Appendix 10-2: Caloosahatchee River Watershed Protection Plan Update

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INTRODUCTION

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BACKGROUND

The Caloosahatchee River and Estuary (CRE) is located on the lower west coast of Florida. The river, also known as the C-43 canal, runs 70 kilometers (km) [43 miles (mi)] from Lake Okeechobee at Moore Haven (S-77) to the Franklin Lock and Dam (S-79) at Olga (**Figure 1**). The Franklin Lock demarcates the head of the Caloosahatchee Estuary. The estuary extends about 42 km (26 mi) downstream to Shell Point, where it empties into San Carlos Bay in the southern portion of the greater Charlotte Harbor system. The CRE provides tremendous opportunities for population and economic growth, luring both year-round and seasonal residents along with agricultural, recreational, and business interests. It serves as a nursery ground for many commercial and recreational fish species and is also home (seasonally or annually) to several threatened and endangered aquatic and avian species. For these reasons, it is essential to maintain the health of the estuary for both the local economy and the environment.

Like most populated areas in the state, natural habitats, drainage patterns, and land uses within the Caloosahatchee River Watershed have been significantly altered over time. Loss of natural habitat from riverfront and coastal development, increased urban development and stormwater runoff, construction of drainage canals, and agricultural activities have affected the quality, quantity, timing, and distribution of flows to the estuary. Land clearing and impervious areas have increased both the volume and timing of wet season flows from the watershed, while dry season flows have decreased due to the lack of natural storage and increased water supply demand for agricultural and urban development. Storage within the watershed has decreased from the drainage of land to accommodate grazing, citrus farms, and other agricultural and urban development.

In 2007, the Northern Everglades and Estuaries Protection Program (NEEPP) was authorized under Section 373.4595, Florida Statutes (F.S.), in response to legislative findings that the Lake Okeechobee, Caloosahatchee River, and St. Lucie River watersheds are critical water resources that have been and continue to be adversely affected from changes to hydrology and water quality. The NEEPP legislation specifically called for the development of the three northern watershed protection plans: Lake Okeechobee, St. Lucie, and Caloosahatchee. The Caloosahatchee River Watershed Protection Plan (CRWPP) (SFWMD et al., 2009), aims to

