



# Coastal Stormwater Supplement to the Georgia Stormwater Management Manual

First Edition  
April 2009



(Source: Georgia Department of Economic Development)



(Source: Center for Watershed Protection)



(Source: Georgia Department of Economic Development)

# Coastal Stormwater Supplement to the Georgia Stormwater Management Manual

First Edition  
April 2009

Prepared By:  
Center for Watershed Protection  
8390 Main Street, 2<sup>nd</sup> Floor  
Ellicott City, MD 21043

The development of this Coastal Stormwater Supplement was facilitated by the Chatham County-Savannah Metropolitan Planning Commission. It was funded as a cooperative effort between the Chatham County-Savannah Metropolitan Planning Commission, the Georgia Department of Natural Resources Environmental Protection Division and, through stakeholder outreach and involvement, the cities and counties of coastal Georgia.

This project was financed, in part, through a grant from the U.S. Environmental Protection Agency under the Provisions of Section 319(h) of the Federal Water Pollution Control Act, as amended. This project was also financed, in part, by the Coastal Management and Coastal Nonpoint Source Management Programs of the Georgia Department of Natural Resources and the U.S. Department of Commerce National Oceanic and Atmospheric Administration.

This document was prepared under grant award #NA06NOS4190253 from the Office of Ocean and Coastal Resource Management in the National Oceanic and Atmospheric Administration. The statements, findings, conclusions and recommendations are those of the author(s) and do not necessarily reflect the views of OCRM or NOAA.



THIS PAGE INTENTIONALLY LEFT BLANK

# Foreword

## Preface

Prior to the 1980s, stormwater management was synonymous with flood control. Post-construction stormwater management systems consisted primarily of pipes designed to convey stormwater runoff directly to rivers, streams and other aquatic resources. Flood control basins were occasionally installed to reduce peak discharge rates and alleviate localized and downstream flooding, but little thought was given to stormwater quality. Although this stormwater management approach worked well to reduce flooding and protect public safety, it did not address the wider range of negative impacts that land development can have on the health of rivers, streams and other aquatic resources.

During the 1980s, communities began to realize that, in order to better protect aquatic resources from the negative impacts of the land development process, both stormwater quantity *and* stormwater quality had to be addressed. With the introduction of Phase I of the National Pollutant Discharge Elimination System (NPDES) Stormwater Program in 1990, and Phase II of the NPDES Stormwater Program in 1999, communities began to revise and expand their local stormwater management programs. The programs that these communities developed focused on *managing* stormwater quantity and quality and tended to rely heavily on traditional stormwater management practices, such as wet and dry ponds, to *mitigate*, rather than *prevent*, the negative impacts of the land development process.

Since then, a number of communities around the country have concluded that “an ounce of prevention is worth a pound of cure.” They have been working to shift the focus away from the *mitigation* of the negative impacts of the land development process and place it on their *prevention*, by creating post-construction stormwater management programs that successfully integrate stormwater management and natural resource protection with the site planning and design process. These communities are increasingly using their stormwater management programs to protect and/or restore valuable natural resources, create attractive public and private spaces and engage residents and businesses in environmental stewardship.

Picking up on this national trend, this Coastal Stormwater Supplement (CSS) to the Georgia Stormwater Management Manual (GSMM) provides information that can be used to shift the focus of coastal Georgia’s post-construction stormwater management efforts onto the *prevention*, rather than the *mitigation*, of the negative impacts of the land development process. It provides Georgia’s coastal communities with comprehensive guidance on an integrated, *green infrastructure*-based approach to natural resource protection, stormwater management and site design that can be used to better protect coastal Georgia’s unique and vital natural resources from the negative impacts of land development and nonpoint source pollution.

## Acknowledgements

The development of this CSS was facilitated by the Chatham County-Savannah Metropolitan Planning Commission. It represents the culmination of a cooperative, collaborative effort between the Chatham County-Savannah Metropolitan Planning Commission, the Georgia Department of Natural Resources Environmental Protection Division and, through stakeholder outreach and involvement, the cities and counties of coastal Georgia, including:

---

Appling County	Long County
Atkinson County	McIntosh County
Bacon County	Pierce County
Bryan County	Tattnall County
Brantley County	Toombs County
Bulloch County	Ware County
Camden County	Wayne County
Candler County	City of Savannah
Charlton County	City of Garden City
Chatham County	City of Richmond Hill
Clinch County	City of Hinesville
Coffee County	City of Jesup
Effingham County	City of Brunswick
Evans County	City of Darien
Glynn County	City of Kingsland
Jeff Davis County	City of St. Mary's
Liberty County	

This project was financed, in part, through a grant from the U.S. Environmental Protection Agency under the Provisions of Section 319(h) of the Federal Water Pollution Control Act, as amended. This project was also financed, in part, by the Coastal Management and Coastal Nonpoint Source Management Programs of the Georgia Department of Natural Resources and the U.S. Department of Commerce National Oceanic and Atmospheric Administration.

Individuals contributing to the development of this CSS included:

- Michael Novotney (Center for Watershed Protection), Project Manager and Lead Author
- Kelly Collins and Greg Hoffman (Center for Watershed Protection)

Tim Carter and the University of Georgia River Basin Center deserve special recognition for their contribution to the development of this CSS. They provided assistance with the creation of the stormwater utility handbook and model post-construction stormwater management ordinance that accompany this document.

A special thank you is also extended to the following individuals, whose thoughtful comments and insights on this document greatly improved its organization and utility:

- Jeannie Lewis Rhodes (Georgia Department of Natural Resources)
- Jackie Jackson Teel (Chatham County-Savannah Metropolitan Planning Commission)
- Bill Hodgins (City of Savannah)
- Dan Hitchcock (Clemson University)
- Dave Briglio (MACTEC Engineering and Consulting, Inc.)
- Dave Hirschman (Center for Watershed Protection)
- Keren Giovengo (University of Georgia Marine Extension Service)
- Jon Ambrose (Georgia Department of Natural Resources)
- Michelle Vincent (Georgia Department of Natural Resources)
- Angela Westin (Georgia Department of Natural Resources)

Thanks are also due to everyone who took the time and effort to provide comments and suggestions on earlier drafts of this CSS, including all of the stakeholders who met several times over the course of eighteen months to review the progress of the CSS and provide invaluable feedback to the development team:

---

Brannyn Allen	Christa Frangiamore	Brannen Parcel
Jill Andrews	Jim Freeman	Billy Joe Parker
Sarah Barmeyer	Sarah Gaines Barmeyer	Randy Payne
Laura Barrett	Dan Gay	George Peters
Jan Bass	Jim Gilbert	Nate Pierce
Gregg Bayard	Gene Giovanco	Bill Piper
Travis Bazemore	Denise Grabowski	Raymond Pittman
Amy Bell	Suzie Grams	Luke Potts
Brett Bennett	Randall Griffin	Adam Ragsdale
Will Berson	Nicole Grissett	Chris Rains
Aaron Bivins	Warren Hankinson	Butch Register
Joe Bolt	Tom Havens	Courtney Reich
Scott Brazell	Dan Hawthorne	Tricia Reynolds
Carey Brown	Rachael Hodge	Ray Richard
Donald Brown	Katie Hoover Alvarado	Gordon Rogers
Jim Bruner	Nate Hunt	Marcus Rubenstein
Travis Burke	Dennis Hutton	Bill Sapp
Jason Butler	Loretta Hylton	Polly Sattler
John Butts	Larry Jones	Matt Saxon
Steve Byrd	Phillip Jones	Bill Shanahan
Dale Caldwell	Bob Joyner	Pete Shonka
Chris Carroll	Jeff King	Lonny Shook
John Carswell	Jeff Kirkland	Bill Shuman
Tom Cetti	Todd Kline	Gary Shuman
C.J. Chance	Jennifer Kline	Paul Simonton
Kathy Chapman	Bob Klink	Luther Smart
Rick Charnock	David Kyler	Dick Smith
Conn Cole	Christine Laporte	Kelly Spratt
Sam Collier	Wayne Lee	Stuart Stevens
James Collins	Sarah Lewis	Kirk Tatum
Teresa Concannon	Jennifer Little	Jennifer Taylor
Lynette Cook	Sarah Lumpkin	Bob Thomson
Luther Cosner	Robert Mack	Tom Thomson
Christopher Cox	Ryan Madson	Susan Todd
Darrell Crosby	Tayna Mandel	Bill Uhl
Downer Davis	Robert Marr	Suzanne Van Parreren
Mike Davis	Dan McFee	Alice Vick
John Day	Christine McKay	Sam Vick
Mike DeMell	Neil McKenzie	Julie Walden
Deatre Denion	Charles McMillian	Laura Walker
Travis Douce	Tara Merrill	Andy Weber
Dale Dudley	Alec Metzger	Diana Wedincamp
Sanford Elton	Nick Millionis	Ann Welch
Sonny Emmert	Warren Milliken	Gil Wertz
Rowland Eskridge	Russell Moncrief	Joseph White
Charles Ezelle	Kelie Moore	Megan Williams
John Farmer	Ebrahim Nadji	Michael Willouby
Jian Fei	David Nash	Joe Wilson
Ron Feldner	Mark Nelson	Steve Wohlfeil
Dan Fischer	Nick Ogden	Paul Wolff
Janice Flory	Ray O'Neill	Jim Wright
Bill Foster Jr.	Kelly O'Rourke	John Wynne

Finally, a special thank you is extended to the many communities, agencies and individuals who worked so hard to create and publish the GSMM back in 2001. Those of you that are familiar with the GSMM will quickly realize that this CSS builds on the valuable information that is presented within that document. Without the GSMM, this CSS would have required much more time, money and effort to create.

