EFFECTIVE EROSION CONTROL PLANS

Bruce Hasbrouck, CEP

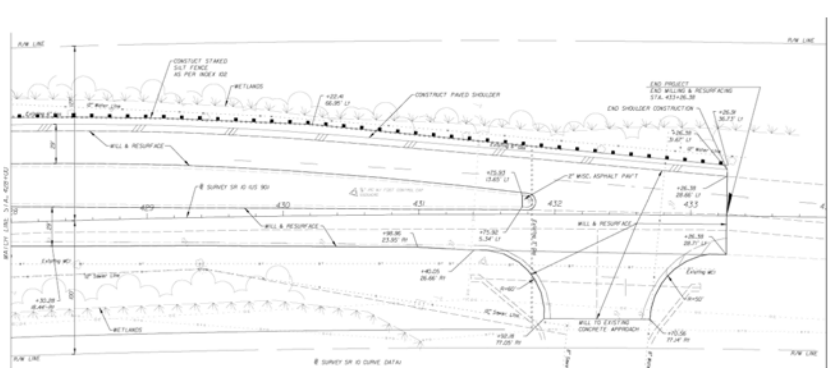
Faller, Davis & Associates, Inc.

&

Larry Ritchie, FDOT

TRANSPORTATION PROJECTS

- **Most FDOT projects require development of Stormwater Pollution Prevention Plan sheets and notes.**



DESIGNERS!!!

- **Designers are the first and sometimes only people who review plans and provide erosion prevention and sediment control (E & SC) materials and methods for a project.**
- **A designer's knowledge of the project area and available E & SC tools are critical in developing a plan to help prevent erosion and control discharge of sediment and turbid water.**

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THINGS TO CONSIDER

- FIELD VISITS…

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THINGS TO CONSIDER…

- **IDENTIFY YOUR RECEIVING WATERS!! – The State of Florida has several different classes of waterbodies. Each class of waterbody has different water quality criteria associated with it.**

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RECEIVING WATERS

- **Class I-V Waters have water quality criteria which states that discharges must be less than of equal to 29 Nepholometric Turbidity Units (NTUs) above the natural background.**
- **Outstanding Florida Waterbodies have water quality criteria which states that discharges must be 0 NTUs above the natural background.**

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RECEIVING WATERS

- **The Florida Department of Environmental Protection maintains a list of all waterbodies along with their classifications. This list can be found here:**

  http://www.dep.state.fl.us/water/wqssp/index.htm

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CHEMICAL TREATMENT

- **Section 104-6.4.10 Chemical Treatment – Provides language for the use of Polyacrylamides(PAM) and Aluminum Sulfate on FDOT construction projects provided the contractor can produce the toxicity testing information found in the E & SC Manual.**
- **Currently, the Department has established two separate pay items for Chemical Treatment:**
  - **104-19 Chemical Treatment, Per square yard**
  - **104-20 Chemical Treatment, Per each**

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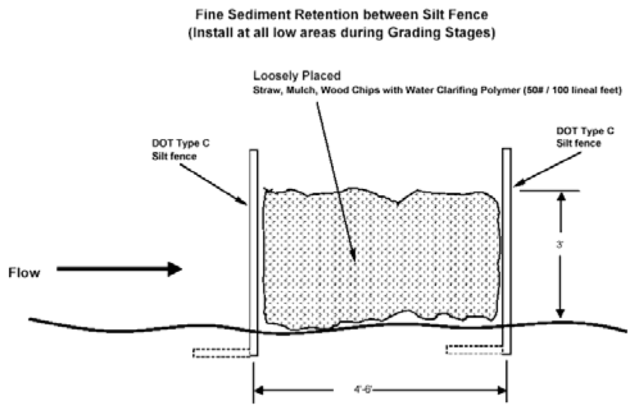
PAM ENHANCED SILT FENCE



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PAM ENHANCED SILT FENCE

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PAM ENHANCED RECPS

- **Create an extremely erosion resistant surface**
- **Increase water quality discharges**
- **Bind clays, metals, fertilizer and seed into a bonded matrix with the matting**

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DEVELOPMENTAL SPECIFICATION

- Lump Sum payment for all aspects of erosion and sediment control.
- References the Designer and Reviewer Manual as the guidance document for designing erosion and sediment control plans.

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DEVELOPMENTAL SPEC.

- Requires the Contractor's Engineer to submit his plan for review to FDEP or the WMD's before he can start work.
- Contains turbidity sampling criteria for each rain event measuring 0.50 inches or greater.
- Requires the Specialty Engineer to make field visits in conjunction with the staging of a construction project to ensure that the plan he developed is being correctly installed in the field.

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Erosion Control – NOT!

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Erosion Control – NOT!

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Erosion Control – YES!