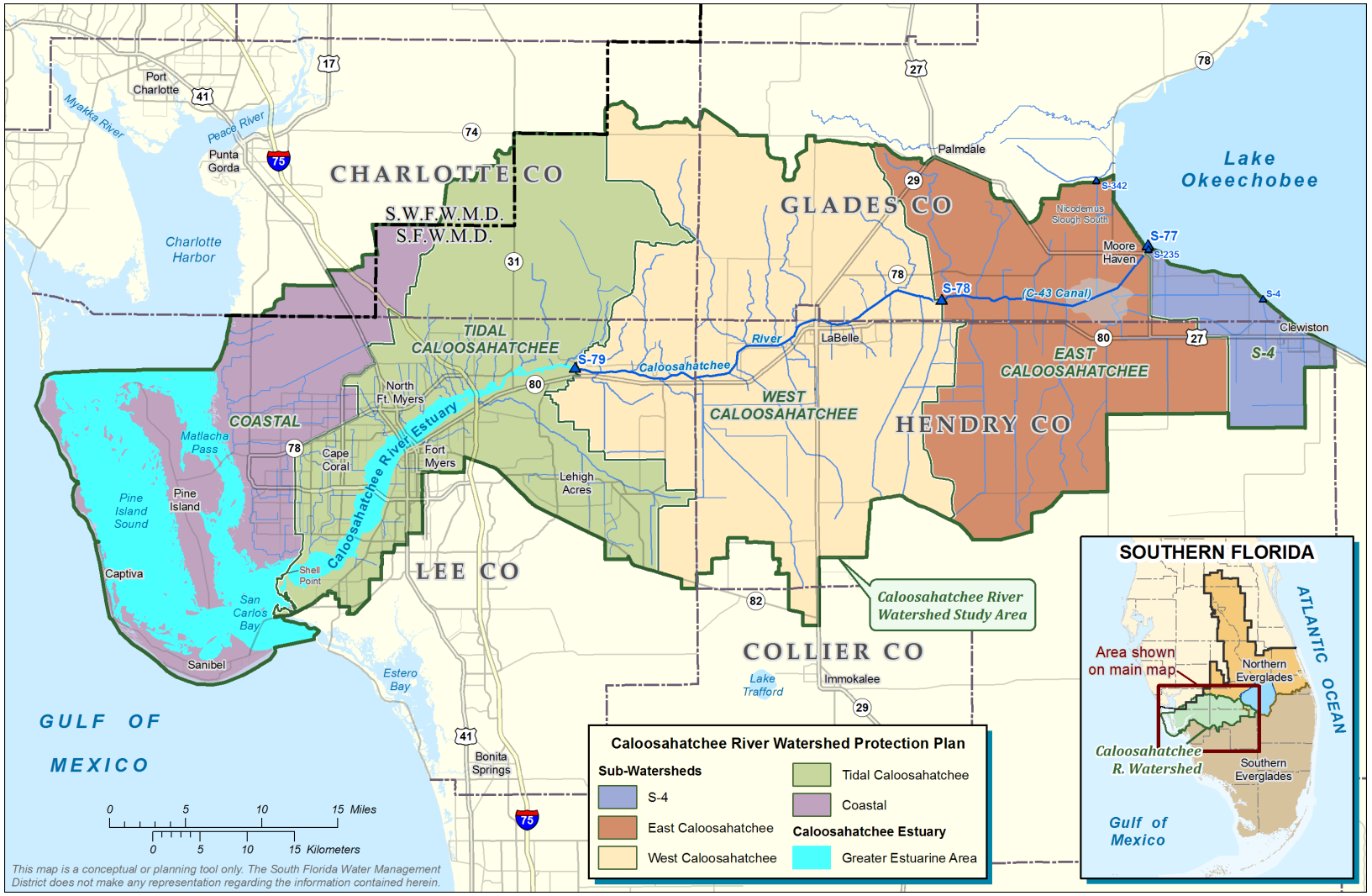

Figure 1. Sub-watersheds of the Caloosahatchee River Watershed.

minimize undesirable flows to the estuary and improve the quality of water delivered to the estuary, through implementation of the three major elements specified by the NEEPP legislation: Watershed Construction Project, Watershed Source Control Program, and Watershed Research and Water Quality Monitoring Program. The South Florida Water Management District (SFWMD or District), the Florida Department of Environmental Protection (FDEP), and the Florida Department of Agriculture and Consumer Services (FDACS), collectively identified in the legislation as the coordinating agencies, developed the CRWPP in 2008 with extensive stakeholder input. The plan was released in January 2009 and must be updated every three years.

This update fulfills the legislative requirement for the three-year update to the CRWPP and focuses on the coordinating agencies' progress since 2009 toward meeting the plan's goals. It also defines current and proposed nutrient reduction and storage projects that will require funding for implementation and identifies the lead agency or agencies for implementing each activity or project. As supporting information for this update, the CRWPP new project/activity sheets are included in Attachment A, and revised nutrient loading rates and reduction factors associated with Best Management Practices (BMPs) and technologies are provided in Attachment B. Assumptions for BMP implementation rates are provided in Attachment C. An overview of the Caloosahatchee River Watershed and Estuary monitoring efforts is covered in Attachment D.

Coordinating Agencies' Roles and Areas of Responsibility

The coordinating agencies are tasked with implementing the NEEPP, each with specific areas of responsibility (**Figure 2**). The SFWMD, in cooperation with the FDEP and FDACS, is the lead agency for annual status reports and three-year updates to the CRWPP; however, each agency is responsible for implementing its respective programs.

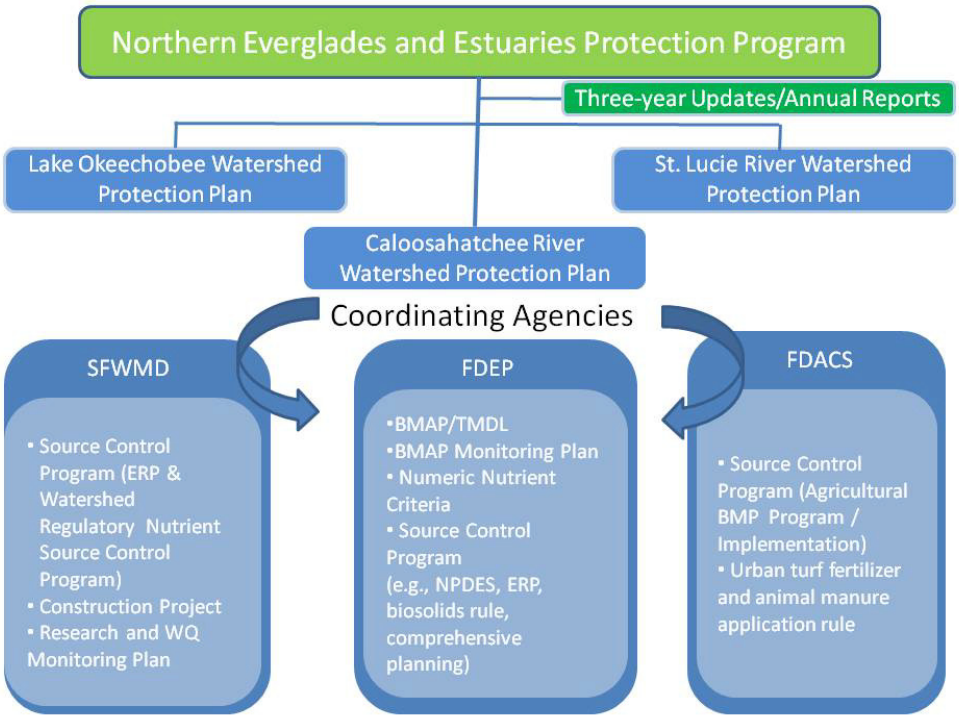

Figure 2. Coordinating agencies' areas of responsibility associated with the Northern Everglades and Estuaries Protection Program (NEEPP).

