	O		1-2 inches 2-3" sandy soils
2	Oats	125	4	O	A	A	O	A	A		1-2 inches 2-3" sandy soils
3	Rye	125	4	O	A	O	O	A	O	A	1-2 inches 2-3" sandy soils
4	Perennial Ryegrass	125	4	O	A	O	O	A	O		0.5 inches 1-2" sandy soils
5	Annual Ryegrass	125	4	O	A	O	O	A	O	A	0.5 inches 1-2" sandy soils
6	Winter Wheat	125	4	O	A	O	O	A	O	A	1-2 inches 2-3" sandy soils
7	Foxtail Millet	30 PLS	0.7		O			O			0.5 inches 1-2" sandy soils
8	Pearl Millet	20 PLS	0.5		O			O			0.5 inches 1-2" sandy soils

1. Winter seeding requires 3 tons per acre of straw mulch for proper stabilization.
2. May be planted throughout summer if soil moisture is adequate or seeded area can be irrigated.
3. Applicable on slopes 3:1 or less.
4. Fifty pounds per acre of Annual Lespedeza may be added to 1/2 the seeding rate of any of the above species.
5. Use varieties currently recommended for Delaware. Contact a County Extension Office for information.
6. Warm season grasses such as Millet or Weeping Lovegrass may be used between 5/1 and 9/1 if desired. Seed at 3-5 lbs. per acre. Good on low fertility and acid areas. Seed after frost through summer at a depth of 0.5".

Figure 3.4.3.2a Temporary seeding guidelines

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ADDITIONAL STANDARD AND SPECIFICATIONS FOR PERMANENT STABILIZATION

Definition: The establishment of perennial vegetation to provide permanent stabilization on disturbed areas.

Purpose: To permanently stabilize soil on disturbed areas and to reduce sediment and runoff to downstream or off-site areas.

Conditions Where Practice Applies
Graded or cleared areas subject to erosion and where a permanent, long-lived vegetative cover is needed. In most cases, vegetation is the preferred method of stabilizing bare soil because of its numerous benefits. However, it cannot be expected to provide an erosion control cover and prevent soil slippage on a soil that is not stable due to its texture, structure, water movement or excessively steep slope.

Minimum Soil Conditions Needed for the Establishment and Maintenance of Permanent Vegetative Cover

1. Enough fine-grained materials to provide the capacity to hold at least a moderate amount of available moisture. A noticeable exception would be planting lovegrass and serecia lespedeza, which can be planted on a sandy soil.
2. Sufficient pore space to permit adequate root penetration.
3. The soil shall be free from any material harmful to plant growth.
4. If these conditions cannot be met, see **Section 3.4.1, Standard and Specifications for Topsoiling**.

Specifications

1. Site Preparation
   a. Prior to seeding, install needed erosion and sediment control practices such asdiversions, grade stabilization structures, berms, dikes, grassed waterways, and sediment basins.
   b. Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application, anchoring and maintenance. All irregularities in the surface must be corrected in order to prevent the formation of depressions or water pockets.
2. Seedbed Preparation
   a. It is important to prepare a good seedbed to insure the success of establishing vegetation. The seedbed shall be well pulverized, loose, uniform, and free of large clods, rocks, and other objectionable material.
   b. Flat areas and slopes up to 3:1 grade shall be loose and friable to a depth of at least 4 inches. The top layer of soil shall be loosened by raking, disking or other acceptable means before seeding.

c. Slopes steeper than 3:1 shall have the top 1-3 inches of soil loose and friable before seeding.

3. Soil Amendments

a. Lime - Apply liming materials based on the recommendations of a soil test in accordance with the approved nutrient management plan. If a nutrient management plan is not required, apply dolomitic limestone at the rate of 1 to 2 tons per acre. Apply limestone uniformly and incorporate into the top 4 to 6 inches of soil. For additional information, see **Section 3.4.3.1, Additional Standards and Specifications for Soil Testing**.

b. Fertilizer - Apply fertilizer based on the recommendations of a soil test in accordance with the approved nutrient management plan. If a nutrient management plan is not required, apply 10-10-10 at the rate of 600 pounds per acre. Apply fertilizer uniformly and incorporate into the top 4 to 6 inches of soils. For additional information, see **Section 3.4.3.1, Additional Standards and Specifications for Soil Testing**.

c. Incorporation - On sloping land, the final disking and harrowing operation should be on the contour wherever feasible. On slopes steeper than 3:1, the lime and fertilizer shall be worked in the best way possible.

4. Seeding

a. Select a mixture from **Figure 3.4.3.3a**.

b. Every bag of seed is required by law to have an analysis tag attached to it. This tag contains essential information about the content and quality of the turf seed therein. All of the data on the tag relates in some way to the seed in the bag. Following is a list of items and information that they represent:

- "Product" is the species or type of seed that was tested.
- "Lot" refers to the specific lot of seed tested, providing a tracking of the varieties, production field and components in the bag.
- "% Purity" is the number of seeds of a species/variety, expressed as percentages of the whole, found in the mix. "VNS" means "Variety Not Stated" indicating uncertainty about the quality and characteristics of the seed.
- "% Germination" refers to the percentage of seed that germinated during testing.
- "Other Crop Seeds" is the percentage of crop seeds of the tested sample that have been found during a physical separation of the sample.
- "Inert Matter" is the percentage of dust, stems, soil, chaff, etc. of the total weight of the tested sample.
- "Weed Seed" refers to the percentage of weed seeds in a sample.
- "Noxious Weeds" are the weed seeds considered by local law to be noxious. This number must always be zero.
- "Origin", "Net Weight" and "Date Tested" are self-explanatory.

c. Apply seed uniformly with a broadcast seeder, drill, cultipacker or hydroseeder. All seed will be applied at the recommended rate and planting depth. Drill seeding is the preferred method, especially when light, fluffy seeds are in the mix. When hydroseeding is the chosen method, the total rate of seed should be increased by 25% over the rates recommended in **Figure 3.4.3.3a**. Seed mixtures loaded into boxes or containers, such as those found on drill seeders, should be agitated to prevent stratification in the box. Some seeders are also equipped with multiple boxes to separate the seed by species, resulting in even distribution.

d. Seed that has been broadcast must be covered by raking or dragging and then lightly tamped into place using a roller or cultipacker. If hydroseeding is used and the seed and fertilizer is mixed, they will be mixed on site and the seeding shall be done immediately and without interruption.

5. Mulching

All mulching shall be done in accordance with **Section 3.4.5, Standards and Specifications for Mulching**.

6. Irrigation

a. Adequate moisture is essential for seed germination and plant growth. Daily irrigation can be critical in establishing permanent vegetation during dry or hot weather or on adverse site conditions.

b. Irrigation must be carefully controlled to prevent runoff and subsequent erosion. Inadequate or excessive irrigation can do more harm than good.

7. Maintenance

a. It takes one full year to establish permanent vegetation from the time of planting. Inspect seeded areas for failure and reestablish vegetation as soon as possible. Depending on site conditions, it may be necessary to irrigate, fertilize, overseed, or re-establish plantings in order to provide permanent vegetation for adequate erosion control.

b. Maintenance fertilization rates should be established by soil test recommendations in accordance with an approved nutrient management plan. Spring seedings may require an application of fertilizer between September 1 and October 15, at least every two years. Fall seedings may require the same between March 15 and May 1 the following year. If slow release fertilizer is used, follow-up fertilizations may not be necessary for several years. Lime according to soil test recommendations at least once every five years. For additional information, see **Section 3.4.3.1, Additional Standards and Specifications for Soil Testing**.

8. Special Conditions

Under certain site conditions, alternative vegetative stabilization techniques are necessary. Examples include steeply sloped areas, extremely low fertility soils, acidic soils (pH less than 4.0) and dune stabilization. When any of these or other unusual site conditions are encountered, DNREC and/or the appropriate delegated agency may require products, seed species, mixtures and rates other than those listed in the following tables in order to achieve successful stabilization.

PERMANENT SEEDING AND SEEDING DATES

Seeding Mixtures		Seeding Rate[1]		Optimum Seeding Dates [2] O = Optimum Planting Period A = Acceptable Planting Period							Remarks
Mix No.	Certified Seed[3]			Coastal Plain			Piedmont			All[4]	
	Well Drained Soils	lb/Ac	lb/1000 sq.ft.	2/1-4/30	5/1-8/14	8/15-10/31	3/1-4/30	5/1-7/31	8/1-10/31	10/31-2/1	
1	Tall Fescue Weeping Lovegrass	140 10	3.2 0.23	A	O	A	A	O	A	Add 100 lbs./ac Winter Rye	Good erosion control mix Tolerant of low fertility soils Lovegrass very difficult to mow; Germinates only in hot weather
2	Deertongue Sheep Fescue Common Lespedeza[5] Inoculated	30 30 15	0.69 0.69 0.35	A	O	A	A	O	A	Add 100 lbs./ac Winter Rye	Good erosion control mix Tolerant of low fertility soils Good wildlife cover and food
3	Tall Fescue (Turf-type) **or** Strong Creeping Red Fescue **or** Perennial Ryegrass **plus** Flatpea[5]	50 50 50 15	1.15 1.15 1.15 0.34	O	A	O	O	A	O	Add 100 lbs./ac. Winter Rye	Good erosion control mix Tall Fescue for droughty conditions. Creeping Red Fescue for heavy shade. Flatpea to suppress woody vegetation.
4	Strong Creeping Red Fescue Kentucky Bluegrass Perennial Ryegrass **or** Redtop **plus** White Clover[5]	100 70 15 5 3	2.3 1.61 0.35 0.11 0.07	O	A	O	O	A	O	Add 100 lbs./ac. Winter Rye	Suitable waterway mix. Canada Bluegrass more drought tolerant. Use Redtop for increased drought tolerance.
5	Switchgrass[6,7] **or** Coastal Panicgrass Big Bluestem Little Bluestem Indian Grass	10 10 5 5 5	0.23 0.23 0.11 0.11 0.1		O			O			Native warm-season mixture. Tolerant of low fertility soils. Drought tolerant. Poor shade tolerance. N fertilizer discouraged - weeds
6	Tall Fescue (turf-type) (Blend of 3 cultivars)	150	3.5	O	A	O	O	A	O		Managed filter strip for nutrient uptake.
7	Tall Fescue Ky. Bluegrass (Blend) Perennial Ryegrass	150 20 20	3.5 0.46 0.46	O	A	O	O	A	O		Three cultivars of Kentucky Bluegrass. Traffic tolerant.
8	Big Bluestem[7] Indian Grass[7] Little Bluestem[7] Creeping Red Fescue **plus one of:** Partridge Pea Bush Clover Wild Indigo Showy Tick-Trefoil	10 10 8 30 5 3 3 2	0.23 0.23 0.18 0.69 0.11 0.07 0.07 0.05	O	A		O	A			All species are native. Indian Grass and Bluestem have fluffy seeds. Plant with a specialized native seed drill. Creeping Red Fescue will provide erosion protection while the warm season grasses get established.

Figure 3.4.3.3a Seed mixes and recommended seeding dates

Seeding Mixtures		Seeding Rate[1]		Optimum Seeding Dates [2] O = Optimum Planting Period A = Acceptable Planting Period							Remarks
Mix No.	Certified Seed[3]			Coastal Plain			Piedmont			All[4]	
	Poorly Drained Soils	lb/Ac	lb/1000 sq.ft.	2/1-4/30	5/1-8/14	8/15-10/31	3/1-4/30	5/1-7/31	8/1-10/31	10/31-2/1	
9	Redtop Creeping Bentgrass Sheep Fescue Rough Bluegrass	75 35 30 45	1.72 0.8 0.69 1	O	A	O	O	A	O	Add 100 lbs./ac. Winter Rye	Quick stabilization of disturbed sites and waterways
10	Reed Canarygrass[6]	10	0.23	A		O	A		O		Good erosion control, wildlife cover and wetland revegetation.
	Residential Lawns										
11	Tall Fescue Perennial Ryegrass Kentucky Bluegrass Blend	100 25 30	2.3 0.57 0.69	O	A	O	O	A	O		High value, high maintenance, light traffic, irrigation necessary. Well drained soils, full sun.
12	Tall Fescue Perennial Ryegrass Sheep Fescue	100 25 25	2.3 0.57 0.57	O	A	O	O	A	O		Moderate value, low maintenance, traffic tolerant
13	Creeping Red Fescue Chewings Fescue Rough Bluegrass Kentucky Bluegrass	50 50 20 20	1.15 1.15 0.4 0.4	O	A	O	O	A	O		Shade tolerant, moderate traffic tolerance, moderate maintenance.
14	Creeping Red Fescue Rough Bluegrass **or** Chewings Fescue	50 90	1.15 2.1	O	A	O	O	A	O		Shade tolerant, moisture tolerant.
15	K-31 Tall Fescue	150	3.5	O	A	O	O	A	O		Monoculture, but performs well alone in lawns. Discouraged.

1. When hydroseeding is the chosen method of application, the total rate of seed should be increased by 25%.
2. Winter seeding requires 3 tons per acre of straw mulch. Planting dates listed above are average for Delaware. These dates may require adjustment to reflect local conditions.
3. All seed shall meet the minimum purity and minimum germination percentages recommended by the Delaware Department of Agriculture. The maximum % of weed seeds shall be in accordance with Section 1, Chapter 24, Title 3 of the Delaware Code.
4. Cool season species may be planted throughout summer if soil moisture is adequate or seeded area can be irrigated.
5. All leguminous seed must be inoculated.
6. Warm season grass mix and Reed Canary Grass cannot be mowed more than 4 times per year.
7. Warm season grasses require a soil temperature of at least 50 degrees in order to germinate, and will remain dormant until then.

Figure 3.4.3.3a Seed mixes and recommended seeding dates (cont.)

Permanent Stabilization Mixtures for Various Uses		
	Planting Mixtures by Soil Drainage Class	
Application	Well Drained Soils[1]	Poorly Drained Soils[1]
Residential/commercial lots	11,12,13,15	14,15
Residential open space	8	Contact plant specialist for site specific recommendations.
Pond and channel banks, dikes, berms and dams	2, 4	9,10,14
Drainage ditches, swales, detentions basins	3, 4, 13	9,14
Filter strips	2, 5, 6	6, 13
Grassed waterways, spillways	1,2,4	6, 9
Recreation areas, athletic fields	7,15	14,15
Steep slopes and banks, roadsides, borrow areas	1,2,3,4	4, 6
Sand and gravel pits, sanitary landfills	1,2,3,5	3, 4
Dredged material, spoilbanks, borrow areas	1,2	9,10
Streambanks and shorelines[2]	2, 3	2, 3
Utility rights-of-way	1,2,3,4	3,14

1. Refer to **Fig. 3.4.3.3a** for detailed information on seed mixes.
2. Refer to Chapters 16 and 18 of the NRCS Field Engineering Manual for additional measures.
NOTE: Refer to NRCS critical area planting standard for additional seed mixtures.

Figure 3.4.3.3b Seed mix selection chart

SPECIES	RECOMMENDED SEED VARIETIES
Tall Fescue	Alamo E, Apache II, Guardian, Rebel II, Shenandoah, Safari, Crossfire, Titan 2, Duke, Barrington, Comstock, Crossfire, Dominion, Heritage, Plantation, Rebel 2000, Titan 2
Kentucky Blue Grass	*Low Maintenance Varieties*: Barirus, Caliber, Eagleton, Freedom, Haga, Livingston, Merit, Midnight, Monopoly, Washington *Shade Tolerant Varieties*: Princeton, America, Brilliant, Champagne, Coventry, Unique, Liberator, Moonlight, Showcase, Nuglade, Compact
Perennial Rye Grass	Palmer III, Blazer II, Pennfine, Seville, Pinnacle, Pick MDR
Creeping Red Fescue	Cindy Lou, Jasper, Dawson, Pennlawn, Flyer, Ruby, Salem
Red Top	Streaker, Barracuda
Chewings Fescue	Longfellow, Jamestown, Discovery, Scaldis, Bighorn

NOTES:
1. The grass species listed in **Fig. 3.4.3.3a** are often available in many varieties. The seed choices listed above are the recommended varieties based on regional performance and availability.
2. The varieties listed above are examples of recommended varities. Contact University of Delaware, Cooperative Extension Service for additional information.

Figure 3.4.3.3c Recommended seed varieties

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STANDARD AND SPECIFICATIONS FOR MULCHING

Definition: The application of a protective layer of straw or other suitable material to the soil surface.

Purpose: To protect the soil surface from the forces of raindrop impact and overland flow. Mulch helps to conserve moisture, reduce run-off and erosion, control weeds, prevent soil crusting and promote the establishment of desired vegetation.

Conditions Where Practice Applies:
Mulching can be used at anytime where protection of the soil surface is desired. The primary purpose of mulching is to provide protection for newly seeded disturbed areas. However, it can also be used for stand-alone protection of the soil surface under adverse weather conditions when seed germination could be jeopardized.

Site Preparation
Prior to mulching, install any needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, channels and sediment basins. For maximum performance, apply mulch in a two-step process.

Step One: Apply seed and soil amendments at required rates.

Step Two: Apply mulch at required rates. Depending on site conditions, hydraulically applied mulches may be applied in a one-step process where all components may be mixed together in single tank loads. Consult with the manufacturer for further details.

Mulching Procedures

1. Materials and Amounts

a. *Straw* - Straw shall be unrotted small grain straw applied at the rate of 1-1/2 to 2 tons per acre, or 70 to 90 pounds (two bales) per 1,000 square feet. Mulch materials shall be relatively free of weeds and shall be free of noxious weeds such as; thistles, Johnsongrass, and quackgrass. Spread mulch uniformly by hand or mechanically. For uniform distribution of hand spread mulch, divide area into approximately 1,000 square feet sections and place 70-90 pounds (two bales) of mulch in each section.

b. *Wood chips* - Apply at the rate of approximately 6 tons per acre or 275 pounds per 1,000 square feet when available and when feasible. These are particularly well suited for utility and road rights-of-way. If wood chips are used, increase the application rate of nitrogen fertilizer by 20 pounds of N per acre (200 pounds of 10-10-10 or 66 pounds of 30-0-0 per acre).

c. *Hydraulically applied mulch* -The following conditions apply to hydraulically applied mulch:

i. Definitions:

a. Wood fiber mulch shall consist of specially prepared wood that has been processed to a uniform state, is packaged for sale as a hydraulic mulch for use with hydraulic seeding equipment, and consists of a minimum of 70% virgin or recycled wood fiber combined with 30% paper fiber and additives.

b. Blended fiber mulch shall consist of any hydraulic mulch that contains greater than 30% paper fiber. The paper component must consist of specially prepared paper that has been processed to a uniform fibrous state and is packaged for sale as a hydraulic mulch for use with hydraulic seeding equipment.

c. A bonded fiber matrix (BFM) consists of long strand, specially prepared wood fibers that have been processed to a uniform state held together by a water resistant bonding agent. BFMs shall contain no paper (cellulose) mulch but may contain small percentages of synthetic fibers to enhance performance.

d. Refer to **Figure 3.4.5a** for conditions and limitations of use for each of the above categories of hydraulic mulch.

ii. All components of the hydraulically applied mulches shall be pre-packaged by the manufacturer to assure material performance. Field mixing of the mulch components is acceptable, but must be done per manufacturers recommendations to ensure the proper results.

iii. Hydraulic mulches shall be applied with a viable seed and at manufacturer's recommended rates. Increased rates may be necessary based on site conditions.

iv. Hydraulically applied mulches and additives shall be mixed according to manufacturers recommendations.

iv. Materials within this category shall only be used when hydraulically applied mulch has been specified for use on the approved Sediment and Stormwater Plan, or supplemental approval from the plan approval agency has been obtained in writing for a specific area.

v. Application:

a. Apply product to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope.

b. Do not apply to saturated soils, or if precipitation is anticipated within 24-48 hours.

c. During the spring (March 1 to May 31) and fall (September 1 to November 30) seasons, hydraulic mulches may be applied in a one-step process where all components are mixed together in single-tank loads. It is recommended that the product be applied from opposing directions to achieve optimum soil coverage.

d. During the summer (June 1 to August 31) and winter (December 1 to February 28) seasons, the following two-step process is required:

Step One– Mix and apply seed and soil amendments with a small amount of mulch for visual metering.

Step Two – Mix and apply mulch at manufacturers recommended rates over freshly seeded surfaces. Apply from opposing directions to achieve optimum soil coverage.

e. Minimum curing temperature is 40^0 F (4^0 C). The best results and more rapid curing are achieved at temperatures exceeding 60^0 F (15^0 C). Curing times may be accelerated in high temperature, low humidity conditions on dry soils.

vi. Recommended application rates are for informational purposes only. Conformance with this standard and specification shall be performance-based and requires **100% soil coverage**. Any areas with bare soil showing shall be top dressed until full coverage is achieved.

d. *Compost blanket (CB)* - Loosely applied with a pneumatic blower so that a 1" compost blanket uniformly covers the **soil with 100% coverage**. This application can be used with seed to promote germination by applying the approved seed mix directly into the loosely blown compost. The compost blanket performs best on slopes less than 2:1 and requires no mulch anchoring.

2. Anchoring mulch - Mulch must be anchored immediately to minimize loss by wind or water. This may be done by one of the following methods, depending upon size of area, erosion hazard, and cost.

a. *Crimping* - A crimper is a tractor drawn implement designed to punch and anchor mulch into the top two (2) inches of soil. This practice affords maximum erosion control but is limited to flatter slopes where equipment can operate safely. On sloping land, crimping should be done on the contour whenever possible.

b. *Tracking* - Tracking is the process of cutting mulch (usually straw) into the soil using a bulldozer or other equipment that runs on cleated tracks. Tracking is used primarily on slopes 3:1 or steeper and should be done up and down the slope with cleat marks running across the slope.

c. *Liquid mulch binders* - Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and other areas where the mulch will be moved by wind or water. All other areas should have a uniform application of binder. The use of synthetic binders is the preferred method of mulch binding and should be applied at the rates recommended by the manufacturer.

d. *Paper fiber* - The fiber binder shall be applied at a net dry weight of 750 lbs/ac. The wood cellulose fiber shall be mixed with water, and the mixture shall contain a maximum of 50 lbs. of wood cellulose fiber per 100 gallons.

e. *Nettings* - Synthetic or organic nettings may be used to secure straw mulch. Install and secure according to the manufacturers recommendations.

MULCHING MATERIAL SELECTION GUIDE

Percent Slope	Type of Mulch / App. Rate*	Dec. 1 to Feb. 28(29)	March 1 to May 31	June 1 to Aug. 31	Sept. 1 to Nov. 30
Less than 2%	Blended Fiber @ 2000 lbs/ac. minimum	xxxxxxxxxxxxxxxxx	OK (≤ 1 ac.)	xxxxxxxxxxxxxxxxx	OK (≤ 1 ac.)
	Wood Fiber @ 2000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3000 lbs/ac. min.	OK	OK	OK	OK
	Straw @ 2 Tons/ac. Min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
2% to 5.9%	Wood Fiber @ 2000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3000-3500 lbs/ac. min	OK	OK	OK	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
6% to 10.9%	Wood Fiber @ 2000-2500 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3500-4000 lbs/ac. min.	OK	OK	OK	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
11% to 24.9%	Wood Fiber @ 2500-3000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3500-4000 lbs/ac. min.	OK	OK	OK	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
25% to 33%	Wood Fiber @ 2500-3000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 4000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
33% and up	BFM @ 4000-4500 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	Straw @ 2 Tons/ac. min.***	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	2:1 Max.	2:1 Max.	2:1 Max.	2:1 Max.

* Note: Manufacturers Recommended Rates for informational purposes only. Performance standard requires 100% soil coverage.
** Note: Stabilization Matting must be applied in accordance with Section 3.4.6 of the Delaware ESC Handbook.
***Note: Straw applied on slopes greater than 33% must be netted (this does not apply to topsoil stockpiles).
OK = Acceptable to use during this time period.
xxx = Not acceptable to use during this time period.
All application rates are minimums

Figure 3.4.5a Mulching material selection guide

Mulching

1. Materials and Amounts

a. *Straw* - Straw shall be unrotted small grain straw applied at the rate of 1-1/2 to 2 tons per acre, or 70 to 90 pounds (two bales) per 1,000 square feet. Mulch materials shall be relatively free of weeds and shall be free of noxious weeds such as; thistles, Johnsongrass, and quackgrass. Spread mulch uniformly by hand or mechanically. For uniform distribution of hand spread mulch, divide area into approximately 1,000 square feet sections and place 70-90 pounds (two bales) of mulch in each section.

b. *Wood chips* - Apply at the rate of approximately 6 tons per acre or 275 pounds per 1,000 square feet when available and when feasible. These are particularly well suited for utility and road rights-of-way. If wood chips are used, increase the application rate of nitrogen fertilizer by 20 pounds of N per acre (200 pounds of 10-10-10 or 66 pounds of 30-0-0 per acre).

c. *Hydraulically applied mulch* -The following conditions apply to hydraulically applied mulch:

i. Definitions:

a. Wood fiber mulch shall consist of specially prepared wood that has been processed to a uniform state, is packaged for sale as a hydraulic mulch for use with hydraulic seeding equipment, and consists of a minimum of 70% virgin or recycled wood fiber combined with 30% paper fiber and additives.

b. Blended fiber mulch shall consist of any hydraulic mulch that contains greater than 30% paper fiber. The paper component must consist of specially prepared paper that has been processed to a uniform fibrous state and is packaged for sale as a hydraulic mulch for use with hydraulic seeding equipment.

c. A bonded fiber matrix (BFM) consists of long strand, specially prepared wood fibers that have been processed to a uniform state held together by a water resistant bonding agent. BFMs shall contain no paper (cellulose) mulch but may contain small percentages of synthetic fibers to enhance performance.

d. Refer to **Figure 3.4.5a** for conditions and limitations of use for each of the above categories of hydraulic mulch.

ii. All components of the hydraulically applied mulches shall be pre-packaged by the manufacturer to assure material performance. Field mixing of the mulch components is acceptable, but must be done per manufacturers recommendations to ensure the proper results.

iii. Hydraulic mulches shall be applied with a viable seed and at manufacturer's recommended rates. Increased rates may be necessary based on site conditions.

iv. Hydraulically applied mulches and additives shall be mixed according to manufacturers recommendations.

iv. Materials within this category shall only be used when hydraulically applied mulch has been specified for use on the approved Sediment and Stormwater Plan, or supplemental approval from the plan approval agency has been obtained in writing for a specific area.

v. Application:
   a. Apply product to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope.
   b. Do not apply to saturated soils, or if precipitation is anticipated within 24-48 hours.
   c. During the spring (March 1 to May 31) and fall (September 1 to November 30) seasons, hydraulic mulches may be applied in a one-step process where all components are mixed together in single-tank loads. It is recommended that the product be applied from opposing directions to achieve optimum soil coverage.
   d. During the summer (June 1 to August 31) and winter (December 1 to February 28) seasons, the following two-step process is required:
      Step One– Mix and apply seed and soil amendments with a small amount of mulch for visual metering.
      Step Two – Mix and apply mulch at manufacturers recommended rates over freshly seeded surfaces. Apply from opposing directions to achieve optimum soil coverage.
   e. Minimum curing temperature is 40^0 F (4^0 C). The best results and more rapid curing are achieved at temperatures exceeding 60^0 F (15^0 C). Curing times may be accelerated in high temperature, low humidity conditions on dry soils.

vi. Recommended application rates are for informational purposes only. Conformance with this standard and specification shall be performance-based and requires **100% soil coverage**. Any areas with bare soil showing shall be top dressed until full coverage is achieved.

d. *Compost blanket (CB)* - Loosely applied with a pneumatic blower so that a 1" compost blanket uniformly covers the **soil with 100% coverage**. This application can be used with seed to promote germination by applying the approved seed mix directly into the loosely blown compost. The compost blanket performs best on slopes less than 2:1 and requires no mulch anchoring.