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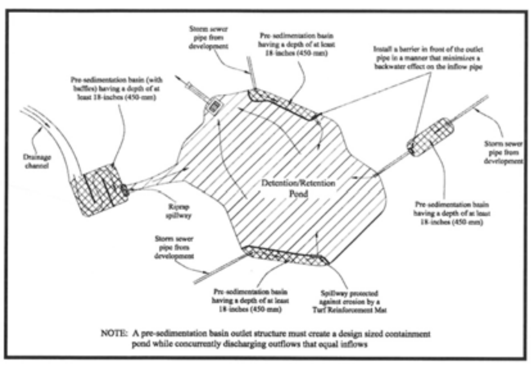
Outline

- Changes
  - Basis of Estimates
  - Estimates Bulletin
  - Erosion and Sediment Control Manual
    - Section IV - Sediment Containment Systems (SCSs)
- FDEP Requirements
- Design Parameters
- Types
  - Basins
  - Bags
  - Outlet Structures
  - Pre-Settlement Basins
- Use of Polymers
- Examples (Reality)



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Basis of Estimates

- 104-1 Artificial Coverings / Rolled Erosion Control Products
- 104-6 Temporary Slope Drain / Runoff Control Structure
- 104-7 Sediment Basin / Containment System
- 104-10-3 Sediment Barrier
- 104-11 Floating Turbidity Barrier
- 104-12 Staked Turbidity Barrier – Nylon Reinforced
- 104-15 Sediment Tracking Prevention Device
- 104-18 Inlet Protection System
- 104-20 Chemical Treatment

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Estimates Bulletin 09-02

Florida Department of Transportation

CHARLIE CRIST
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

STEPHANIE C. KOPELOUSOS
SECRETARY

ESTIMATES BULLETIN 09-02

DATE: July 9, 2009

TO: District Estimates Coordinators, District Design Engineers

FROM: Phillip Greg Davis, State Estimates Engineer

Paul Steinman, State Construction, Engineer

COPIES TO: Lora Hollingsworth, Brian Blanchard, Duane Brautigam, David O'Hagan, Chester Henson

SUBJECT: Erosion Control

ISSUE BACKGROUND: Section 104 of the Specifications, *Prevention, Control, and Abatement of Erosion and Water Pollution*, has been updated to refer to the *State Of Florida Erosion and Sediment Control Designer and Reviewer Manual "E&SC Manual"*. This manual is available online at http://www.dot.state.fl.us/specificationsoffice/Implemented/URLinSpecs/Files/FLErosionSedimentManual.pdf. With this manual, additional materials and methods are available to the contractor for controlling erosion.

Design Standards have been updated to work with the available options from the E&SC manual.

Pay Items have been updated to include the new nomenclature, as well as changes to measurement and payment for various activities.

Expansion of the temporary erosion prevention and sediment control Best Management Practices (BMPs) available to designers and contractors allows greater product selection, promotes competition within the erosion and sediment control industry, and affords the Department greater resource protection with the most up to date technology. These are the driving factors behind this Specification change.

IMPLEMENTATION: The updated pay items and/or descriptions will be available, effective with the January 2010 letting. Additional notes and recommendations for each item are included below.

Update Pay Items: All dates shown below are for the project's effective letting date.

Rolled Erosion Control Products: The description for Artificial Coverings was expanded to include Rolled Erosion Control Products (RECPs). They are commonly used to protect disturbed slopes or channels against erosion due to rainfall or flowing water. These products will continue to be used when shown in the plans, or as called for by the Engineer. When used on a slope, use the E&SC manual Selection Guide to determine the correct product type. When used in a drainage channel, shear stress and velocity calculations must be completed, as shown in the E&SC manual.

www.dot.state.fl.us

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Estimates Bulletin 09-02

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Estimates Bulletin 09-02

- **Sediment Basins: The E&SC manual description is now Sediment Containment Systems. These** systems work to retain sediment, as well as to slow water velocities. Designers should continue to estimate one "cleaning/sediment removal" or cleanout per system on the project.
- 104- 7- Sediment Basins/Containment Systems, per each
- 104- 9- Sediment Basins/Containment

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STATE OF FLORIDA

EROSION AND SEDIMENT CONTROL
DESIGNER AND REVIEWER MANUAL
June 2007

Prepared for:

Florida Department of Transportation
&
Florida Department of Environmental Protection
Tallahassee, FL

Prepared by:

HydroDynamics Incorporated
Parker, CO

In cooperation with:

Stormwater Management Academy
University of Central Florida
Orlando, FL

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FLORIDA STORMWATER EROSION AND SEDIMENTATION CONTROL INSPECTOR'S MANUAL

Florida Department of Environmental Protection
Nonpoint Source Management Section
Tallahassee, Florida

July 2008

This publication was funded in part by the Florida Department of Environmental Protection with a Section 319 Nonpoint Source Management Program Grant from U.S. Environmental Protection Agency.

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- **FDEP Manual:**
- **"Always remember that the rules are performance based—i.e., the measures used at a construction site must effectively control erosion and prevent sedimentation from reaching a regulated receiving water for the site to be in compliance."**
- **"The implementation of BMPs according to this manual is no guarantee of success, nor is it a constraint to prevent the use of other more efficient or cost-effective measures."**

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- NPDES Generic Permit –SWPPP Part V, D. Contents Plan,

  a. Erosion and Sediment Controls

  (3) Sediment Basins

  - ✓ (a) For drainage basins with 10 or more disturbed acres at one time, a temporary (or permanent) sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures, shall be provided where attainable until final stabilization.