This document was prepared under grant award #NA06NOS4190253 from the Office of Ocean and Coastal Resource Management in the National Oceanic and Atmospheric Administration. The statements, findings, conclusions and recommendations are those of the author(s) and do not necessarily reflect the views of OCRM or NOAA.

# Table of Contents

Title Page.....	i
Foreword .....	iii
Table of Contents .....	vii
List of Tables.....	xiii
List of Figures.....	xvii
List of Text Boxes.....	xxi
<b>1.0 Introduction.....</b>	<b>1-1</b>
1.1 Background .....	1-1
1.2 Applicability of the Supplement .....	1-2
1.3 Purpose the Supplement.....	1-3
1.4 Organization of the Supplement .....	1-4
1.5 Regulatory Status of the Supplement.....	1-5
1.6 Relationship of the Supplement to the Georgia Stormwater Management Manual .....	1-5
1.7 How to Get Copies of the Supplement.....	1-6
1.8 How to Find the Supplement on the Internet .....	1-7
1.9 Contact Information.....	1-7
References.....	1-8
<b>2.0 Coastal Natural Resources .....</b>	<b>2-1</b>
2.1 Overview .....	2-1
2.2 Aquatic Resources.....	2-1
2.2.1 Freshwater Resources.....	2-1
2.2.1.1 Rivers and Streams.....	2-1
2.2.1.2 Freshwater Wetlands .....	2-2
2.2.2 Estuarine Resources.....	2-4
2.2.2.1 Tidal Rivers.....	2-4
2.2.2.2 Sounds .....	2-4
2.2.2.3 Tidal Creeks.....	2-5
2.2.2.4 Coastal Marshlands .....	2-5
2.2.2.5 Tidal Flats .....	2-6
2.2.2.6 Scrub-Shrub Wetlands .....	2-7
2.2.3 Marine Resources .....	2-7
2.2.3.1 Near Coastal Waters .....	2-7
2.2.3.2 Beaches .....	2-7
2.2.4 Groundwater Resources .....	2-8
2.2.4.1 Groundwater Aquifers.....	2-8
2.3 Terrestrial Resources.....	2-8
2.3.1 Dunes .....	2-9
2.3.2 Maritime Forests .....	2-9
2.3.3 Marsh Hammocks .....	2-10
2.3.4 Evergreen Hammocks.....	2-10
2.3.5 Canebreaks.....	2-10
2.3.6 Bottomland Hardwood Forests .....	2-11
2.3.7 Beech-Magnolia Forests .....	2-11
2.3.8 Pine Flatwoods.....	2-11
2.3.9 Longleaf Pine-Wiregrass Savannas.....	2-12



2.3.10 Longleaf Pine-Scrub Oak Woodlands.....	2-13
2.4 Other Resources.....	2-13
2.4.1 Shellfish Harvesting Areas .....	2-13
2.4.2 Aquatic Buffers.....	2-13
2.4.3 Floodplains.....	2-14
2.5 Summary .....	2-14
References.....	2-15
<b>3.0 The Need for Natural Resource Protection and Stormwater Management.....</b>	<b>3-1</b>
3.1 Overview.....	3-1
3.2 Direct Impacts of Land Development.....	3-2
3.3 Indirect Impacts of Land Development.....	3-2
3.3.1 Effects of Land Development on Stormwater Runoff .....	3-3
3.3.2 Effects of Land Development on Aquatic Resources.....	3-6
3.3.2.1 Effects of Land Development on Freshwater Resources .....	3-6
3.3.2.2 Effects of Land Development on Estuarine Resources.....	3-10
3.3.2.3 Effects of Land Development on Marine Resources .....	3-11
3.3.2.4 Effects of Land Development on Groundwater Resources .....	3-12
3.4 Addressing the Impacts with Natural Resource Protection and Stormwater Management.....	3-13
References.....	3-14
<b>4.0 Stormwater Management and Site Planning and Design Criteria .....</b>	<b>4-1</b>
4.1 Overview .....	4-1
4.2 Applicability and Exemptions.....	4-1
4.2.1 Applicability.....	4-1
4.2.2 Exemptions .....	4-2
4.3 Site Planning and Design Criteria.....	4-2
4.3.1 SP&D Criteria #1: Natural Resources Inventory.....	4-3
4.3.2 SP&D Criteria #2: Use of Green Infrastructure Practices.....	4-4
4.3.3 SP&D Criteria #3: Stormwater Management Concept Plan.....	4-8
4.3.4 SP&D Criteria #4: Stormwater Management Design Plan.....	4-9
4.3.5 SP&D Criteria #5: Downstream Analysis.....	4-11
4.3.6 SP&D Criteria #6: Stormwater Management System Inspection and Maintenance Plan.....	4-11
4.3.7 SP&D Criteria #7: Erosion and Sediment Control Plan .....	4-12
4.3.8 SP&D Criteria #8: Landscaping Plan .....	4-12
4.3.9 SP&D Criteria #9: Stormwater Pollution Prevention Plan.....	4-12
4.4 Post-Construction Stormwater Management Criteria.....	4-13
4.4.1 SWM Criteria #1: Stormwater Runoff Reduction .....	4-14
4.4.2 SWM Criteria #2: Stormwater Quality Protection.....	4-16
4.4.3 SWM Criteria #3: Aquatic Resource Protection.....	4-17
4.4.4 SWM Criteria #4: Overbank Flood Protection .....	4-19
4.4.5 SWM Criteria #5: Extreme Flood Protection .....	4-20
4.5 Special Stormwater Management and Site Planning and Design Criteria .....	4-20
4.5.1 Special Criteria for Shellfish Harvesting Areas .....	4-20
4.5.1.1 Special Criteria #1: Increased Stormwater Runoff Reduction .....	4-20
4.5.1.2 Special Criteria #2: Enhanced Aquatic Resource Protection.....	4-21
4.6 Summary .....	4-21
References.....	4-24