2. Anchoring mulch - Mulch must be anchored immediately to minimize loss by wind or water. This may be done by one of the following methods, depending upon size of area, erosion hazard, and cost.

a. *Crimping* - A crimper is a tractor drawn implement designed to punch and anchor mulch into the top two (2) inches of soil. This practice affords maximum erosion control but is limited to flatter slopes where equipment can operate safely. On sloping land, crimping should be done on the contour whenever possible.

b. *Tracking* - Tracking is the process of cutting mulch (usually straw) into the soil using a bulldozer or other equipment that runs on cleated tracks. Tracking is used primarily on slopes 3:1 or steeper and should be done up and down the slope with cleat marks running across the slope.

c. *Liquid mulch binders* - Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and other areas where the mulch will be moved by wind or water. All other areas should have a uniform application of binder. The use of synthetic binders is the preferred method of mulch binding and should be applied at the rates recommended by the manufacturer.

d. *Paper fiber* - The fiber binder shall be applied at a net dry weight of 750 lbs/ac. The wood cellulose fiber shall be mixed with water, and the mixture shall contain a maximum of 50 lbs. of wood cellulose fiber per 100 gallons.

e. *Nettings* - Synthetic or organic nettings may be used to secure straw mulch. Install and secure according to the manufacturers recommendations.

Standard Detail & Specifications

Mulching

DELAWARE EROSION & SEDIMENT CONTROL HANDBOOK

MULCHING MATERIAL SELECTION GUIDE

Percent Slope	Type of Mulch / App. Rate*	Dec. 1 to Feb. 28(29)	March 1 to May 31	June 1 to Aug. 31	Sept. 1 to Nov. 30
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	Wood Fiber @ 2000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3000 lbs/ac. min.	OK	OK	OK	OK
	Straw @ 2 Tons/ac. Min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
2% to 5.9%	Wood Fiber @ 2000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3000-3500 lbs/ac. min	OK	OK	OK	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
6% to 10.9%	Wood Fiber @ 2000-2500 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3500-4000 lbs/ac. min.	OK	OK	OK	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
11% to 24.9%	Wood Fiber @ 2500-3000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 3500-4000 lbs/ac. min.	OK	OK	OK	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
25% to 33%	Wood Fiber @ 2500-3000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	BFM @ 4000 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	Straw @ 2 Tons/ac. min.	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	OK	OK	OK	OK
33% and up	BFM @ 4000-4500 lbs/ac. min.	xxxxxxxxxxxxxxxxx	OK	xxxxxxxxxxxxxxxxx	OK
	Straw @ 2 Tons/ac. min.***	OK	OK	OK	OK
	Stabilization Matting**	OK	OK	OK	OK
	1" Compost Blanket (CB)	2:1 Max.	2:1 Max.	2:1 Max.	2:1 Max.

* Note: Manufacturers Recommended Rates for informational purposes only. Performance standard requires 100% soil coverage.
** Note: Stabilization Matting must be applied in accordance with Section 3.4.6 of the Delaware ESC Handbook.
***Note: Straw applied on slopes greater than 33% must be netted (this does not apply to topsoil stockpiles).
OK = Acceptable to use during this time period.
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All application rates are minimums

Source: Delaware ESC Handbook & Filtrexx™ International

Symbol:

Detail No. **DE-ESC-3.4.5**
Sheet 3 of 3
Date: 03/13

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Chapter 5

Pollution Prevention Practices

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STANDARD AND SPECIFICATIONS FOR CONSTRUCTION SITE WASTE MANAGEMENT & SPILL CONTROL

Definition: Practices implemented to reduce the potential for stormwater runoff to transport construction site wastes that may contaminate surface or ground water. In the event of a spill, control the source of the spill, remediate, and properly dispose of hazardous substances.

Purpose: TTo prevent the generation of nonpoint source pollution from construction sites through effective handling, storage and disposal of building materials and other construction site wastes. To prevent hazardous wastes from contaminating surface and ground water, remediate spills, and dispose of contaminated substances/ materials properly.

Conditions Where Practice Applies: All earth disturbing activities which disturb greater than 5000 square feet where hazardous substances/materials are stored and used.

Planning Consierations:

Many potential pollutants other than sediment are associated with construction activities. These include pesticides (insecticides, fungicides, herbicides, and rodenticides); fertilizers used for the establishment of vegetation; petrochemicals (oils, fuels and asphalt degreasers); construction chemicals (concrete products, sealers, and paints); wash water associated with these products; paper; wood; garbage and sanitary wastes. Targeting potential spill areas, minimizing exposure to rainfall, and lengthening flow paths to receiving waters are essential when developing a spill prevention and control plan.

The variety of pollutants present, spill potential and the severity of their effects are dependent on a number of factors:

1. **The nature of the construction activity.** For example, potential pollution associated with fertilizer usage may be greater along a highway or at a housing development than it would be at a shopping center development due to greater landscaping requirements. Most large construction sites will have fuel tanks on-site for re-fueling construction vehicles and equipment.

2. **The physical characteristics of the construction site.** The majority of pollutants generated at construction sites are carried to surface waters via runoff. Therefore, the factors affecting runoff volume, such as the amount, intensity, and frequency of rainfall; soil infiltration rates; surface roughness; slope length and steepness; and area denuded, all contribute to pollutant loadings.

3. **The proximity of surface waters to the nonpoint pollutant source.** As the distance separating pollutant-generating activities from surface waters decreases, the likelihood of water quality impacts increases.

Practices

The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above. On all construction sites, an individual should be designated to oversee and enforce waste management procedures and spill prevention practices.

1. Construction site wastes - general

a. Designate a waste collection area onsite that does not receive a substantial amount of runoff and does not drain directly to a waterbody. Storage areas should not be located near inlets or stormwater management conveyance systems.

b. Reduce the sources of waste to the greatest extent possible.

c. Ensure that containers have watertight lids so they can be covered before periods of rain, and keep containers in a covered area whenever possible. Dumpsters and other containers should not be hosed out. Let the trash-hauling contractor clean out containers.

d. Schedule waste collection to prevent containers from overfilling. During the demolition phase of construction, provide extra containers and schedule more frequent pickups.

e. Collect, remove and dispose of all construction site wastes at authorized disposal areas. A local environmental agency can be contacted to identify these disposal sites.

f. Provide proper sanitary facilities for construction workers.

2. Hazardous Materials

a. Local waste management authorities should be consulted about the requirements for handling and disposing of hazardous materials. Right-to-know and reporting requirements for chemicals and chemical compounds must be followed.

b. The entire product should be used before disposing of the container. A hazardous waste container should be emptied and cleaned before it is disposed of to prevent leaks. If product remnants are wet or moist, let them dry before cleaning and disposing of the container.

c. The original product label should never be removed from the container as it contains important safety information. Follow the manufacturers recommended safety measures and method of disposal, which should be printed on the label.

d. If excess products need to be disposed of, they should never be mixed during disposal unless specifically recommended by the manufacturer.

e. Hazardous waste containers should be placed in secondary containment.

f. State or local solid waste regulatory agencies or private firms should be consulted to ensure the proper disposal of contaminated soils that have been exposed. Some landfills might accept contaminated soils, but they require laboratory tests first.

3. Pesticides

a. Follow all federal, state, and local regulations that apply to the use, handling, or disposal of pesticides.

b. Store pesticides in a cool, dry, covered area lined with plastic sheeting. Check containers for leaks or deterioration. Maintain a list of products in storage.

c. Warning signs should be posted in storage areas, and areas recently treated.

d. Follow the recommended application rates and methods.

e. Applicators should wear suitable, protective clothing, in accordance with the law.

f. Pesticides should be used only in conjunction with the principles of Integrated Pest Management (IPM). Pesticides should be a tool of last resort; methods that are the least disruptive to the environment and human health should be used first.

g. Disposal of excess pesticides and pesticide related wastes must conform to registered label directions set forth in applicable federal, state and local regulations.

h. Pesticides should be disposed of through either a licensed waste management firm or a treatment, storage, and disposal (TSD) facility. Containers should be triple-rinsed before disposal, and rinse waters should be reused as product.

4. Petroleum Products

a. Store petroleum products and fuel for vehicles in covered areas, lined with a double layer of plastic sheeting or similar material.

b. Vehicle fueling operations should be established in a designated area. The aboveground fueling tanks need to be set in an impervious berm with a capacity 10 percent greater than that of the largest container.

c. Routine inspections of the tank and the secondary containment are required.

d. Clearly label all products.

e. Keep tanks off the ground with lids securely fastened.

f. Oil and oily wastes such as crankcase oil, cans, rags, and paper dropped into oils and lubricants should be disposed of in proper receptacles or recycled.

g. Waste oil for recycling should not be mixed with degreasers, solvents, antifreeze, or brake fluid.

5. Nutrient Management

a. Store fertilizers in covered areas not subject to stormwater runoff.

b. Apply fertilizers at the minimum rate and to the minimum area necessary, preferably based on soil tests.

c. Work fertilizers and liming materials into the soil to depths of 4 to 6 inches.

d. Use detergents only as recommended, and limit their use onsite. Wash water containing detergents should not be dumped into the storm drain system. It should be directed to a sanitary sewer or be otherwise contained so that it can be treated or properly disposed of.

6. Education

a. Educate employees regarding the potential environmental impacts of improperly managed construction waste material.

b. Educate workers on site about proper spill prevention.

c. Train construction workers in proper materials storage, handling and disposal.

d. Offer hands-on training classes in spill remediation.

e. Distribute or post informational material regarding chemical control.

Maintenance:

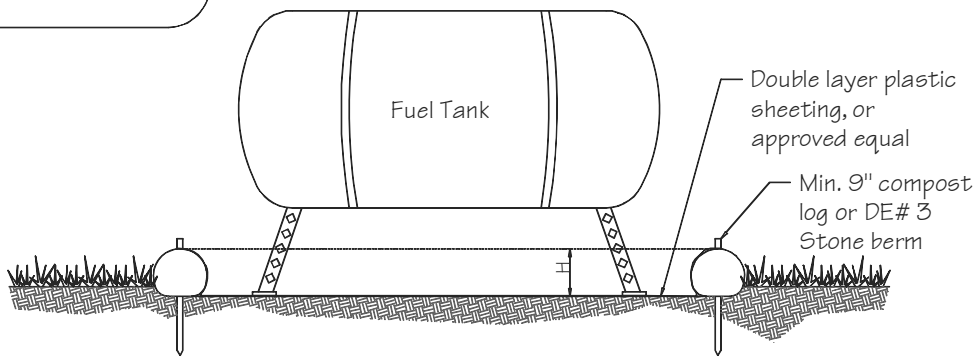
Containers or equipment that may malfunction and cause leaks or spills should be identified through regular inspection of storage and use areas. Equipment and containers should be inspected regularly for leaks, corrosion, support or foundation failure, or any other signs of deterioration and should be tested for soundness. Any found to be defective should be repaired or replaced immediately. Ample supplies and spill kits need to be readily available on site for spill remediation. Perform periodic reconnaissance of the construction site to identify any additional waste material or waste sources that need to be addressed.

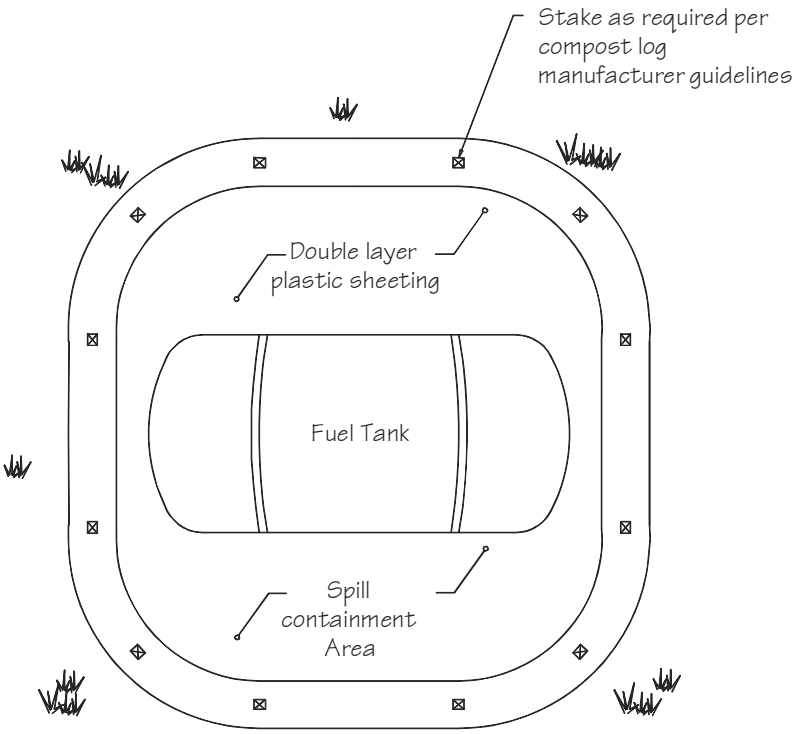
Standard Detail & Specifications

Construction Site Waste Mgt & Spill Control

DATA TO BE PROVIDED

Volume of Potential Pollution
Height of containment
Area of containment
Volume of containment





Source:	Symbol:	Detail No.
Delaware ESC Handbook		**DE-ESC-3.6.1** Sheet 1 of 5 Date: 03/13

Construction Site Waste Mgt & Spill Control

Pollution Prevention – Spill Prevention

1. Fueling should only take place in signed designated areas, away from downstream drainage facilities and watercourses.
2. Fueling must be with nozzles equipped with automatic shut-off to control drips. Do not top off.
3. Protect the areas where equipment or vehicles are being repaired, maintained, fueled or parked from storm water run-on and runoff.
4. Use barriers such as berms to prevent storm water run-on and runoff, and to contain spills.
5. Place a "Fueling Area" sign next to each fueling area.
6. Store hazardous materials such as fuel, solvents, oil and chemicals in secondary containment.
7. Inspect vehicles and equipment for leaks on each day of use. Repair fluid and oil leaks immediately.
8. Absorbent spill clean-up materials and spill kits must be available in fueling areas and on fuel trucks.
9. If fueling is to take place at night, make sure the fueling area is sufficiently illuminated.
10. Properly dispose of used oil, fluids, lubricants and spill clean-up materials.

CLEAN UP SPILLS

1. If it is safe to do so, immediately contain and clean up any chemical and/or hazardous material spills.
2. Properly dispose of used oil, fluids, lubricants and spill clean-up materials.
3. Do not bury spills or wash them down with water.

LEAKS AND DRIPS

1. Use drip pans or absorbent pads at all times. Place under and around leaky equipment.
2. Do not allow oil, grease, fuel or chemicals to drip onto the ground.
3. Have spill kits and clean up material on-site.
4. Repair leaky equipment promptly or remove problem vehicles and equipment from the site. Clean up contaminated soil immediately.
5. Store contaminated waste in sealed containers constructed of suitable material. Label these containers properly.
6. Clean up all spills and leaks. Promptly dispose of waste and spent clean up materials.

Construction Site Waste Mgt & Spill Control

Notes:

The Construction Site Pollution Prevention Plan should include the following elements:

1. Material Inventory

Document the storage and use of the following materials:

a. Concrete
b. Detergents
c. Paints (enamel and latex)
d. Cleaning solvents
e. Pesticides
f. Wood scraps
g. Fertilizers
h. Petroleum based products

2. Good housekeeping practices

a. Store only enough product required to do the job.
b. All materials shall be stored in a neat, orderly manner in their original labeled containers and covered.
c. Substances shall not be mixed.
d. When possible, all of a product shall be used up prior to disposal of the container.
e. Manufacturers' instructions for disposal shall be strictly adhered to.
f. The site foreman shall designate someone to inspect all BMPs daily.

3. Waste management practices

a. All waste materials shall be collected and stored in securely lidded dumpsters in a location that does not drain to a waterbody.
b. Waste materials shall be salvaged and/or recycled whenever possible.
c. The dumpsters shall be emptied a minimum of twice per week, or more if necessary. The licensed trash hauler is responsible for cleaning out dumpsters.

Source:	Symbol:	Detail No.
Adapted from USEPA Pub. 840-B-92-002		**DE-ESC-3.6.1** Sheet 3 of 5 Date: 03/13

Construction Site Waste Mgt & Spill Control

Notes (cont.)

d. Trash shall be disposed of in accordance with all applicable Delaware laws.

e. Trash cans shall be placed at all lunch spots and littering is strictly prohibited. Recycle bins shall be placed near the construction trailer.

f. If fertilizer bags can not be stored in a weather-proof location, they shall be kept on a pallet and covered with plastic sheeting which is overlapped and anchored.

4. Equipment maintenance practices

a. If possible, equipment should be taken to off-site commercial facilities for washing and maintenance.

b. If performed on-site, vehicles shall be washed with high-pressure water spray without detergents in an area contained by an impervious berm.

c. Drip pans shall be used for all equipment maintenance.

d. Equipment shall be inspected for leaks on a daily basis.

e. Washout from concrete trucks shall be disposed of in a temporary pit for hardening and proper disposal.

f. Fuel nozzles shall be equipped with automatic shut-off valves.

g. All used products such as oil, antifreeze, solvents and tires shall be disposed of in accordance with manufacturers' recommendations and local, state and federal laws and regulations.

5. Spill prevention practices

a. Potential spill areas shall be identified and contained in covered areas with no connection to the storm drain system.

b. Warning signs shall be posted in hazardous material storage areas.

c. Preventive maintenance shall be performed on all tanks, valves, pumps, pipes and other equipment as necessary.

d. Low or non-toxic substances shall be prioritized for use.

Construction Site Waste Mgt & Spill Control

Notes (cont.)

e. Contact information for reporting spills through the DNREC 24-Hour Toll Free Number shall be prominently posted.

6. Education

a. Best management practices for construction site pollution control shall be a part of regular progress meetings.

b. Information regarding waste management, equipment maintenance and spill prevention shall be prominently posted in the construction trailer.

CONTACT INFORMATION

DNREC 24-Hour Toll Free Number	**800-662-8802**
DNREC Solid & Hazardous Waste Branch	**302-739-9403**

Source:	Symbol:	Detail No.
Adapted from USEPA Pub. 840-B-92-002		**DE-ESC-3.6.1** Sheet 5 of 5 Date: 03/13

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STANDARD AND SPECIFICATIONS FOR CONCRETE WASHOUT

Definition: A designated and protected area used to rinse out concrete mixers and pumps after delivery onsite.

Purpose: The wash water from concrete producing equipment is alkaline and contains high levels of chromium, which if not disposed of in a secure area, can leach into the ground or runoff into stormdrains or surface waters causing contamination, increased pH, and potential pipe clogging. The concrete washout station 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).

Conditions Where Practice Applies: Concrete washouts shall be designated for all jobsites that require concrete equipment to be cleaned onsite. They may vary in size for a single family lot versus a large commercial development, but should be utilized in all applications.

Design Criteria:

Location

Concrete washout facilities should not be located within 50 feet of stormdrain inlet, swales, wetlands or waterbodies. They should be placed so that it is convenient for the concrete trucks to access and utilize the station, yet not within highly active construction areas that the washout is accidentally damaged causing a leak or spill. They should also not be located in an area that receives a significant amount of runoff, i.e., in a sump or bottom of hill, which could cause capacity or leaching issues. The washout facility must have a paved or gravel access drive leading to it with a minimum width of 10 feet and sloped downwards towards the washout at 2% slope. The access drive shall connect to a paved or gravel surface. Signs should be placed designating the facility and throughout the construction site to direct traffic to its location.

Type

For an excavated concrete washout, the facility should be minimum 6'x6' at the bottom and 3' deep. The facility may be larger and should be sized per the expected loadings (i.e., if a pump truck is needed to install the concrete, then the increase in washout volume should be accounted for with a larger facility). The area should be excavated to the required depth with 2:1 side slopes. The excavated area should be lined with minimum 10mil of polyethylene fabric. The liner should be anchored in place by backfilling underneath a 1 foot

high, 1 foot wide berm, located around the perimeter except for the access road. If anticipated to empty out and reuse the washout, the liner may be draped over the berm and anchored on the downslope side with sandbags. The liner shall be free of holes, tears or other defects that would compromise the impermeability of the material. In high groundwater situations and permeable soils, the liner will prevent the concrete wastewater from leaching prior to it solidifying.

Prefabricated concrete washouts can also be used and are useful for site that cannot excavate below ground, or need the versatility of being able to move the station to different locations. A manufactured unit with minimum 4'x4' area and 12" depth should be placed on top of a wooden pallet. The unit should be lined with a minimum 4mil polyethylene liner (must meet manufacturer's recommendations) that can be tied off during rain events. After the washout unit is utilized it should remain exposed (except during rain events) so that the wastewater can evaporate, leaving only solid concrete residue. The pallet can then be picked up with a forklift and disposed of in a dump truck. A typical 4'x4' unit can accommodate 10 washouts before needing to be replaced. The unit size or disposal frequency should be adjusted depending on the expected frequency of use.

Maintenance and Disposal:

Concrete washout stations should be inspected regularly to ensure there are no leaks and that the facility has not reached 75 percent of its capacity. In addition, the site must be checked for evidence of concrete washout in non-designated washout areas. If non-designated areas are being utilized, additional education, signage and/or stations shall be provided.

When the facility has reached 75 percent of its capacity, or when desired to remove the concrete, the hardened solids can be discarded whole, or it can be broken up and reused on-site. If disposed of, a recycling center should be investigated that will reuse the discarded remains for road aggregate or other applications. If the facility is to be reused after disposal, then a new liner must be installed if the original has been compromised or removed. If the concrete is buried onsite, it should be covered with a minimum of 1' of clean, compacted fill that is stabilized to prevent erosion.

Standard Detail & Specifications

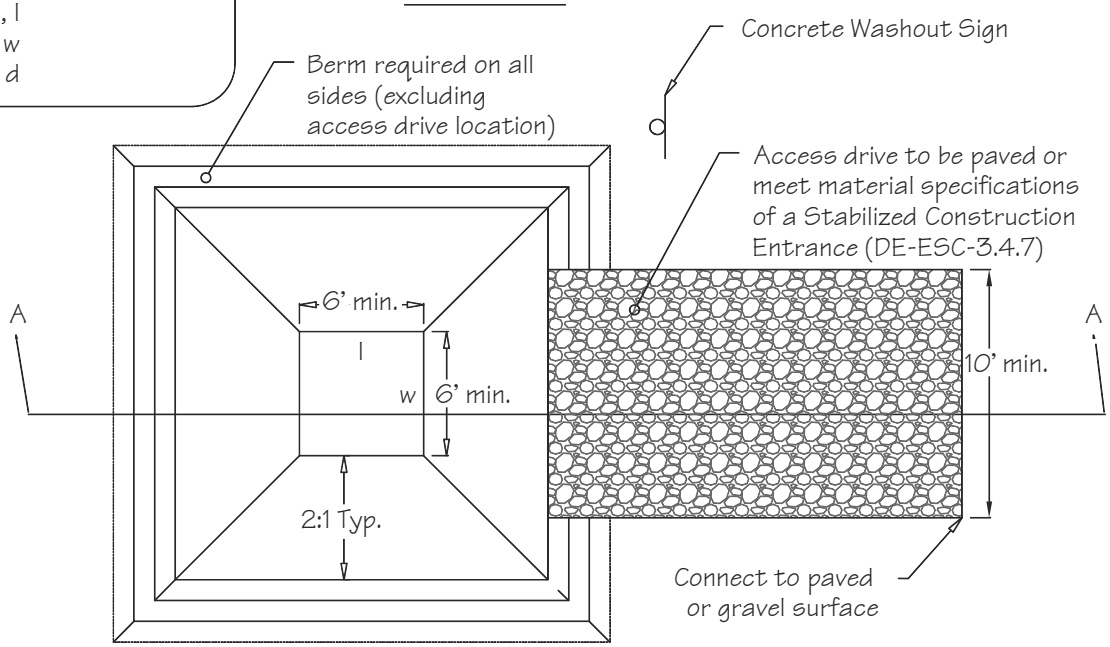
Concrete Washout

DELAWARE EROSION & SEDIMENT CONTROL HANDBOOK

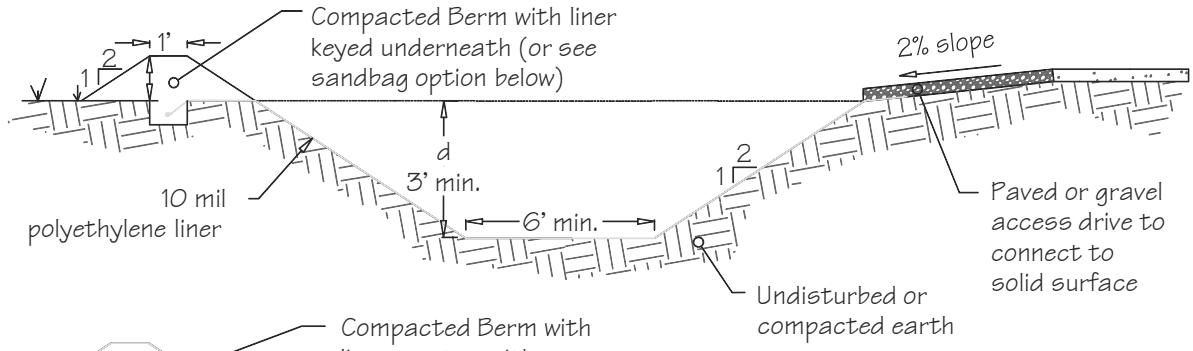
DATA TO BE PROVIDED

Length, l
Width, w
Depth, d

Plan View



Section A-A



Alternate Liner Option

Note: Prefabricated concrete washout option not shown.