In addition, local stakeholders play a key role in implementing NEEPP. Local governments, special districts, and other stakeholders are essential in helping achieve water quality and storage targets through development and implementation of local projects and by providing local information and knowledge that help focus and guide coordinating agencies' decisions.

Total Maximum Daily Loads

In accordance with NEEPP, the CRWPP must contain an implementation schedule for pollutant load reductions that are consistent with any adopted Total Maximum Daily Loads (TMDLs) and in compliance with applicable state water quality standards. The FDEP developed the TMDL for the Caloosahatchee Estuary and has subsequently started a Basin Management Action Plan (BMAP) development process. With stakeholder input on the draft, the TMDL technical document was finalized (FDEP, 2009) and the rule was adopted [Rule 62-304.800, Florida Administrative Code (F.A.C.)] in 2009. The TMDL focuses on the Caloosahatchee Estuary (downstream of the S-79 structure) (**Figure 3)**, which encompasses three water body identification areas (WBIDs 3240 A–C) determined to be impaired for nutrients (FDEP, 2009).

The ecological target for the Caloosahatchee Estuary is seagrass light requirements in San Carlos Bay at the mouth of the Caloosahatchee River (**Figure 3**). The Hydrological Simulation Program—Fortran (HSPF) and Environmental Fluid Dynamics Code (EFDC) models were linked to simulate the hydrologic and water quality functions of the Caloosahatchee River Basin and its receiving waters (see 2009 CRWPP). The overall approach was to model the existing Caloosahatchee River Estuary total nitrogen (TN) and "then reduce these loads to be consistent with the chlorophyll *a* levels that permit the target light attenuation (consistent with a healthy seagrass meadow)" (FDEP, 2009).

The final TMDL for the Caloosahatchee Estuary is 9,086,094 pounds (4,121 metric tons, or mt) per year of TN, which represents a load reduction of 23 percent (FDEP, 2009). All of the load reduction was allocated to the categories of National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit and agricultural sources. It should be noted that TN (and not total phosphorus, or TP) has been identified as the key pollutant of concern in the estuary.

Basin Management Action Plan

A BMAP must be developed once the TMDL is established according to the NEEPP. The Caloosahatchee Estuary TMDL will be met through the BMAP and, currently, the FDEP is in the planning phase of BMAP development for this estuary. **Table 1** summarizes accomplishments to date on the estuary's BMAP development process. Through its dialogue with local stakeholders, the FDEP is currently revisiting the Caloosahatchee Estuary TMDL concurrent with BMAP planning and implementation. While some technical revisions are being discussed, BMAP development continues. Additional TMDLs are being developed to encompass the tidal tributary and freshwater portions of the main stem Caloosahatchee River (**Figure 4**), and further BMAP planning efforts may be initiated in those basins when the TMDLs have been adopted. Technical team meetings are planned to continue key local stakeholder input.

Caloosahatchee Basin Management Action Plans and Caloosahatchee Watershed Protection Plan Construction Project Alignment

As discussed in the *Basin Management Action Plan* section, the Caloosahatchee Estuary nutrient TMDL will be implemented primarily through a BMAP, which is currently under development. The BMAP and CRWPP both have the goal of achieving the estuarine TMDL. While this is the goal of the BMAP, it is only one component of the CRWPP, which also has water quantity/storage goals to maintain a healthy salinity envelope. This interagency effort

focuses on avoiding duplicative efforts between the FDEP and SFWMD, while minimizing inconsistencies between the CRWPP and BMAP. While this is challenging as the BMAP and CRWPP used different evaluation tools, there will be an opportunity to align these two processes during development of the freshwater Caloosahatchee TMDL when the TMDL/BMAP modeling effort is revisited. During this effort, SFWMD and FDEP staff will work together closely to coordinate the CRWPP and the BMAP processes and to align specific components where possible.

One component of the alignment process involves local water quality projects and associated load reductions. The FDEP is currently inventorying local water quality projects dating back to 2000 and estimating project-specific load reductions. It is anticipated that the FDEP's BMAP list of local water quality projects and their associated load reductions will be adopted in the next CRWPP Update, while water quality projects moving forward in the updated CRWPP will be captured in the future BMAP implementation plans. This update incorporates the 2009 CRWPP list of local water quality projects and new projects identified since 2008.

Table 1. Summary of progress to date for Caloosahatchee River Estuary (CRE) Basin Management Action Plan (BMAP) development.