<b>5.0</b>	<b>Calculating the Stormwater Runoff Volumes Associated with the Stormwater Management Criteria .....</b>	<b>5-1</b>
5.1	Overview .....	5-1
5.2	Calculating the Stormwater Runoff Volume Associated with the Stormwater Runoff Reduction Criteria (SWM Criteria #1) .....	5-1
5.3	Calculating the Stormwater Runoff Volume Associated with the Water Quality Protection Criteria (SWM Criteria #2) .....	5-3
5.4	Calculating the Stormwater Runoff Volume Associated with the Aquatic Resource Protection Criteria (SWM Criteria #3) .....	5-4
5.4.1	Step 1: Determine the Amount of Rainfall Generated by the 1-Year, 24-Hour Storm Event.....	5-4
5.4.2	Step 2: Determine the Runoff Curve Number for the Development Site Under Post-Development Conditions .....	5-4
5.4.2.1	Runoff Curve Numbers .....	5-7
5.4.3	Step 3: Compute the Stormwater Runoff Volume Generated by the 1-Year, 24-Hour Storm Event Under Post-Development Conditions.....	5-11
5.4.4	Step 4: Determine the Initial Abstraction and Initial Abstraction Ratio Under Post-Development Conditions .....	5-11
5.4.5	Step 5: Determine the Time of Concentration for the Development Site Under Post-Development Conditions .....	5-12
5.4.6	Step 6: Compute the Uncontrolled Peak Discharge Under Post-Development Conditions .....	5-16
5.4.7	Step 7: Determine the Ratio of the Controlled Peak Discharge to the Uncontrolled Peak Discharge .....	5-21
5.4.8	Step 8: Calculate the Ratio of the Required Storage Volume to the Stormwater Runoff Volume .....	5-23
5.4.9	Step 9: Determine the Required Storage Volume .....	5-25
5.5	Calculating the Stormwater Runoff Volume Associated with the Overbank Flood Protection Criteria (SWM Criteria #4) .....	5-25
5.6	Calculating the Stormwater Runoff Volume Associated with the Extreme Flood Protection Criteria (SWM Criteria #5) .....	5-27
	References.....	5-30
<b>6.0</b>	<b>Satisfying the Stormwater Management and Site Planning and Design Criteria .....</b>	<b>6-1</b>
6.1	Overview .....	6-1
6.2	Site Planning and Design Process .....	6-2
6.3	Integrating Natural Resource Protection and Stormwater Management with the Site Planning and Design Process .....	6-4
6.3.1	Step 1: Pre-Application Meeting .....	6-7
6.3.2	Step 2: Review of Local, State and Federal Stormwater Management and Site Planning and Design Requirements .....	6-7
6.3.3	Step 3: Natural Resources Inventory.....	6-8
6.3.4	Step 4: Prepare Stormwater Management Concept Plan .....	6-10
6.3.4.1	Step 4.1: Use Better Site Planning Techniques .....	6-12
6.3.4.2	Step 4.2: Use Better Site Design Techniques .....	6-15
6.3.4.3	Step 4.3: Calculate Stormwater Management Criteria .....	6-18
6.3.4.4	Step 4.4: Apply Low Impact Development Practices .....	6-19
6.3.4.5	Step 4.5: Check to See If Stormwater Management Criteria Have Been Met.....	6-27
6.3.4.6	Step 4.6: Apply Stormwater Management Practices.....	6-27

5.3.4.7	Step 4.7: Check to See If Stormwater Management Criteria Have Been Met.....	6-37
5.3.4.8	Step 4.8: Finalize Stormwater Management Concept Plan .....	6-37
6.3.5	Step 5: Consultation Meeting.....	6-37
6.3.6	Step 6: Prepare Stormwater Management Design Plan .....	6-38
6.3.7	Beyond the Stormwater Management Design Plan .....	6-39
6.4	Meeting the Stormwater Management and Site Planning and Design Criteria on Local Road, Highway and Bridge Development Projects.....	6-39
6.4.1	Local Highway Development Projects .....	6-41
6.4.2	Local Bridge Development Projects.....	6-42
6.4.3	Local Street and Roadway Development Projects.....	6-42
6.4.4	Local Back (Dirt and Gravel) Road Development Projects .....	6-42
	References.....	6-44
<b>7.0</b>	<b>Green Infrastructure Practices.....</b>	<b>7-1</b>
7.1	Overview .....	7-1
7.2	Recommended Green Infrastructure Practices.....	7-2
7.3	Other Green Infrastructure Practices .....	7-4
7.3.1	New and Innovative Green Infrastructure Practices .....	7-4
7.4	Applying Green Infrastructure Practices During the Site Planning & Design Process.....	7-4
7.4.1	Step 4.1: Use Better Site Planning Techniques.....	7-4
7.4.2	Step 4.2: Use Better Site Design Techniques .....	7-6
7.4.3	Step 4.3: Calculate Stormwater Management Criteria .....	7-7
7.4.4	Step 4.4: Apply Low Impact Development Practices .....	7-7
7.4.5	Step 4.5: Check to See If Stormwater Management Criteria Have Been Met .....	7-8
7.5	Green Infrastructure Practice Selection.....	7-8
7.5.1	Step 1: Evaluate Ability to Help Satisfy the Stormwater Mangement Criteria .....	7-9
7.5.2	Step 2: Evaluate Overall Feasibility .....	7-16
7.5.3	Step 3: Evaluate Site Applicability .....	7-20
7.6	Better Site Planning Technique Profile Sheets.....	7-23
7.6.1	Protect Primary Conservation Areas .....	7-25
7.6.2	Protect Secondary Conservation Areas .....	7-29
7.7	Better Site Design Technique Profile Sheets .....	7-33
7.7.1	Reduce Clearing and Grading Limits .....	7-35
7.7.2	Reduce Roadway Lengths and Widths .....	7-39
7.7.3	Use Fewer or Alternative Cul-de-Sacs.....	7-43
7.7.4	Reduce Parking Lot Footprints .....	7-47
7.7.5	Create Landscaping Areas in Parking Lots .....	7-51
7.7.6	Reduce Driveway Lengths and Widths.....	7-53
7.7.7	Reduce Sidewalk Lengths and Widths.....	7-55
7.7.8	Reduce Building Footprints.....	7-57
7.7.9	Reduce Setbacks and Frontages.....	7-59
7.8	Low Impact Development Practice Profile Sheets .....	7-63
7.8.1	Soil Restoration .....	7-65
7.8.2	Site Reforestation/Revegetation .....	7-71
7.8.3	Green Roofs.....	7-77
7.8.4	Permeable Pavements .....	7-85
7.8.5	Undisturbed Pervious Areas.....	7-95
7.8.6	Vegetated Filter Strips .....	7-101
7.8.7	Grass Channels .....	7-109
7.8.8	Simple Downspout Disconnection.....	7-117

7.8.9	Rain Gardens .....	7-125
7.8.10	Stormwater Planters.....	7-135
7.8.11	Dry Wells.....	7-143
7.8.12	Rainwater Harvesting .....	7-151
7.8.13	Bioretention Areas .....	7-157
7.8.14	Infiltration Practices .....	7-163
7.8.15	Dry Swales.....	7-169
	References.....	7-175

## **8.0 Stormwater Management Practices.....8-1**

8.1	Overview .....	8-1
8.2	Recommended Stormwater Management Practices .....	8-2
8.2.1	General Application Practices .....	8-2
8.2.2	Limited Application Practices .....	8-4
8.3	Other Stormwater Management Practices.....	8-5
8.3.1	Not Recommended Stormwater Management Practices .....	8-5
8.3.2	New and Innovative Stormwater Management Practices.....	8-5
8.4	Applying Stormwater Management Practices During the Site Planning & Design Process.....	8-5
8.4.1	Step 4.6: Apply Stormwater Management Practices .....	8-5
8.4.2	Step 4.7: Check Post-Construction Stormwater Management Criteria .....	8-7
8.5	Stormwater Management Practice Selection .....	8-8
8.5.1	Step 1: Evaluate Ability to Help Satisfy the Stormwater Management Criteria .....	8-8
8.5.2	Step 2: Evaluate Overall Feasibility .....	8-14
8.5.3	Step 3: Evaluate Site Applicability .....	8-17
8.6	General Application Stormwater Management Practice Profile Sheets.....	8-19
8.6.1	Stormwater Ponds.....	8-21
8.6.2	Stormwater Wetlands.....	8-35
8.6.3	Bioretention Areas .....	8-47
8.6.4	Filtration Practices.....	8-59
8.6.5	Infiltration Practices .....	8-69
8.6.6	Swales .....	8-83
8.7	Limited Application Stormwater Management Practice Profile Sheets .....	8-93
	References.....	8-95

## **9.0 Local Post-Construction Stormwater Management Programs .....9-1**

9.1	Overview .....	9-1
9.2	Developing an Effective Local Post-Construction Stormwater Management Program.....	9-1
9.3	Step 1: Program Planning.....	9-4
9.3.1	Step 1.1: Assess Community and Its Watersheds .....	9-4
9.3.2	Step 1.2: Assess Existing Stormwater Management Program.....	9-5
9.3.3	Step 1.3: Develop Program Goals and Objectives .....	9-6
9.3.4	Step 1.4: Develop Implementation Plan and Preliminary Budget .....	9-7
9.4	Step 2: Develop a Stormwater Management Approach.....	9-10
9.4.1	Step 2.1: Develop an Approach to Address Stormwater Management at the Site Scale .....	9-10
9.4.2	Step 2.2: Develop Supporting Stormwater Management and Site Planning & Design Criteria .....	9-10