Source:	Symbol:	Detail No.
Adapted from Colorado Urban Storm Drainage Criteria Manual, Vol 3	CW	**DE-ESC-3.6.2** Sheet 1 of 2 Date: 03/13

Concrete Washout

Construction Notes:

1. Locate washout area a minimum of 50 feet from open channels, stormdrain inlets, wetlands or waterbodies.
2. Locate washout area so that it is accessible to concrete equipment (service with a minimum 10 foot wide gravel accessway), but so it is not in a highly active construction area causing accidental damage.
3. Minimum dimensions for prefabricated units are 4 feet by 4 feet by 1 foot deep with a minimum 4mil polyethylene plastic liner. Minimum dimensions for constructed concrete washout areas are 6 feet by 6 feet by 3 feet deep, with a minimum 10mil polyethylene liner, 2:1 side slopes, and a 1 foot high by 1 foot wide compacted fill berm.
4. The liner must be free of tears or holes and placed over smooth surfaces to prevent puncturing. For excavated washouts, anchor the liner underneath the berm or overtop with sandbags or concrete blocks to hold in place.
5. Provide a sign designating the washout area, and for large construction sites, provide signs throughout directing traffic to its location.
6. Allow washed out concrete mixture to harden through evaporation of the wastewater. Once the facility has reached 75 percent of its capacity, remove the hardened concrete by reusing the broken aggregate onsite, recycling, or disposing of offsite. The hardened material can be buried on site with minimum of 1 foot of clean, compacted fill.
7. Apply a new liner before reusing the station for additional washouts after maintenance has occurred.

STANDARD AND SPECIFICATIONS FOR CONCRETE MIXING OPERATION

Definition: A designated and protected area to capture concrete slurry from operations that generate concrete or concrete products manufactured by mixing Portland cement, sand, aggregate, or similar materials utilizing onsite storage silos.

Purpose: The cementitious waste from concrete producing equipment is alkaline and contains high levels of chromium, which if not contained in a secure area, can leach into the ground or runoff into stormdrains or surface waters causing contamination, increased pH, and potential pipe clogging. A protected mixing area allows any residual by-product to be contained within a designated area instead of being washed into sensitive areas or leached into the ground.

Conditions Where Practice Applies: Construction site concrete mixing utilizing onsite storage silos regardless of location shall have designated controls to prevent liquid cementitious waste from coming into contact with surface water or soil. Containment areas may vary in size, but must be utilized in all applications where onsite mixing operations require bulk storage silos.

Design Criteria:

Location

Onsite concrete mixing operations should not be located within 50 feet of stormdrain inlet, swales, wetlands or waterbodies. They should be placed so that it is convenient for the telescopic lifts to access and utilize the station, yet not within highly active construction areas that the containment area is accidentally damaged causing a leak or spill. The containment area should have a gravel or paved access drive leading to it with a minimum width of 10 feet.

Type

Bulk storage silos and mixing units may vary from project to project. The bulk storage silo and mixing unit area is to be underlain with a 10-mil poly liner, and must be contained on a minimum of three sides by a poly lined 12-inch high berm using DE #57 stone (or 18" lined compost log). The side not protected with a border may

only be the upslope side of the containment area. The containment area must be sized to allow for 3.5 cubic feet of storage per cubic foot size of the mixing unit, and fully surround the mixing silo. The silo and mixing unit should not be raised higher than the top of the perimeter berm. After the containment area is utilized it should remain exposed so that the wastewater can evaporate, leaving only solid concrete residue. The containment area may be excavated or the dimensions increased to allow for greater storage capacity and longer time between liner replacement.

Maintenance and Disposal:

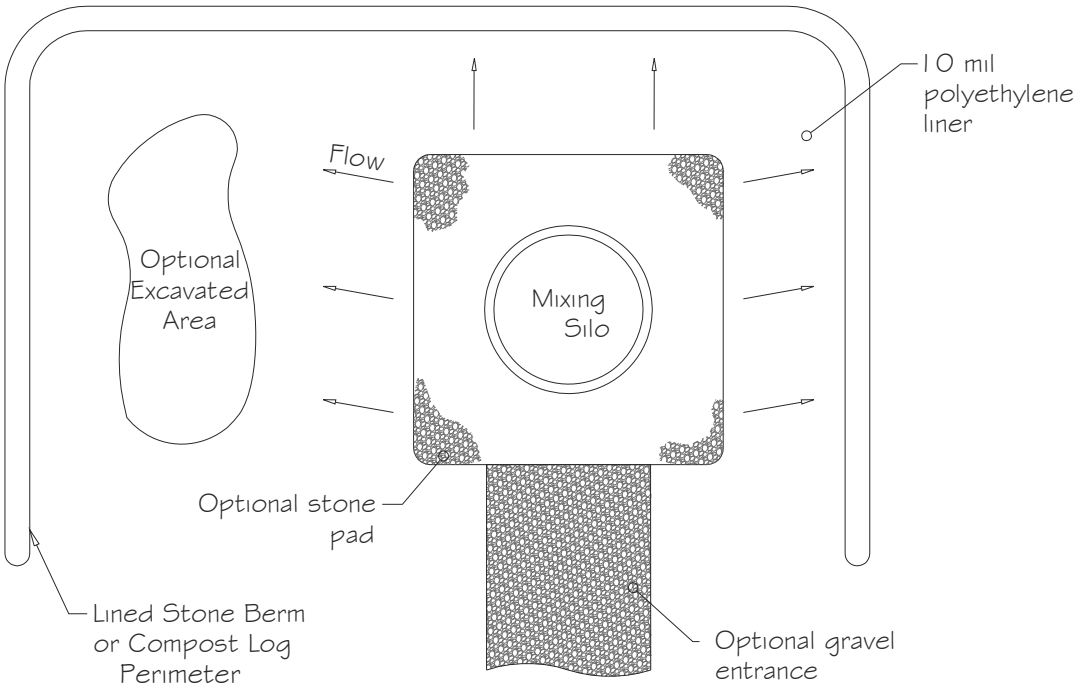
Inspect the containment area regularly to ensure that the liner is free of any rips or tears; if so, replace or patch the liner. Check the perimeter to ensure any liquid cementitious material has not traversed through the border; the stone berm or compost log may need amending if disturbed by construction equipment. If concrete has accumulated to 75% of the height of the border elevation, than the hardened concrete shall be removed, or the facility enlarged. If disposed of, a recycling center should be investigated that will reuse the discarded remains for road aggregate or other applications. If the facility is to be reused after disposal, then a new liner should be installed. If the concrete is buried onsite, it should be covered with a minimum of 1' of clean, compacted fill that is stabilized to prevent erosion.

Standard Detail & Specifications

Concrete Mixing Operation

DELAWARE EROSION & SEDIMENT CONTROL HANDBOOK

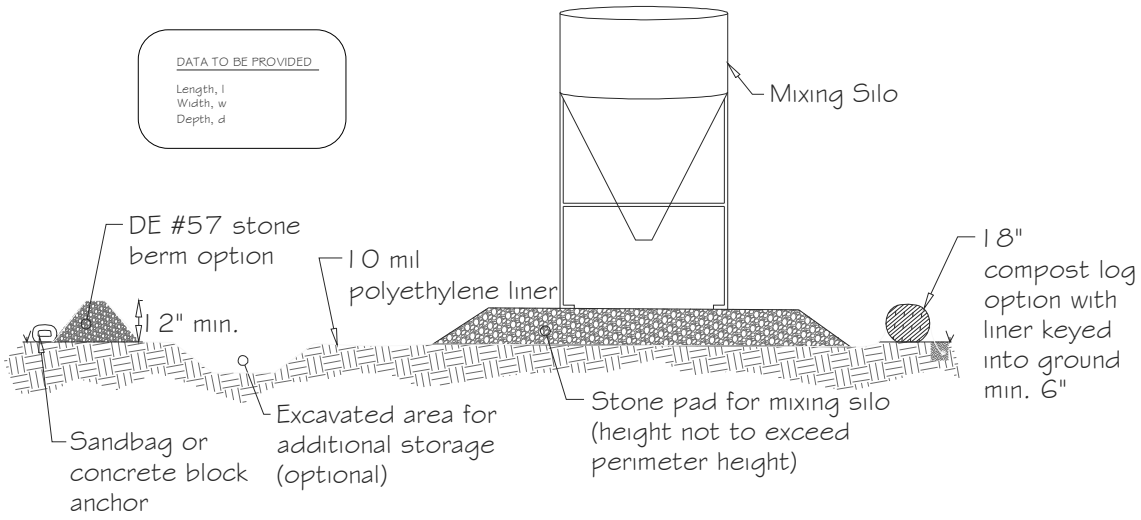
Plan View



NOTE: Berm required on all sides (excluding access drive location)

DATA TO BE PROVIDED

Length, l
Width, w
Depth, d



Section View

Source:	Symbol:	Detail No.
Adapted from MN/DOT Concrete Manual, Chap. 4	CMO	DE-ESC-3.6.3 Sheet 1 of 2 Date: 03/13

Concrete Mixing Operation

Construction Notes:

1. Locate concrete mixing and containment area a minimum of 50 feet from open channels, stormdrain inlets, wetlands or waterbodies.
2. Locate concrete mixing and containment area so that it is accessible to telescopic lifts (service with a minimum 10 foot wide gravel or paved accessway), but so it is not in a highly active construction area causing accidental damage.
3. Minimum volume for installed containment areas are 3.5 cubic feet per cubic foot of mixing capacity. The installed containment area must encompass the storage silo and mixing unit, and be surround on three sides minimum by a 12" high stone berm (DE #57) or 18" compost log
4. The 10-mil poly liner must be free of tears or holes and placed over smooth surfaces to prevent puncturing. The liner shall cover the perimeter control and be secured on the backside using cement or sand bags, or keyed into the ground a minimum of 6".
5. Allow cementitious waste to harden through evaporation of the wastewater. Once the facility has reached 75 percent of its capacity, remove the hardened concrete by reusing the broken aggregate onsite, recycling, or disposing of offsite. The hardened material can be buried on site with minimum of 1 foot of clean, compacted fill.
6. Apply a new liner before reusing the station for additional mixing after maintenance has occurred.

Chapter 6

Post Construction Stormwater Management

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POND

Code 378

Definition

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at spillway elevation is 3 ft or more. The depth of water impounded is defined as the difference between the spillway inlet elevation and the channel elevation at the point of discharge.

Purpose

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality. This standard also applies to stormwater management ponds that are not within the scope of SCS Technical Release No. 60.

Scope

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

3. The effective height of the dam is 35 ft or less, and the dam is hazard class (a). See Appendix A of this standard for structure (hazard) classification definitions.

4. Dams that exceed the scope of this standard shall be designed and constructed to meet the requirements of SCS Technical Release No. 60.

Conditions where practice applies

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and an emergency spillway, or (3) a principal spillway.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water in the pond. The quality shall be suitable for the water's intended use.

Reservoir area. The topography and soils of the site shall permit storage of water at a depth and volume that ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable. The sediment storage volume shall be no less than the expected sediment accumulation during a period equal to the design life.

Planning considerations

Water Quantity

1. Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge. The drainage area for wet ponds should be at least four (4) acres for each acre-foot of water. These requirements may be reduced if a dependable source of groundwater or diverted surface water contributes to the pond.

2. Variability of effects caused by seasonal or climatic changes.

3. Effects on the downstream flows or aquifers that could affect other water uses or users.

4. Potential for multiple use.

5. Effects on the volume of downstream flow to prohibit undesirable environmental, social or economic effects.

Water Quality

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment attached substances that are carried by runoff.

2. Effects on the visual quality of onsite and downstream water resources.

3. Short-term and construction-related effects of this practice on the quality of downstream water courses.

4. Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.

5. Effects on wetlands and water-related wildlife habitats.

6. Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.

7. Effects of soil water level control on the salinity of soils, soil water, or downstream water.

8. Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

Design criteria for embankment ponds

Foundation. A foundation investigation is required on all embankment ponds. As a minimum it shall include information along the centerline of the proposed dam, in the emergency spillway location, and the planned borrow area. The type of equipment used and the extent of the investigation will vary from site to site. All investigations shall be logged using the Unified Soil Classification System.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall be no steeper than one horizontal to one vertical.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

Earth embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 ft for one-way traffic and 26 ft for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

Table 1.-Minimum top width for dams

Total height of embankment	Top Width
ft	ft
10 or less	6
10-15	8
15-20	10
20-25	12
25-35	14
35 or more	15

The combined upstream and downstream side slopes of the settled embankments shall be no less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable.

If needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56 and 69).

The minimum elevation of the top of the settled embankment shall be 1 ft above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top of the dam shall be 2 ft for all dams having more than a 20-acre drainage area or more than 20 ft in effective height.

The design height of the dam shall be increased by the amount needed to ensure that after settlement the height of the dam equals or exceeds the design height. This increase shall be no less than 5 percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

The crest elevation shall be no less than 0.5 ft below the crest of the emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 ft for those having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. See Table 4 for additional requirements. The diameter of the pipe shall be no less than 4 in. If the pipe conduit diameter is 10 in or greater, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway. Runoff rates and volumes shall be determined using one or more of the following references:

1. SCS Engineering Field Manual
2. SCS National Engineering Handbook, Section 4, "Hydrology"
3. SCS Technical Release 55, "Urban Hydrology for Small Watersheds"
4. SCS Technical Release 20, "Computer Program for Project Formulation"

Pipe conduits under or through the dam shall meet the following requirements. The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall be no less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

For dams 20 ft or less in effective height, acceptable pipe materials are cast-iron, steel, corrugated steel or aluminum, asbestos-cement, concrete, plastic, vitrified clay with rubber gaskets, and cast-in-place reinforced concrete. Asbestos-cement, concrete, and vitrified clay pipe shall be laid in a concrete bedding. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 ft in effective height, conduits shall be plastic, reinforced concrete, cast-in-place reinforced concrete, corrugated steel or aluminum, or welded steel pipe. The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 ft. Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet. Protective coatings of asbestos-bonded, asphalt coated, or vinyl coating on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5.

Specifications in tables 2 and 3 are to be followed for polyvinyl chloride (PVC), steel, and aluminum pipe.

Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Practice standard 430-FF provides criteria for cathodic protection of welded steel pipe.

Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 ft.

2. The conduit is of smooth pipe larger than 8 in. in diameter.

3. The conduit is of corrugated pipe larger than 12 in. in diameter.

Table 2.-Acceptable PVC pipe for use in earth dams[1]

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
in		ft
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6, 8, 10, 12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

[1]Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ATSM-D-1785 or ATSM-D-2241.

Table 3.-Minimum gauge for corrugated metal pipe [2-2/3-in x 1/2-in corrugations][1]

Fill height (ft)	Minimum gauge for steel pipe with diameter (in) of-						Minimum thickness (in)[2] of aluminum pipe with diameter (in) of-			
	21 and less	24	30	36	42	48	21 and less	24	30	36
1-15	16	16	16	14	12	10	0.06	0.06	0.075	0.075
15-20	16	16	16	14	12	10	.06	.075	.105	.105
20-25	16	16	14	12	10	10	.06	.105	.135	[3]

[1] Pipe with 6-, 8-, and 10-in diameters has 1-1/2 in x 1/4-in corrugations.
[2] Riveted or helical fabrication.
[3] Not permitted.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

The drain is to consist of sand meeting fine concrete aggregate requirements (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made.

The drain shall be a minimum of 2 ft thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 in. beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam.

The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protecting drain fill from surface erosion will be necessary.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase by 15% the seepage path along the pipe.

Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1-1/4 in.

Table 4.-Minimum spillway capacity

Drainage area	Effective height of dam[1]	Storage	Minimum design storm[2] Frequency Prin. Splwy.	Emer. Splwy.	Minimum duration
acre	ft	acre-ft	yr	yr	hr
20 or less	20 or less	Less than 50	5	10	24
20 or less	More than 20	Less than 50	10	25	24
More than 20	20 or less	Less than 50	10	25	24
All others		-	25	50	24

[1] As defined under "Scope."
[2] Select rain distribution based on climatological region.

Emergency spillways. Emergency spillways convey large flood flows safely past earth embankments.

An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an emergency spillway: a conduit with a cross-sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed emergency spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 ft, the emergency spillway shall have a bottom width of not less than 10 ft.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural emergency spillways. If chutes or drops are used for principal spillways or principal emergency or emergency spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices and the National Engineering Handbook-Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

Visual resource design. The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material

can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Design criteria for excavated ponds

Runoff. Provisions shall be made for a pipe and emergency spillway if necessary. Runoff flow patterns shall be considered when locating the pit and placing the spoil (see table 4).

Side slopes. Side slopes of excavated ponds shall be stable and shall be no steeper than one horizontal to one vertical. Flatter side slopes are strongly recommended for safety. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

Perimeter form. If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 ft, with the top graded to a continuous slope away from the pond.

2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 ft from the edge of the pond.

3. Shaped to a designed form that blends visually with the landscape.

4. Used for low embankment and leveling.

5. Hauled away.

Plans and specifications

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. See page S-378-1 for items to be considered in development of the construction drawings and specifications.

Substantiating Data for Documentation

Installation and construction check notes shall be kept in sufficient detail to determine if the practice meets standards and specifications. Minimum requirements as applicable are:

1. Profile notes along centerline of top of completed embankment.

2. Cross section notes at one or more locations on the completed embankment.

3. Profile notes along centerline of earth spillway.

4. Cross section notes of earth spillways as needed to determine whether planned grade and dimensions have been met.

5. Location, size, type, grade, and/or pertinent elevations of the principal spillway, trickle tube, influent and/or effluent lines, and all other required appurtenances.

6. Depth and area of normal pool if these minimums are a part of specifications.

7. Maximum and minimum operational elevations.

8. Statement on condition or adequacy of clearing of the site and reservoir if this is a part of the plan.

9. Statement as to the condition or adequacy of vegetation on the embankment, spillway, and other disturbed areas.

10. Information on whether pond has been stocked.

11. Information on whether design features for fish management were incorporated.

12. Type and adequacy of sealing treatment.

13. Type and location of fencing and safety features where appropriate.

Sufficient survey will be made to determine quantities if required by the drawings and specifications or to determine number of practice units as applicable.

Measurements and computations for quantities will be recorded and filed to the extent that they are required to determine the number of practice units performed, or as requested by the landuser.

SOIL CONSERVATION SERVICE

DELAWARE

CONSTRUCTION SPECIFICATIONS FOR

POND (378)

These construction specifications apply to all ponds designed to meet the requirements of practice standard Pond (378).

Embankment Ponds

Foundation Preparation

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish. Where needed to establish vegetation, the topsoil and sod are to be stockpiled and spread on the completed dam and spillways. Foundation surfaces shall be sloped to no steeper than 1:1. The foundation area shall be thoroughly scarified before placement of the fill material. The surface shall, if necessary, have water added and be compacted so that the first layer of fill material may be compacted and bonded to the foundation.

The cutoff trench and any other required excavations shall be excavated to the lines and grades shown on the drawings or as staked in the field. To the extent they are suitable, excavated materials are to be used in the embankment.

Existing stream channels in the foundation area shall be sloped no steeper than 1:1 and deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

Foundation areas shall be kept free of standing water when fill is being placed on them.

Fill Placement

The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones over six (6) inches in diameter (except for rock fills), and other objectionable material.

Backfill material shall be placed around structures, pipe conduits, and antiseep collars at approximately the same rate on all sides to prevent damage from unequal loading.

The placing and spreading of fill material shall be started at the lowest point of the foundation and the fill brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers except where openings or sectionalized fills are called for. In those cases, the slope of the bonding surfaces between embankment in-place and embankment to be placed will not be steeper than three (3) horizontal to one (1) vertical. The bonding surface is to be treated the same as that specified for the foundation so as to ensure a good bond with the new fill.

The distribution and gradation of materials shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream portions of the fill. Where zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings.

Moisture Control

The moisture content of the fill material shall be such that the required compaction can be obtained. Material that is too wet shall be dried to meet this requirement. Material that is too dry shall have water added and mixed until the requirement is met.

Compaction

The construction equipment shall be operated over the areas of each layer of fill in a way that will result in the required compaction. Special equipment shall be used when the required compaction cannot be obtained without it.

When a minimum required density is specified, each layer of fill shall be compacted as necessary to achieve a density not less than that specified.

Fill adjacent to structures, pipe conduits, and antiseep collars shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually-directed

power tampers or plate vibrators. Compaction adjacent to concrete structures will not be started until the concrete has attained sufficient strength to support the load.

Erosion Protection

Vegetation shall be established on all exposed surfaces of the embankment, spillway, and borrow area where soil and climatic conditions permit. Where soil or climatic conditions preclude the use of vegetation, and erosion protection is needed, non-vegetative means such as mulches or gravel may be used. In some cases, temporary vegetation may be used until conditions are right for establishment of permanent vegetation. The embankment and spillway shall be fenced where necessary to protect the vegetation.

Seedbed preparation, seeding, fertilizing, and mulching shall comply with the SCS Standards and Specifications for Critical Area Planting, Practice Code 342.

Principal Spillways

Corrugated metal pipe and its fittings shall conform to the standards set forth in the appropriate American Society of Testing Materials Designation(s) suitable for the intended purpose. These may include, but not be limited to, ASTM A-760, A-762, A-849, A-885, B-745, and B-790. Antiseep collars are to be of materials compatible with the pipe and installed so as to be watertight. The pipe shall be installed in accordance with the manufacturer's instructions. The pipe shall be firmly and uniformly bedded throughout its length and shall be installed to line and grade as shown on the drawings.

Concrete

Concrete shall receive the detail in mix design and testing consistent with the size and requirements of the job. Mix requirements or necessary strength should be specified. Type of cement, air entrainment, slump, aggregate or other properties are to be specified where necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing should be specified. Reinforcing steel is to be placed as indicated in the drawings and held securely in place during concrete placement. Subgrades and forms are to be installed to line and grade and the forms are to be mortar tight and unyielding as the concrete is placed.

Drainage Diaphragm, Foundation, and Embankment Drains

Drainage diaphragm, foundation, and embankment drains, when required, will be placed to line and grade as shown on the drawings. Detailed requirements for drain material and any required pipe will be shown in the drawings and specifications for the job.

Embankment and Excavated Ponds

All completed construction shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized and held within legal limits. All work will be conducted in a skillful and professional manner.

The completed job shall present a professional appearance.

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical.

Fencing and cover to control erosion and pollution shall be established as needed.

Appropriate safety measures, such as warning signs, rescue facilities, fencing, etc., shall be included in the construction drawings and specifications.

An operation and maintenance plan shall be agreed to by the owner and operator.

APPENDIX A

STRUCTURE (HAZARD) CLASSIFICATION
FOR
POND (378)

Structure Classification

All structures (dams) will be reviewed and classed according to factors and procedures outlined in 520.21 of Subchapter C, Subpart C - Dams, SCS National Engineering Manual as supplemented herein. The class ("a," "b," and "c") as contained in this document is related to the damage that might result from a sudden major breach of the earth embankment. Structure classification and land use for runoff determination must take into consideration the anticipated changes in land use throughout the expected life of the structure. The classification of a dam is the responsibility of the designer, and subject to review and concurrence of the approving authority.

The classification of a dam is determined only by the potential hazard from failure not by the criteria. Classification factors in the National Engineering Manual, as supplemented, are given below:

Class "a" - Structures located in rural, agricultural, or urban areas dedicated to remain in flood tolerant usages where failure may damage non-resident buildings, agricultural land, floodplains, or county roads.

Class "b" - Structures located in predominantly rural or agricultural areas where failure may damage isolated homes, main highways or minor railroads, or cause interruption of use or service of relatively important public utilities.

Class "c" - Structures located where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads.

Where breach analysis has indicated that overtopping of downstream roads will occur, the following guidelines will be used:

Class	Depth of Flow (d) ft.
"a"	d is less than or equal to 1.0
"b"	d is greater than 1.0 but less than 3.0
"c"	d is greater than 3.0

Urban areas are defined as metropolitan areas, cities, and suburbs, including areas in transition from agriculture to residential-industrial.

Technical Guide
Section IV
September 1990
SCS, Delaware

APPENDIX B

AMENDED SMALL POND DESIGN REQUIREMENTS
FOR
URBAN STORMWATER MANAGEMENT PONDS
CONSTRUCTED UNDER
CHAPTER 40, TITLE 7, DELAWARE CODE, JUNE 15, 1990

These requirements supplement and, in some situations, replace the criteria contained in the Code 378 when the purpose for the pond is to meet local and State requirements established for stormwater management.

The page number in Code 378 where the supplements or replacement requirements must be made are listed along with the revised text.

Page 4 - first paragraph first sentence

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam.