Date	Meetings in Ft. Myers	Main Topics Covered
July 22, 2009	BMAP Kickoff	Introduction to BMAP process and final TMDL
September 24, 2009	BMAP Technical Meeting	Introduction to allocation approaches and project crediting; review of other BMAPs on project allocations, types, and credit values
February 24, 2010	BMAP Technical Meeting	Initial stakeholder allocation discussion; hypothetical allocation exercise; nutrient reduction project descriptions; SFWMD partnership projects
September 22, 2010	BMAP Technical Meeting	Draft stakeholder allocations discussed; discussion of BMAP structure change (no office Basin Working Group); continued discussion of project types and credit; solicitation for stakeholders to finalize project lists
March 8, 2011	BMAP Technical Meeting	Summary of updated loading and interim targets; continued dialogue on draft allocations including stakeholder input; discussion on Monitoring Plan
April 12, 2011	Pre-TMDL Meeting	Discussion of possible future FDEP TMDLs in the Caloosahatchee River Watershed
December 14, 2011	BMAP Technical Meeting	Status of BMAP management activities, monitoring and documentation

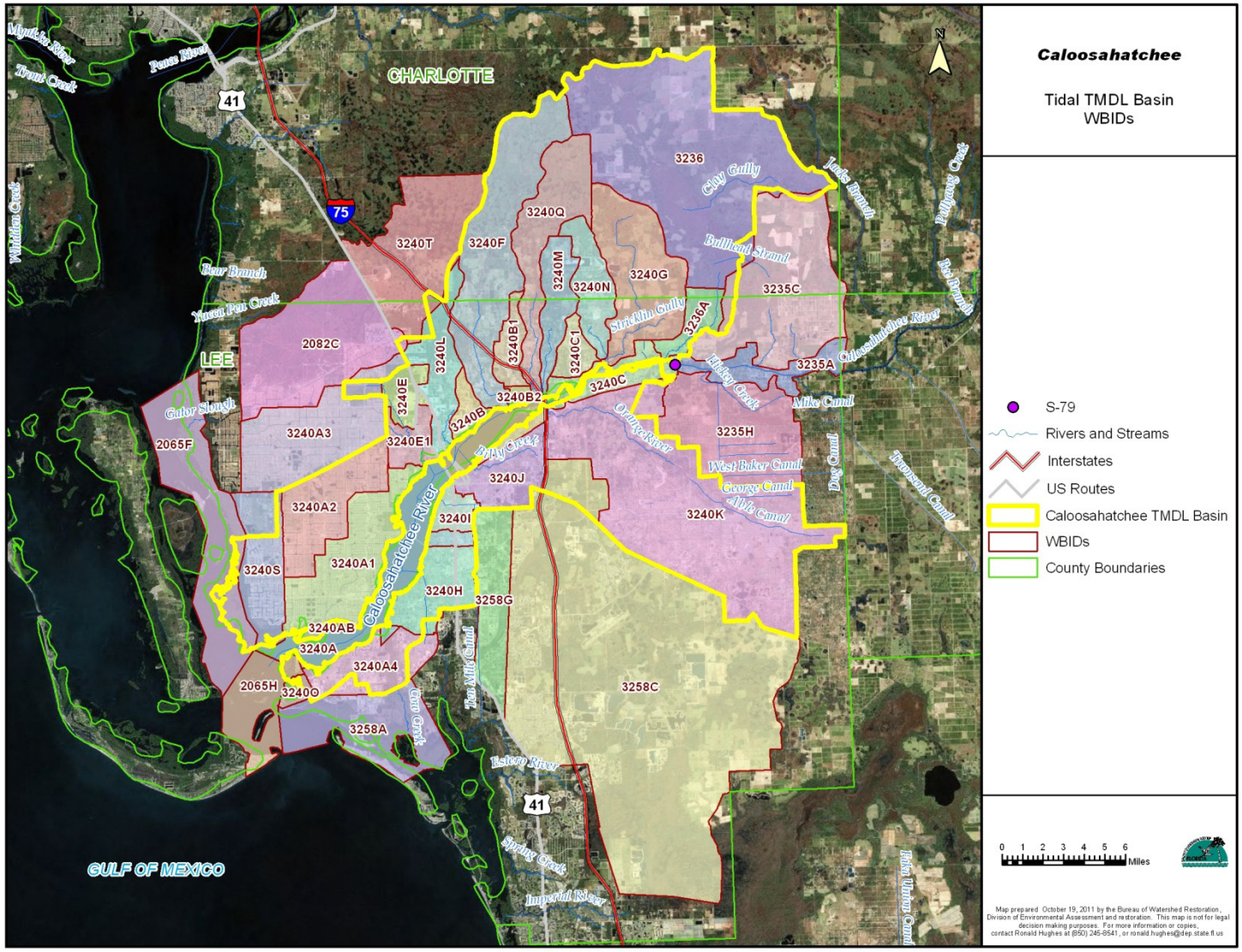

Figure 3. Caloosahatchee River Watershed water body identification areas (WBIDs 3240 A–C) included in the estuary's Total Maximum Daily Load (TMDL; FDEP, 2009).