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E&SC Manual Section IV - Sediment Containment Systems (SCSs)

- Sediment Containment Systems (SCSs) are:
  - ✓ barriers having hydraulic controls that function by modifying the storm-runoff hydrograph and slowing water velocities.
  - ✓ allows for the deposition of larger suspended particles by gravity.

"The only structural BMPs that can effectively remove sediment when large storm water discharges occur from active construction sites are strategically placed SCSs. "

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- According to the Manual, "Designers must include properly designed SCSs as an integral part of their E&SC plan."
- More importantly, the development of effective SCSs must be based upon capturing design size particles.

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- Deposition of sediment in an SCS is dependent upon many different parameters, including:

  - Mass of the suspended particles falling through contained waters
  - Surface area and containment storage volume for incoming runoff waters
  - Sufficient flow path lengths within the containment system
  - Uniform flow zones within the storage volume
  - Discharge rates of water out of the containment system

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Designing SCSs into an E&SC Drawing

While construction sites present dynamic conditions, Designers can prepare for worse case scenarios by assuming the following on construction activities for lands that discharge into a SCS:

1. Land development activities resulting in 100% bare ground conditions.
2. Constructing vertical/big box structures.
3. Linear projects resulting in 100% bare ground conditions that can be a tributary to a SCS.

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Defining Sediment Containment Systems

When capturing all runoff waters, efficiency of the containment system is 100%.

However, the feasibility of retaining all runoff waters throughout the life of a construction site (i.e. retention) may be difficult for most sites.

Instead of trying to retain all runoff waters, a containment system should detain an adequate volume of runoff long enough to capture suspended "design size" particles.

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Sediment Containment System Classifications

- Type-1 Sediment Containment System — Design-Size Particle <0.075 mm (very fine sand and clays)
- Type-2 Sediment Containment System — Design-Size Particle 0.075 - 0.41 mm (between very fine sand and medium sands)
- Type-3 Sediment Containment System — Design-Size Particle > 0.41 mm (larger than medium sands)

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Type-1 Sediment Containment System

- *A Type-1 SCS will require development of a structure to capture the maximum possible number of coarse silt and smaller suspended particles. Since particles of this size settle very slowly without flocculation, large storage volume Type-1 SCSs require long flow-path lengths, large containment volumes, and controlled discharges.*

- ***Usually, development of Type-1 SCSs requires the expertise of a professional having skills in proper design of embankments, outlet structures, and spillways.***

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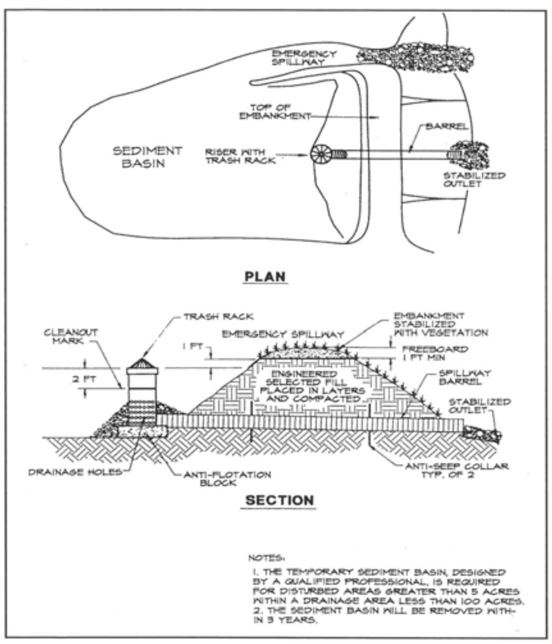

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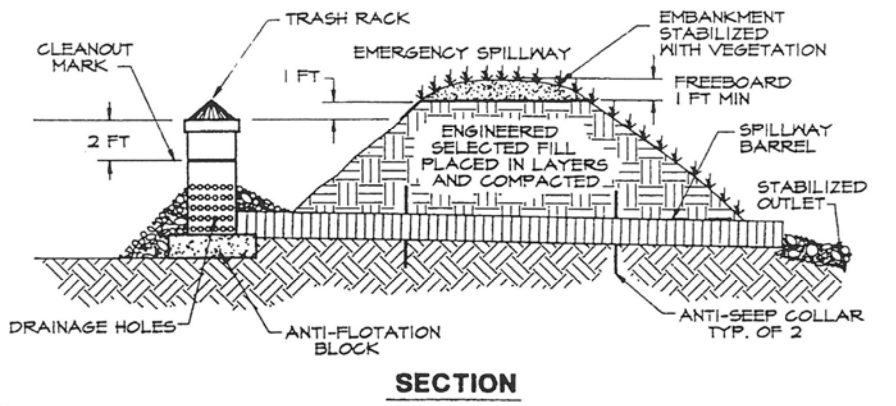

Type-2 Sediment Containment System

- *The Type-2 SCS will capture suspended particles that settle faster than particles requiring Type-1 structures. Consequently, use of smaller storage volumes and shorter flow-path lengths is feasible. As with a Type-1 structure, these sediment control systems will also have controlled discharges. The traditional sediment trap best represents Type-2 systems.*
- ***Depending upon the complexity of the structure, development of Type-2 SCSs may or may not require the expertise of a professional having skills in proper design of embankments, outlet structures, and spillways.***