Page 4 - new paragraph at the bottom of the page

The floor of the pond shall be graded as flat as possible to permit uniform ponding. Side slopes leading to the floor should be no steeper than three horizontal to one vertical. Approximately one foot below the normal pool elevation, a ten foot level bench shall be provided.

Pond slopes above the normal pool elevation also shall be no steeper than three horizontal to one vertical and a reverse slope bench, at least ten feet wide must be provided approximately one foot above the normal pool elevation.

Page 5 - fifth paragraph beginning with "The crest elevation" shall be replaced with the following:

The crest elevation of the principal spillway for all stormwater management ponds shall be no less than one foot below the crest of the emergency spillway.

Page 7 - center paragraph regarding seepage control

Seepage control along a pipe conduit spillway shall be provided. Anti-seep collars shall be installed around all conduits through earth fills according to the following criteria.

1. Sufficient collars shall be placed to increase the seepage length along the conduit by a minimum of 15 percent of the pipe length located within the saturation zone.

2. The normal saturation zone shall be determined by projecting a line at a slope of four horizontal to one vertical from the point where the normal water meets the upstream slope to a point where this line intersects the invert of the pipe conduit.

3. Maximum collar spacing shall be 14 times the minimum projection above the pipe. The minimum collar spacing shall be 5 times the minimum projection.

4. Anti-seep collars should be placed within the saturated zone. In cases where the spacing limit will not allow this, at least one collar will be in the saturated zone.

5. All anti-seep collars and their connections to the conduit shall be watertight and made of material compatible with the conduit.

6. Collar dimensions shall extend a minimum of two feet in all directions around the pipe.

Page 8 - disregard the discussion regarding the drainage diaphragm

Page 8 - replace the last sentence on the page and replace with the following:

Drop inlet spillways must all have adequate antivortex devices.

Low stage releases shall have a non-clogging trash rack.

Page 9 - Table 4 must be modified for stormwater management

Table 4.-Minimum spillway capacities

Drainage Area	Effective Height of Dam	Storage	Minimum design storm: Frequency Prin. Splwy.	Minimum design storm: Frequency Emer. Splwy.	Minimum design storm: Minimum duration
acre	ft	acre-ft	yr	yr	hr
20 or less	Any	Less than 50	10	100	24
More than 20	20 or less	Less than 50	10	100	24
All others			25	100	24

Page 10 - Second paragraph beginning with "Construction," second sentence

They shall be trapezoidal and shall be located in undisturbed earth. Emergency spillways on stormwater management ponds shall not be located on fill material.

Page 11 - "Design criteria for excavated ponds," second paragraph, first sentence

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than three horizontal to one vertical. A 10 foot level bench shall be provided one foot below the normal pool elevation. Pond slopes above the normal pool elevation shall be no steeper than three horizontal to one vertical and a reverse slope bench, at least ten feet wide, shall be located one foot above the normal pool elevation.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
_____, DELAWARE

SCS-PS-378
348-349-402

POND OR DAM

OPERATION AND MAINTENANCE PLAN

OPERATOR_____DATE_____

ADDRESS_____

_____

A properly operated and pond or dam is an asset to your farm. This pond or dam was designed and installed to collect and provide storage of runoff water for beneficial use. The estimated life span of this installation is at least ten years. The life of the structure can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This conservation practice will require you to perform periodic maintenance and may also require operational items to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

GENERAL RECOMMENDATIONS

- Periodically inspect the spillways and inlets for proper functioning for their ability to maintain the water level to design elevations.

- Periodically check the elevation of the earthfills and restore to grade, if necessary.

- Maintain vigorous growth of desirable vegetative coverings. This includes reseeding, fertilization and controlled application of herbicides when necessary. Periodic mowing will be needed to control height and growth of woody vegetation. Maintain the embankment and emergency spillway by mowing. Do not mow during the nesting season (April 1 to August 1).

- If fences are installed, they shall be maintained to prevent unauthorized or livestock entry.

- Immediately remove any blockage or obstructions of spillways, trash racks and pipelines.

- Remove debris that may accumulate in the pond and immediately upstream or downstream from the pond.

- Determine and eliminate causes of settlement or cracks in the earthen sections and repair damage.

- Check all rock riprap for accelerated weathering and displacement. Replace to original grade.

- Repair or replace rusted or damaged metal.

- Eradicate or otherwise remove all rodents or burrowing animals and repair any damage caused by their activity.

- Immediately repair any vehicular or livestock damage to any earthfills, spillways and outlets.

- Make sure all structure drains are functional and soil is not being transported through the drainage system; repair if not functioning. The screens and/or rodent guards shall also be kept in place.

- Prevent the growth of woody vegetation on embankments. Tree growth on the dam will create leaks.

SPECIFIC RECOMMENDATIONS FOR YOUR INSTALLATION

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

CONTACT YOUR LOCAL SOIL CONSERVATION SERVICE OFFICE FOR ANY ADDITIONAL TECHNICAL ASSISTANCE YOU MIGHT NEED FOR IMPLEMENTATION OF THIS OPERATION AND MAINTENANCE PLAN FOR YOUR STRUCTURE.

ALL PROGRAMS AND SERVICES OF THE SOIL CONSERVATION SERVICE ARE OFFERED ON A NONDISCRIMINATORY BASIS, WITHOUT REGARD TO RACE, COLOR, NATIONAL ORIGIN, RELIGION, SEX, AGE, MARITAL STATUS, OR HANDICAP.

United States
Department of
Agriculture

Natural Resources
Conservation
Service

Suite 101
1203 College Park Drive
Dover, Delaware 19904-8713

September 19, 1996

RECEIVED
SEP 24 1996

Mr. Randy Greer
Div. of Soil & Water Cons.
DNREC, P.O. Box 1401
Dover, DE 19903

Dear Mr. Greer:

SUBJECT: NRCS Pond Standard 378

I am sending you this memo as a follow-up to our conversation regarding the use of smooth bore, corrugated plastic pipe in ponds. The NRCS Pond Standard 378 requires that embankment pond principal spillway pipe be capable of withstanding the design load with a maximum of 5 percent deflection. Corrugated plastic pipe typically needs to deflect more than 5 percent to develop its full strength. Thus, corrugated plastic pipe is unsuitable for an embankment pond. However, for an excavated pond or a combination excavated and low embankment (less than 3 feet of water impounded), there is no such restriction on the pipe material.

Please call me if you have any further questions regarding the use of corrugated plastic pipe in NRCS 378 Ponds.

Sincerely,

Ronald F. Gronwald

RONALD F. GRONWALD
State Conservation Engineer

cc:
John Barwick, Sussex Conservation District

The Natural Resources
Conservation Service
is an agency of the
Department of Agriculture

An Equal Opportunity Employer

1.0 Stormwater Infiltration

Definition: Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a two day period. Design variants include:

- 1-A Infiltration Trench
- 1-B Infiltration Basin

Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to exfiltrate into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices are suitable for use in residential and other urban areas where *measured* soil permeability rates exceed 1 inch per hour. To prevent possible groundwater contamination, infiltration should not be utilized at sites designated as stormwater hotspots. Extraordinary care shall be taken to assure that long-term infiltration rates are achieved through the use of performance bonds, post construction inspection and long-term maintenance.

Infiltration Construction Checklist

This checklist has been designed for infiltration practices constructed in accordance with the Delaware Sediment and Stormwater Program's Green Technology BMPs Standards, Specifications and Details

PROJECT INFORMATION

Project Name: _____

Location: _____

Contractor: _____

Construction Reviewer: _____

Date(s) / Time(s) of Inspections: _____

_____

_____

KEY:

✓	**Item meets standard**
X	**Item not acceptable**
N/A	**Item not applicable**

I. Pre-Construction

_____ A. Facility location staked out. Extents of infiltration practice (to include pre-treatment area) delineated and access by equipment prohibited to prevent compaction of existing soils.

_____ B. Upstream drainage area stabilized or effectively diverted.

_____ C. Materials on-site and dimensions and properties checked.

- _____ (1) Underdrain/discharge pipe
- _____ (2) Overdrain/discharge pipe
- _____ (3) Underdrain stone
- _____ (4) Geotextile fabric
- _____ (5) Sand
- _____ (6) Supplemental storage pipe
- _____ (7) Outfall pipe
- _____ (8) Riser pipe
- _____ (9) Observation ports

_____ D. Equipment on the site large enough to excavate infiltration area from the sides of the facility.

Project Name:_____

Construction Reviewer:_____

II. Excavation

_____ A. Facility excavated to dimensions and at location as per the approved plan.

_____ B. Stepwise excavation used for infiltration facilities.

_____ C. Facility excavated from the sides so as to not compact the existing soil.

_____ D. Groundwater not encountered during excavation.
(Note: If groundwater is encountered during the excavation process, construction of the facility must cease and the designer notified that a plan modification is necessary)

_____ E. Sides of infiltration trench excavation vertical.

_____ F. Bottom of excavation within design slope range.

_____ G. Bottom of trench excavation scarified prior to placement of sand.

_____ H. Geotextile fabric placed along the vertical sides of the trench, tuck into sand at the bottom for anchoring.

III. Structural Components

(For infiltration practices containing underdrains and/or overdrain pipe discharge components)

_____ A. Discharge pipe installed from overdrain to discharge point.

Discharge pipe diameter:_____

Discharge pipe material:_____

_____ B. Outlet protection provided at discharge point.

_____ C. Underdrain pipe material according to approved plan. *(Note: If underdrain pipe material is not specified, it shall be SDR 35 minimum)*
Underdrain pipe material:_____

_____ D. Underdrain pipe sizes according to approved plans.

Underdrain pipe diameter(s): _____

_____ E. Underdrain pipe perforations according to approved plans.
(Note: If not specified on the plan, three rows of 5/8" diameter perforations, 6" on-center, shall be provided)

_____ F. Underdrain piping lay flat or with positive slope toward outlet.

_____ G. Clean-outs and/or observation ports provided at endpoints of underdrain pipes or as shown on the approved Plan.

_____ H. Double-washed crushed aggregate, clean DE #57 stone, used for the underdrain gravel. Stone free of rock dust, fines and soil particles.

_____ I. Depth of stone over underdrain piping checked. ***Depth of stone:*** _____

Project Name:_____

Construction Reviewer:_____

IV. Grading

_____ A. Channel protection and/or level spreader provided at infiltration practice inlets as specified on the approved plan.

_____ B. Side slopes of infiltration basin no steeper than 3:1.

_____ C. Bottom of basin graded as per the Plan.

_____ D. Earth spillway constructed to design elevation and dimensions.

V. Vegetation

_____ A. Vegetation planted on the bottom and slopes of the basin as indicated on the vegetation spec on the Plan.

_____ B. For trenches, placement of topsoil and sod over the pea gravel, if this option is specified on Plan.

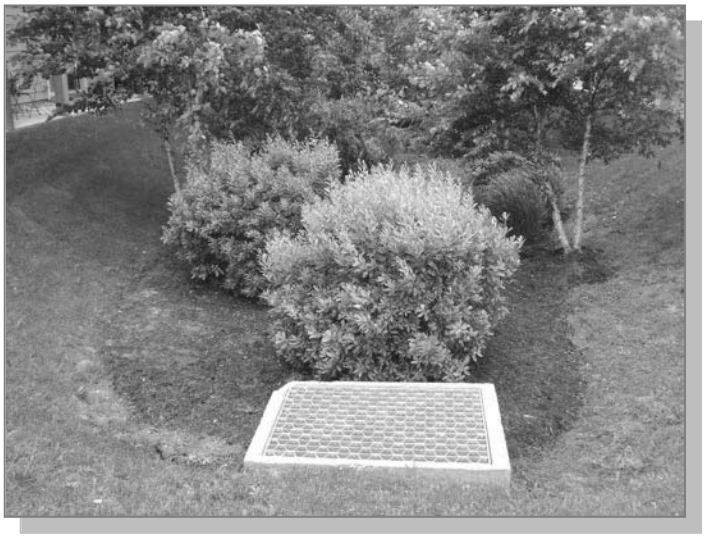
VI. Erosion and Sediment Control

_____ A. Installed matting in spillway as specified on Plan.

_____ B. For trenches, geotextile emerges from the sides of the trench and folds over stone to protect against sediment contamination during site construction.

2.0 Bioretention

Definition: Practices that capture and store stormwater runoff and pass it through a filter bed of engineered soil media comprised of sand, lignin and organic matter. Filtered runoff may be collected and returned to the conveyance system, or allowed to infiltrate into the soil. Design variants include:



- 2-A Traditional Bioretention
- 2-B In-Situ Bioretention (including Rain Gardens)
- 2-C Streetscape Bioretention
- 2-D Engineered Tree Boxes
- 2-E Stormwater Planters
- 2-F Advanced Bioretention Systems

Bioretention systems are typically designed to manage stormwater runoff from frequent, small magnitude storm events, but may provide stormwater detention of larger storms (e.g., 10-yr) in some circumstances. Bioretention practices shall generally be designed such that larger storm events bypass the system into a separate facility where site conditions allow.

For each of the design variants above, there are two basic configurations:

- *Underdrain Designs*: Practices with a positive discharge using perforated pipe; pollutant reduction occurs through a combination of runoff reduction and treatment by the filtering media. Addition of an infiltration sump is required to maximize runoff reduction performance. Advanced systems may provide greater pollutant removal capabilities through the use of improved media components and/or internal modifications that encourage partial anaerobic conditions.
- *Infiltration Designs:* Practices with no underdrains that can infiltrate the design storm volume within 48 hours; pollutant reduction is based solely on the load reduction provided by the design retention storage volume.

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are discussed in more detail below.

Bioretention Facility Construction Checklist

This checklist has been designed for bioretention facilities constructed in accordance with the Delaware Sediment and Stormwater Program's Post Construction Stormwater Management BMP Standards and Specifications

PROJECT INFORMATION

Project Name: _____

Location: _____

Contractor: _____

Construction Reviewer: _____

Date(s) / Time(s) of Inspections: _____

_____

_____

KEY:

✓	**Item meets standard**
X	**Item not acceptable**
N/A	**Item not applicable**

I. Pre-Construction

_____ A. Pre-construction meeting held.

_____ B. Facility location staked out. Extents of bioretention facility delineated and access by equipment prohibited to prevent compaction of existing soils.

_____ C. Upstream drainage area stabilized or effectively diverted.

_____ D. Materials on-site and dimensions and properties checked.

_____ (1) Underdrain/discharge pipe
_____ (2) Overflow catch basin
_____ (3) Underdrain stone
_____ (4) Filter fabric
_____ (5) Bioretention soil media
_____ (6) Plants (*Note: Plants need not be at the site at onset of construction)*

_____ E. Equipment on the site large enough to excavate bioretention trench from the sides of the facility.

KEY:

✓ **Item Meets Standard**

X Item Not Acceptable

N/A Item Not Applicable

Project Name:_____

Construction Reviewer:_____

II. Excavation

_____ A. Facility excavated to dimensions and at location as per the approved plan.

_____ B. Stepwise excavation used for infiltration bioretention facilities.
(Note: only excavate the portion of the bioretention facility that may be backfilled with bioretention soil media in the same day)

_____ C. Facility excavated from the sides so as to not compact the existing soil.

_____ D. Groundwater not encountered during excavation.
(Note: If groundwater is encountered during the excavation process, construction of the facility must cease and the designer notified that a plan modification is necessary)

_____ E. Sides of excavation vertical.

_____ F. Bottom of excavation within design slope range.

_____ G. Sides and bottom of excavation scarified prior to placement of bioretention soil media.

III. Structural Components

(For bioretention facilities containing underdrains and/or pipe discharge components)

_____ A. Discharge pipe installed from overflow catch basin to discharge point.

Discharge pipe diameter:_____

Discharge pipe material:_____

_____ B. Outlet protection provided at discharge point.

_____ C. Overflow catch basin installed at elevations as specified on the approved plan (minimum of 6" higher than design top elevation of bioretention soil media).

_____ D. Underdrain pipe material according to approved plan.
(Note: If underdrain pipe material is not specified, it shall be SDR 35 minimum)
Underdrain pipe material:_____

_____ E. Underdrain pipe sizes according to approved plans.

Underdrain pipe diameter(s): _____

_____ F. Underdrain pipe perforations according to approved plans.
(Note: If not specified on the plan, three rows of 5/8" diameter perforations, 6" on-center, shall be provided)

KEY:

✓ **Item Meets Standard**

X Item Not Acceptable

N/A Item Not Applicable

Project Name:_____

Construction Reviewer:_____

III. Structural Components (continued)

_____ G. Underdrain piping laid flat or with positive slope toward outlet.

_____ H. Clean-outs and/or observation ports provided at endpoints of underdrain pipes.

_____ I. Double-washed crushed aggregate, clean DE #57 stone, used for the underdrain gravel. Stone free of rock dust, fines and soil particles.

_____ J. Minimum 3" of gravel over underdrain piping.

_____ K. Filter fabric in accordance with approved plan specification laid between underdrain gravel layer and bioretention soil media.
Filter fabric manufacturer's product number: _____

IV. Grading

_____ A. Channel protection and/or level spreader provided at bioretention facility inlets as specified on the approved plan.

_____ B. Side slopes of buffer area (above design top of bioretention soil media) no steeper than 3:1.

_____ C. Top of berm constructed to design elevation and width.

_____ D. Earth spillway constructed to design elevation and dimensions.

V. Bioretention Soil Media

_____ A. Bioretention soil media provided in accordance with current DNREC policy.

_____ B. Bioretention soil media placed in lifts of one foot and spread out using an excavator from the side of the excavation to minimize compaction. Skid steer loaders or other small equipment shall not be used within the bioretention facility excavation to place the soil media.

_____ C. Bioretention soil media placed when media is optimally moist (not wet or dry) and there is no precipitation.

_____ D. Bioretention soil media placed within infiltration bioretention facilities during the same day that the area is excavated to prevent contamination if a runoff event should occur prior to placement of soil media.

_____ E. Bioretention soil media allowed to settle for at least one storm event before the final lift is added.

KEY:

✓ **Item Meets Standard**

X Item Not Acceptable

N/A Item Not Applicable

Project Name:_____

Construction Reviewer:_____

V. Bioretention Soil Media (continued)

_____ F. Bioretention soil media depth not less than 36" unless otherwise specified on the approved plan.

_____ G. Topdressing of 3" double-shredded aged hardwood mulch applied if desired or required by the approved plan. *(Note: A biodegradable netting may be used to prevent wind losses until several wet-dry cycles have occurred)*

VI. Vegetation

_____ A. Vegetation planted within the bioretention soil media according to the numbers and species on the approved bioretention planting plan.

_____ B. Plants occupy not more than 50% of the total surface area of the bioretention soil media.

_____ C. Individual plant spacing follows the recommendations on the plan.

_____ D. Trees planted only around the perimeter of the facility in the native soils, not in the bioretention soil media.

VII. Erosion and Sediment Control

_____ A. Silt fence placed around the bioretention area perimeter to prevent sediment contamination prior to full stabilization of contributory drainage area.

_____ B. Inlet protection provided on any catch basins that discharge to the bioretention facility.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Bioretention

Provide the following as it relates to the bioretention facility's surface area and available storage:

- ❑ Post construction verification contours of the bioretention facility, including any forebays, at 1-foot intervals
- ❑ A minimum of two cross sections showing elevations, inside slopes, top width and backslope, as applicable (to scale). Cross sections should be taken through inlet and outlet structures as applicable.
- ❑ Lowest top of bank elevation ****The acceptable top of bank elevation may be no lower than the design elevation for top of bank.*
- ❑ Calculations of the surface area of the bioretention soil surface. ****The allowable variance from the design surface area of the bioretention surface is ten percent less than the design surface area.*
- ❑ Calculations of the volume of the bioretention facility as constructed with incremental storage and cumulative storage volumes in cubic feet for each one-foot elevation contour. ****The allowable variance from the design volume of the bioretention surface storage is ten percent less than the design volume.*

Provide the following information related to the inlet and outlet structures within the bioretention facility. ****The allowable variance for elevations on any structure is 0.1 ft*:

- ❑ Diameter and material of all inlet and outlet pipes
- ❑ Invert elevations of all inlet and outlet pipes
- ❑ Dimensions (length, width, depth, d50) for all areas of rock outlet protection
- ❑ Dimensions and material of overflow structures
- ❑ Profile through principal spillway showing inverts and dimensions of all pipes, weirs, orifices, risers and other appurtenances, as applicable (to scale)
- ❑ Cross-section of emergency spillway (to scale)
- ❑ Profile through emergency spillway (to scale)

****When the allowable variances are exceeded for bioretention facility surface area or volume or structure elevations, supplemental calculations must be submitted to determine if the bioretention facility, as constructed, meets the design requirements. Submit the following*:

- ❑ Calculations of outflow from the bioretention facility for all design storms. Routing computations must be based on the constructed volumes and elevations for the facility.
- ❑ Calculations demonstrating that the design requirements have been met in the constructed condition.

3.0 Permeable Pavement Systems

Definition: Paving surfaces that capture and temporarily store stormwater by filtering runoff through voids in the pavement surface into an underlying reservoir. Filtered runoff may be collected and returned to the conveyance system, or allowed to infiltrate into the soil.

Design variants include:

- 3-A Porous Asphalt (PA)
- 3-B Pervious Concrete (PC)
- 3-C Permeable interlocking concrete Pavers (PP) or Concrete grid Pavers (CP)
- 3-D Plastic Grid Pavers (GP)

Other variations of permeable pavement that are DNREC approved permeable pavement surface materials are also encompassed in this section.

Permeable pavement systems may be designed to provide stormwater detention for all design storm events. Permeable pavement practices that are unable to infiltrate all design storms are often combined with a separate facilities to provide controls for larger runoff events.

Regardless of which design variant is chosen, the runoff reduction credit applied to the practice is the volume of runoff that is being stored in the reservoir layer underneath the permeable pavement and infiltrated over a period of 48-hours. It is recommended that an underdrain and control structure be constructed within the reservoir for long term maintenance and facility inspections.

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the native soils.

4.0 Vegetated Roofs

Definition:

Practices, on top a building, that capture and store rainfall in an engineered growing media, which is designed to support plant growth. A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Vegetated Roofs, also known as green roofs, typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Two types of vegetated roofs exist: extensive or intensive. They vary based on the depth of soil and type of plants.

© Bethany Blues Restaurant, Lewes

Design variants include:

- 4-A Extensive Vegetated Roofs: Shallow growing media with drought resistant succulent plants, such as sedums
- 4-B Intensive Vegetated Roofs: Deep growing media with traditional plantings and irrigation

Vegetated Roofs provide runoff reduction and water quality treatment for small storms, including the Resource Protection event (RPv). Typically they are not designed to provide stormwater detention of larger Cv and Fv storms although some intensive vegetated roof systems may be designed to meet or partially meet these criteria, or the vegetated roof could be integrated with a rainwater harvesting system. However, most vegetated roof designs generally are combined with a separate facility located away from the building to provide large storm controls.

This specification is intended for situations where the primary design objective of the Vegetated Roof is stormwater management. Green roof benefits go beyond just stormwater management, but the ancillary benefits are not covered within this specification.

5.0 Rainwater Harvesting

Photo courtesy of Lake County (IL) Stormwater Management Commission

Definition: Rainwater Harvesting systems intercept, divert, store and release rainfall for future use. Rainwater that falls onto impervious surfaces is collected and conveyed into an above- or below-ground storage tank (also referred to as a cistern or rain tank), where it can be used for non-potable water uses and on-site stormwater disposal/infiltration. Non-potable uses may include landscape irrigation, exterior washing (e.g. car washes, building facades, sidewalks, street sweepers, fire trucks, etc.), flushing of toilets and urinals, fire suppression (sprinkler) systems, supply for chilled water cooling towers, replenishing and operation of water features, distribution to a green wall or living wall system, and laundry. In many instances, Rainwater Harvesting can be combined with a secondary stormwater practice to enhance stormwater retention and/or provide treatment of overflow from the Rainwater Harvesting system.

Rainwater Harvesting systems are separated into two categories. Design variants include:

- 5-A Seasonal Rainwater Harvesting Systems
- 5-B Continuous Rainwater Harvesting Systems

By providing a renewable source of water to end users, Rainwater Harvesting systems can have environmental and economic benefits beyond stormwater management (e.g., increased water conservation, water supply during drought and mandatory municipal water supply restrictions, decreased demand on municipal or groundwater supply, decreased water costs for the end-user, potential for increased groundwater recharge, etc.).

6.0 Restoration Practices

Definition: Restoration Practices include Regnerative Stormwater Conveyance Systems, also known as Coastal Plain Outfalls, and other practices that restore existing degraded natural systems to their former functional condition. Streambank stabilization is also included in this category.

Photo: Hala Flores, Anne Arundel Co., MD

Regenerative Stormwater Conveyance Systems (RSCS) are open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow. In doing so, these systems safely convey, attenuate, and treat the quality of stormwater runoff. These structures utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. The physical characteristics of the RSCS channel are best characterized by the Rosgen A or B stream classification types, where "bedform occurs as a step/pool, cascading channel which often stores large amounts of sediment in the pools associated with debris dams" (Rosgen, 1996). The pretreatment, recharge, and water quality sizing criteria presented in these guidelines are similar to criteria for a typical stormwater filtering device. These structures feature surface/subsurface runoff storage seams and an energy dissipation design that is aimed at attenuating the flow to a desired level through energy and hydraulic power equivalency principles.

Streambank stabilization includes bioengineering techniques as well as structural solutions to abate the mass wasting of soil as a result of the movement of water. Despite the name, many of these practices can be used to stabilize shorelines as well as streambanks.

Design variants for Restoration Practices include:

- 6-A. Step Pool RSCS
- 6-B. Seepage Wetland RSCS
- 6-C. Streambank Stabilization

7.0 Rooftop Disconnection

Photo courtesy of Montgomery County, Maryland

Definition: Rooftop Disconnection involves managing runoff close to its source by intercepting, infiltrating, filtering, treating or reusing it as it moves from the rooftop to the drainage system. Rooftop Disconnection practices can be used to reduce the volume of runoff that enters the combined or separate storm sewer systems.