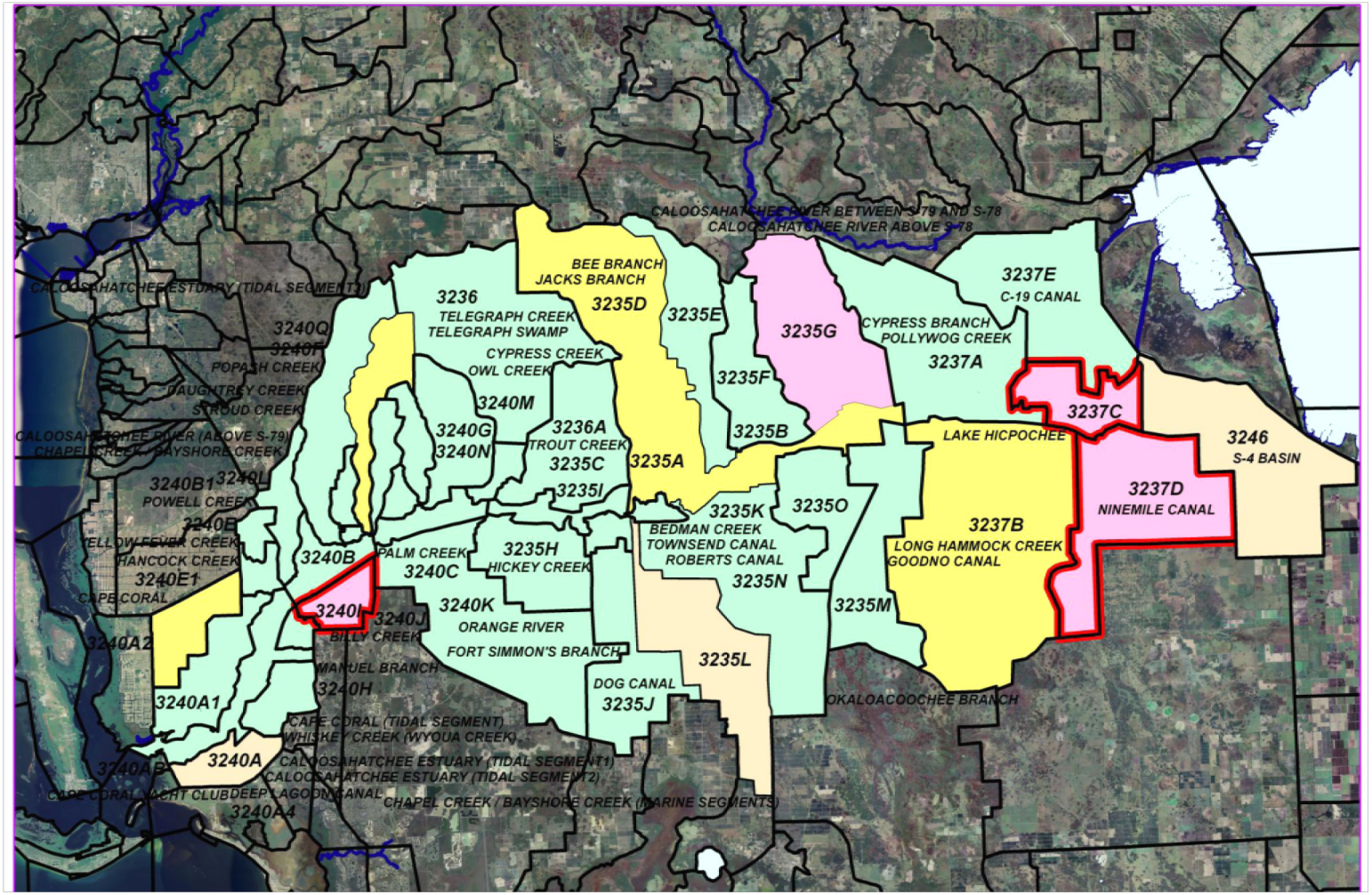

Figure 4. Target impaired WBIDs for potential Caloosahatchee River Watershed TMDLs. [Note: Pink WBIDs indicate dissolved oxygen (DO) impairment, pink with red outline indicate DO impairment with a federal TMDL, yellow WBIDs indicate nutrient impairments, and orange/peach WBIDs are both nutrient and DO impairments; from FDEP presentation dated April 12, 2011.]

Numeric Nutrient Criteria

Both the United States Environmental Protection Agency (USEPA) and the FDEP are currently in the process of developing numeric nutrient criteria for Florida. Both are ongoing efforts scheduled to conclude after this CRWPP Update is finalized and will depend on various external factors beyond the scope of this update. Related impacts of the rulemaking process on current TMDL and BMAP activities are presently unknown but will be important to the Northern Everglades watersheds. Additional details on the evolving state and federal processes of numeric nutrient criteria development are available at www.dep.state.fl.us/water/wqssp/nutrients and http://water.epa.gov/lawsregs/rulesregs/florida_index.cfm, respectively. **Table 2** highlights some key chronological events related to the overall development of numeric nutrient criteria (note that dates for future activities are subject to change).

Table 2. Overview of timeline for numeric nutrient criteria (NNC).