9.4.3	Step 2.3: Develop an Approach to Address Stormwater Management at the Watershed Scale .....	9-11
9.5	Step 3: Develop Post-Construction Stormwater Management Ordinance.....	9-13
9.6	Step 4: Develop Stormwater Guidance Manual .....	9-13
9.7	Step 5: Develop a Plan Review and Approval Process.....	9-14
9.7.1	Step 5.1: Scope Out Plan Review and Approval Process.....	9-15
9.7.2	Step 5.2: Create Permit Applications, Instructions and Checklists .....	9-15
9.7.3	Step 5.3: Forecast Staff Needs and Acquire Plan Review Staff .....	9-16
9.7.4	Step 5.4: Provide Training for Plan Reviewers and Site Designers .....	9-16
9.7.5	Step 5.5: Set Up Performance Bond Process, Forms and Tracking System.....	9-16
9.8	Step 6: Develop Construction Inspection Program .....	9-17
9.8.1	Step 6.1: Scope Out the Inspection Process .....	9-17
9.8.2	Step 6.2: Create Checklists and As-Built Certification Forms.....	9-18
9.8.3	Step 6.3: Forecast Staff Needs and Acquire Inspection Staff .....	9-18
9.8.4	Step 6.4: Provide Training for Inspectors and Contractors.....	9-19
9.9	Step 7: Develop Inspection and Maintenance Program.....	9-19
9.9.1	Step 7.1: Scoping the Inspection and Maintenance Program .....	9-20
9.9.2	Step 7.2: Create Checklists, Inspection Forms and Enforcement Tools .....	9-20
9.9.3	Step 7.3: Forecast Staff Needs and Acquire Inspection Staff .....	9-21
9.9.4	Step 7.4: Create and Disseminate Outreach Materials for Responsible Parties.....	9-21
9.10	Step 8: Develop Program Tracking and Evaluation System .....	9-21
9.10.1	Step 8.1: Develop a Framework for Program Tracking and Evaluation.....	9-22
9.10.2	Step 8.2: Develop Program Tracking and Evaluation Protocols .....	9-23
9.10.3	Step 8.3: Write Annual Reports.....	9-23
9.11	Summary .....	9-24
	References.....	9-25
	<b>Glossary .....</b>	<b>10-1</b>
	<b>Appendix A High Priority Plant and Animal Species and Habitat Areas .....</b>	<b>A-1</b>
	<b>Appendix B Coastal Georgia Rainfall Analysis .....</b>	<b>B-1</b>
	<b>Appendix C Coastal Stormwater Management Practice Monitoring Protocol.....</b>	<b>C-1</b>
	<b>Appendix D Model Post-Construction Stormwater Management Ordinance .....</b>	<b>D-1</b>

# List of Tables

## 3.0 The Need for Natural Resource Protection and Stormwater Management

3.1	Projected Population Growth in the 10-County Population Study Area .....	3-1
-----	--	-----

## 4.0 Stormwater Management and Site Planning and Design Criteria

4.1	Summary of the Site Planning and Design Criteria .....	4-2
4.2	Resources to be Identified and Mapped During the Natural Resources Inventory .....	4-4
4.3	Primary Conservation Areas .....	4-7
4.4	Secondary Conservation Areas .....	4-8
4.5	Summary of the Post-Construction Stormwater Management Criteria .....	4-13
4.6	Allowable Uses Associated with the Multi-Zone Aquatic Buffer System.....	4-19
4.7	How the Criteria Help Address the Negative Impacts of the Land Development Process.....	4-23

## 5.0 Calculating the Stormwater Runoff Volumes Associated with the Stormwater Management Criteria

5.1	Classifying Hydrologic Soil Groups According to Soil Texture .....	5-5
5.2	Antecedent Moisture Conditions and Seasonal Rainfall Limits .....	5-7
5.3	Runoff Curve Numbers for Urban Lands.....	5-8
5.4	Runoff Curve Numbers for Cultivated Agricultural Lands.....	5-9
5.5	Runoff Curve Numbers for Other Agricultural Lands .....	5-10
5.6	Initial Abstraction Values for Runoff Curve Numbers.....	5-11
5.7	Manning's Roughness Coefficients for Sheet Flow .....	5-13
5.8	Adjustment Factor ( $F_p$ ) for Pond and Swamp Areas That Are Spread Across a Development Site.....	5-17
5.9	Calculating the Stormwater Runoff Volume Associated with the Overbank Flood Protection Criteria .....	5-26
5.10	Calculating the Stormwater Runoff Volume Associated with the Extreme Flood Protection Criteria .....	5-28

## 6.0 Satisfying the Stormwater Management and Site Planning and Design Criteria

6.1	How Better Site Planning Techniques Can Be Used To Help Satisfy the Stormwater Management Criteria.....	6-14
6.2	How Better Site Design Techniques Can Be Used to Help Satisfy the Stormwater Management Criteria.....	6-17
6.3	Ability of Low Impact Development and Stormwater Management Practices to Reduce Annual Stormwater Runoff Volumes and Pollutant Loads.....	6-21
6.4	How Low Impact Development Practices Can Be Used to Help Satisfy the Stormwater Management Criteria .....	6-22
6.5	How Stormwater Management Practices Can Be Used to Help Satisfy the Stormwater Management Criteria .....	6-33

## 7.0 Green Infrastructure Practices

7.1	How Green Infrastructure Practices Can Be Used to Help Satisfy the Stormwater Management Criteria.....	7-10
7.2	Factors to Consider When Evaluating the Overall Feasibility of Green Infrastructure Practices.....	7-17
7.3	Factors to Consider When Evaluating the Applicability of Green Infrastructure Practices on a Development Site .....	7-21
7.4	Impervious Cover Created by Various Turnaround Options .....	7-44
7.5	Conventional Minimum Parking Ratios.....	7-48
7.6	Factors to Consider When Evaluating the Overall Feasibility of Using Soil Restoration on a Development Site.....	7-67
7.7	Routine Maintenance Activities Typically Associated with Soil Restoration .....	7-69
7.8	Factors to Consider When Evaluating the Overall Feasibility of Using Site Reforestation/Revegetation on a Development Site.....	7-73
7.9	Routine Maintenance Activities Typically Associated with Site Reforestation/Revegetation.....	7-75
7.10	Factors to Consider When Evaluating the Overall Feasibility of Using a Green Roof on a Development Site .....	7-80
7.11	Routine Maintenance Activities Typically Associated with Green Roofs.....	7-82
7.12	Factors to Consider When Evaluating the Overall Feasibility of Using a Permeable Pavement System on a Development Site.....	7-89
7.13	Challenges Associated with Using Permeable Pavement Systems in Coastal Georgia .....	7-90
7.14	Routine Maintenance Activities Typically Associated with Permeable Pavement Systems.....	7-93
7.15	Factors to Consider When Evaluating the Overall Feasibility of Using Undisturbed Pervious Areas to “Receive” Stormwater Runoff on a Development Site .....	7-97
7.16	Routine Maintenance Activities Typically Associated with Undisturbed Pervious Areas Used to “Receive” Stormwater Runoff .....	7-100
7.17	Factors to Consider When Evaluating the Overall Feasibility of Using a Vegetated Filter Strip on a Development Site .....	7-104
7.18	Challenges Associated with Using Vegetated Filter Strips in Coastal Georgia.....	7-105
7.19	Routine Maintenance Activities Typically Associated with Vegetated Filter Strips .....	7-108
7.20	Factors to Consider When Evaluating the Overall Feasibility of Using a Grass Channel on a Development Site .....	7-112
7.21	Challenges Associated with Using Grass Channels in Coastal Georgia.....	7-113
7.22	Routine Maintenance Activities Typically Associated with Grass Channels .....	7-116
7.23	Factors to Consider When Evaluating the Overall Feasibility of Using a Simple Downspout Disconnection on a Development Site .....	7-120
7.24	Challenges Associated with Using Simple Downspout Disconnections in Coastal Georgia .....	7-120
7.25	Routine Maintenance Activities Typically Associated with Simple Downspout Disconnections .....	7-123
7.26	Factors to Consider When Evaluating the Overall Feasibility of Using a Rain Garden on a Development Site.....	7-127
7.27	Challenges Associated with Using Rain Gardens in Coastal Georgia .....	7-128
7.28	Routine Maintenance Activities Typically Associated with Rain Gardens.....	7-132
7.29	Factors to Consider When Evaluating the Overall Feasibility of Using a Stormwater Planter on a Development Site .....	7-138
7.30	Challenges Associated with Using Stormwater Planters in Coastal Georgia .....	7-138
7.31	Routine Maintenance Activities Typically Associated with Stormwater Planters.....	7-142