Rooftop Disconnection reduces a portion of the Resource Protection Volume (RPv). In order to meet requirements for larger storm events, Rooftop Disconnection must be combined with additional practices.

Rooftop impervious areas may be disconnected from the drainage system and flow to other BMPs for management, including:

- Sheet flow to a filter strip or open space (see ***Specification 9.***)
- Infiltration by small infiltration practices such as dry wells or french drains (see ***Specification 1.***)
- Filtration by rain gardens or stormwater planters (see ***Specification 2.***)
- Storage and reuse with a rain barrel, cistern or other storage system (see ***Specification 5.***)

8.0 Vegetated Channels

Definition: Vegetated open channels that are designed to convey the design storm volume (RPv and Cv, may also convey the Fv as designed).

Design variants include:

- 8-A Bioswale
- 8-B Vegetated Channel

Grass channels systems shall not be designed to provide stormwater detention. Vegetated channels can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets and pipes. The performance of Vegetated channels will vary depending on the underlying soil permeability. Their runoff reduction performance can be boosted when compost amendments are added to the bottom of the channel. Vegetated channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography, soils, and water table permit.

Vegetated Channels
Construction Checklist

This checklist has been designed for vegetated channels in accordance with the Delaware Sediment and Stormwater Program's Post Construction Stormwater Management BMP Standards and Specifications.

PROJECT INFORMATION

Project Name: _____

Location: _____

Contractor: _____

Construction Reviewer: _____

Date(s) / Time(s) of Inspections: _____

_____

_____

KEY:

✓	**Item meets standard**
X	**Item not acceptable**
N/A	**Item not applicable**

I. Pre-Construction

_____ A. Facility location staked out. Extents of vegetated channel (to include pre-treatment area) delineated and access by equipment prohibited to prevent compaction of existing soils.

_____ B. Upstream drainage area stabilized or effectively diverted prior to beginning construction of the channel.

_____ C. Pretreatment type

_____ (1) Grass Filter Strip
_____ (2) Gravel or Stone Diaphragm
_____ (3) Gravel or Stone Level Spreader
_____ (4) Initial Sediment Forebay
_____ (5) Check Dams, if required on the approved Plan
_____ (5) Other: _____

_____ D. Verify the equipment on the site are large enough to excavate the channel from the sides; not sitting in the bottom of the channel footprint.

Project Name:_____

Construction Reviewer:_____

II. Excavation

_____ A. Facility excavated to dimensions and at location as per the approved plan.

_____ B. Facility excavated from the sides so as to not compact the existing soil.

_____ C. Groundwater not encountered during excavation.
(Note: If groundwater is encountered during the excavation process, construction of the facility must cease and the designer notified that a plan modification is necessary)

_____ D. Outlet protection provided at discharge point.

IV. Grading

_____ A. Proper grading connecting the pretreatment practice to the vegetated channel as specified on the approved Plan.

_____ B. Side slopes installed as per the approved Plan.

_____ C. Bottom of channel graded as per the approved Plan.

_____ D. Installation of stone check dams, if required on the approved Plan.

VI. Vegetation

_____ A. Vegetation planted on the bottom and slopes of the channel as indicated on the approved Plan.

_____ B. Seeding applied at a rate to achieve 90% germination.

VII. Erosion and Sediment Control

_____ A. Installed erosion control matting in the conveyance area as specified on the approved Plan.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Biofiltration Swales

Provide the following as it relates to the biofiltration swale's slope and cross section:

- ❑ Profile along the length of the biofiltration swale (parallel to flow direction) with high and low spot elevations along the bottom noted. ****The allowable variance for the constructed slope of the swale is 0.001 ft/ft.*
- ❑ Cross-section at the beginning of the swale
- ❑ Cross-section at the discharge point of the swale
- ❑ Cross-sections at fifty-foot stations along the swale.
- ❑ Label the cross section locations on plan view to correspond with the individual cross section details. All cross-sections must include the following:
    - ❑ Bottom width dimension
      ****The acceptable bottom width may be no less than the design bottom width*
    - ❑ Top width dimension
    - ❑ Swale bottom elevation at left and right bank
    - ❑ Top of bank elevation for left and right bank
    - ❑ Left and right side slope (H:V)
      ****The side slopes may be no steeper than 3:1*

Provide the following information related to the structures within the biofiltration swale. ****The allowable variance for invert elevations on any structure is 0.1 ft*:

- ❑ Diameter and material of all pipes
- ❑ Invert elevations of all pipes
- ❑ Dimensions (length, width, depth, d50) for all areas of rock outlet protection
- ❑ Diameter, material and invert of underdrain at the discharge point, if applicable
- ❑ Overflow elevation of level spreader, if applicable
- ❑ Delineate locations of permanent check dams, if applicable.
- ❑ Provide weir overflow elevation of each permanent check dam, if applicable.

****When the allowable variances are exceeded for the biofiltration swale slope or structure invert elevations, or the constructed bottom width of the swale is less than the design width, supplemental calculations must be submitted to determine if the biofiltration swale, as constructed, meets the design requirements. Submit the following:*

- ❑ Calculations demonstrating that the water quality management and conveyance requirements have been met in the constructed condition.

9.0 Sheet Flow to Filter Strip or Open Space

Definition:

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants of filter strips are *Vegetated Filter Strips* and *Conserved Open Space*. The design, installation, and management of these design variants are quite different, as outlined in this specification.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the criteria contained herein to convert the concentrated flow to sheet flow.

Applicable practices include:

- 9-A. Sheet Flow to Vegetated Filter Strip
- 9-B. Sheet Flow to Vegetated Conserved Open Space

Sheet flow practices reduce a portion of the Resource Protection Volume (RPv). In order to meet requirements for larger storm events, sheet flow practices must be combined with additional practices.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Filter Strips

Provide the following as it relates to the filter strip's slope:

- ❑ Profiles through the width of the filter strip (parallel to flow direction) at fifty-foot intervals along the length of the filter strip, including profiles at either end of the filter strip. ****The allowable variance for the constructed slope of the filter strip is 0.001 ft/ft.*
- ❑ Each profile should provide the following:
  - ❑ Elevation at the edge of the impervious surface
  - ❑ Elevation of top of level spreader stone trench, if applicable
  - ❑ Elevation at the beginning of the filter strip
  - ❑ Elevation at the design downstream point of the filter strip

Provide the following as it relates to the filter strip's drainage area:

- ❑ Spot grades on a 50-foot grid within the filter strip's drainage area to delineate the full drainage area flowing to the filter strip.
- ❑ Area in acres or square feet of the drainage area noted on the plan.

****When the allowable variance is exceeded for the filter strip slope, or the drainage area or flow length exceeds the design, supplemental calculations must be submitted to determine if the filter strip, as constructed, meets the design requirements. Submit the following:*

- ❑ Calculations demonstrating that the water quality management requirements have been met in the constructed condition.

10.0 Detention Practices

Definition: Detention Practices are storage practices that are explicitly designed to provide stormwater detention for the Conveyance Event, Cv (10-year) and Flooding Event, Fv (100-year). Design variants include:

- 10-A Dry Detention Pond
- 10-B Dry Extended Detention Basin
- 10-C Underground Detention Facilities

Dry Detention Ponds and Dry Extended Detention Basins are widely applicable for most land uses and are best suited for larger drainage areas. An outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on the bed and banks of the receiving stream. Dry Detention Ponds receive some credit for pollutant removal, while Dry Extended Detention Basins receive both runoff reduction and pollutant removal credits.

The key difference between Dry Detention Ponds and Dry Extended Detention Basins is that, in addition to management of the Cv and Fv, a Dry Extended Detention Basin provides up to a 24-hour detention of all or a portion of the Resource Protection Volume (RPv). An under-sized outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream. Extended detention differs from a Dry Detention Pond's stormwater detention, since it is designed to achieve a minimum drawdown time, rather than a maximum peak rate of flow. Dry Detention Ponds, which are designed only to manage the larger Conveyance Event and Flooding Event will often detain smaller storm events for only a few minutes or hours.

Underground Detention Facilities include vaults and tanks. Underground Detention Vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Underground Detention Tanks are underground storage facilities typically constructed with large diameter metal or plastic pipe. Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for space-limited areas where there is not adequate land for a dry detention basin or multi-purpose detention area. Prefabricated concrete vaults are available from commercial vendors. In addition, several pipe manufacturers have developed packaged detention systems. Underground detention vaults do not receive any runoff reduction or pollutant removal credit, and should be considered only for management of larger storm events.

Dry Detention Facilty
Construction Checklist

For permanent structures per Delaware NRCS Pond Code 378, Delaware Sediment and Stormwater Regulations, and Post Construction Stormwater Management BMP Standards and Specifications

PROJECT INFORMATION

Project Name: _____

Location: _____

Contractor: _____

Construction Reviewer: _____

Date(s) / Time(s) of Inspections: _____

_____

_____

KEY:

✓	**Item meets standard**
X	**Item not acceptable**
N/A	**Item not applicable**

I. Materials and equipment.

_____ Pipe and appurtenances on-site prior to construction and dimensions checked.

____ 1) Material (including protective coating, if specified).

____ 2) Diameter

____ 3) Dimensions of pre-cast concrete outlet structure.

____ 4) Required dimensions between water control structures (orifices, weirs, etc.) are in accordance with plans.

____ 5) Barrel stub for prefabricated pipe structures at proper angle for design barrel slope.

____ 6) Number and dimensions of prefabricated anti-seep collars.

____ 7) Watertight connectors and gaskets.

____ 8) Outlet drain valve.

_____ Appropriate compaction equipment available, including hand and small power tamps.

_____ Project benchmark near pond site.

_____ Equipment for temporary de-watering.

Project Name:_____

Construction Reviewer:_____

II. Subgrade preparation.

_____ Area beneath embankment stripped of all vegetation, topsoil and organic matter.

_____ Cut-off trench excavated a minimum of 4 FT below subgrade and minimum 4 FT below proposed pipe invert, with side slopes no steeper than 1:1.

_____ Impervious material used to backfill cut-off trench.

III. Pipe spillway installation.

_____ Method of installation detailed on plans.

A. Bed preparation.

_____ Installation trench excavated with 1:1 side slopes.

_____ Stable, uniform, dry subgrade of relatively impervious material. *(If subgrade is wet, contractor shall have defined steps before proceeding with installation.)*

_____ Invert at proper elevation and grade.

B. Pipe placement.

_____ Metal/Plastic pipe

____ 1) Watertight connectors and gaskets properly installed

____ 2) Anti-seep collars properly spaced and having watertight connections to pipe.

____ 3) Backfill placed and tamped by hand under “haunches” of pipe.

____ 4) Remaining backfill placed in max. 8” lifts using small power tamping equipment until 2’ cover over pipe is reached.

_____ Concrete pipe

____ 1) Pipe set on blocks or concrete slab for pouring of low cradle.

____ 2) Pipe installed with rubber gasket joints with no spalling in gasket interface area.

____ 3) Excavation for lower half of anti-seep collar(s) with reinforcing steel set.

____ 4) Entire area where anti-seep collar(s) will come in contact with pipe coated with mastic or other approved waterproof sealant.

____ 5) Low cradle and bottom half of anti-seep collar installed as monolithic pour and of an approved mix.

____ 6) Upper half of anti-seep collar(s) formed with reinforcing steel set.

Project Name:_____

Construction Reviewer:_____

Concrete pipe (continued)

____ 7) Concrete for collar of an approved mix and vibrated into place. (Protected from freezing while curing, if necessary.)

____ 8) Forms stripped and collar inspected for honeycomb prior to backfilling. Parge if necessary.

C. Backfilling

_____ Fill placed in maximum 8" lifts.

_____ Backfill taken minimum 2' above top of anti-seep collar elevation before traversing with heavy equipment.

IV. Riser/Outlet structure installation.

A. Metal riser

_____ Riser base excavated or formed on stable subgrade to design dimensions.

_____ Embedded section of aluminum or aluminized pipe to be painted with zinc chromate or equivalent on **inside and outside** surfaces.

_____ Set on blocks to design elevations and plumbed.

_____ Reinforcing bars placed at right angles and projecting into sides of riser.

_____ Concrete poured so as to fill inside of riser to invert of barrel.

B. Pre-cast concrete structure

_____ Dry and stable subgrade.

_____ Riser base set to design elevation.

_____ If more than one section, no spalling in gasket interface area; gasket or approved caulking material placed securely.

_____ Watertight and structurally sound collar or gasket joint where structure connects to pipe spillway.

C. Poured concrete structure

_____ Footing excavated or formed on stable subgrade, to design dimensions with reinforcing steel set.

_____ Structure formed to design dimensions, with reinforcing steel set as per plan.

_____ Concrete of an approved mix and vibrated into place. (Protected from freezing while curing, if necessary.)

_____ Forms stripped and structure inspected for "honeycomb" prior to backfilling. Parge if necessary.

V. Embankment construction.

A. Fill material.

Project Name:_____

Construction Reviewer:_____

_____ Soil engineer's test.

_____ Visual test by inspector.

B. Compaction.

_____ Soil engineer's test.

_____ Visual test by inspector.

C. Embankment.

_____ Fill placed in max. 8" lifts and compacted with appropriate equipment.

_____ Constructed to design cross-section, side slopes and top width.

_____ Constructed to design elevation plus allowance for settlement.

VI. Impounded area construction.

_____ Excavated/graded to design contours and side slopes.

_____ Inlet pipes have adequate outfall protection.

_____ Forebay

VII. Earth emergency spillway construction.

_____ Spillway located in cut or structurally stabilized with riprap, gabions, concrete, etc.

_____ Excavated to proper cross-section, side slopes and bottom width.

_____ Entrance channel, crest, and exit channel constructed to design grades and elevations.

VIII. Outlet protection.

A. End section.

_____ Securely in place and properly backfilled.

B. Endwall

_____ Footing excavated or formed on stable subgrade, to design dimensions and reinforcing steel set, if specified.

_____ Endwall formed to design dimensions with reinforcing steel set as per plan.

_____ Concrete of an approved mix and vibrated into place. (Protected from freezing, if necessary.)

_____ Forms stripped and structure inspected for "honeycomb" prior to backfilling. Parge if necessary.

C. Riprap apron/channel.

_____ Apron/channel excavated to design cross-section with proper transition to existing ground.

_____ Geotextile in place.

_____ Stone sized as per plan and uniformly placed at the thickness specified.

Project Name:_____

Construction Reviewer:_____

IX. Vegetative stabilization.

_____ Approved seed mixture or sod.

_____ Proper surface preparation and required soil amendments.

_____ Stabilization matting or other stabilization materials, as per plan.

IX. Miscellaneous.

_____ Toe drain.

_____ Temporary dewatering device installed as per plan w/appropriate fabric, stone size and perforations if included.

_____ Drain for ponds having a permanent pool.

_____ Trash rack/anti-vortex device secured to outlet structure.

_____ Trash protection for low flow pipes, orifices, etc.

_____ Fencing (when required).

_____ Access road.

_____ Set aside area for clean-out and maintenance.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Ponds

Provide the following as it relates to the stormwater management pond's storage volume:

- ❑ Surveyed contours of the constructed stormwater management pond including forebays, micropools, and elevations below permanent pool at 1- or 2-foot intervals based on the datum of the approved plan. (One-foot contours will generally be expected for projects located in Kent and Sussex Counties. For sites with greater elevation differences (+20' across the site) such as is often found in New Castle County, 2-foot contours will be accepted.)
- ❑ Pond bottom elevations on a fifty-foot grid with high and low points noted
- ❑ Lowest top of bank elevation at fill for embankment/combination pond or lowest top of bank elevation for excavated pond. ****The acceptable top of bank elevation may be no lower than the design elevation for top of bank.*
- ❑ Actual cross section showing elevations, inside slopes, benching, top width and backslope, as applicable (to scale).
- ❑ Elevation of permanent pool, if applicable.
- ❑ Calculations of the volume of the pond as constructed with incremental storage and cumulative storage volumes in cubic feet for each one-foot elevation contour. ****The allowable variance from the design volume of the basin is ten percent.*

Provide the following information related to the inlet and outlet structures within the stormwater facility. ****The allowable variance for invert elevations on any structure is 0.1 ft*:

- ❑ Diameter and material of all inlet and outlet pipes
- ❑ Invert elevations of all inlet and outlet pipes
- ❑ Dimensions (length, width, depth, d50) for all areas of rock outlet protection
- ❑ Dimensions and material of outfall structures
- ❑ Profile through principal spillway showing inverts and dimensions of all pipes, weirs, orifices, risers and other appurtenances, as applicable (to scale)
- ❑ Cross-section of emergency spillway (to scale)
- ❑ Profile through emergency spillway (to scale)

****When the allowable variances are exceeded for either stormwater management pond volume or outlet structure invert elevations, supplemental calculations must be submitted to determine if the stormwater management pond, as constructed, meets the design requirements. Submit the following:*

- ❑ Calculations of outflow from the stormwater management pond for all design storms. Routing computations must be based on the post construction verification survey volumes and elevations for the facility.

Underground Detention Facility Construction Checklist

This checklist has been designed for underground detention facilities constructed in accordance with the Delaware Sediment and Stormwater Program's Post Construction Stormwater Management BMP Standards and Specifications

PROJECT INFORMATION

Project Name: _____

Location: _____

Contractor: _____

Construction Reviewer: _____

Date(s) / Time(s) of Inspections: _____

_____

_____

KEY:

✓	**Item meets standard**
X	**Item not acceptable**
N/A	**Item not applicable**

I. Pre-Construction.

_____ A. Pre-construction meeting held prior to beginning the facility (as required by the Delegated Agency).

_____ B. Facility location staked out.

_____ C. Upstream drainage area stabilized or effectively diverted.

_____ D. Materials on-site and dimensions and properties checked.

- _____ (1) Underground chambers and end caps
- _____ (2) Manhole/Maintenance access catch basin
- _____ (3) Perforated pipe outlet underdrains, if applicable
- _____ (4) Filter fabric as specified on the Plan
- _____ (5) Acceptable size of washed, crushed angular stone as per the Plan
- _____ (6) Acceptable fill materials as per the Plan
- _____ (7) Vibratory roller
- _____ (8) Dewatering equipment

KEY:

✓ **Item Meets Standard**

X Item Not Acceptable

N/A Item Not Applicable

Project Name:_____

Construction Reviewer:_____

II. Excavation.

_____ A. Facility excavated to dimensions and at location as per the approved plan. Excavation must be free of any standing water.

_____ B. Stepwise excavation used for infiltration facilities by preventing any compaction in the bottom of the facility.

_____ C. Facility excavated from the sides so as to not compact the existing soil.

_____ D. Groundwater encountered during excavation?
(Note: If groundwater is encountered during the excavation process, construction of the facility must cease and the designer notified that a plan modification is necessary)

_____ E. Sides of excavation vertical.

_____ F. Bottom of excavation level.

III. Structural Components.

_____ A. Discharge pipe installed at discharge point.

Discharge pipe diameter:_____

Discharge pipe material:_____

_____ B. Outlet protection provided at discharge point, if applicable.

_____ C. Outlet control structure installed at correct invert.

_____ D. Manhole/maintenance catch basin installed at elevations as specified on the approved plan.

_____ E. Clean-outs and/or observation ports installed as per the Plan.

_____ F. Inlet catch basins installed at the correct inverts.

_____ G. Washed, crushed angular stone used for the facility bed.

_____ H. Minimum 6" of stone on the bottom of excavation or as prescribed by the design engineer. ***Stone depth***: _____

_____ I. Chambers laid out in the method shown on Plan.

_____ J. Minimum 6" of stone on the top of the chambers or at the depth prescribed by the design engineer. Stone placed on top of the installed chambers as per the Plan.

Stone depth: _____

KEY:

✓ **Item Meets Standard**

X Item Not Acceptable

N/A Item Not Applicable

Project Name:_____

Construction Reviewer:_____

III. Structural Components (continued)

_____ K. Geotextile, in accordance with approved Plan, laid between chambers and stone bed.
Geotextile manufacturer's product number: _____

_____ L. Geotextile, in accordance with approved Plan, wrapped around the Storage/Filtration Chamber.
Geotextile manufacturer's product number: _____

_____ M. Geotextile, in accordance with approved Plan, laid on top of the stone bed above the chambers.

Geotextile manufacturer's product number: _____

_____ N. Approved fill, compacted on top of the geotextile above the chambers,

Depth of fill: _____

Other Unique Structural Components included:

_____ O. Underdrain pipe material according to approved Plan, if applicable.
Underdrain pipe material:_____

_____ P. Underdrain pipe sizes according to approved Plan, if applicable.

Underdrain pipe diameter(s): _____

_____ Q. Underdrain pipe perforations according to approved Plan.

_____ R. Other: _____

_____

_____ S. Other: _____

_____

KEY:

✓ **Item Meets Standard**

X Item Not Acceptable

N/A Item Not Applicable

Project Name:_____

Construction Reviewer:_____

IV. Grading for impervious finished surface

_____ A. Pavement sub-base, compacted. ***Material:*** _____

_____ B. Impervious finished surface applied and finished grade lines achieved.

Other finished surface options:

_____ C. Fill material compacted. ***Material:*** _____

_____ D. Finished surface of vegetation, 4" minimum of topsoil, amendments, mulching, and mulch anchoring as per the vegetation specifications on the Plan.

VI. Erosion and Sediment Control.

_____ A. Site stormwater diverted around the excavation of the underground detention system.

_____ B. Inlet protection provided on any catch basins that discharge to the underground detention system.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Underground Storage Facilities

Provide the following information related to the structural elevations and dimensions of the underground storage facility. ******The allowable variance for elevations on any structure is 0.1 ft***:

- ❑ Grate and invert elevations of all structures
- ❑ Invert and diameter of all pipes or chambers within underground storage system that is accessible following construction.
- ❑ Elevation and dimension of any weirs within underground structures.

11.0 Stormwater Filtering Systems

Definition:

Practices that capture and temporarily store the design storm volume and pass it through a filter media or material. Filtered runoff may be collected and returned to the conveyance system, or allowed to partially infiltrate into the soil. Design variants include:

- 11-A Non-Structural Sand Filter
- 11-B Surface Sand Filter
- 11-C Three-Chamber Underground Sand Filter
- 11-D Perimeter Sand Filter (including "Delaware" Modular Sand Filter)

Bioretention also functions as a Stormwater Filtering System; however, since it also requires a vegetative component, Bioretention is included as in a separate specification (see **Specification 2.0, Bioretention**).

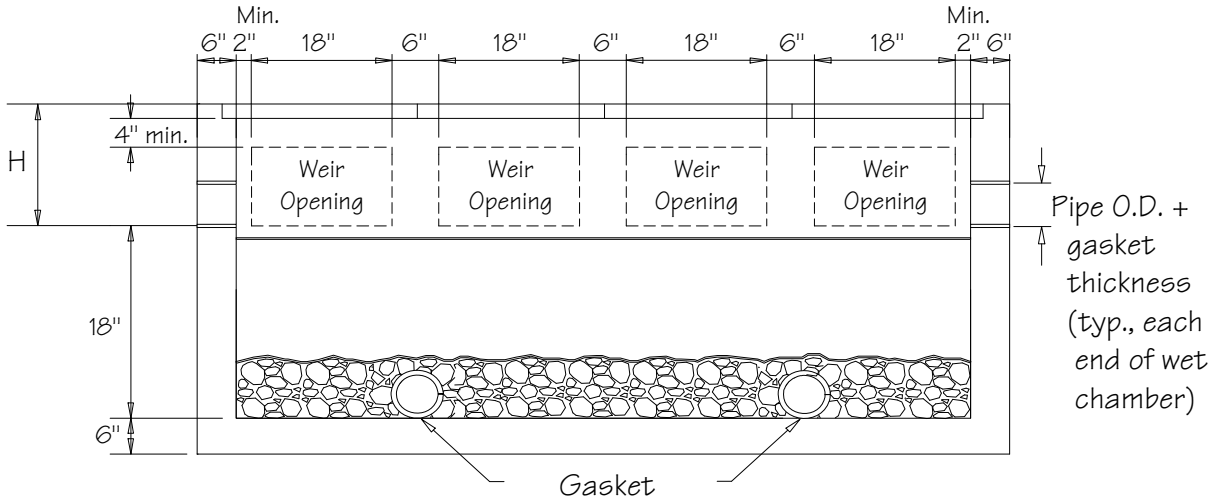
Stormwater Filtering Systems are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater Filtering Systems capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. The filter consists of two chambers: the first is devoted to settling, and the second serves as a filter bed consisting of a sand filter media.