Date	Lead Agency	Status/Action
1998	USEPA	Developed policy document for a National Nutrient Strategy
2000/2001	USEPA	Released Nutrient Criteria Technical Guidance Manuals for Lakes, Rivers and Streams, and Estuaries documents
2000/2001	USEPA	Released Ambient Water Quality Recommendations documents for various national eco-regions
2003	FDEP	Kicked-off TAC process
2004	USEPA/FDEP	Executed mutual agreement on Numeric Nutrient Criteria Plan Development for Florida
2004–2007	FDEP	Conducted TAC deliberations on lakes, rivers, and streams NNC
2007	USEPA/FDEP	Executed mutual agreement on revised Numeric Nutrient Criteria Plan Development for Florida
Aug. 2008	FWF et al.	Filed suit to compel USEPA to set NNC
Jan. 2009	USEPA	Declared NNC necessary via a determination letter
Aug. 2009	EPA/FWF	Agreed on a Consent Decree that contains implementation dates for NNC: freshwater flowing waters and lakes proposed rule by January 2010 and final by October 2010; estuaries and coastal waters proposed rule by January 2010 and final by October 2010
Spring 2009	FDEP	Held several TAC meetings to finalize NNC
Jul. 2009	FDEP	Released draft NNC
Nov. 2009	USEPA/FWF	Upheld Consent Decree
Jan. 2010	USEPA	Proposed freshwater flowing waters and lakes rule
Feb–Apr. 2010	USEPA	Held six public hearing and takes public comment on rule
Jun. 2010	USEPA/FWF	Agreed to extend timelines for estuaries, coast waters, and South Florida canals to proposed rule by November 2011 and final by August 2012; announced formation of a Scientific Advisory Board to review these waters
Aug. 2010	USEPA	Released Notice of Data Availability for additional comment on NNC freshwater rule

Date	Lead Agency	Status/Action
Dec. 6, 2010	USEPA	Released final rule for freshwater lakes, flowing waters in most of the state, and springs
Mar. 2011	USEPA	Released "Stoner" Memo to give guidance to states on eight key elements for nutrient management
Apr. 2011	FDEP	Petitioned USEPA to rescind determination letter, final freshwater rule and to halt all current rulemaking; FDEP also listed a schedule for rulemaking
Jun. 2011	USEPA	Issued letter that neither denies or accepts petition but states that they will observe progress
Jun–Sep. 2011	FDEP	Initiated rulemaking via public process including three series of meetings and website for public input during development of nutrient standards
Dec. 2011	FDEP	Environmental Regulation Commission adopted amended rules for numeric nutrient standards
Jan–Mar. 2012	FDEP	Take state's rule before the Florida legislature for ratification if ERC adoption is successful
Mar. 2012	USEPA	Due date for USEPA freshwater rule to be in effect
Mar. 2012	USEPA	Due date for proposed for estuaries, coastal waters, and South Florida canals NNC
Nov. 2012	USEPA	Due date for USEPA to release final rule for estuaries, coastal waters, and South Florida canals NNC

ERC – Environmental Regulatory Commission
FDEP – Florida Department of Environmental Protection
FWF – Florida Wildlife Federation
NNC – Numeric Nutrient Criteria
TAC – Technical Advisory Committee
USEPA – U.S. Environmental Protection Agency

Plan Components and Their TMDL/BMAP Relationships

The three main CRWPP components are the Pollutant Control Program, Construction Project, and Research and Water Quality Monitoring Program (RWQMP). This section describes these components, their relationships to each other in the CRWPP, and their relationships to the TMDL and BMAP efforts (see **Figure 5**).

- **Pollutant Control Program.** This program is a multi-faceted approach to reducing pollutant loads by improving the management of pollutant sources within the watershed. It comprises source control programs being implemented by the coordinating agencies including BMPs, on-site treatment technologies, stormwater and wastewater infrastructure upgrades and master planning, and regulatory programs focused on water quality and quantity.
- **Construction Project.** This component identifies water quality and storage projects to improve hydrology, water quality, and aquatic habitats within the watershed. It includes regional, sub-regional, and local scale water quality and quantity projects [e.g., reservoirs, Stormwater Treatment Areas (STAs), chemical treatment, and local stormwater projects].

- **Research and Water Quality Monitoring Program.** The RWQMP builds upon the District's existing research program and is intended to carry out, comply with, or assess the plans, programs, and other responsibilities created by the CRWPP. The program will also conduct an assessment of the water volumes and timing from the Lake Okeechobee and Caloosahatchee River watersheds and their relative contributions to the estuary. The primary purpose of this component is to track progress toward achieving the water quality and storage targets.

The relationship among the components of the CRWPP, TMDL, and BMAP is complex (**Figure 5**). The Pollutant Control Program (source control) is the first building block of the water quality treatment train. It includes the development of performance measures to evaluate the effectiveness of the collective source control programs, which is further described in the *Pollutant Source Control Program* section. Source controls are cost-effective for improving water quality but sub-regional and regional projects are ultimately necessary to meet the nutrient TMDL targets. Therefore, the Construction Project component, including regional, sub-regional and local water quality and quantity projects, builds upon the Pollution Control Program efforts to maximize load reductions and water storage. The RWQMP monitors the health of the estuary and provides research needed to support or refine the water quality and storage goals. It also provides a platform for evaluating plan performance and goals based on measured data and modeling results. The BMAP has an overlapping goal with the CRWPP of achieving the Caloosahatchee Estuary TMDL for TN. Both the BMAP and CRWPP include local water quality projects geared toward reducing watershed loading. In accordance with NEEPP, the CRWPP also provided the basis for the FDEP's Caloosahatchee Estuary BMAP effort.