7.32	Factors to Consider When Evaluating the Overall Feasibility of Using a Dry Well on a Development Site .....	7-145
7.33	Challenges Associated with Using Dry Wells in Coastal Georgia .....	7-146
7.34	Routine Maintenance Activities Typically Associated with Dry Wells .....	7-150
7.35	Factors to Consider When Evaluating the Overall Feasibility of Using a Rainwater Harvesting System on a Development Site.....	7-153
7.36	Routine Maintenance Activities Typically Associated with Rainwater Harvesting Systems .....	7-156
7.37	Factors to Consider When Evaluating the Overall Feasibility of Using a Bioretention Area on a Development Site.....	7-159
7.38	Challenges Associated with Using Bioretention Areas in Coastal Georgia .....	7-160
7.39	Factors to Consider When Evaluating the Overall Feasibility of Using an Infiltration Practice on a Development Site.....	7-166
7.40	Challenges Associated with Using Infiltration Practices in Coastal Georgia.....	7-167
7.41	Factors to Consider When Evaluating the Overall Feasibility of Using a Dry Swale on a Development Site .....	7-171
7.42	Challenges Associated with Using Dry Swales in Coastal Georgia .....	7-171

## **8.0 Stormwater Management Practices**

8.1	How Stormwater Management Practices Can Be Used to Help Satisfy the Stormwater Management Criteria .....	8-10
8.2	Factors to Consider When Evaluating the Overall Feasibility of Stormwater Management Practices.....	8-15
8.3	Factors to Consider When Evaluating the Applicability of Stormwater Management Practices on a Development Site .....	8-18
8.4	Factors to Consider When Evaluating the Overall Feasibility of Using a Stormwater Pond on a Development Site .....	8-28
8.5	Challenges Associated with Using Stormwater Ponds in Coastal Georgia .....	8-29
8.6	Routine Maintenance Activities Typically Associated with Stormwater Ponds.....	8-32
8.7	Factors to Consider When Evaluating the Overall Feasibility of Using a Stormwater Wetland on a Development Site .....	8-42
8.8	Challenges Associated with Using Stormwater Wetlands in Coastal Georgia .....	8-43
8.9	Routine Maintenance Activities Typically Associated with Stormwater Wetlands.....	8-45
8.10	Factors to Consider When Evaluating the Overall Feasibility of Using a Bioretention Area on a Development Site.....	8-50
8.11	Challenges Associated with Using Bioretention Areas in Coastal Georgia .....	8-51
8.12	Routine Maintenance Activities Typically Associated with Bioretention Areas .....	8-56
8.13	Factors to Consider When Evaluating the Overall Feasibility of Using a Filtration Practice on a Development Site.....	8-64
8.14	Challenges Associated with Using Filtration Practices in Coastal Georgia .....	8-64
8.15	Routine Maintenance Activities Typically Associated with Filtration Practices.....	8-66
8.16	Factors to Consider When Evaluating the Overall Feasibility of Using an Infiltration Practice on a Development Site.....	8-73
8.17	Challenges Associated with Using Infiltration Practices in Coastal Georgia .....	8-74
8.18	Routine Maintenance Activities Typically Associated with Infiltration Practices .....	8-80
8.19	Factors to Consider When Evaluating the Overall Feasibility of Using a Swale on a Development Site .....	8-87
8.20	Challenges Associated with Using Swales in Coastal Georgia .....	8-89
8.21	Routine Maintenance Activities Typically Associated with Swales.....	8-91



**9.0 Local Post-Construction Stormwater Management Programs**

9.1 Example Action Items for Local Stormwater Management Programs.....9-8

9.2 Common Inconsistencies Between Existing Development Rules and the Approach to Stormwater Management Presented in this Coastal Stormwater Supplement .....9-13

# List of Figures

## 1.0 Introduction

1.1	Natural Beauty of Coastal Georgia.....	1-1
1.2	Coastal Marshlands are One of Coastal Georgia's Most Valuable Natural Resources .....	1-1
1.3	Georgia's Coastal Nonpoint Source Management Area and Area of Special Interest .....	1-2
1.4	Manual for Erosion and Sediment Control in Georgia .....	1-3
1.5	Cypress Swamps Provide Valuable Habitat for Wood Storks .....	1-5
1.6	Alligators are One of the Many Creatures that Call Coastal Georgia Home.....	1-6

## 2.0 Coastal Natural Resources

2.1	Georgia's Coastal Nonpoint Source Management Area and Area of Special Interest .....	2-1
2.2	Altamaha River.....	2-1
2.3	Freshwater Marsh .....	2-2
2.4	Swamp .....	2-3
2.5	Okefenokee Swamp.....	2-3
2.6	Forested Depressional Wetland .....	2-3
2.7	Shipping on the Savannah River .....	2-4
2.8	Doboy Sound.....	2-5
2.9	Tidal Creek .....	2-5
2.10	Coastal Marshlands .....	2-5
2.11	Georgia's Coastal Marshlands.....	2-6
2.12	Tidal Flat.....	2-6
2.13	Scrub-Shrub Wetland.....	2-7
2.14	Sapelo Island and the Near Coastal Waters of the Atlantic Ocean.....	2-7
2.15	Beach on Jekyll Island .....	2-7
2.16	Floridan Aquifer System .....	2-8
2.17	Dunes on Cumberland Island.....	2-9
2.18	Maritime Forest .....	2-9
2.19	Marsh Hammock.....	2-10
2.20	Canebrake .....	2-10
2.21	Bottomland Hardwood Forest .....	2-11
2.22	Green-Fly Orchid.....	2-11
2.23	Flatwoods Salamander .....	2-12
2.24	Longleaf Pine-Wiregrass Savanna .....	2-12
2.25	Longleaf Pine.....	2-12
2.26	"Open" Shellfish Harvesting Area.....	2-13
2.27	Freshwater Stream and Adjacent Aquatic Buffer .....	2-13
2.28	Tidal Creek and Adjacent Floodplain .....	2-14

## 3.0 The Need for Natural Resource Protection and Stormwater Management

3.1	10-County Population Study Area .....	3-1
3.2	Clear and Level Building Site .....	3-2
3.3	Land Disturbing Activities Alter Site Hydrology .....	3-3
3.4	Changes in Site Hydrology Resulting from the Land Development Process .....	3-3
3.5	Pollutants that Accumulate on Impervious Surfaces are Transported Downstream During Storm Events .....	3-4
3.6	Bankfull Event.....	3-6

3.7	Overbank Flooding Event .....	3-6
3.8	Stream Channel Enlargement and Loss of Riparian Vegetation.....	3-7
3.9	Fish Kill of Atlantic Menhaden .....	3-7
3.10	Increased Ponding in a Freshwater Wetland .....	3-8
3.11	Excessive Sediment Accumulation in a Freshwater Wetland.....	3-8
3.12	Increased Productivity in a Freshwater Wetland .....	3-9
3.13	Trash and Debris Reduce the Aesthetic Value of Freshwater Wetlands.....	3-9
3.14	Increased Salinity Fluctuations Can Negatively Affect the Health of Shrimp and Other Aquatic Organisms .....	3-10
3.15	Algal Bloom.....	3-10
3.16	Shellfish Bed Contamination and Closure.....	3-11
3.17	Beach Contamination.....	3-12
3.18	Known Confined Groundwater Aquifer Recharge Areas .....	3-12
<b>4.0</b>	<b>Stormwater Management and Site Planning and Design Criteria</b>	
4.1	Green Infrastructure: An Interconnected Network of Undisturbed Natural Areas and Open Spaces .....	4-5
4.2	Bay Street Community Center, Savannah, GA.....	4-15
4.3	Multi-Zone Aquatic Buffer System .....	4-18
<b>5.0</b>	<b>Calculating the Stormwater Runoff Volumes Associated with the Stormwater Management Criteria</b>	
5.1	Bay Street Community Center, Savannah, GA.....	5-3
5.2	Average Velocities for Estimating Travel Time for Shallow Concentrated Flow.....	5-15
5.3	Approximate Geographic Boundaries for NRCS (SCS) Rainfall Distributions .....	5-18
5.4	Unit Peak Discharge for NRCS (SCS) Type II Rainfall Distribution .....	5-19
5.5	Unit Peak Discharge for NRCS (SCS) Type III Rainfall Distribution.....	5-20
5.6	Ratio of Uncontrolled Peak Discharge to Controlled Peak Discharge .....	5-22
5.7	Approximate Detention Basin Routing for NRCS (SCS) Type I, IA, III and III Rainfall Distributions .....	5-24
<b>6.0</b>	<b>Satisfying the Stormwater Management and Site Planning and Design Criteria</b>	
6.1	Site Planning and Design Process .....	6-1
6.2	Conventional Site Design.....	6-3
6.3	Conservation Site Design .....	6-3
6.4	New Urbanist Site Design.....	6-4
6.5	Integrating Natural Resource Protection and Stormwater Management with the Site Planning and Design Process .....	6-6
6.6	Conservation (Cluster) Development Versus Conventional Development .....	6-8
6.7	Buildable Area and Primary and Secondary Conservation Areas .....	6-9
6.8	Developing a Stormwater Management Concept Plan.....	6-11
6.9	Delineation of Primary and Secondary Conservation Areas.....	6-13
6.10	Stormwater Management Concept Plan that Incorporates a Variety of Better Site Planning and Design Techniques.....	6-18
6.11	Reforestation of a Disturbed Pervious Area .....	6-19
6.12	Green Roof Used in Place of a Traditional Impervious Rooftop.....	6-20
6.13	Rain Garden Used to "Receive" Stormwater Runoff.....	6-20
6.14	Stormwater Management Concept Plan that Incorporates a Variety of Low Impact Development Practices .....	6-27