Type-3 Sediment Containment System

- *The least effective method to control suspended particles in runoff waters*
- *Not necessarily design structures, as found with Type-1 and Type-2 systems, but are often temporary BMPs commonly found on construction sites*
  - ✓ *silt-fence barriers,*
  - ✓ *inlet control structures, and*
  - ✓ *ditch check structures.*

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Effectiveness of Sediment Containment Systems

- Field studies were conducted by EPA to characterize containment systems and to evaluate their effectiveness for trapping sediment.
- It was concluded from these studies that efficiencies of sediment containment systems could be increased by:
  - Using techniques that reduce inflow energy
  - Allowing sufficient travel time for design-size particles to fall through the water
  - Preventing re-suspension of particles

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Dewatering Activities

- Dewatering operations are an important component in the construction process and receive special attention from the local water management agencies.
- Regulators are especially concerned with the protection of wetlands from drawdown effects and protecting the receiving water body from sedimentation and capacity limitations.

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Types of Dewatering Methods

- Rim Ditching
  - Most Common
  - Least Expensive
  - Dirtiest Water
- Sock Pipe/Horizontal Wells
  - More Expensive
  - Cleaner Water
- Well Point Systems
  - Most Expensive
  - Cleanest Water

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Turbidity Monitoring for Off-site Discharge

- When dewatering operations consist of off-site discharge, the contractor must ensure the effluent meets state water quality standards.
- The standards for discharging water into a receiving body cannot exceed 29 nephelometric turbidity units (NTUs) above background. (Zero NTUs for OFWs)
- Samples of the effluent should be taken at the discharge point into the receiving body. For best results, samples should be taken 2 times a day, at least 4 hours apart.

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Using SCSs for Dewatering

- Usually involves pumping water into a SCSs to ensure proper settlement of suspended particles.
- Equations found in Table IV-2 can assist Designers in development of a small SCS needed for these dewatering activities.
- Designers can provide preliminary assessments and recommendations using the following assumptions:
  - The design size particle will be 0.02 mm
  - The discharge rate of water out of the SCS will equal the pumping rate
  - The minimum volume of contained water will be that found for a Type-2 system

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STATE OF FLORIDA EROSION & SEDIMENT CONTROL - DESIGNER & REVIEWER MANUAL

Table IV-5: Minimum Parameters for Sediment Containment Systems (Fifield, 2004)

MINIMUM PARAMETERS	ENGLISH UNITS
Surface Area	$SA_m = (1.2 \times Q_{out}) \div V_S$
Flow-Path Length	$L = [(L \div W_e) \times SA_m]^{0.5}$
Effective Width	$W_e = SA_m \div L$
Type-1 System Volume *(Select the larger value)*	$VOL_m \geq 2.2 \times SA_m$ or $VOL_m \geq$ runoff from a 2-year, 24-hour storm event up to 3,600 ft.^{3}/ac. of disturbed upstream land
Type-2 System Volume	$VOL_m \geq 2.2 \times SA_m$
Net Effectiveness	NEff = AEff x PEG
Average Depth	$D_{avg} \geq 2.2$ ft.
Outlet Depth	2.0 ft.

LEGEND

AEff = Apparent effectiveness (%) of the SCS to remove design size (and larger) particles suspended in runoff waters = $20(L \div W_e) - (L \div W_e)^2$

D_{avg} = (Actual volume) ÷ (actual surface area)

V_S = Particle settling velocity (ft./sec.)

L = Particle flow distance (ft.)

VOL_m = Minimum water volume (ft.^{3})

NEff = Net effectiveness (%)of the SCS to remove all particles suspended in runoff waters

W_e = Effective pond width (ft.)

PEG = Percent of particles that are equal to or greater than the design-size particle (%)

SA_m = Minimum water-surface area of system (ft.^{2})

Q_{out} = Outflow (ft.^{3}/sec.)

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Pre-Sedimentation Basins

- During the construction phase of a project, significant amounts of sediment can potentially flow into (and often out of) a SCS.
- Increased efficiency can occur by trapping larger diameter particles with a pre-sedimentation (a.k.a. forebay) and/or introducing a polymer (when suspended clay colloidal materials exist) or possibly alum (for other types of colloidal materials).
- Essentially, a pre-sedimentation basin is a small SCS specifically designed to capture anticipated sediment loading from disturbed lands.
- Important that sufficient volume exist to capture larger diameter sediments while inflow rates equal outflow rates.

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Pre-Sedimentation Basins

- During the land development or linear phase of a project, Designers must use data on:
  - upstream erodibility of soils,
  - hydrologic characteristics of contributing basins, and
  - a design storm event to determine the size of a pre-sedimentation basin.
- It is important that all pre-sedimentation basins have a minimum depth of 18 inches.