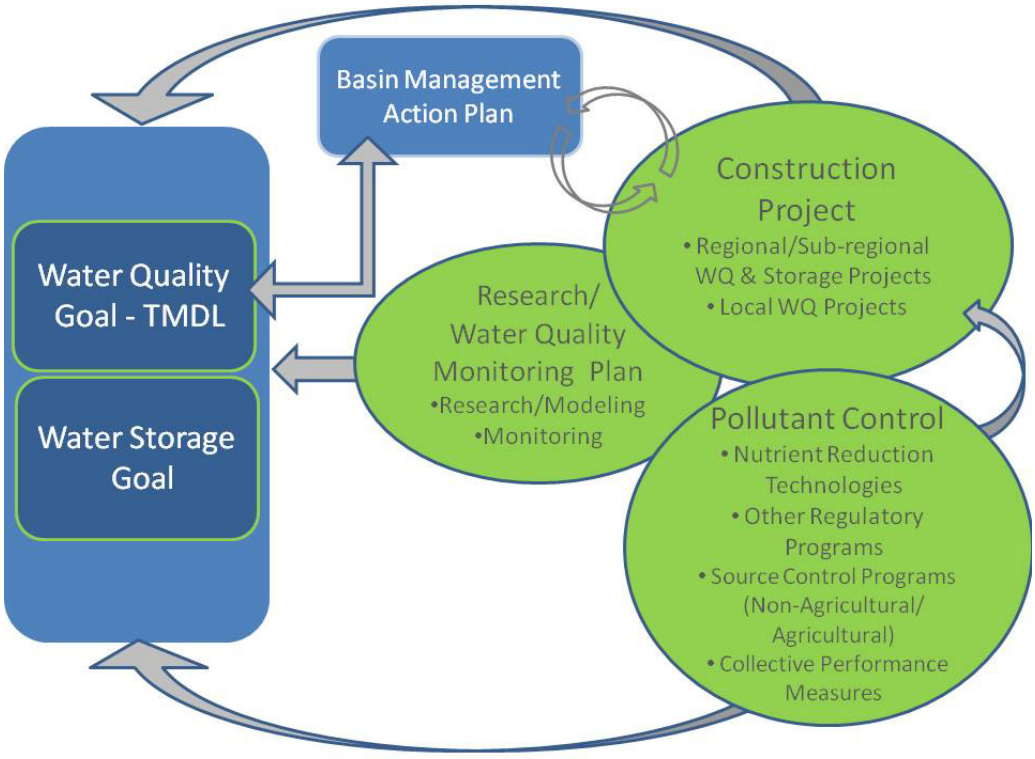

Figure 5. Responsibilities of the coordinating agencies associated with the NEEPP.

PLAN BOUNDARY AND LAND USE

CRWPP Planning Boundary Updates

In the 2009 CRWPP, Chapter 2 includes descriptions of the five sub-watersheds that comprise the Caloosahatchee River Watershed. The CRWPP study area includes the areas that drain to the mouth of the Caloosahatchee River and the associated offshore estuarine area. The watershed, sub-watersheds, and related features are shown in **Figure 1**.

During the wet season, about half of the discharge from the S-4 Sub-watershed flows into the Caloosahatchee River Watershed; the remainder discharges directly to Lake Okeechobee. The East and West Caloosahatchee sub-watersheds, along with the contributions from the S-4 Sub-watershed, drain to the S-79 structure, which separates the upstream freshwater portion of the watershed from the downstream tidal portion. The majority of downstream releases from the S-79 structure to the Tidal Caloosahatchee Sub-watershed occur during the wet season. The Tidal Caloosahatchee Sub-watershed includes the Caloosahatchee River Estuary and the area below S-79 that drains to the mouth of the Caloosahatchee River at Shell Point. The Coastal Sub-watershed includes the areas that drain to the offshore estuary, comprised of San Carlos Bay, Pine Island Sound, and Matlacha Pass.

The boundary of the CRWPP study area has been modified slightly from the 2009 CRWPP. These changes were made for consistency with the District's enterprise Arc Hydro Enhanced Database (AHED), which serves as its official database of record for hydrologic feature locations. AHED is updated periodically to reflect new hydrologic information gained from activities such as permit applications and studies.

Table 3 provides a comparison between the 2009 and 2012 study area acreages. During this period, the overall watershed acreage increased by about 10,600 acres, or 1.0 percent. The main change was the addition of the Nicodemus Slough South unit (5,600 acres) to the East Caloosahatchee Sub-watershed, which under normal conditions drains southward into the C-43 Canal at Lake Hicpochee. Smaller changes resulted from the extension of watershed boundaries in the Tidal Caloosahatchee and Coastal sub-watersheds, as well as some minor changes in the interior boundaries between sub-watersheds.

Table 3. Comparison of the sub-watersheds acreages between the 2009 Caloosahatchee River Watershed Protection Plan (CRWPP) and this update.