Stormwater Filtering Systems are a versatile option because they consume very little surface land and have few site restrictions. They provide moderate pollutant removal performance at small sites where space is limited. However, filters have limited or no runoff volume reduction capability, so designers should consider using up-gradient runoff reduction practices, which have the effect of decreasing the design storm volume (and size) of the filtering practices. Filtering practices are also suitable to provide special treatment at designated stormwater hotspots. A list of potential stormwater hotspots applications can be found in ***Appendix 4, Stormwater Hotspots Guidelines.***

Stormwater Filtering Systems are typically not to be designed to provide stormwater detention (Cv

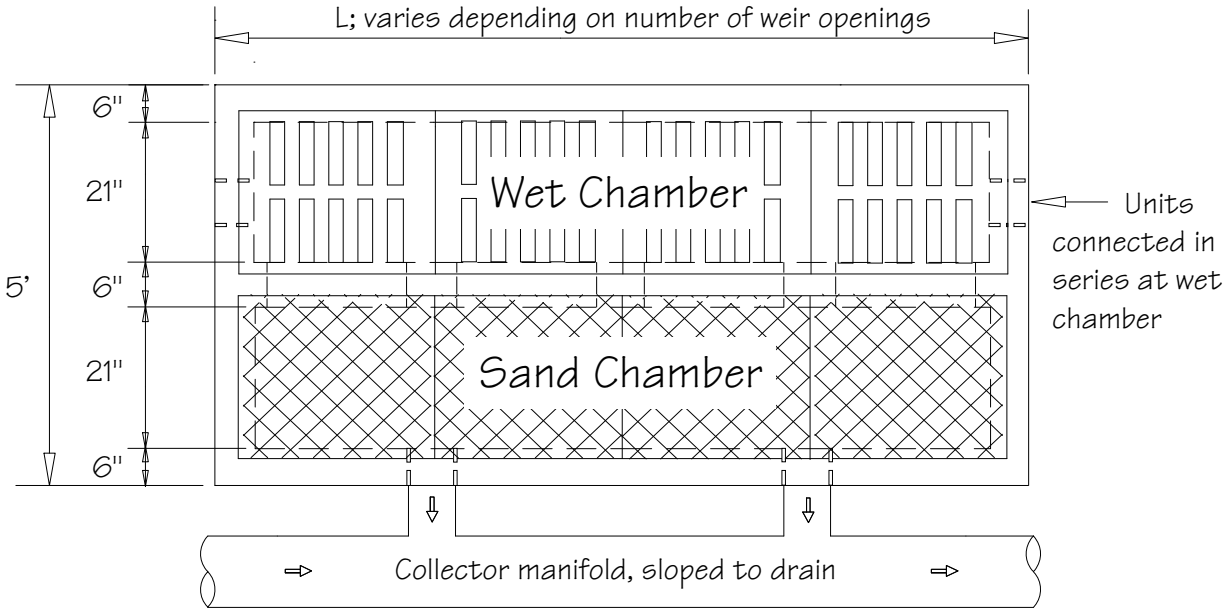
Standard Detail & Specifications

Delaware Modular Sand Filter



Std. Unit: H = 10"
Hi-Head Unit : H = 30"

Elevation View

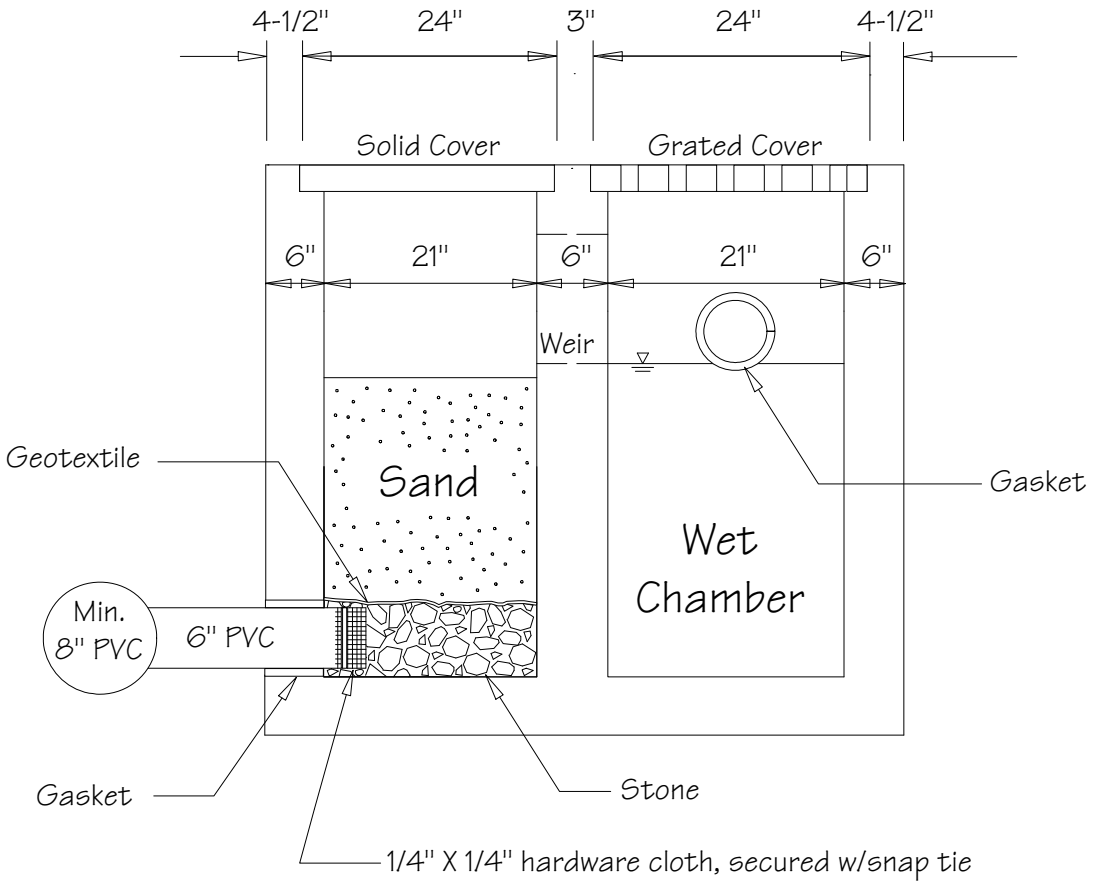


Plan View

Source:	Symbol:	Detail No.
Design: Shaver/Baldwin Modifications: Carey/Greer Drawing: Modified from Vandemark & Lynch	**Sand Filter**	**DE-SWM-1.0** Sheet 1 of 2 Date: 3/98

Standard Detail & Specifications

Delaware Modular Sand Filter



Section View

Materials

1. Sand - Concrete sand (AASHTO M6 or equiv.)
2. Stone - ¾" washed (DE No. 57 or equiv.)
3. Geotextile - Woven drainage fabric (Amoco 1198, Mirafi-700XG or equiv.)
4. Piping - PVC (Min. SDR 35)
5. Gaskets - Compatible w/ PVC schedule (A-LOK, Star Seal or equiv.)
6. Grates - Cast iron storm drain (East Jordan 6957 Type "M-2" or equiv.)
7. Solid covers - Cast iron storm drain (East Jordan 6957 Type "A" or equiv.)
8. Frames - ¼" steel angle
9. Concrete - 4500 psi at 28 days
10. Min. Reinforcing - 2 mats of 6" X 6" W4/W4 wire mesh

Source:	Symbol:	Detail No.
Design: Shaver/Baldwin Modifications: Carey/Greer Drawing: Modified from Vandemark & Lynch	**Sand Filter**	**DE-SWM-1.0** Sheet 2 of 2 Date: 3/98

Filtering Systems
Construction Checklist

This checklist has been designed for filtering systems constructed in accordance with the Delaware Sediment and Stormwater Program's Post Construction Stormwater Management BMP Standards and Specifications

PROJECT INFORMATION

Project Name: _____

Location: _____

Contractor: _____

Construction Reviewer: _____

Date(s) / Time(s) of Inspections: _____

_____

_____

KEY:

✓	**Item meets standard**
X	**Item not acceptable**
N/A	**Item not applicable**

I. Pre-Construction.

_____ A. Pre-construction meeting held prior to beginning the facility (as required by the Delegated Agency). Facility location staked out.

_____ B. Materials on-site and dimensions and properties checked.

- _____ (1) Underground precast chambers.
- _____ (2) Connector pipes and gaskets between chambers.
- _____ (3) Outlet pipe.
- _____ (4) Geotextile fabric as specified on the Plan, if applicable.
- _____ (5) Clean AASHTO M-6/ASTM C-33 medium aggregate concrete sand.
- _____ (6) Underdrain or perforated pipe as specified on the Plan.
- _____ (7) Dewatering equipment

Project Name:_____

Construction Reviewer:_____

II. Excavation.

_____ A. Facility excavated to dimensions and at location as per the approved plan. Excavation must be free of any standing water.

_____ B. Stepwise excavation used for infiltration facilities by preventing any compaction in the bottom of the facility.

_____ C. Facility excavated from the sides so as to not compact the existing soil.

_____ D. Groundwater encountered during excavation?
(Note: If groundwater is encountered during the excavation process, construction of the facility must cease and the designer notified that a plan modification is necessary)

_____ E. Sides of excavation vertical.

_____ F. Bottom of excavation level.

III. Structural Components.

_____ A. Discharge pipe installed at discharge point.

Discharge pipe diameter:_____

Discharge pipe material:_____

_____ B. Outlet protection provided at discharge point, if applicable.

_____ C. Outlet control structure installed at correct invert.

_____ D. Manhole/maintenance catch basin installed at elevations as specified on the approved plan.

_____ E. Clean-outs and/or observation ports installed as per the Plan.

_____ F. Inlet catch basins installed at the correct inverts.

_____ G. Washed, crushed angular stone used for the facility bed.

_____ H. Minimum 6" of <u>stone on the bottom</u> of excavation or as prescribed by the design engineer. ***Stone depth***: _____

_____ I. Chambers laid out in the method shown on Plan.

_____ J. Minimum 6" of <u>stone on the top</u> of the chambers or at the depth prescribed by the design engineer. Stone placed on top of the installed chambers as per the Plan.

Stone depth: _____

Project Name:_____

Construction Reviewer:_____

III. Structural Components (continued)

_____ K. Geotextile, in accordance with approved Plan, laid between chambers and stone bed.
Geotextile manufacturer's product number: _____

_____ L. Geotextile, in accordance with approved Plan, wrapped around the Storage/Filtration Chamber.
Geotextile manufacturer's product number: _____

_____ M. Geotextile, in accordance with approved Plan, laid on top of the stone bed above the chambers.

Geotextile manufacturer's product number: _____

_____ N. Approved fill, compacted on top of the geotextile above the chambers,

Depth of fill: _____

Other Unique Structural Components included:

_____ O. Underdrain pipe material according to approved Plan, if applicable.
Underdrain pipe material:_____

_____ P. Underdrain pipe sizes according to approved Plan, if applicable.

Underdrain pipe diameter(s): _____

_____ Q. Underdrain pipe perforations according to approved Plan.

_____ R. Other: _____

_____

_____ S. Other: _____

_____

IV. Grading for impervious finished surface

_____ A. Pavement sub-base, compacted. ***Material:*** _____

_____ B. Impervious finished surface applied and finished grade lines achieved.

Project Name:_____

Construction Reviewer:_____

Other finished surface options:

_____ C. Fill material compacted. ***Material:*** _____

_____ D. Finished surface of vegetation, 4" minimum of topsoil, amendments, mulching, and mulch anchoring as per the vegetation specifications on the Plan.

VI. Erosion and Sediment Control.

_____ A. Site stormwater diverted around the excavation of the underground detention system.

_____ B. Inlet protection provided on any catch basins that discharge to the underground detention system.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Sand Filters

Provide the following information related to the structural elevations and dimensions of the sand filter. ******The allowable variance for elevations on any structure is 0.1 ft***:

- ❑ Chamber dimensions of sedimentation (wet) chamber and filtration (sand) chamber. If modular units are used, chamber dimensions must be provided for all units.
- ❑ Grate elevations at all four corners of the sand filter. If modular units are used, provide corner elevations of each modular unit.
- ❑ Internal weir elevations between the two chambers.
- ❑ Water surface elevation in the sedimentation chamber.
- ❑ Sand surface elevation in the filtration chamber.
- ❑ Overflow catch basin dimensions, grate elevation and invert elevation.
- ❑ Pipe material and diameter of discharge pipe from overflow catch basin.

12.0 Constructed Wetlands

Definition: Practices that mimic natural wetland areas to treat urban stormwater by incorporating permanent pools with shallow storage areas. Constructed Wetlands are explicitly designed to provide stormwater detention for larger storms (Cv and Fv) above the RPv storage. Design variants include:

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- 12-A Traditional Constructed Wetlands
- 12-B Wetland Swales
- 12-C Ephemeral Constructed Wetlands
- 12-D Submerged Gravel Wetland (to be added at a later date)

Constructed Wetlands are shallow depressions that receive stormwater inputs for water quality treatment. The majority of the wetland surface area is covered by shallow (<1' deep) wetland area, with greater depths in the forebay and pools within the wetland. Wetlands possess variable microtopography to promote dense and diverse wetland cover. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for gravitational settling, biological uptake, and microbial activity.

The Constructed Wetlands design variants all share commonalities, but are also unique in their performance credits. None of the design variants receive any retention allowance, though they all have pollutant reduction capabilities. Traditional Constructed Wetlands (12-A), should be considered for use after all other upland runoff reduction opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e. 10-year, 100-year or flood control events) to manage. Both Wetland Swales (12-B) and Ephemeral Constructed Wetlands (12-C) can provide some runoff reduction credits, particularly in well drained soils. Submerged Gravel Wetlands are to be added at a later date, and will only provide pollution reduction credits.

Constructed Wetlands have both community and siting criteria (see *Section 12.3 Wetland Feasibility Criteria*) that should be considered before incorporating the stormwater practice onsite.

13.0 Wet Ponds

Definition: Wet Ponds are stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake and microbial activity. Wet Ponds are widely applicable for most land uses and are best suited for larger drainage areas. Runoff from each new storm enters the wet pond and partially displaces pool water from previous storms. The pool also acts as a barrier to re-suspension of sediments and other pollutants deposited during prior storms. When sized properly, Wet Ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Wet Ponds can also provide storage above the permanent pool to help meet stormwater management requirements for larger storms. Design variants include:

- 13-A Wet Pond
- 13-B Wet Extended Detention (ED) Pond

A Wet ED Pond differs from a typical Wet Pond in that a Wet ED Pond provides 24-hour detention of all or a portion of the Resource Protection Volume (RPv). Optional internal baffles in the Wet ED Pond extend the flow path through the pond from the inflow point to the outlet. In addition, an undersized outlet structure restricts stormwater flow so it backs up and is stored within the Wet ED Pond. The temporary ponding enhances the ability of particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream.

Wet Ponds should be considered for use after all other upland runoff reduction opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e. Cv an Fv) to manage.

Wet Ponds do not receive any stormwater retention credit and should be considered only for pollutant removal efficiency and to manage flood events. Wet Ponds have both community and environmental concerns (see ***Section 13.3 Wet Pond Feasibility Criteria***) that need to be considered before applying them.

STORMWATER/SEDIMENT POND
TYPICAL SEQUENCE OF CONSTRUCTION
FOR EMBANKMENT PONDS WITH RISER/BARREL OUTLET STRUCTURE

1. NOTIFY PLAN REVIEW/CONSTRUCTION REVIEW AGENCY AS REQUIRED.
    a. Arrange the pre-construction meeting.
    b. Clear up any questions regarding the approved plan.

2. PRE-CONSTRUCTION MEETING WITH CONSTRUCTION REVIEW AGENCY
    a. Review the site plan and layout and discuss any problems or changes needed to the plan.
    b. Obtain approvals for the plan changes from the appropriate inspection or plan review agency.
    c. Discuss the stages of construction which notification to the construction review agency is needed.

3. SITE LAYOUT
    a. Make sure site layout agrees with the plan.
    b. Check elevation of the proposed outfall structure.
    c. Physically mark any areas not to be disturbed, such as limit of disturbance, wetlands, property lines, etc.

4. INSTALL PERIMETER E & S CONTROLS
    a. Sediment controls will be needed at the downstream perimeter during the clearing and grubbing for the pond wherever sediment may leave the site.

5. INSTALL TEMPORARY CHANNEL DIVERSION
    a. Divert clean water flow away from pond area.
    b. Stabilize the diversion.

6. CLEAR AND GRUB THE POND AREA

7. REMOVE TOPSOIL FROM THE POND AREA
    a. Stockpile the soil in an approved location.
    b. Stabilize the stockpile area.

8. FACILITY STAKEOUT
    a. Stakeout centerline of embankment, inside and outside toe of slopes.

9. CUT-OFF TRENCH/EMBANKMENT AREA
    a. Arrange to meet the site reviewer to discuss location of cut-off trench.
    b. If cut-off trench is needed, determine where material will come from before trench is opened.
    c. Make arrangements for dewatering of the cut-off trench if necessary.
    d. Fill cut-off trench with suitable material assuring proper compaction to existing ground elevation.

10. CONSTRUCT OUTFALL CHANNEL
    a. Rock outlet protection with filter cloth.
    b. Remaining channel constructed and stabilized.

11. INSTALL BARREL WITH ANTI-SEEP COLLARS
    a. This should be done BEFORE any embankment work.
    b. Prepare the bedding for the barrel.
    c. Place barrel and anti-seep collars checking pipe grade.
    d. Watertight pipe connections to be checked.
    e. Backfill of barrel with particular attention to the compaction requirements. All structural backfill shall be completely free of rocks and other objectionable material.

12. RISER PLACEMENT
    a. Check riser structure for conformance to specification.
    b. Check elevation of structure.
    c. Set riser and pour concrete riser base.

13. INSTALL ANY EROSION CONTROL STRUCTURES REQUIRED

14. CONSTRUCT REMAINING CORE AND EMBANKMENT
    a. Most impervious material placed in core of embankment.
    b. Material should be checked and approved for suitability.
    c. Compact the embankment according to specifications.
    d. Check UNSETTLED elevation and top width of embankment.
    e. Stabilize embankment.

15. DIVERT FLOWS INTO PIPE SYSTEM

16. CONSTRUCT EMERGENCY SPILLWAY
    a. If earth spillway, construct in undisturbed ground.
    b. Check elevation of control section and exit channel.

17. INSTALL INFLOW CHANNELS
    a. Stabilize according to plan including pipe outfalls into pond.

18. COMPLETE EXCAVATION OF POND TO FINAL GRADE

19. VEGETATIVELY STABILIZE ALL DISTURBED AREAS

20. COMPLETE POND CONVERSION
    a. Requires approval of inspector to convert from sediment to stormwater control.
    b. Properly dewater the pond in an approved manner.
    c. Remove accumulated sediment and restore pond to design grade. Complete final stabilization.
    d. Make any structural modifications to the riser for permanent function.

SEDIMENT/STORMWATER MANAGEMENT BASIN CONSTRUCTION CHECKLIST

For permanent structures per Delaware NRCS Pond Code 378,
Delaware Sediment and Stormwater Regulations, and
Post Construction Stormwater Management BMPs Standards and Specifications.

KEY		***PROJECT INFORMATION***
√	Item meets standard	Project ID:_____
X	Item not acceptable	Contractor:_____
N/A	Item not applicable	Inspector: _____
C	Item requires engineer's cert.	Date(s): _____

I. Materials and equipment.

_____ Pipe and appurtenances on-site prior to construction and dimensions checked.

____ 1) Material (including protective coating, if specified).

____ 2) Diameter

____ 3) Dimensions of metal riser or pre-cast concrete outlet structure.

____ 4) Required dimensions between water control structures (orifices, weirs, etc.) are in accordance with plans.

____ 5) Barrel stub for prefabricated pipe structures at proper angle for design barrel slope.

____ 6) Number and dimensions of prefabricated anti-seep collars.

____ 7) Watertight connectors and gaskets.

____ 8) Outlet drain valve.

_____ Appropriate compaction equipment available, including hand and small power tamps.

_____ Project benchmark near pond site.

_____ Equipment for temporary de-watering.

II. Subgrade preparation.

_____ Area beneath embankment stripped of all vegetation, topsoil and organic matter.

_____ Cut-off trench excavated a minimum of 4 FT below subgrade and minimum 4 FT below proposed pipe invert, with side slopes no steeper than 1:1.

_____ Impervious material used to backfill cut-off trench.

III. Pipe spillway installation.

_____ Method of installation detailed on plans.

A. Bed preparation.

_____ Installation trench excavated with 1:1 side slopes.

_____ Stable, uniform, dry subgrade of relatively impervious material. *(If subgrade is wet, contractor shall have defined steps before proceeding with installation.)*

_____ Invert at proper elevation and grade.

B. Pipe placement.

_____ Metal/Plastic pipe

____ 1) Watertight connectors and gaskets properly installed

____ 2) Anti-seep collars properly spaced and having watertight connections to pipe.

____ 3) Backfill placed and tamped by hand under "haunches" of pipe.

____ 4) Remaining backfill placed in max. 8" lifts using small power tamping equipment until 2' cover over pipe is reached.

_____ Concrete pipe

____ 1) Pipe set on blocks or concrete slab for pouring of low cradle.

____ 2) Pipe installed with rubber gasket joints with no spalling in gasket interface area.

____ 3) Excavation for lower half of anti-seep collar(s) with reinforcing steel set.

____ 4) Entire area where anti-seep collar(s) will come in contact with pipe coated with mastic or other approved waterproof sealant.

____ 5) Low cradle and bottom half of anti-seep collar installed as monolithic pour and of an approved mix.

____ 6) Upper half of anti-seep collar(s) formed with reinforcing steel set.

____ 7) Concrete for collar of an approved mix and vibrated into place. (Protected from freezing while curing, if necessary.)

____ 8) Forms stripped and collar inspected for honeycomb prior to backfilling. Parge if necessary.

C. Backfilling

_____ Fill placed in maximum 8" lifts.

_____ Backfill taken minimum 2' above top of anti-seep collar elevation before traversing with heavy equipment.

IV. Riser/Outlet structure installation.

A. Metal riser

_____ Riser base excavated or formed on stable subgrade to design dimensions.

_____ Embedded section of aluminum or aluminized pipe to be painted with zinc chromate or equivalent on **inside and outside** surfaces.

_____ Set on blocks to design elevations and plumbed.

_____ Reinforcing bars placed at right angles and projecting into sides of riser.

_____ Concrete poured so as to fill inside of riser to invert of barrel.

B. Pre-cast concrete structure

_____ Dry and stable subgrade.

_____ Riser base set to design elevation.

_____ If more than one section, no spalling in gasket interface area; gasket or approved caulking material placed securely.

_____ Watertight and structurally sound collar or gasket joint where structure connects to pipe spillway.

C. Poured concrete structure

_____ Footing excavated or formed on stable subgrade, to design dimensions with reinforcing steel set.

_____ Structure formed to design dimensions, with reinforcing steel set as per plan.

_____ Concrete of an approved mix and vibrated into place. (Protected from freezing while curing, if necessary.)

_____ Forms stripped and structure inspected for “honeycomb” prior to backfilling. Parge if necessary.

V. Embankment construction.

A. Fill material.

_____ Soil engineer’s test.

_____ Visual test by inspector.

B. Compaction.

_____ Soil engineer’s test.

_____ Visual test by inspector.

C. Embankment.

_____ Fill placed in max. 8” lifts and compacted with appropriate equipment.

_____ Constructed to design cross-section, side slopes and top width.

_____ Constructed to design elevation plus allowance for settlement.

VI. Impounded area construction.

_____ Excavated/graded to design contours and side slopes.

_____ Inlet pipes have adequate outfall protection.

_____ Forebay

_____ Wet pond requirements.

____ **1)** 10 FT reverse slope bench one foot above normal pool elevation.

____ **2)** 10 FT wide level bench one foot below normal pool elevation.

VII. Earth emergency spillway construction.

_____ Spillway located in cut or structurally stabilized with riprap, gabions, concrete, etc.

_____ Excavated to proper cross-section, side slopes and bottom width.

_____ Entrance channel, crest, and exit channel constructed to design grades and elevations.

VIII. Outlet protection.

A. End section.

_____ Securely in place and properly backfilled.

B. Endwall

_____ Footing excavated or formed on stable subgrade, to design dimensions and reinforcing steel set, if specified.

_____ Endwall formed to design dimensions with reinforcing steel set as per plan.

_____ Concrete of an approved mix and vibrated into place. (Protected from freezing, if necessary.)

_____ Forms stripped and structure inspected for "honeycomb" prior to backfilling. Parge if necessary.

C. Riprap apron/channel.

_____ Apron/channel excavated to design cross-section with proper transition to existing ground.

_____ Filter fabric in place.

_____ Stone sized as per plan and uniformly placed at the thickness specified.

IX. Vegetative stabilization.

_____ Approved seed mixture or sod.

_____ Proper surface preparation and required soil amendments.

_____ Excelsior mat or other stabilization materials, as per plan.

X. Miscellaneous

_____ Toe drain.

_____ Temporary dewatering device installed as per plan w/appropriate fabric, stone size and perforations if included.

_____ Drain for ponds having a permanent pool.

_____ Trash rack/anti-vortex device secured to outlet structure.

_____ Trash protection for low flow pipes, orifices, etc.

_____ Fencing (when required).

_____ Access road.

_____ Set aside area for clean-out and maintenance.

STORMWATER MANAGEMENT FACILITY
POST CONSTRUCTION VERIFICATION DOCUMENT
SUBMITTAL CHECKLIST

Ponds

Provide the following as it relates to the stormwater management pond's storage volume:

- ❑ Surveyed contours of the constructed stormwater management pond including forebays, micropools, and elevations below permanent pool at 1- or 2-foot intervals based on the datum of the approved plan. (One-foot contours will generally be expected for projects located in Kent and Sussex Counties. For sites with greater elevation differences (+20' across the site) such as is often found in New Castle County, 2-foot contours will be accepted.)
- ❑ Pond bottom elevations on a fifty-foot grid with high and low points noted
- ❑ Lowest top of bank elevation at fill for embankment/combination pond or lowest top of bank elevation for excavated pond. ****The acceptable top of bank elevation may be no lower than the design elevation for top of bank.*
- ❑ Actual cross section showing elevations, inside slopes, benching, top width and backslope, as applicable (to scale).
- ❑ Elevation of permanent pool, if applicable.
- ❑ Calculations of the volume of the pond as constructed with incremental storage and cumulative storage volumes in cubic feet for each one-foot elevation contour. ****The allowable variance from the design volume of the basin is ten percent.*

Provide the following information related to the inlet and outlet structures within the stormwater facility. ****The allowable variance for invert elevations on any structure is 0.1 ft*:

- ❑ Diameter and material of all inlet and outlet pipes
- ❑ Invert elevations of all inlet and outlet pipes
- ❑ Dimensions (length, width, depth, d50) for all areas of rock outlet protection
- ❑ Dimensions and material of outfall structures
- ❑ Profile through principal spillway showing inverts and dimensions of all pipes, weirs, orifices, risers and other appurtenances, as applicable (to scale)
- ❑ Cross-section of emergency spillway (to scale)
- ❑ Profile through emergency spillway (to scale)

****When the allowable variances are exceeded for either stormwater management pond volume or outlet structure invert elevations, supplemental calculations must be submitted to determine if the stormwater management pond, as constructed, meets the design requirements. Submit the following:*

- ❑ Calculations of outflow from the stormwater management pond for all design storms. Routing computations must be based on the post construction verification survey volumes and elevations for the facility.