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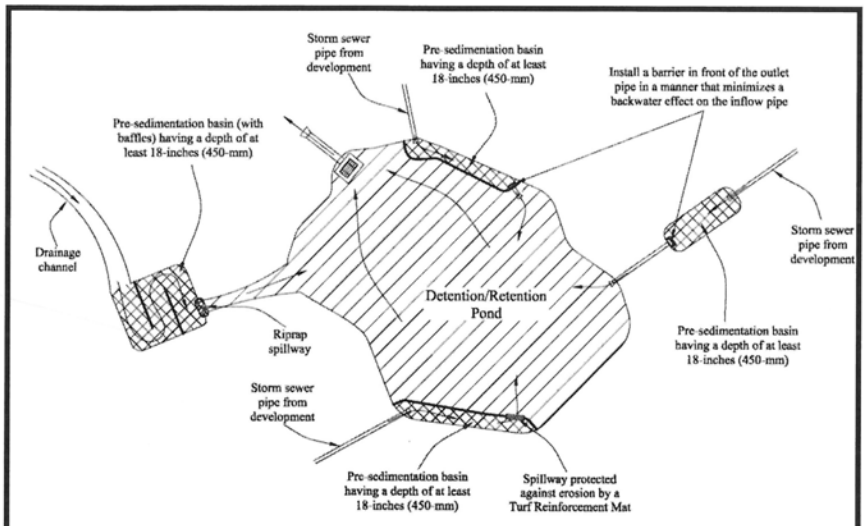
Calculations

By applying and modifying information found in Fifield (2004), use the following equations to calculate the size of a pre-sedimentation basin:

- **Sediment Yield = (K_{site} / K_{chart}) x LR x $A^{1.12}$ (cubic feet)**
- **Surface Area = 0.67 x Sediment Yield (square feet)**
- **Length = 3.79 x (Surface Area) 0.50 (feet)**
- **Width = 0.10 x Length (feet)**

Where

- **K_{site} = Anticipated Soil Erodibility Factor of the site**
- **K_{chart} = Soil Erodibility Factor (found in ES&C Manual)**
- **LR = Loading Ratio value (found in ES&C Manual)**
- **A = Contributing area in acres**



NOTE: A pre-sedimentation basin outlet structure must create a design sized containment pond while concurrently discharging outflows that equal inflows

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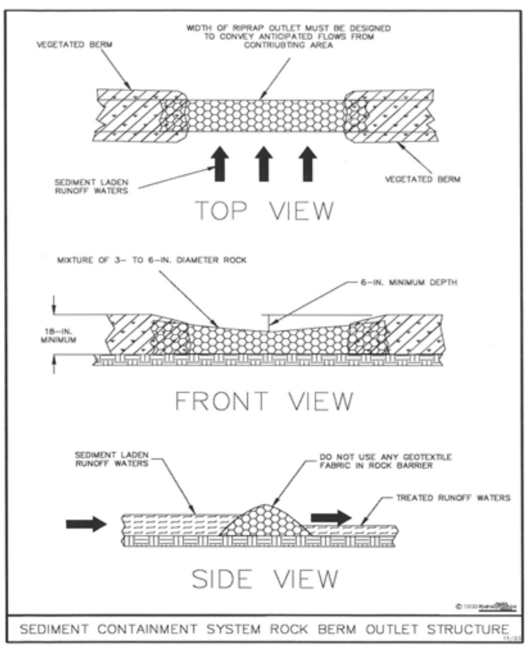
Rock berm Outlet Structures

- Provide a relatively maintenance free method for releasing contained waters when outflow values are equal to inflow values.

- Method of a structure to capture larger diameter suspended particles.
- Allows the discharge of contained waters.
- Relatively maintenance free outlet structure.



Sediment Containment – Single Chamber

- Provide a location for deposition of large diameter suspended particles in runoff from small contributing basins.
- Installed in low points of small drainage basins
- Used in areas where limited space exists for a sediment containment system.
- Should be installed before construction activities begin.

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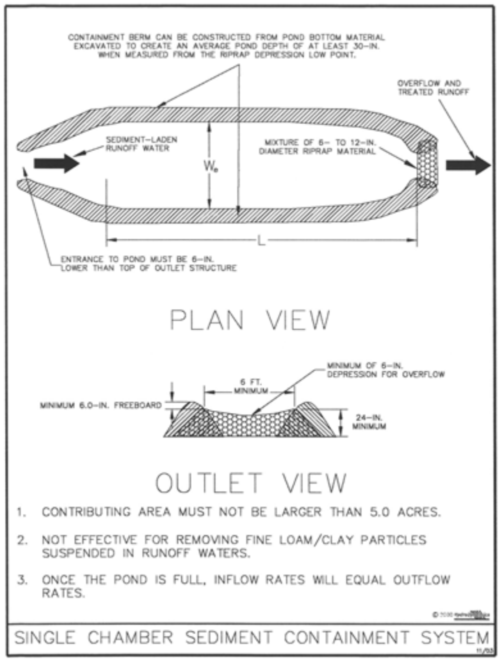

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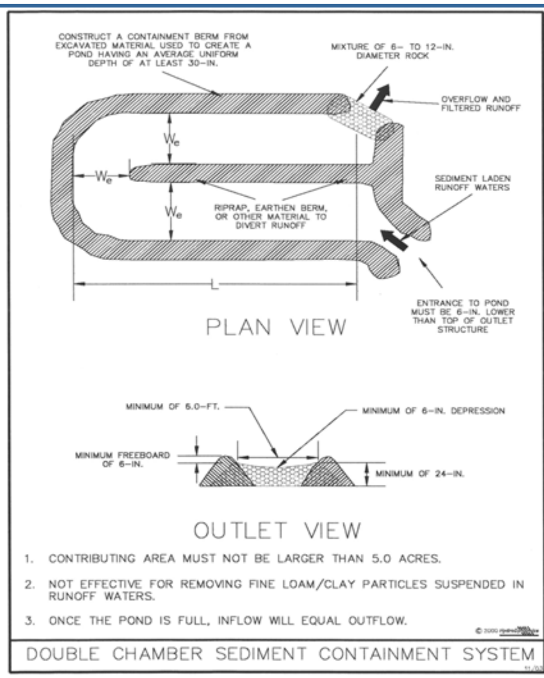
Sediment Containment – Double Chamber

