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

Acknowledgments

Development of this manual was funded by the Florida Department of Transportation and the Florida Department of Environmental Protection.

With Special Thanks to the Manual Advisory Committee

Fernando Ascanio, FDOT
Josh Boan, FDOT
Manoj Chopra, UCF
Susan Davis, SJRWMD
Cammie Dewey, SJRWMD
Jerry Fifield, HDI
Carol Griggs, SJRWMD
Steve Iwinski, APS
Eric Livingston, FDEP
Paul O'Neil, SWFWMD
Rick Renna, FDOT
Andi Reyes, SFWMD
Heather Ritchie, FDEP
Larry Ritchie, FDOT
David Sadler, FDOT
Jenny Sargent, FDOT
Jim Smoot, USGS
Marty Wanielista, UCF
Ben Watson, FDOT
Molly Wood, USGS
Ed Yaun, SFWMD

This manual was edited by Ryan Browne, UCF and approved for publication.

INTRODUCTION

With the adoption of the statewide stormwater rule in 1982, Florida was the first state in the country to require the treatment of stormwater from all new development. The stormwater rule is a technology-based rule relying upon a performance standard (environmental goal) and Best Management Practices (BMPs) design criteria that are presumed to meet the goal. The performance standards are set forth in the Water Resource Implementation Rule (Chapter 62-40, F.A.C.).

Performance standards for erosion and sediment control during grading is to retain sediment on-site, with a backstop that no discharge shall violate the State of Florida's water quality standard for turbidity. Thus, goals of Florida's stormwater regulatory program and the Florida Department of Environmental Protection (FDEP) are to protect water quality and to minimize erosion and sedimentation by requiring the use of effective BMPs during and after grading. Additionally, as mandated by the Clean Water Act (CWA), permits must be obtained for stormwater discharges from construction sites that meet or exceed the Environmental Protection Agency (EPA)'s criteria (see http://www.epa.gov/region5/water/cwa.htm). The EPA has the responsibility of administering CWA requirements by requiring National Pollutant Discharge Elimination System (NPDES) discharge permits.

FDEP implements the NPDES program in Florida and issues Florida NPDES discharge permits. By reviewing http://www.dep.state.fl.us/water/stormwater/npdes/index.htm, readers of this manual can obtain more detailed information on Florida statutory requirements and FDEP programs and requirements.

Purpose of the Manual

This manual will assist designers and reviewers in providing meaningful and practical Erosion and Sediment Control (E&SC) drawings as part of the Stormwater Pollution Prevention Plan (SWPPP) for the contractor to implement. Preparation and review of SWPPP and E&SC drawings need to be done by, or under the supervision of, professionals having demonstrative erosion and sediment control experience and skills necessary for development and review of effective and practical documents. These individuals are identified throughout this manual as Designers. It is important to note that additional qualifications may be required by governmental agencies, such as having construction field experience, supplementary training and education, passing an examination, and so forth.

This manual has been developed to strive toward a consistent level of technical expertise and professional conduct for designers and reviewers developing and reviewing E&SC drawings and SWPPP. These are required not only to meet NPDES stormwater requirements but are also an integral part of the stormwater management plan that must be approved by FDEP or the Water Management Districts (WMDs) to obtain a Florida stormwater or Environmental Resource Permit (ERP). Ultimately, the guidance in this manual strives to ensure the desired benefits of stormwater management systems are being achieved.

Three Basic Definitions

Natural erosion occurs at a relatively slow rate; however, accelerated erosion is primarily caused by the removal of natural vegetation or alteration of the ground contour by land disturbing and construction activities. The nature of construction activities will result in increased erosion rates, transportation of sediment by runoff, and create problems associated with sedimentation. The purpose of this manual is to present methods that Designers can use and reviewers will recognize to reduce sediment in runoff waters and minimize the erosion process on sites where construction activity is occurring. It is important that Designers and reviewers understand the following three basic definitions:

- Erosion: The process by which rainfall, wind and water dislodges soil particles.
  - *Splash erosion* is the dislodging of soil particles by raindrop impacts, resulting in the dispersal and mobilization of the soil particles.
  - *Sheet flow erosion* is the uniform removal of saturated soil particles conveyed in runoff waters.
  - *Rill erosion* is a long, narrow depression or soil incision caused by increased topographic relief and higher runoff velocities. They are the result of concentrated flows that result in vertical (meaning, incising into the ground) and sheet flow erosion.
  - *Gully erosion* is the deep and wide depression caused by concentrated flows.
  - *Stream bank erosion* is the removal of soil by a natural drainage pattern, such as toe cutting and bank sloughing.
  - *Shoreline erosion* is the removal of soil by high-energy wave action, resulting in sloughing and mass wasting.
- Sediment: Soil particles suspended in, or moved by, stormwater runoff.
- Sedimentation: The deposition of sediment.

Some of the factors influencing erosion include soil characteristics, existing vegetative cover, topography and climate. Soil properties which influence erosion by rainfall and stormwater runoff are those which affect the infiltration capacity of a soil and those which affect the resistance of the soil to detachment and transport by flowing or falling water. Vegetative cover plays an extremely important role in reducing erosion and can be controlled during land disturbing activities.

Sequentially scheduling and limiting the removal of vegetation and decreasing the area and duration of exposure can significantly reduce soil erosion and sedimentation. Topographic characteristics of the watershed can influence the amount and rate of stormwater runoff since slope length and gradient directly influence the volume and velocity of runoff and erosion risks. Climate, especially rainfall frequency, intensity and duration are fundamental factors in determining the amount of runoff. As volume and velocity increase, the capacity of runoff to detach and transport soil particles also increases.

This manual will provide guidelines for developing and reviewing effective E&SC drawings that incorporate methods for removing sediment from runoff waters and minimize erosion in a cost effective and practical manner that protects the environment while construction activities occur.

SECTION II

DEVELOPING EFFECTIVE SWPPP'S AND E&SC DRAWINGS

Table of Contents

CONTENTS OF A SWPPP

The Stormwater Pollution Prevention Plan and accompanying E&SC plans shall identify potential sources of pollution that may reasonably be expected to affect the quality of stormwater discharge associated with construction activity. In addition, the plan shall describe and ensure the implementation of BMPs, which will be used to reduce the pollutants in stormwater discharge associated with construction activity and to assure compliance with the terms and conditions of the permit. A thorough understanding of the plan is essential for proper implementation and maintenance.

The SWPPP must be developed before an NOI is filed to receive the Generic Permit for Stormwater Discharge from Large and Small Construction Activities (CGP) coverage and meet or exceed FDEP requirements. Also, beginning on the first day of construction activities, the SWPPP and E&SC drawings must be available at the location identified in the NOI (see http://www.dep.state.fl.us). A copy of the NOI or Notice of Coverage from FDEP shall be posted at the construction site in a prominent place for viewing. The location of the SWPPP is identified in the NOI and may or may not necessarily be at the construction site.

A SWPPP will consist of a narrative (including any calculations), E&SC drawings, and record requirements. In addition, the CGP requires a certification statement to be signed by the operator. It is strongly recommended that the Designer also sign a certification to ensure accountability exists. The SWPPP shall be developed and implemented for each construction site covered by this permit and be prepared in accordance with good engineering and scientific practices.

Narrative Report

The narrative report provides general information on what is to be completed to ensure minimal environmental damage as a construction project is developed. It should briefly describe the overall strategy for erosion and sediment control, as well as summarize the aspects of the project that are important for erosion control on-site for the plan reviewer and project superintendent. A site description shall be included in the narrative report and include at a minimum the following information about the site:

- Description of the construction activity
- Total area of the site and total disturbance area
- Intended sequence of land disturbing activities
- Description of the soils and an identification of those that are highly erodible
- Drainage area for each major discharge point
- Latitude and longitude of each major discharge point
- Names of receiving water(s)
- Description of proposed pollution control measures (i.e. BMPs) to be used
- General sequence during the construction process in which the measures will be installed
- Estimated start date, completion date and stabilization schedule
- If possible, an identification of the contractor or subcontractor responsible for the BMP implementation, inspection, and maintenance