14.0 Soil Amendments

Definition:

Soil Amendment (also called soil restoration) is a technique applied after construction to till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the performance of impervious cover disconnections and grass channels.

14.1 Soil Amendment Stormwater Credit Calculations

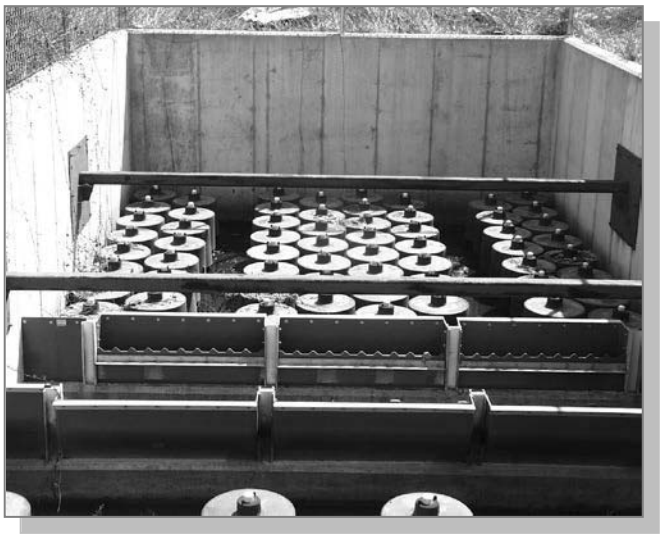
Soil Amendment does not receive a retention allowance. However, the use of soil amendments in accordance with this specification allows disturbed areas to receive a reduction credit for the annual runoff. The adjustment varies depending on the soil's Hydrologic Soil Group. Pollutant loads are assumed to be reduced by the equivalent reduction in runoff. **Table 14.1** summarizes the runoff and pollutant reduction credits for this practice. Soil amendments can also enhance the performance of other runoff reduction practices that rely on surface infiltration. Runoff and pollutant reduction credits for these types of applications are discussed in the respective specifications for those practices.

14.1 Soil Amendment Performance Credits

Runoff Reduction	
Retention Allowance	0%
RPv	HSG A – 38% Annual Runoff Reduction HSG B – 50% Annual Runoff Reduction HSG C - 29% Annual Runoff Reduction HSG D – 13% Annual Runoff Reduction
Cv	10% of RPv Allowance
Fv	1% of RPv Allowance
Pollutant Reduction	
TN Reduction	100% of Load Reduction
TP Reduction	100% of Load Reduction
TSS Reduction	100% of Load Reduction
NOTE: Runoff reduction allowances are for amendment area only.	

15.0 Proprietary Practices

Definition: Proprietary Practices are manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts caused by stormwater runoff.



Certain Proprietary Practices may be eligible for some amount of treatment credit, provided they have been approved by the Department and meet the performance criteria outlined in this specification. Proprietary practices will generally not be eligible for retention volume credit unless the practice can demonstrate the occurrence of runoff reduction processes.

15.1 Proprietary Practice Stormwater Credit Calculations

Proprietary Practices will receive no retention credit (R_v) unless explicitly approved by the Department. However, they may be credited as treatment practices, provided they meet the performance criteria outlined in ***Section 15.5, Proprietary Practice Design Criteria.***

15.1 Proprietary Practices Performance Credits

Runoff Reduction	
Retention Allowance	0%
RPv -A/B Soil	0%
RPv - C/D Soil	0%
Cv	0%
Fv	0%
Pollutant Reduction	
TN Reduction	See DURMM documentation
TP Reduction	See DURMM documentation
TSS Reduction	See DURMM documentation

16.0 Source Controls

Definition: Source Control consists of measures to prevent pollutants from coming into contact with stormwater runoff. Preventing pollutant exposure to rainfall and runoff is an important management technique that can reduce the amount of pollutants in runoff and the need for stormwater treatment.

Source Control practices and pollution prevention can include a wide variety of management techniques that address nonpoint sources of pollution. These practices are typically non-structural, require minimal or no land area, and involve moderate effort and cost to implement, when compared to structural treatment practices. Therefore, project planning and design should consider measures to minimize or prevent the release of pollutants so they are not available for mobilization by runoff.

Design variants include:

- 16-A Nutrient Management
- 16-B Street Sweeping

Urban Nutrient Management involves the reduction of fertilizer to grass lawns and other urban areas down to the minimum required to sustain adequate vegetative cover. The implementation of urban Nutrient Management is based on public education and awareness, targeting suburban residences and businesses, with emphasis on reducing excessive fertilizer use. Although the availability of “Lo-P” or “No-P” fertilizer formulations have improved the situation, managing excess nutrient applications in urban settings will continue to be an important element in the overall goal to minimize impacts from urban stormwater runoff.

Street Sweeping and storm drain cleanout practices rank among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their National Pollutant Discharge Elimination System (NPDES) stormwater permits. The ability for these practices to achieve pollutant reductions is uncertain given current research findings. Only a few Street Sweeping studies provide sufficient data to statistically determine the impact of street sweeping and storm drain cleanouts on water quality and to quantify their improvements. Fewer studies are available to evaluate the pollutant reduction capabilities due to storm drain inlet or catch basin cleanouts. Nevertheless, the use of modern equipment under a well-managed program has been shown to yield measurable benefits and thus this practice should be considered for inclusion in any source control program.

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Chapter 7

Dewatering
&
Use of Flocculants

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STANDARD AND SPECIFICATIONS FOR PORTABLE DEWATERING PRACTICES

Definition: A portable device through which sediment-laden water is pumped to trap and retain the sediment.

Purpose: To trap and retain sediment prior to pumping the water to drainageways, adjoining properties, and rights-of-way below a project site.

Conditions Where Practice Applies
A portable dewatering practice may be used on sites where space is limited, such as urban construction, where direct discharge of sediment-laden water to stream and storm drainage systems is to be avoided and where larger dewatering practices are impractical.

Design Criteria

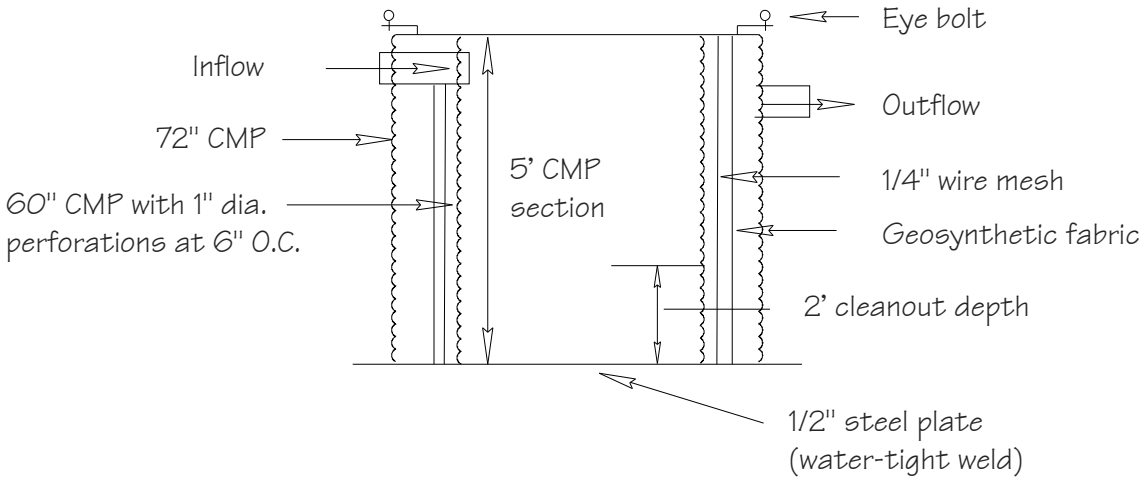
Location
The portable dewatering practice shall be located for ease of clean-out and disposal of the trapped sediment, and to minimize the interference with construction activities and pedestrian traffic.

Size
In the absence of other sizing criteria, the following formula should be used in determining the storage volume of the portable dewatering practice: Pump Discharge (G.P.M.) x 32 = Cubic Foot Storage.

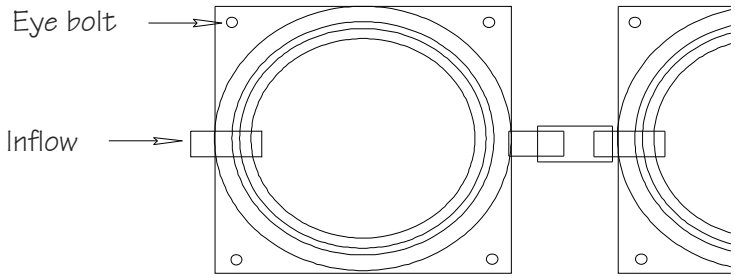
Details for a portable sediment tank and a geotextile dewatering bag are included in the Handbook. Other container designs may be used if the storage volume is adequate and approval is obtained from the local approving agency.

Standard Detail & Specifications

Portable Sediment Tank



Section



Plan

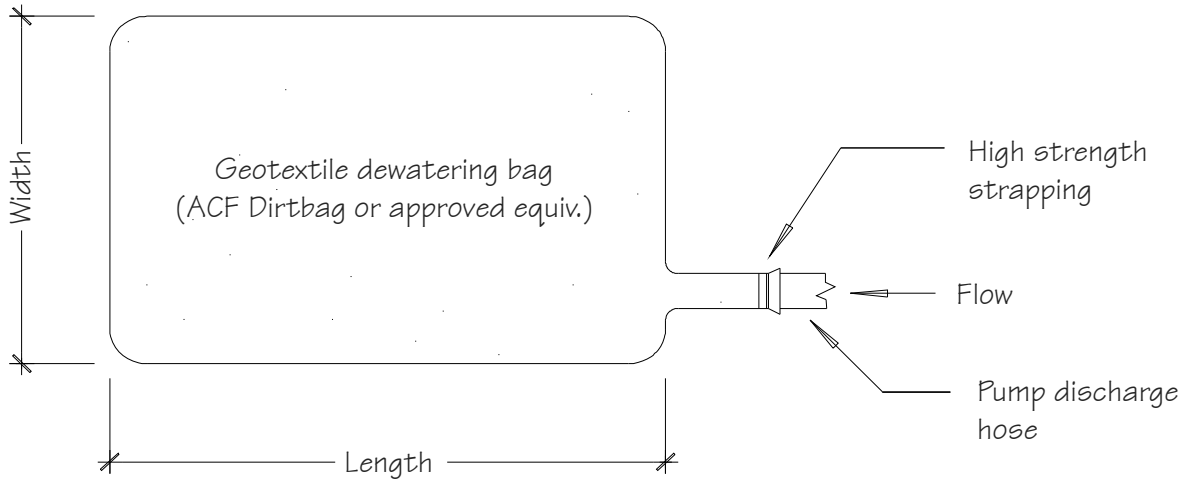
Construction Notes:

1. Required storage volume = 1 c.f. storage/1 gpm pump discharge.
2. Tanks may be connected in series to provide required storage.

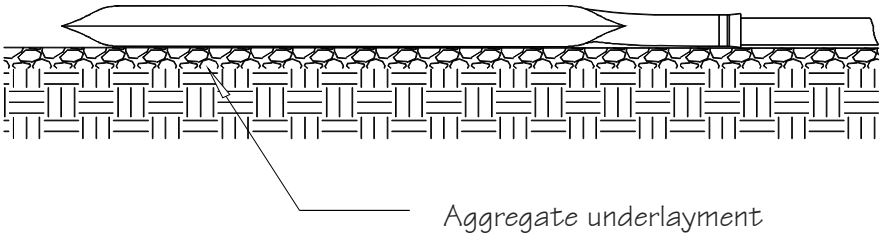
Source:	Symbol:	Detail No.
Adapted from MD Stds. & Specs. for ESC	ST	**DE-ESC-3.2.1.1** Sheet 1 of 1 Date: 12/03

Standard Detail & Specifications

Geotextile Dewatering Bag



Plan



Profile

Source:	Symbol:	Detail No.
Adapted from ACF Products, Inc.	GB	**DE-ESC-3.2.1.2** Sheet 1 of 2
		Date: 12/03

Geotextile Dewatering Bag

Construction Notes:

1. The dewatering bag should be placed so the incoming water flows into and through the bag, and then flow off the site without creating more erosion. The neck should be tied off tightly to stop the water from flowing out of the bag without going through the walls. The dewatering bag should be placed on a gravel bed to allow water to flow in all directions.

2. The dewatering bag is considered full and should be disposed when it is impractical for the bag to filter the sediment out at a reasonable flow rate. At this point, it should be replaced with a new bag.

3. Disposal may be accomplished as directed by the construction reviewer. If the site allows, the bag may be buried on site and seeded, visible fabric removed and seeded or removed from site to a proper disposal area.

Materials:

1. The geotextile fabric shall be a Type GD-IV.

2. The dewatering bag shall be sewn with a double needle machine using high strength thread. All structural seams will be sewn with high strength, double stitched "J" type. Seam strength test will have the following minimum average roll values:

Type	TEST METHOD	TEST RESULT
Heavy duty	ASTM D-4884	100 lb / in

3. The dewatering bag shall have an opening large enough to accommodate a four (4) inch discharge hose with attached strap to tie off the hose to prevent the pumped water from escaping from the bag without being filtered.

Source:	Symbol:	Detail No.
Adapted from ACF Products, Inc.	GB	**DE-ESC-3.2.1.2** Sheet 2 of 2 Date: 12/03

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STANDARD AND SPECIFICATIONS FOR PUMPING PIT

Definition: A temporary pit which is constructed to trap and filter water for pumping to a suitable discharge area.

Purpose: To remove excess water from excavations and/or traps.

Conditions Where Practice Applies

Pumping pits are primarily used to de-water other erosion and sediment control practices such as sediment traps and basins. They may also be used to collect and filter water during the excavation phase of construction, such as during excavation for structural foundations.

Design Criteria

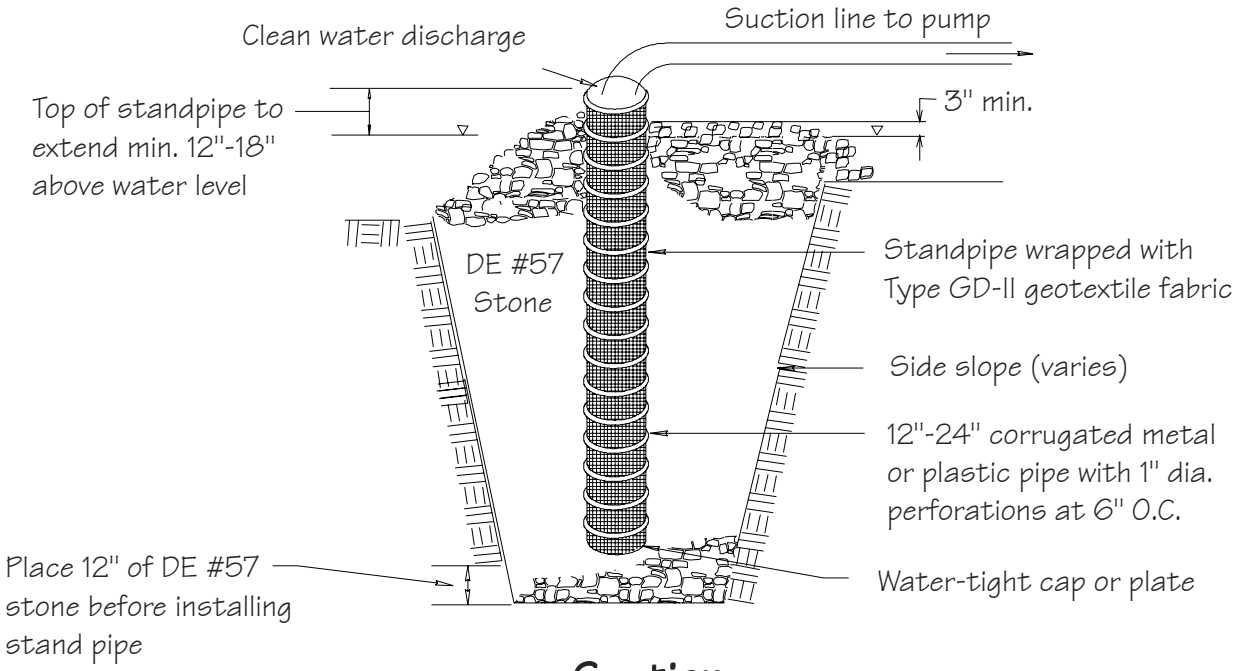
The type of pumping pits and their locations should be shown on the plan. A design is not required but construction should conform to the general criteria outlined on Standard Drawing.

A perforated vertical standpipe is placed in the center of the pit to collect filtered water. Water is then pumped from the center of the pipe to a suitable discharge area.

Discharge of water pumped from the standpipe should be to a stabilized area. If water from the pit will be pumped directly to a storm drainage system or free flowing stream, a Type GD-II (see **Appendix A-3**) geotextile should be wrapped around the standpipe to ensure clean water discharge. It is recommended that 1/4-1/2 inch hardware cloth wire be wrapped around and secured to the standpipe prior to attaching the filter cloth. This will increase the rate of water seepage into the standpipe.

Standard Detail & Specifications

Pumping Pit - Type 1



Section

Construction Notes:

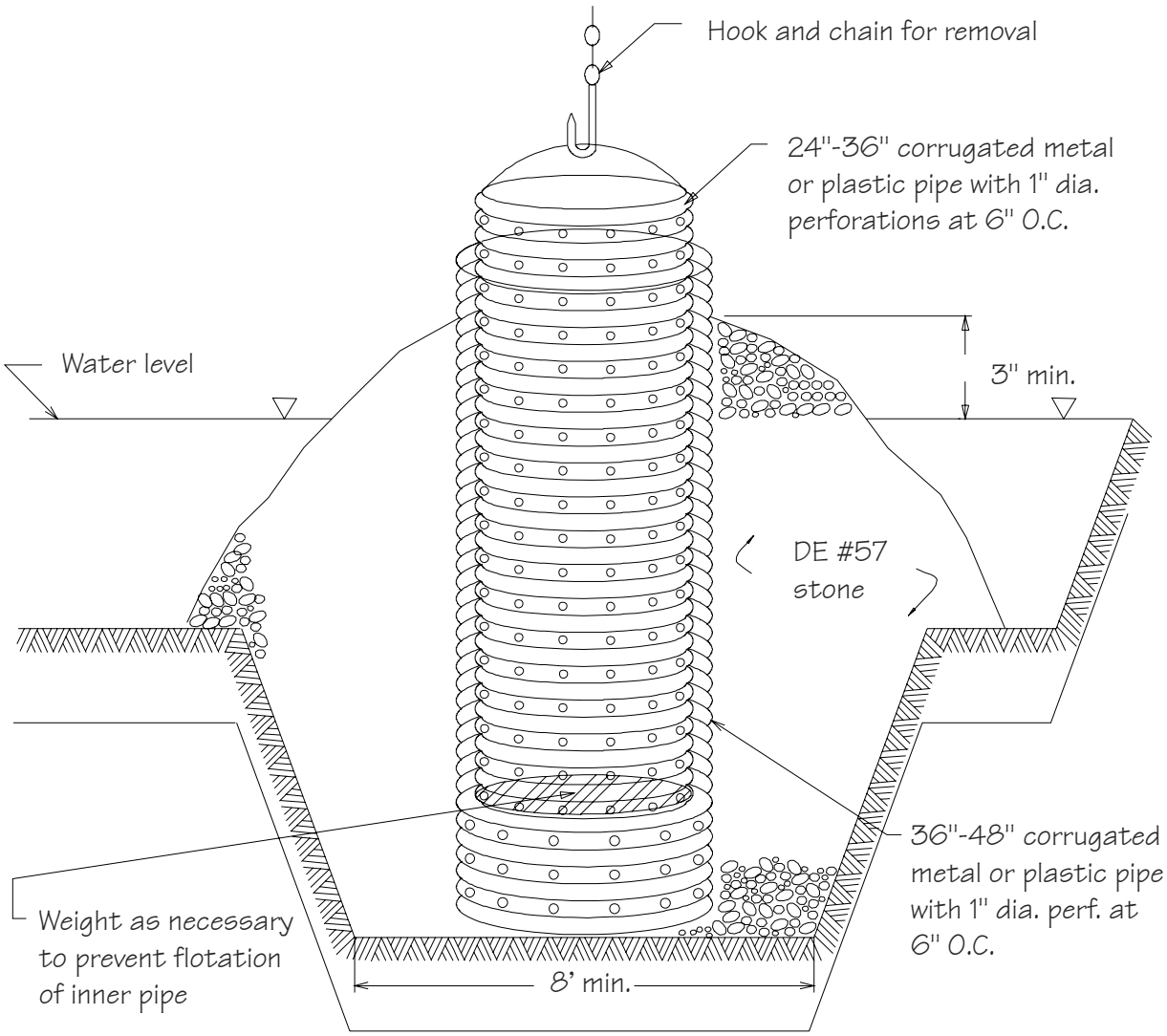
1. Pit dimensions are variable.
2. The standpipe should be constructed by perforating a 12" to 24" diameter corrugated or PVC pipe. The perforations shall be 1/2" X 6" slits or 1" diameter holes 6" on center.
3. A base of DE #57 aggregate should be placed in the pit to a depth of 12". After installing the standpipe, the pit surrounding the standpipe should then be backfilled with DE #57 aggregate.
4. The standpipe should extend 12" to 18" above the lip of the pit or riser crest elevation (basin dewatering).

NOTE: **If discharge will be pumped directly to a storm drainage system, the standpipe must be wrapped with Type GD-II geotextile fabric before installation. If desired, 1/2" hardware cloth may be placed around the standpipe, prior to attaching the geotextile fabric. This will increase the rate of water seepage into the pipe.**

Source:	Symbol:	Detail No.
Adapted from MD Stds. & Specs. for ESC	PP-1	**DE-ESC-3.2.2.1** Sheet 1 of 1 Date: 12/03

Standard Detail & Specifications

Pumping Pit - Type 2



Section

Source:	Symbol:	Detail No.
Adapted from MD Stds. & Specs. for ESC	PP-2	**DE-ESC-3.2.2.2** Sheet 1 of 2 Date: 12/03

DELAWARE EROSION & SEDIMENT CONTROL HANDBOOK

Standard Detail & Specifications

Pumping Pit - Type 2

Construction Notes:

1. Pit shall have a minimum bottom width of 8'.
2. The inside standpipe should be constructed by perforating a 24" to 36" diameter corrugated or PVC pipe. The perforations shall be 1/2" X 6" slits or 1" diameter holes 6" on center.
3. The outside pipe shall be at least 12" larger in diameter than the inside pipe.
4. After installing the standpipes, the pit surrounding the standpipes should then be backfilled with DE #57 aggregate. The height of the stone shall be a min. 3" above the design high water elevation in the trap or basin.
5. The standpipes should extend 12" to 18" above the design high water elevation in the trap or basin.

NOTE: **If discharge will be pumped directly to a storm drainage system, the standpipe must be wrapped with Type GD-II geotextile fabric before installation. If desired, 1/2" hardware cloth may be placed around the standpipe, prior to attaching the geotextile fabric. This will increase the rate of water seepage into the pipe.**

Source:	Symbol:	Detail No.
Adapted from MD Stds. & Specs. for ESC	PP-2	**DE-ESC-3.2.2.2** Sheet 2 of 2 Date: 12/03

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STANDARD AND SPECIFICATIONS FOR DEWATERING DEVICE

Definition: An appurtenace to a sediment trapping structure typically consisting of perforated pipe with a filtering media.

Purpose: To allow sediment-laden runoff to be filtered prior to being discharged to a suitable outlet.

Conditions Where Practice Applies:
Dewatering devices are appropriate where the discharge from a sediment trapping structure can be accomplished via gravity flow. In general, the skimmer dewatering device shall be the preferred option. Under some circumstances, skimmer-type dewatering devices may also be used for pump-out type dewatering activities.

Design Criteria:
The dewatering device shall be designed in such a manner so as to remove the relatively clean water without removing any of the sediment that has settled out and without removing any appreciable quantities of floating debris. Devices utilizing perforated pipe shall provide an adequated number of perforations to maintain its function should partial clogging occur. Some additional criteria for specific types of devices are as follows:

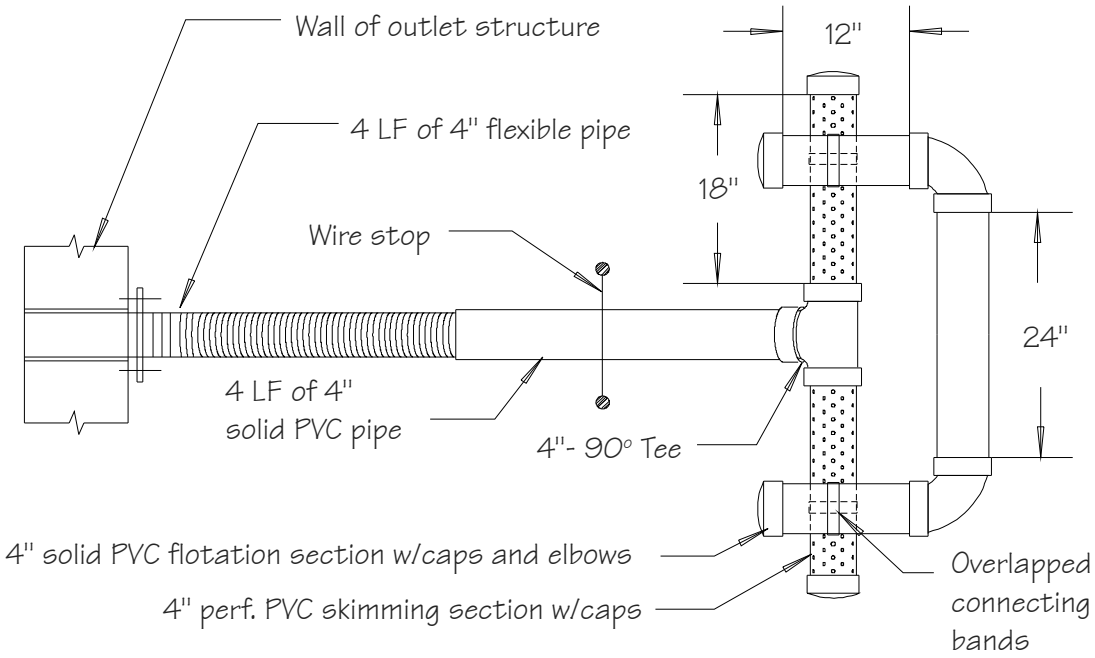
1. Skimmer - Skimmers must be designed so as to float just beneath the water surface in order to remove sediment-laden water most efficiently. If the skimmer floats too high, it may not function at all, leaving the sediment trapping structure without adequate volume for subsequent runoff events. Experience has also shown that if the connection pipe from the skimmer to the outlet structure is entirely constructed with flexible pipe, it is prone to floatation and will inhibit proper functioning. If additional filtration is necessary, the filtering media shall consist of a Type GD-II (see **Appendix A-3**) geotextile fabric wrapped around the perforated portion of the skimmer and attached with plastic snap ties, bands, etc.