- Same parameters as Single Chamber
- The length parameter is to be reduced by 50% (i.e., **Lfinal = ½ x Length)**
  - ✓ as calculated by the Designer from equations found in the pre-sedimentation basin section.

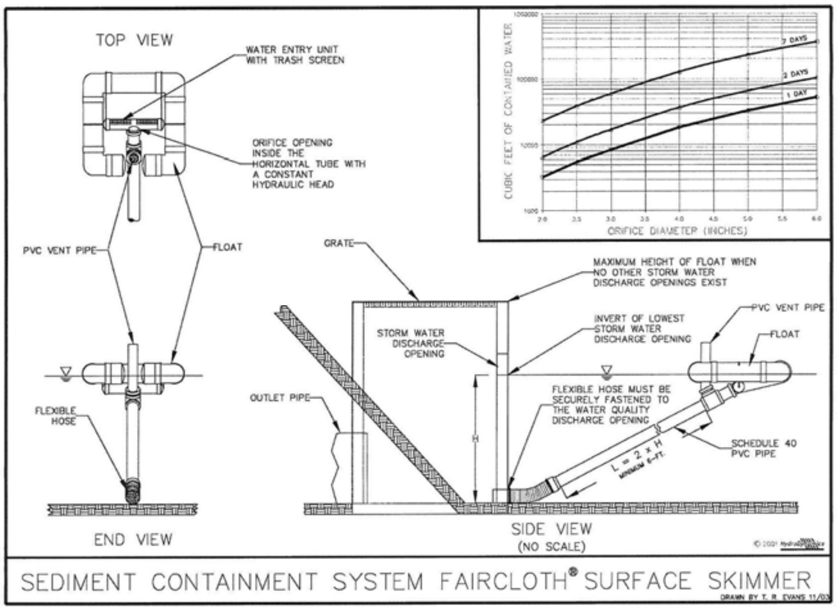


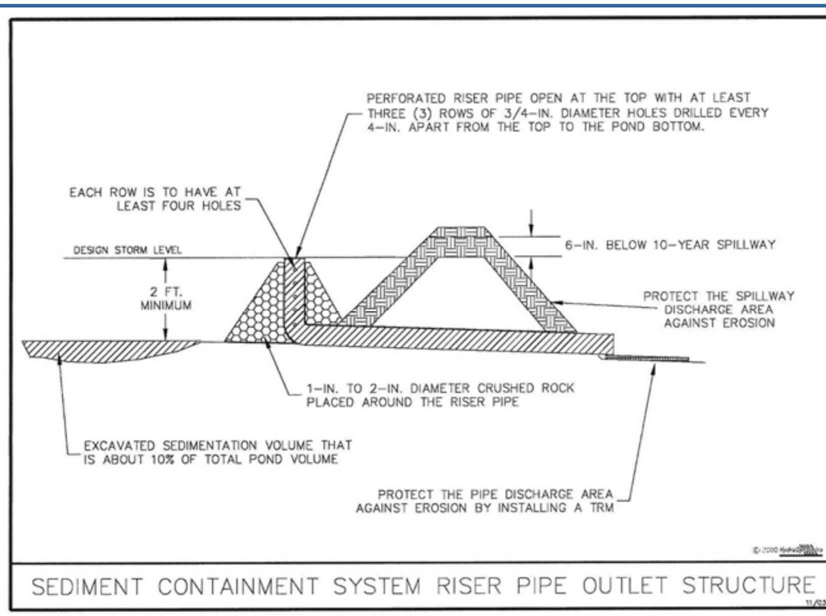
Sizing Sediment Containment Systems

- For drainage basins with 10 or more disturbed acres at one time, a temporary (or permanent) sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures, shall be provided where attainable until final stabilization.

SCS Outlet Structures

- An important element of effective sediment containment systems is the outlet structure. These are required for containing runoff waters from a structure and can include the following systems:
  - Surface Skimmers
  - Perforated Riser Pipes


TOP VIEW
WATER ENTRY UNIT WITH TRASH SCREEN
ORIFICE OPENING INSIDE THE HORIZONTAL TUBE WITH A CONSTANT HYDRAULIC HEAD
PVC VENT PIPE
FLOAT
FLEXIBLE HOSE
END VIEW
CUBIC FEET OF CONTAINED WATER
ORIFICE DIAMETER (INCHES)
3 DAYS
2 DAYS
1 DAY
GRATE
MAXIMUM HEIGHT OF FLOAT WHEN NO OTHER STORM WATER DISCHARGE OPENINGS EXIST
INVERT OF LOWEST STORM WATER DISCHARGE OPENING
PVC VENT PIPE
FLOAT
STORM WATER DISCHARGE OPENING
OUTLET PIPE
H
FLEXIBLE HOSE MUST BE SECURELY FASTENED TO THE WATER QUALITY DISCHARGE OPENING
L = 2 x H
SCHEDULE 40 PVC PIPE
SIDE VIEW
(NO SCALE)
SEDIMENT CONTAINMENT SYSTEM FAIRCLOTH® SURFACE SKIMMER
DRAWN BY T. R. EVANS 11/03