6.15	Stormwater Pond .....	6-28
6.16	Stormwater Wetland.....	6-28
6.17	Bioretention Area .....	6-29
6.18	Infiltration Trench .....	6-29
6.19	Wet Swale .....	6-30
6.20	Dry Detention Basin Used to Provide Water Quantity Management .....	6-30
6.21	Stormwater Management Train .....	6-31

## 7.0 Green Infrastructure Practices

7.1	Reforestation of a Disturbed Pervious Area .....	7-3
7.2	Green Roof Used in Place of a Traditional Impervious Rooftop.....	7-3
7.3	Rain Garden Used to “Receive” Stormwater Runoff.....	7-3
7.4	Using Green Infrastructure Practices During the Creation of a Stormwater Management Concept Plan.....	7-5
7.5	Coastal Marshland are Considered to be a Primary Conservation Area .....	7-25
7.6	Primary and Secondary Conservation Areas Identified at the Beginning of the Site Planning and Design Process .....	7-26
7.7	Conservation Area in Midway, GA.....	7-29
7.8	Reduced Clearing and Grading Limits Used on a Development Site .....	7-35
7.9	Reduced Street Width Used on a Residential Development Site .....	7-39
7.10	Potential Design Options for Reduced Roadway Widths .....	7-40
7.11	Cul-de-Sac on a Residential Development Site.....	7-43
7.12	Alternative Cul-de-Sac Designs.....	7-44
7.13	Parking Lot on a Commercial Development Site .....	7-47
7.14	Structured Parking Deck on an Office Park Development Site.....	7-48
7.15	Permeable Pavers Used in a Parking Lot.....	7-49
7.16	Landscaping Island Located Within a Parking Lot .....	7-51
7.17	Shared Driveway on a Residential Development Site.....	7-53
7.18	Residential Development Site with Sidewalks on One Side of the Street .....	7-55
7.19	Reducing Building Footprints Can Help Reduce the Amount of Impervious Cover Created on Development Sites .....	7-57
7.20	Reduced Front Yard Setbacks Results in the Creation of Less Impervious Cover on Development Sites.....	7-59
7.21	Reduced Side Yard Setbacks and Narrower Frontages Used on Residential Development Sites.....	7-60
7.22	Alternative Lot Designs .....	7-60
7.23	Organic Compost .....	7-66
7.24	Active Replanting of Native Trees in a Disturbed Pervious Area.....	7-72
7.25	Components of a Green Roof System .....	7-78
7.26	Intensive Green Roof System .....	7-78
7.27	Extensive Green Roof System .....	7-79
7.28	Components of a Permeable Pavement System .....	7-86
7.29	Various Permeable Pavement Surfaces .....	7-87
7.30	Use of a Level Spreader Upstream of an Undisturbed Pervious Area .....	7-96
7.31	Filter Strip Around the Perimeter of a Parking Lot.....	7-102
7.32	Vegetated Filter Strip .....	7-103
7.33	Grass Channel Along a Local Roadway.....	7-110
7.34	Grass Channel .....	7-111
7.35	Simple Downspout Disconnections to Pervious Areas.....	7-118
7.36	Simple Downspout Disconnection .....	7-119
7.37	Various Rain Gardens .....	7-126

7.38	Various Stormwater Planters .....	7-136
7.39	Stormwater Planters .....	7-137
7.40	Dry Well.....	7-144
7.41	Rainwater Harvesting System .....	7-152
7.42	Major Components of a Rainwater Harvesting System .....	7-152
7.43	Various Bioretention Areas.....	7-158
7.44	Infiltration Trench .....	7-164
7.45	Infiltration Practices.....	7-165

## 8.0 Stormwater Management Practices

8.1	Stormwater Pond .....	8-2
8.2	Stormwater Wetland.....	8-2
8.3	Bioretention Area .....	8-3
8.4	Infiltration Trench .....	8-3
8.5	Wet Swale .....	8-4
8.6	Dry Detention Basin Used to Provide Water Quantity Management .....	8-4
8.7	Using Stormwater Management Practices During the Creation of a Stormwater Management Concept Plan.....	8-6
8.8	Stormwater Management Train .....	8-7
8.9	Various Stormwater Ponds .....	8-23
8.10	Schematic of a Typical Wet Pond .....	8-24
8.11	Schematic of a Typical Wet Extended Detention Pond .....	8-25
8.12	Schematic of a Typical Micropool Extended Detention Pond .....	8-26
8.13	Schematic of a Typical Multiple Pond System .....	8-27
8.14	Various Stormwater Wetlands .....	8-37
8.15	Schematic of a Typical Shallow Wetland .....	8-38
8.16	Schematic of a Typical Shallow Extended Detention Wetland .....	8-39
8.17	Schematic of a Typical Pond/Wetland System.....	8-40
8.18	Schematic of a Typical Pocket Wetland .....	8-41
8.19	Various Bioretention Areas.....	8-48
8.20	Schematic of a Typical Bioretention Area .....	8-49
8.21	Various Filtration Practices .....	8-60
8.22	Schematic of a Typical Surface Sand Filter .....	8-62
8.23	Schematic of a Typical Perimeter Sand Filter .....	8-63
8.24	Infiltration Trench .....	8-70
8.25	Infiltration Practices.....	8-71
8.26	Schematic of a Typical Infiltration Trench.....	8-72
8.27	Various Swales .....	8-84
8.28	Schematic of a Typical Dry Swale .....	8-85
8.29	Schematic of a Typical Wet Swale .....	8-86

## 9.0 Local Post-Construction Stormwater Management Programs

9.1	Post-Construction Stormwater Management Program Process Development Process.....	9-3
-----	--	-----

---

# List of Text Boxes

## **4.0 Stormwater Management and Site Planning and Design Criteria**

- 4.1 Green Infrastructure..... 4-5
- 4.2 Hydrologic Modeling of Pre-Development Conditions Using the Simple Method ..... 4-15
- 4.3 Establishing an Aquatic Buffer ..... 4-18

## **5.0 Calculating the Stormwater Runoff Volumes Associated with the Stormwater Management Criteria**

- 5.1 Calculating the Runoff Reduction Volume ..... 5-3

## **6.0 Satisfying the Stormwater Management and Site Planning and Design Criteria**

- 6.1 Conservation Development ..... 6-8
- 6.2 Example Plan Preparer Certification ..... 6-38
- 6.3 Example Owner/Developer Certification ..... 6-38

THIS PAGE INTENTIONALLY LEFT BLANK

## 1.0 Introduction

### 1.1 Background

Nearly two decades ago, the U.S. Congress recognized that land development and nonpoint source pollution were negatively impacting our nation's coastal waters (US EPA, 1993). These valuable aquatic resources provide habitat, food and shelter for many important aquatic and terrestrial organisms and contribute greatly to the natural beauty, economic well-being and quality of life found in our nation's coastal areas (Figure 1.1).

Members of Congress recognized that a comprehensive effort was needed to control and minimize the negative impacts that land development and nonpoint source pollution were having on these important natural resources. Without one, they believed, these

impacts, which include changes in hydrology, decreased water quality, due to increased levels of sediment, nutrients, metals, hydrocarbons, bacteria and other pollutants, increased water temperatures, reduced dissolved oxygen levels, degradation of habitat and an overall decline in wildlife abundance and diversity (US EPA, 2005), would be felt not only by the aquatic and terrestrial organisms that depend on them for survival, but by the general public as well.