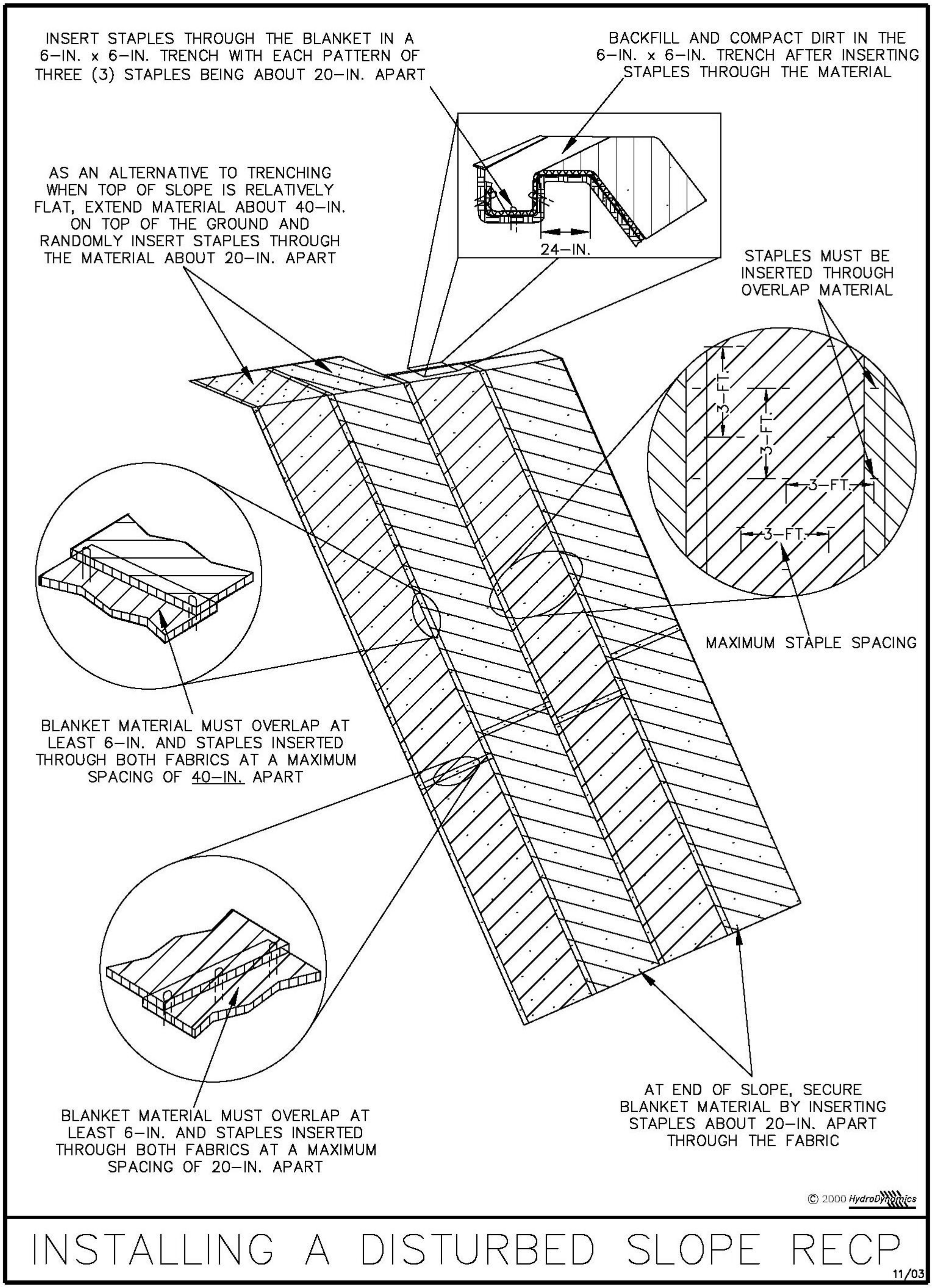


Figure III-2: Illustration of Installing a RECP on a Disturbed Slope

Permission is given by HydroDynamics Incorporated to copy and reproduce this detail