PERFORATED RISER PIPE OPEN AT THE TOP WITH AT LEAST THREE (3) ROWS OF 3/4-IN. DIAMETER HOLES DRILLED EVERY 4-IN. APART FROM THE TOP TO THE POND BOTTOM.
EACH ROW IS TO HAVE AT LEAST FOUR HOLES
DESIGN STORM LEVEL
2 FT. MINIMUM
6-IN. BELOW 10-YEAR SPILLWAY
PROTECT THE SPILLWAY DISCHARGE AREA AGAINST EROSION
1-IN. TO 2-IN. DIAMETER CRUSHED ROCK PLACED AROUND THE RISER PIPE
EXCAVATED SEDIMENTATION VOLUME THAT IS ABOUT 10% OF TOTAL POND VOLUME
PROTECT THE PIPE DISCHARGE AREA AGAINST EROSION BY INSTALLING A TRM
SEDIMENT CONTAINMENT SYSTEM RISER PIPE OUTLET STRUCTURE
11/03

SCS for Barrier to Culvert

- To reduce inflow velocity so that deposition of suspended particles found in runoff can occur upstream of the barrier.
- Installed on the upstream side of culverts.
- Installed as part of total sediment containment system.

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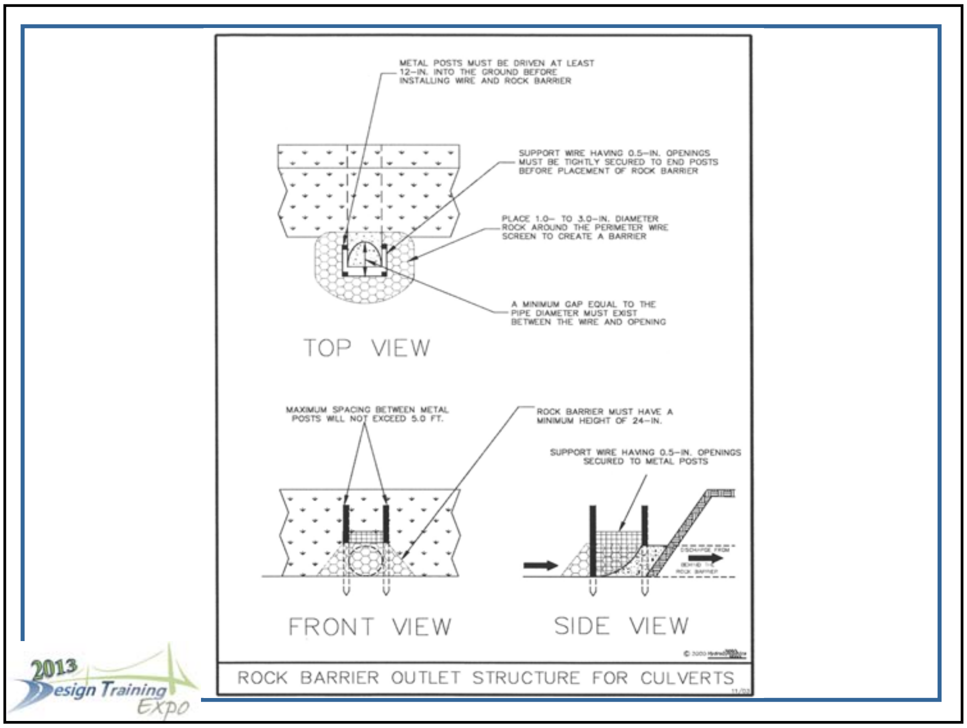
METAL POSTS MUST BE DRIVEN AT LEAST 12-IN. INTO THE GROUND BEFORE INSTALLING WIRE AND ROCK BARRIER
SUPPORT WIRE HAVING 0.5-IN. OPENINGS MUST BE TIGHTLY SECURED TO END POSTS BEFORE PLACEMENT OF ROCK BARRIER
PLACE 1.0- TO 3.0-IN. DIAMETER ROCK AROUND THE PERIMETER WIRE SCREEN TO CREATE A BARRIER
A MINIMUM GAP EQUAL TO THE PIPE DIAMETER MUST EXIST BETWEEN THE WIRE AND OPENING
TOP VIEW
MAXIMUM SPACING BETWEEN METAL POSTS WILL NOT EXCEED 5.0 FT.
ROCK BARRIER MUST HAVE A MINIMUM HEIGHT OF 24-IN.
SUPPORT WIRE HAVING 0.5-IN. OPENINGS SECURED TO METAL POSTS
FRONT VIEW
SIDE VIEW
ROCK BARRIER OUTLET STRUCTURE FOR CULVERTS
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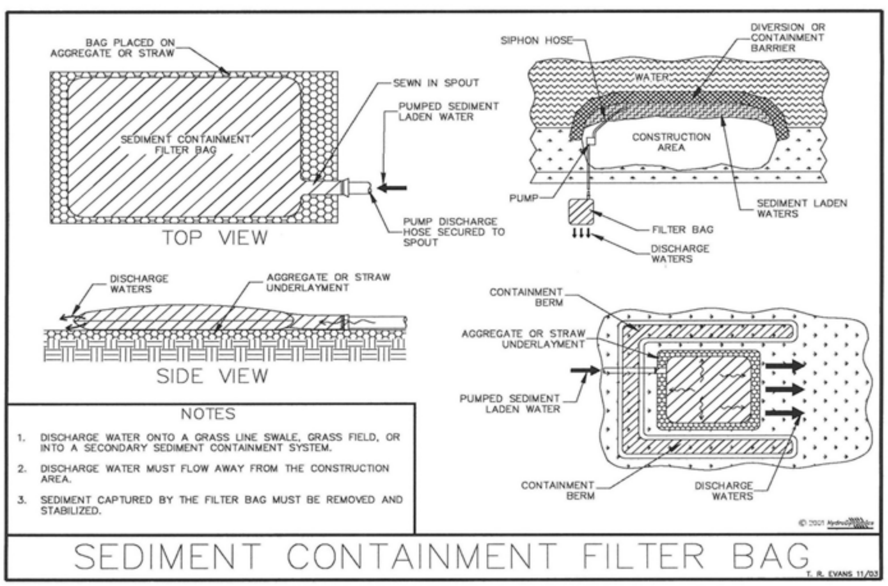
Sediment Containment Filter Bag