With the passage of Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), the U.S. Congress required states and territories with approved coastal management programs to develop comprehensive coastal nonpoint source pollution management programs. Shortly after Georgia's Coastal Management Program received approval from the National Oceanic and Atmospheric Administration (NOAA) in 1998, the Georgia Department of Natural Resources Environmental Protection Division (GA EPD), in conjunction with the Coastal Resources Division (CRD), began developing the state's Coastal Nonpoint Source (NPS) Management Program.



**Figure 1.2: Coastal Marshlands are One of Coastal Georgia's Most Valuable Natural Resources**

(Source: Jeannie Lewis Rhodes, Georgia Department of Natural Resources)



**Figure 1.1: Natural Beauty of Coastal Georgia**

(Source: Jeannie Lewis Rhodes, Georgia Department of Natural Resources)

In 2002, the State's Coastal NPS Management Program was reviewed by the United States Environmental Protection Agency (US EPA) and NOAA and received conditional approval. In order to receive final approval, the state must provide for the implementation of several additional "management measures," which are intended to help balance land development and economic growth with the protection of coastal Georgia's valuable terrestrial and aquatic resources (Figure 1.2).

This Coastal Stormwater Supplement (CSS) represents the culmination of the state's efforts to provide for the implementation of the federally-established "management measures" related to



new development, watershed protection and site development (US EPA, 1993). Specifically, it provides guidance on using environmentally sensitive better site planning and design techniques, small-scale, low impact development practices and traditional stormwater management techniques (e.g., detention) to:

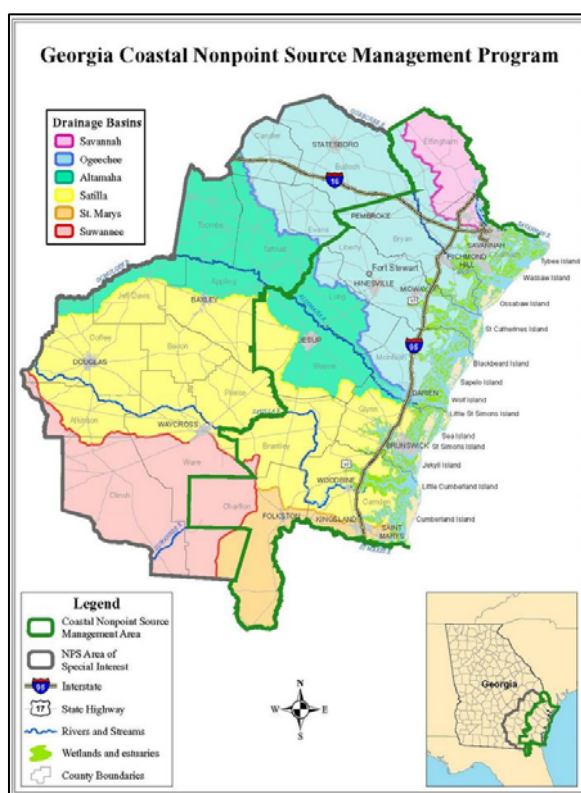
- Reduce the total suspended solids (TSS) loads contained in post-construction stormwater runoff by 80 percent, as measured on an average annual basis
- Maintain pre-development site hydrology
- Preserve areas that are particularly susceptible to erosion and sediment loss
- Preserve areas that provide important stormwater management benefits and/or provide valuable habitat for aquatic and terrestrial organisms
- Protect the integrity of streams, wetlands and other natural drainage features
- Limit land disturbing activities, such as clearing and grading and cutting and filling, to protect existing vegetation and reduce erosion and sediment loss
- Limit increases in site imperviousness

In providing for the implementation of these “management measures,” this CSS lays the foundation for an integrated, *green infrastructure*-based approach to natural resource protection, stormwater management and site design that can be used to protect coastal Georgia’s unique and vital natural resources from the negative impacts of the land development process.

Although the term *green infrastructure* can mean different things to different people, in its broadest and, perhaps, truest sense, the term refers to an interconnected network of undisturbed natural areas and open space that helps preserve the ecological function of our watersheds (Benedict and McMahon, 2006). This interconnected network of aquatic and terrestrial resources supports a wide range of important resident and migratory organisms, provides important stormwater management benefits and contributes greatly to coastal Georgia’s natural beauty, economic well-being and quality of life. Protecting this vital network of aquatic and terrestrial resources, which is the primary goal of this CSS, requires an integrated approach to natural resource protection and stormwater management.

## 1.2 Applicability of the Supplement

This CSS, like the state’s Coastal NPS Management Program, seeks to reduce the impacts of land development and nonpoint source pollution in a 24-county region located in southeast Georgia (Figure 1.3). Like the Georgia Stormwater Management Manual, it provides technical guidance that can be used to meet the post-construction stormwater management requirements of the National Pollution Discharge Elimination System (NPDES) permitting program. It



**Figure 1.3: Georgia’s Coastal Nonpoint Source Management Area and Area of Special Interest**

(Source: Georgia Department of Natural Resources)

also provides technical guidance for permit applicants seeking Coastal Marshlands Protection Act permits (O.C.G.A. §12-5-280 through §12-5-297, as amended).

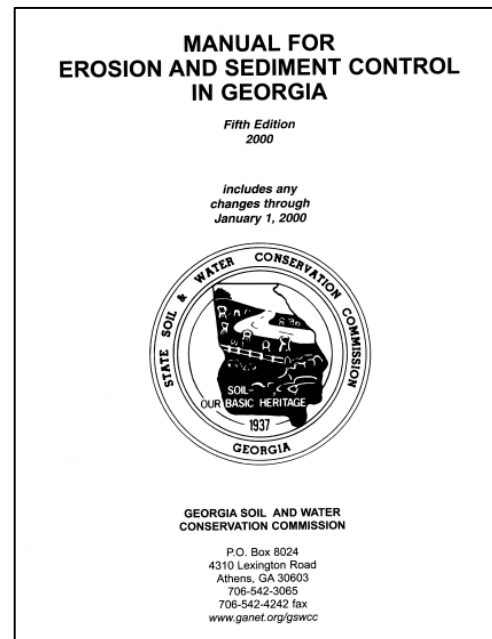
For administrative purposes, the state's Coastal NPS Management Program has divided the 24-county coastal region into two distinct areas:

- Coastal Nonpoint Source Management Area: Georgia's Coastal Nonpoint Source Management Area is comprised of the first two tiers of counties that border the Atlantic Ocean. This 11-county area is also known as the *Coastal Management Program Service Area* and is synonymous with the area regulated by the *Georgia Coastal Management Act* (O.C.G.A. §12-5-320 through §12-5-329). Counties included within Georgia's Coastal Nonpoint Source Management Area include: Bryan, Brantley, Camden, Charlton, Chatham, Effingham, Glynn, Liberty, Long, McIntosh and Wayne.
- Coastal Nonpoint Source Area of Special Interest: Georgia's Coastal Nonpoint Source Area of Special Interest is made up of an additional 13 counties located immediately to the west of the Coastal Nonpoint Source Management Area. Counties included within the state's Coastal Nonpoint Source Area of Special Interest include: Appling, Atkinson, Bacon, Bulloch, Candler, Clinch, Coffee, Evans, Jeff Davis, Pierce, Tatnall, Toombs and Ware.

### 1.3 Purpose of the Supplement

The purpose of this CSS is to protect Georgia's existing water quality standards, particularly those of the state's coastal waters. It also provides for the implementation of the federally established "management measures" related to new development, watershed protection and site development in the Coastal Nonpoint Source Management Area and Area of Special Interest. To provide for the implementation of these "management measures," it provides comprehensive guidance on an integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design that can be used by Georgia's coastal communities to better protect coastal Georgia's unique and vital natural resources from the negative impacts of land development and nonpoint source pollution.

It should be noted that this CSS does not provide guidance on managing *construction* stormwater runoff on development sites. While many of the better site planning and design techniques, low impact development practices and traditional stormwater management techniques discussed in this CSS can also be used to address *construction* stormwater runoff, more extensive guidance on the control of *construction* stormwater runoff can be found in the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2000) (Figure 1.4).