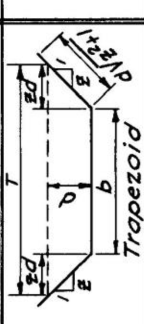
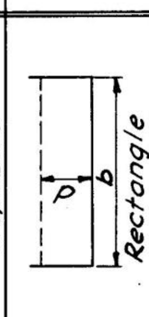
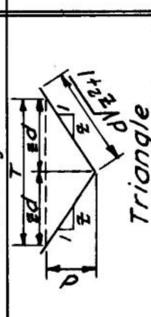
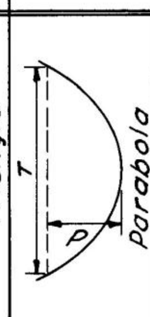
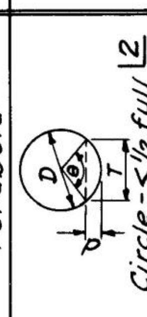
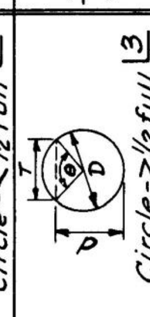
Table III-1: Manning's Roughness Coefficients for Various Materials (Fifield, 2004)

Material	Depth of 0 to 6 in.	Depth of 6 in. to 24 in.	Depth >24 in.
Bare soil[a]	0.023	0.020	0.020
Rock cut[a]	0.045	0.035	0.025
Gravel riprap[a]			
D_{50} = 1.0 inches	0.044	0.033	0.030
D_{50} = 2.0 inches	0.066	0.041	0.034
Rock riprap[a]			
D_{50} = 6.0 inches	0.104	0.069	0.035
D_{50} = 12 inches	----	0.078	0.040
Concrete[a]	0.015	0.013	0.013
Grouted riprap[a]	0.040	0.030	0.028
Stone masonry[a]	0.042	0.032	0.030
Soil cement[a]	0.025	0.022	0.020
Asphalt[a]	0.018	0.016	0.016
Fiberglass roving[a]	0.028	0.021	0.019
Straw (loose) covered with net[a]	0.065	0.033	0.025
EROSION CONTROL BLANKET			
Jute net[a]	0.028	0.022	0.019
Wood excelsior mat[a]	0.066	0.035	0.028
TURF REINFORCEMENT MAT			
Bare ground conditions[b]	0.036	0.026	0.020
Vegetation conditions[b]	0.023	0.020	0.020

a Chen and Cotton (1988)

b IECA (1995)

HYDRAULICS: ELEMENTS OF CHANNEL SECTIONS

Section	Area a	Wetted Perimeter p	Hydraulic Radius r	Top Width T
 Trapezoid	$bd+zd^2$	$b+2d\sqrt{z^2+1}$	$\frac{bd+zd^2}{b+2d\sqrt{z^2+1}}$	$b+2zd$
 Rectangle	bd	$b+2d$	$\frac{bd}{b+2d}$	b
 Triangle	zd^2	$2d\sqrt{z^2+1}$	$\frac{zd}{2\sqrt{z^2+1}}$	$2zd$
 Parabola	$\frac{2}{3}dT$	$T+\frac{8d^2}{3T}$ [1]	$\frac{2dT^2}{3T^2+8d^2}$ [1]	$\frac{3a}{2d}$
 Circle - < ½ full [2]	$\frac{D^2}{8}\left(\frac{\pi\theta}{180}-\sin\theta\right)$	$\frac{\pi D\theta}{360}$	$\frac{45D}{\pi\theta}\left(\frac{\pi\theta}{180}-\sin\theta\right)$	$D\sin\frac{\theta}{2}$ or $2\sqrt{d(D-d)}$
 Circle - > ½ full [3]	$\frac{D^2}{8}\left(2\pi-\frac{\pi\theta}{180}+\sin\theta\right)$	$\frac{\pi D(360-\theta)}{360}$	$\frac{45D}{\pi(360-\theta)}\left(2\pi-\frac{\pi\theta}{180}+\sin\theta\right)$	$D\sin\frac{\theta}{2}$ or $2\sqrt{d(D-d)}$