2. Proprietary Dewatering Devices - The use of any proprietary or pre-engineered dewatering device must recieve prior approval from the Department or one of its delegated agencies.

Maintainance:
Dewatering devices should be inspected after each runoff event to ensure they are functioning properly. Filter media should be replaced as needed.

Standard Detail & Specifications

Skimmer Dewatering Device



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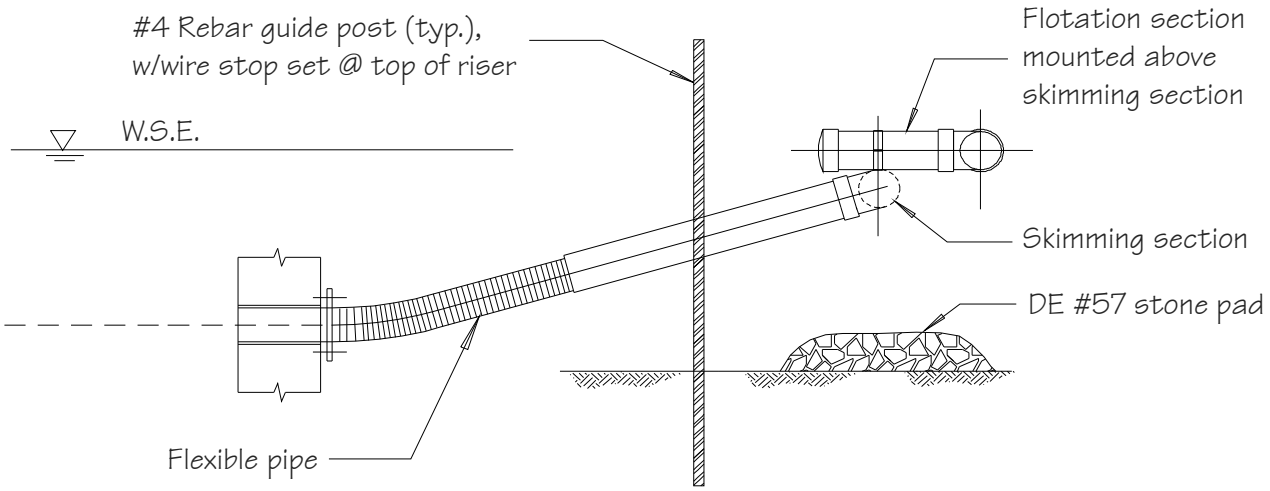

Profile thru ℄ of Pipe

Source:	Symbol:	Detail No.
Adapted from drawing by Vandemark & Lynch, Inc.	SDD	**DE-ESC-3.2.3.1** Sheet 1 of 2 Date: 12/03

DELAWARE EROSION & SEDIMENT CONTROL HANDBOOK

Standard Detail & Specifications

Skimmer Dewatering Device

Construction Notes:

1. Pipe flotation section shall be solvent welded to ensure an airtight assembly. Contractor to conduct a test to check for leaks prior to installation.

2. Skimmer section shall have (12) rows of 1/2" dia. holes, 1-1/4" on center. If additional filtration is necessary, the filtering media shall consist of a Type GD-II geotextile fabric wrapped around the perforated portion of the skimmer and attached with plastic snap ties, bands, etc.

3. Flexible pipe shall be inserted into solid pipe and fastened with (2) #8 wood screws.

4. At a minimum, the structure shall be inspected after each rain and repairs made as needed. If vandalism is a problem, more frequent inspection may be necessary.

5. Construction operations shall be carried out in such a manner that erosion and water pollution are minimized.

6. The structure shall only be removed when the contributing drainage area has been properly stabilized.

Materials:

1. Solid pipe - 4" Sched. 40 PVC
2. Perforated pipe - 4" Sched. 40 PVC
3. 90° Tee (1 ea.) - 4" Sched. 40 PVC
4. 90° Elbow (2 ea.) - 4" Sched. 40 PVC
5. Cap (4 ea.) - 4" Sched. 40 PVC, solid
6. Flexible pipe - 4" corrugated plastic tubing (non-perforated)

Source:	Symbol:	Detail No.
Delaware ESC Handbook	SDD	**DE-ESC-3.2.3.1** Sheet 2 of 2 Date: 12/03

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STANDARD AND SPECIFICATIONS FOR DEWATERING BASIN

Definition: A temporary settling and filtering structure used for dewatering activities.

Purpose: To filter sediment-laden pump discharge water prior to its release to a suitable outlet.

Conditions Where Practice Applies:
Dewatering basins are appropriate whenever sediment-laden water can not be filtered by a gravity-type dewatering device. Furthermore, they are intended to be used at the discharge line from a pump. If sediment-laden water is to be filtered at the intake line, refer to **Section 3.2.2, Standard and Specifications for Pumping Pit**.

Design Criteria

1. The dewatering basin must be sized and operated to allow pumped water to flow through the filtering device without overtopping the structure. The minimum volume provided in the basin shall be based on the following fomula:

   Pump discharge (g.p.m.) x 16 = required volume of storage (cu. ft.)

2. Material which is excavated to construct the basin shall be stockpiled nearby so as to be readily available for restoration when the basin is no longer needed. The stockpile shall be protected with perimeter controls and stabilized in accordance with the Standard and Specifications for Vegetative Stabilization.

3. The inside of the basin may be lined with geotextile fabric to help reduce scour within the basin itself.

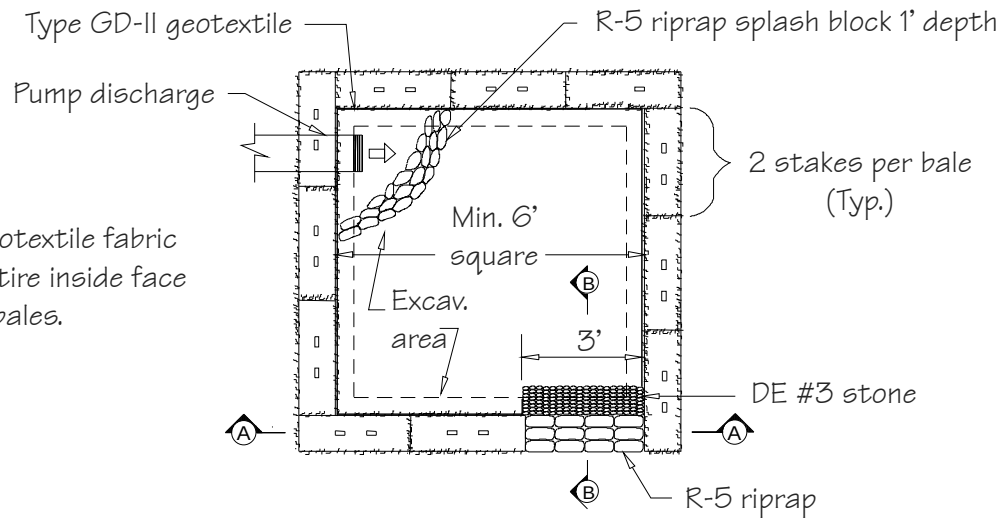
Maintenance

1. The dewatering basin shall be inspected regularly during each day of operation to ensure it is not being overloaded.

2. Once the sediment build-up prevents the structure from functioning as designed, the sediment shall be removed, spread on-site and stabilized or disposed of at an approved disposal site in accordance with the approved plan.

Standard Detail & Specifications

Dewatering Basin - Type 1



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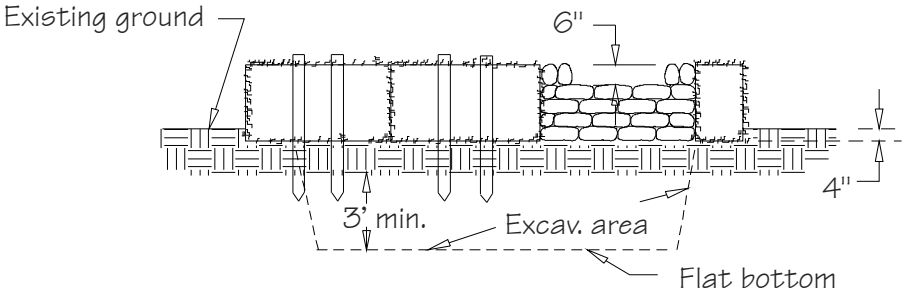
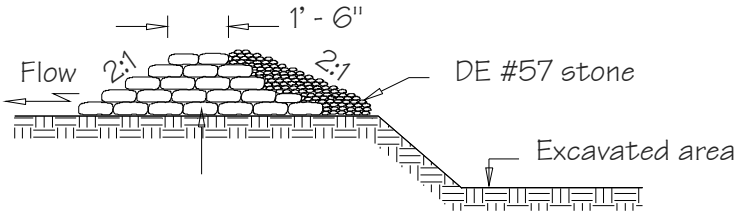


Section A-A



Section B-B

Source:	Symbol:	Detail No.
Adapted from VA ESC Handbook	DWB-1	DE-ESC-3.2.4.1 Sheet 1 of 2 Date: 12/03

Dewatering Basin - Type 1

Construction Notes:

1. Capacity of the basin shall be based on the following formula:

   Pump discharge (gpm) x 16 = cubic feet of storage required

2. Available volume shall be measured from the floor of the excavation to the crest of the stone weir.

3. The excavated area shall be a min. of 3' below the base of the straw bales.

4. Once the water level reaches the crest of the stone weir, the pump shall be shut off while the structure drains down to the elevation of the wet storage.

5. The wet storage area may be dewatered only after a min. of 6 hours of sediment settling time. This effluent shall be pumped across a well vegetated area or through a silt fence prior to entering a watercourse.

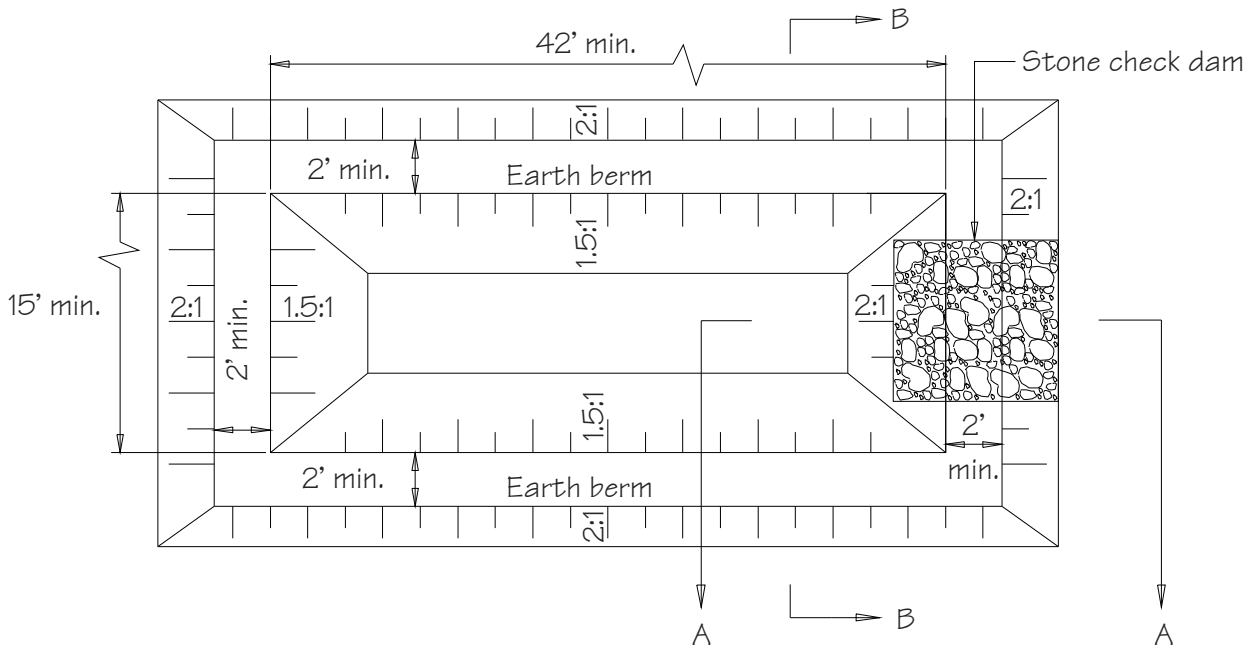
6. Once the wet storage area becomes filled to one-half of the excavated depth, accumulated sediment shall be removed and properly diposed of.

7. The straw bales and/or geotextile fabric shall be inspected on a regular basis and shall be repaired or replaced once sediment prevents the structure from functioning as designed.

Source:	Symbol:	Detail No.
Adapted from VA ESC Handbook	DWB-1	**DE-ESC-3.2.4.1** Sheet 2 of 2 Date: 12/03

Standard Detail & Specifications

Dewatering Basin - Type 2



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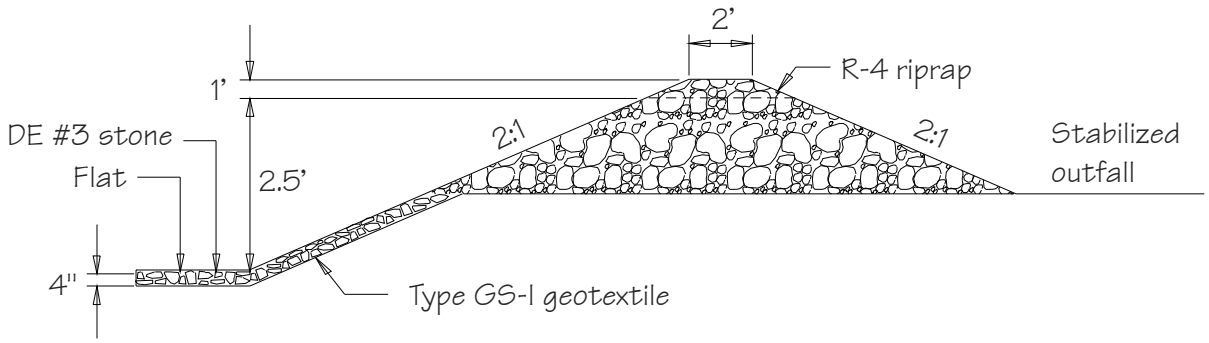


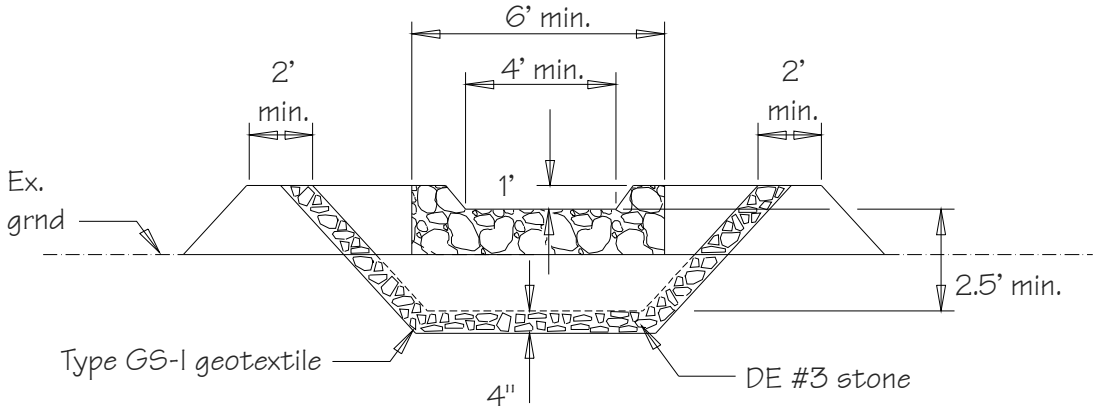
Section A-A

Source:	Symbol:	Detail No.
Adapted from DelDOT Stds. & Specs.	**DWB-2**	**DE-ESC-3.2.4.2** Sheet 1 of 2 Date: 12/03

DELAWARE EROSION & SEDIMENT CONTROL HANDBOOK

Standard Detail & Specifications

Dewatering Basin - Type 2



Section B-B

Construction Notes:

1. Length of the basin shall be based on the following formula:

   Top length (ft) = 26 + .01 x pump discharge (gpm)

2. Basin shall have a min. length of 42 feet, a min. width of 15 feet and a min. depth of 3.5 feet as measured from the floor to the top of the berm.

3. Excess excavated material shall be stockpiled in accorcance with the approved plan and surface runoff shall be diverted around the basin.

4. The outfall from the basin to the receiving waters shall be stabilized. If used in conjunction with the installation of a coffer dam, dewatering shall begin no sooner than 12 hours after coffer dam is completed in order to to allow settling of sediment produced during installation.

5. Pumping into the basin shall cease when the effluent from the basin becomes sediment-laden.

6. Accumulated sediment shall be removed and disposed of in an approved disposal area when the basin is filled to within 18 inches of the crest of the wier.

Source:	Symbol:	Detail No.
Adapted from DelDOT Stds. & Specs.	DWB-2	DE-ESC-3.2.4.2 Sheet 2 of 2 Date: 12/03

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STANDARD AND SPECIFICATIONS FOR FLOCCULATION

Definition: The process by which small particles of fine soils and sediments are induced to aggregate into larger lumps through the application of a chemical agent.

Purpose: To protect streams from the impact of turbid stormwater discharges, especially when construction continues in wet weather conditions. Traditional soil erosion and sediment control practices may not be adequate to control fine particles suspended in runoff, such as clay and fine silt. Chemical treatment can reduce turbidities to levels comparable to dry weather stream flows.

Conditions Where Practice Applies

Flocculation should only be employed when traditional "first line of defense" practices, such as vegetative stabilization, sediment traps, etc. are ineffective and/or additional treatment of stormwater runoff from a disturbed area is warranted. Turbidity is difficult to control once fine particles are suspended in stormwater runoff from construction sites. Flocculation of runoff after settling larger particulate matter in a sediment pond or other practice is an effective turbidity control if the treatment system is properly designed and implemented. Care must be taken to ensure that chemically treated stormwater discharged from construction sites is nontoxic to aquatic organisms and does not violate applicable State or Federal regulations.

Design Considerations

The design and operation of a flocculation system should take into consideration the factors that determine optimum, cost-effective performance, while ensuring non-toxic discharges.

1. Product Evaluation

a. Treatment chemicals must be approved by EPA for potable water use.
b. Petroleum-based polymers are prohibited.
c. The approval of a treatment chemical shall be conditional, subject to monitoring of treated stormwater at the subject construction site.
d. Authorization to use a chemical in the field does not relieve the applicant from responsibility for meeting all discharge and receiving water criteria applicable to a site.

2. Planning Considerations

a. Flocculation systems should be designed as a part of the overall Sediment and Stormwater Management plan whenever problem soils are anticipated. Chemical treatment may be used to correct problem sites in some circumstances with formal written approval.
b. The right chemical must be used at the right dosage. A dosage that is either too low or too high will not produce the best results. There is an optimum dosage rate that must be determined based on the soil type.
c. Flocculants are most effective when applied to the soil surface in anticipation of a runoff event. They may also be installed in the form of "floc blocks" in conveyance system upstream from a sediment trapping practice. If applied directly to a pool of sediment-laden runoff, the coagulant must be mixed rapidly into the water to insure proper dispersion.
d. A flocculation step is important to increase the rate of settling, produce the lowest turbidity, and keep the dosage rate as low as possible.
e. Too little energy input into the water during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.
f. Since the volume of the basin is a determinant in the amount of energy per unit volume, the size of the energy input system could be too small relative to the size of the basin.
g. Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. The discharge should be directed through a physical filter such as a vegetated swale that would catch any unintended floc discharge.

3. Flocculation Materials

a. A variety of flocculent materials are available. Since trace amounts of flocculent will undoubtedly be discharged, the product used should be non-toxic and safe for both human and aquatic life and should not create Biochemical Oxygen Demand (BOD) problems in the downstream discharge waters.
b. One flocculent that has been commonly used for stormwater applications is Polyacrylamide (PAM). Two versions of PAM are available, cationic and anionic. Only anionic PAM should be used, as cationic PAM is considered highly toxic. Anionic PAM has been used for many years in the water and wastewater industry and is considered safe for humans and aquatic life when used at the recommended rates.
c. Chitosan is another flocculent that is derived from the exoskeletons of crustaceans. It is generally considered safe for use in stormwater and water bodies.
d. Selection of an appropriate flocculent is highly dependent on the soil particle type and concentration. Analysis of a sample of the contaminated water is usually required to select the proper product and application rate. Manufacturers of these products will normally assist in this process.

4. Flocculation System Design

a. Flocculation procedures shall be designed in accordance with the manufacturer's recommendations. Ponds or portable tanks are typically used for treatment. Flow-through systems with no means to trap or filter the flocculant are not permitted.
b. A typical flocculation system may contain various components, including but not limited to a stormwater conveyance system, a storage pond, filter, pumps, a chemical feed system, treatment cells, and interconnecting piping.
c. It is recommended that storage ponds or other holding areas have a capacity of 1.5 times the volume to be treated. Bypass should be provided around the system to accommodate extreme storm events.
d. Primary settling should be encouraged in the storage pond. A forebay is helpful.
e. Treatment cell sizing should consider the discharge flow rate and the desired drawdown time.
f. Discharge rates off site must meet all applicable requirements.

5. Monitoring

a. Operational monitoring should include pH, conductivity (as a surrogate for alkalinity), turbidity and temperature of untreated stormwater. Other important quantities include total volume treated, amount of polymer used for treatment and settling time.
b. Discharge monitoring should include pH, turbidity and toxicity of treated stormwater, as well as discharge rates.
c. Any other monitoring necessary to meet federal, state and local water quality standards.

6. Education

a. Each contractor who intends to use chemical treatment should be extensively trained by experienced personnel.
b. If a different contractor is used for chemical stormwater treatment than the general construction site contractor, regular coordination meetings should be held between all responsible parties.

7. Maintenance:

Pretreatment and treatment ponds and cells should be cleaned out periodically, and sediment or floc properly disposed of. Pumps and feed systems must be maintained in good working order. Conveyance systems need to be inspected and maintained in order to function as designed. Check discharge points to ensure that no erosion is occurring from the release of treated runoff.

8. Limitations:

If approval of the chemical treatment system is not received during the application phase of the project, an addendum will be necessary and may result in project delays. Extensive monitoring may be necessary to ensure not only that turbidity reduction goals are being met, but that toxicity of the treated discharge is not an issue. The space necessary for pumps, treatment cells and chemical feed systems can be a problem on smaller sites.

Flocculation

Design Considerations

The design and operation of a flocculation system should take into consideration the factors that determine optimum, cost-effective performance, while ensuring non-toxic discharges.

1. Product Evaluation

a. Treatment chemicals must be approved by EPA for potable water use.
b. Petroleum-based polymers are prohibited.
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d. Authorization to use a chemical in the field does not relieve the applicant from responsibility for meeting all discharge and receiving water criteria applicable to a site.

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d. A flocculation step is important to increase the rate of settling, produce the lowest turbidity, and keep the dosage rate as low as possible.
e. Too little energy input into the water during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.
f. Since the volume of the basin is a determinant in the amount of energy per unit volume, the size of the energy input system could be too small relative to the size of the basin.
g. Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. The discharge should be directed through a physical filter such as a vegetated swale that would catch any unintended floc discharge.

3. Flocculation Materials

a. A variety of flocculent materials are available. Since trace amounts of flocculent will undoubtedly be discharged, the product used should be non-toxic and safe for both human and aquatic life and should not create Biochemical Oxygen Demand (BOD) problems in the downstream discharge waters.

Source:	Symbol:	Detail No.
Adapted from USDOT/FHWA TD-09-001		**DE-ESC-3.1.8** Sheet 1 of 3 Date: 03/13

b. One flocculent that has been commonly used for stormwater applications is Polyacrylamide (PAM). Two versions of PAM are available, cationic and anionic. Only anionic PAM should be used, as cationic PAM is considered highly toxic. Anionic PAM has been used for many years in the water and wastewater industry and is considered safe for humans and aquatic life when used at the recommended rates.
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b. A typical flocculation system may contain various components, including but not limited to a stormwater conveyance system, a storage pond, filter, pumps, a chemical feed system, treatment cells, and interconnecting piping.
c. It is recommended that storage ponds or other holding areas have a capacity of 1.5 times the volume to be treated. Bypass should be provided around the system to accommodate extreme storm events.
d. Primary settling should be encouraged in the storage pond. A forebay is helpful.
e. Treatment cell sizing should consider the discharge flow rate and the desired drawdown time.
f. Discharge rates off site must meet all applicable requirements.

5. Monitoring

a. Operational monitoring should include pH, conductivity (as a surrogate for alkalinity), turbidity and temperature of untreated stormwater. Other important quantities include total volume treated, amount of polymer used for treatment and settling time.
b. Discharge monitoring should include pH, turbidity and toxicity of treated stormwater, as well as discharge rates.
c. Any other monitoring necessary to meet federal, state and local water quality standards.

6. Education

a. Each contractor who intends to use chemical treatment should be extensively trained by experienced personnel.
b. If a different contractor is used for chemical stormwater treatment than the general construction site contractor, regular coordination meetings should be held between all responsible parties.

Flocculation

7. Maintenance:

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