**Figure 1.4: Manual for Erosion and Sediment Control in Georgia**

(Source: Georgia Soil and Water Conservation Commission)

## 1.4 Organization of the Supplement

To enhance its utility and ease of use, this CSS has been divided into nine sections. Each section provides information that supports the implementation of an integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design that can be used to protect coastal Georgia's valuable natural resources from the negative impacts of land development and nonpoint source pollution. The nine sections presented in this document include:

- Section 1.0: Section 1.0 provides an introduction to this CSS. It describes the purpose of the document and summarizes all of the information presented within.
- Section 2.0: Section 2.0 provides an introduction to some of the most valuable aquatic and terrestrial resources found in coastal Georgia. It describes the numerous functions and values that these important natural resources provide.
- Section 3.0: Section 3.0 describes the direct and indirect impacts that land development and nonpoint source pollution can have on the aquatic and terrestrial resources of coastal Georgia. It also outlines an integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design that can be used to help control and minimize these impacts.
- Section 4.0: Section 4.0 presents a comprehensive set of post-construction stormwater management and site planning and design criteria that support an integrated approach to natural resource protection, stormwater management and site design. These criteria can be applied to new development and redevelopment activities occurring within the Coastal Nonpoint Source Management Area and Area of Special Interest.
- Section 5.0: Section 5.0 provides information on using accepted hydrologic methods to calculate the stormwater runoff volumes associated with the stormwater management criteria presented in this CSS. These calculations can be used to plan and design a post-construction stormwater management system that helps protect coastal Georgia's valuable natural resources from the negative impacts of land development and nonpoint source pollution.
- Section 6.0: Section 6.0 provides information about using the site planning and design process to satisfy the post-construction stormwater management and site planning and design criteria presented in this CSS. It provides detailed information about integrating natural resource protection and stormwater management with the site planning and design process.
- Section 7.0: Section 7.0 provides detailed information about the green infrastructure practices (e.g., better site planning and design techniques, low impact development practices) that can be used to meet the stormwater management and site planning and design criteria presented in this CSS. Each profile sheet provided in this Section describes a particular green infrastructure practice and includes information about its proper application, design, installation and maintenance.
- Section 8.0: Section 8.0 provides detailed information about the traditional stormwater management practices, such as wet ponds, wetlands and swales, that can be used to meet the stormwater management and site planning and design criteria presented in this CSS. Each profile sheet provided in this Section describes a particular stormwater

management practice and includes information about its proper application, design, installation and maintenance.

- **Section 9.0:** Section 9.0 provides information that can be used to develop a local post-construction stormwater management program that is consistent with the integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design presented in this CSS. Georgia's coastal communities should find this Section of the document to be a valuable resource in their efforts to develop or enhance their own post-construction stormwater management programs.

## 1.5 Regulatory Status of the Supplement

This CSS has been designed to provide Georgia's coastal communities with comprehensive guidance on an integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design that they can use to better protect the region's valuable natural resources from the negative impacts of land development and nonpoint source pollution. Although communities may choose to use the information presented in this CSS to regulate new development and redevelopment activities, the document itself has no independent regulatory authority. The integrated approach to natural resource protection, stormwater management and site design detailed in this CSS can only become required through:

- (1) Codes and ordinances established by local governments
- (2) Rules and regulations established by other local, state and federal agencies

It is *recommended* that all communities located within Georgia's 24-county coastal region, particularly those communities that are regulated by the NPDES Municipal Stormwater Program, use the information presented in this CSS, or an equivalent post-construction stormwater management manual, to regulate new development and redevelopment activities. Communities are encouraged to review and modify the contents of this CSS, as necessary, to meet local watershed and stormwater management goals and objectives.

## 1.6 Relationship of the Supplement to the Georgia Stormwater Management Manual

In 2001, the Atlanta Regional Commission (ARC), in conjunction with the Georgia Department of Natural Resources Environmental Protection Division (GA EPD) and 35 cities and counties from around the state of Georgia, published the *Georgia Stormwater Management Manual* (GSMM) (ARC, 2001). The GSMM outlines a comprehensive approach to post-construction stormwater management that has greatly improved the way that communities around the state address post-construction stormwater runoff.

Although the GSMM contains a wealth of valuable information about post-construction stormwater management, it does not provide all of the information needed to protect coastal Georgia's valuable natural resources from the negative impacts of land development and nonpoint source pollution. For example, the GSMM does not provide much information about



**Figure 1.5: Cypress Swamps Provide Valuable Habitat for Wood Storks**

(Source: Jeannie Lewis Rhodes, Georgia Department of Natural Resources)

the aquatic and terrestrial resources that can be found in coastal Georgia or about the negative impacts that land development and uncontrolled stormwater runoff can have on these critical natural resources (Figure 1.5). In addition, the GSMM does not provide *detailed* guidance on using green infrastructure practices (e.g., better site planning and design techniques, low impact development practices) or on adapting the design of traditional stormwater management practices, such as wet ponds and swales, to the site characteristics and constraints commonly encountered in coastal Georgia. To provide coastal Georgia with this valuable additional information, this CSS was developed. It builds on the wealth of information presented in the GSMM to promote an integrated, green infrastructure-based approach to natural resource protection, stormwater management and site design that can be used to better protect coastal Georgia's unique and vital natural resources from the negative impacts of land development and nonpoint source pollution.

The approach to natural resource protection and post-construction stormwater management that is currently used throughout most of coastal Georgia focuses primarily on *managing* stormwater quantity (and, in some cases, quality) and relies heavily on traditional stormwater management practices, such as wet and dry ponds, to *mitigate*, rather than *prevent*, the negative impacts of land development and nonpoint source pollution. The integrated approach to natural resource protection, stormwater management and site design presented in this CSS shifts the focus away from the *mitigation* of these impacts and instead places it on their *prevention*. To accomplish this, the CSS introduces the concept of *stormwater runoff reduction*, which effectively puts green infrastructure practices in the same "stormwater management toolbox" as traditional stormwater management practices, such as wet and dry ponds. The introduction of this *stormwater runoff reduction* concept marks an important milestone in the evolution of stormwater management in coastal Georgia. If successfully integrated into existing stormwater management efforts, it will lead to better protection of the aquatic and terrestrial resources that contribute so greatly to the region's natural beauty, economic well-being and quality of life.



**Figure 1.6: Alligators are One of the Many Creatures that Call Coastal Georgia Home**

(Source: Jeannie Lewis Rhodes, Georgia Department of Natural Resources)

The CSS is presented in a format that is similar to that of the GSMM. This allows readers that are already familiar with the GSMM to more efficiently use the information presented within. Although this CSS can be used as a stand-alone stormwater management manual, it does make a number of references to information presented in the GSMM. In case of a conflict between information presented in this CSS and the GSMM, the information contained in this CSS should be considered to be more protective of coastal Georgia's natural resources, habitats and wildlife (Figure 1.6).

### 1.7 How to Get Copies of the Supplement

Hard copies of this CSS can be ordered by calling the Georgia Department of Natural Resources Environmental Protection Division (GA EPD) Nonpoint Source Program at (404) 675-6240 or Coastal District at (912) 264-7284.

**1.8 How to Find the Supplement on the Internet**

Electronic copies of this CSS are available for free download from the following websites:

<http://www.gaepd.org>

<http://www.mpcnaturalresources.org>

<http://www.coastalgeorgiadc.org>

**1.9 Contact Information**

If you have any questions or comments about this CSS, please contact the Georgia Department of Natural Resources Division (GA EPD) Nonpoint Source Program at (404) 675-6240 or Coastal District at (912) 264-7284.

**References**

Atlanta Regional Commission (ARC). 2001. *Georgia Stormwater Management Manual*. Volume 2. Technical Handbook. Atlanta Regional Commission. Atlanta, GA. Available Online: <http://www.georgiastormwater.com/>.

Georgia Soil and Water Conservation Commission (GSWCC). 2000. *Manual for Erosion and Sediment Control in Georgia*. Georgia Soil and Water Conservation Commission. Athens, GA. Available Online: [http://www.georgiaepd.org/Documents/esc\\_manual.html](http://www.georgiaepd.org/Documents/esc_manual.html).

U.S. Environmental Protection Agency (US EPA). 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency. Office of Water. Washington, DC. Available Online: <http://www.epa.gov/nps/urbanmm/>.

U.S. Environmental Protection Agency (US EPA). 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA 840-B-92-002. U.S. Environmental Protection Agency. Office of Wetlands, Oceans and Watersheds. Washington, DC. Available Online: <http://www.epa.gov/nps/MMGI/>.