[1] Satisfactory approximation for the interval $0 < \frac{d}{T} \leqq 0.25$. When $d/T > 0.25$, use $p = \frac{1}{2}\sqrt{16d^2+T^2} + \frac{T^2}{8d}\sinh^{-1}\frac{4d}{T}$

[2] $\theta = 4\sin^{-1}\sqrt{d/D}$ } Insert θ in degrees in above equations
[3] $\theta = 4\cos^{-1}\sqrt{d/D}$

REFERENCE	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE H. H. Bennett, Chief ENGINEERING STANDARDS UNIT	STANDARD DWG. NO. ES-33 SHEET 1 OF 1 DATE 6-6-50

Figure III-3: Channel Cross-Section Equations (NRCS, 1950)

Table III-2: Permissible Shear-Stress Values and Velocities for Various Materials (Fifield, 2004)

Material	Test Time (hr.)	Maximum Shear Stress (lbs./ft.^{2})	Maximum Velocity (ft./sec.)
Bare soil[a]			
Non-cohesive (Diameter = 0.004 to 4.0 in.)	NDG	0.004 to 1.67	NDG
Cohesive Loose (Plasticity Index = 3.0 to 50)	NDG	0.01 to 0.090	NDG
Cohesive Medium Compact (Plasticity Index = 3.0 to 50)	NDG	0.015 to 0.27	NDG
Cohesive Compact (Plasticity Index = 3.0 to 50)	NDG	0.022 to 0.79	NDG
Gravel riprap[a]			
D_{50} = 1.0 inches	NDG	0.31	NDG
D_{50} = 2.0 inches	NDG	0.67	NDG
Rock riprap[a]			
D_{50} = 6.0 inches	NDG	1.99	NDG
D_{50} = 12 inches	NDG	3.99	NDG
Grass (established)[a] Height Classification — Examples			
A (30 in.) — Weeping lovegrass and Yellow bluestem	NDG	3.76	NDG
B (12 to 24 in.) — bermuda grass, Little bluestem, Bluestem, Blue gamma, and other long and short Midwest grasses	NDG	2.09	NDG
C (6 to 12 in.) — Crabgrass, bermuda grass, orchard grass, redtop, Italian ryegrass, Kentucky bluegrass, common lespedeza	NDG	1.05	NDG
D (2 to 6 in.) — bermuda grass, buffalo grass, orchard grass, redtop, Italian ryegrass, common lespedeza	NDG	0.63	NDG
E (1.6 in.) — bermuda grass	NDG	0.31	NDG
Fiberglass Roving[a]			
Single	NDG	0.61	NDG
Double	NDG	0.86	NDG
Straw (loose) covered with net[a]	NDG	1.44	NDG
EROSION CONTROL BLANKET			
Coconut material[c]	0.5	2.26	9.8
Wood excelsior material[a,b,c]	NDG	0.50 to 2.00	4.9 to 7.9
Jute net[a]	NDG	0.45	NDG
Straw blanket with sewn net[b,c]	0.50	1.50 to 1.75	4.9 to 5.9
Straw/coconut blanket with sewn net[b,c]	0.5	2.00 to 2.10	7.9
TURF REINFORCEMENT MAT			
Bare Ground Conditions[a,b,c]	0.50	3.00 to 8.00	8.9 to 20.0
	50	2.00 to 3.00	7.9 to 14.1
Vegetation Established[b,c]	0.50	6.00 to 14.0	14.8 to 25.0
	50	6.00 to 12.0	9.8 to 14.1

a Chen and Cotton (1988)
b IECA (1991, 1992, 1995)
c As reported by the manufacturer
NDG = No data given