- To remove larger diameter size particles from sediment-laden waters by filtration.
- Commonly used to remove water collected behind cofferdams, kelly wells, and dewatering activities.
- Maintenance is important; replace frequently, i.e. weekly.




GeoHay

Use of Polymers or Alum

- When polymers are added in correct amounts to sediment-laden waters, suspended colloidal particles combine resulting in an increased mass that is subject to acceleration by gravity through the water column.
- However, Designers need to be aware that polymers or alum may be detrimental to aquatic life if introduced in inappropriate quantities or not properly selected for site conditions.
- Alum is not to be included in the plans without specific approval by Larry Ritchie in the State Construction Office.

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Determine the Parameters of a SCS

- *Step 1: Determine the Sediment Yield.*
  - *When 2.75 inches of rain falls on a bare ground slope of 2.50%,*
    - *then LR = 210 cu. ft/ac$^{1.12}$ (from Chart)*
  - Sediment Yield = (K_{site} / K_{chart}) x LR x $A^{1.12}$ (cubic feet)
  - *Sediment Yield = (0.40 / 0.43) x 210 x 5.0$^{1.12}$ = 1,185 cubic feet*

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Step 2: Calculate the Basin Parameters

Surface Area = 0.67 x Sediment Yield

- *Surface Area = 0.67 x 1,185 = 794 square feet*

Length = 3.79 x (Surface Area) 0.50

- *Length = 3.79 x (794) 0.5 = 106 feet*

Width = 0.10 x Length (feet)

- *Width = 0.10 x 106 = 11 feet*

Depth = 1.5 feet

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- Thus, when sufficient polymer is continually introduced into runoff waters discharging from 5.0 acres of disturbed lands, a pre-sedimentation basin about 106 feet long, 11 feet wide, and 1.5 feet deep is required.
- It may be adequate to place the SCS in line with the drainage swale to capture anticipated sediment loads caused by a 2.75-inch (and smaller) storm event.

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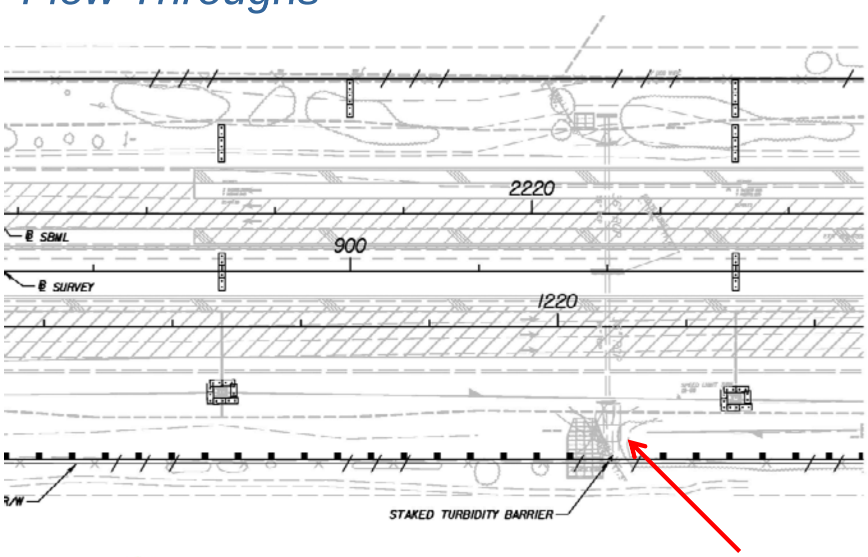
Flow Throughs



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$ 40,000


$179,685


$345,629


Questions?