Sub-Watershed	2009 CRWPP (acres)	2012 CRWPP Update (acres)	Difference Between Mapping Years (acres)	Percent Change (%)
Coastal	227,236	229,322	2,086	0.9%
East Caloosahatchee	198,299	204,093	5,794	2.9%
S-4	42,504	42,146	-358	-0.8%
Tidal Caloosahatchee	262,023	264,705	2,682	1.0%
West Caloosahatchee	349,734	350,114	380	0.1%
Total	**1,079,796**	**1,090,380**	**10,585**	**1.0%**

Land Use

As with the 2009 CRWPP, this update uses the land use mapped from the 2004 aerial photography, because it falls within the period of record (POR) for the water quality evaluation. The acreages for each land use type have been revised to match the updated watershed and sub-watershed boundaries (**Table 4** and **Figure 6**).

For the CRWPP study area as a whole, agricultural categories comprised the primary land-use type, with 44 percent of the total area. Natural areas occupied the next largest group, with 30 percent, followed by urban with 14 percent and open water with 12 percent. Within the agriculture group, improved pasture made up 25 percent of all 2004 agricultural acreage, followed by citrus at 20 percent, sugar cane at 19 percent, and rangeland at 16 percent.

Within the S-4 Sub-watershed, 82 percent of the area was agricultural, almost entirely as sugar cane. Within the East Caloosahatchee Sub-watershed, 75 percent of the area was agricultural, with most of the remainder as natural. Similarly, within the West Caloosahatchee Sub-watershed, 61 percent of the area was agricultural, with most of the remainder as natural. Within the Tidal Caloosahatchee, 37 percent of the area was natural, followed by urban with 31 percent and agriculture with 23 percent. Within the Coastal Sub-watershed, 44 percent of the area was open water, followed by natural with 31 percent, urban with 17 percent, and agriculture with only 8 percent.

This update utilized the 2004 land use data for water quality evaluations since the District's 2008 land use coverage was not available for incorporation into this update. However, an initial comparison between the preliminary 2008 and the 2004 land uses was performed mostly to address the concerns regarding the change in citrus acreages due to the citrus diseases in recent years. The analysis indicated that for the CRWPP study area, the overall urban area increased by about 4 percent between 2004 and 2008. Agricultural acreage remained constant overall, but citrus and sod acreages decreased. Citrus acreage decreased by about 7,200 acres, or about 7 percent, due to the spread of plant diseases. Sod acreage decreased greatly, likely due to the decline in construction of housing, with only about 400 acres remaining in high quality turf production.

Table 4. Land use acreage by sub-watershed for the CRWPP as of 2004.

Land Use Category	Sub-watershed Area, in acres						
	Coastal	East Caloosahatchee	S-4	Tidal Caloosahatchee	West Caloosahatchee	Total for CRWPP	Percent of Total
Residential Low Density	28,317	3,001	548	30,191	14,845	76,903	7.1%
Residential Medium Density	3,733	383	1,506	25,734	1,759	33,113	3.0%
Residential High Density	2,427	59	77	8,606	395	11,565	1.1%
Other Urban	3,977	1,175	2,230	14,425	1,871	23,678	2.2%
Improved Pasture	2,643	36,798	796	21,867	55,544	117,648	10.8%
Unimproved Pasture	475	5,752	-	4,882	12,722	23,831	2.2%
Rangeland, Woodland Pasture	12,056	11,002	278	23,654	31,475	78,464	7.2%
Row Crops	591	1,080	-	1,878	6,393	9,942	0.9%
Sugar Cane	-	57,895	33,062	-	2,058	93,016	8.5%
Citrus	193	26,592	66	840	69,005	96,696	8.9%
Sod	-	289	-	1,436	3,345	5,070	0.5%
Ornamentals	175	16	-	300	369	861	0.1%
Horse Farms	-	140	-	24	38	202	0.0%
Dairies	-	18	-	38	-	56	0.0%
Other Agriculture	2,197	836	325	4,835	2,785	10,978	1.0%
Tree Plantations	69	12,923	-	1,112	28,394	42,498	3.9%
Water	101,256	2,125	658	22,741	3,654	130,432	12.0%
Natural Areas	70,191	42,825	2,136	98,594	114,621	328,367	30.1%
Transportation	507	741	330	2,719	643	4,940	0.5%
Communication, Utilities	515	443	134	832	195	2,120	0.2%
Total	**229,322**	**204,093**	**42,146**	**264,705**	**350,114**	**1,090,380**	**100.0%**

Land Use Categories (Grouped)	Sub-watershed Area, in acres						
	Coastal	East Caloosahatchee	S-4	Tidal Caloosahatchee	West Caloosahatchee	Total for CRWPP	Percent of Total
Urban	39,476	5,802	4,825	82,507	19,709	152,319	14.0%
Agriculture	18,399	153,342	34,527	60,865	212,130	479,262	44.0%
Natural Areas	70,191	42,825	2,136	98,594	114,621	328,367	30.1%
Open Water	101,256	2,125	658	22,741	3,654	130,432	12.0%
Total	**229,322**	**204,093**	**42,146**	**264,705**	**350,114**	**1,090,380**	**100.0%**

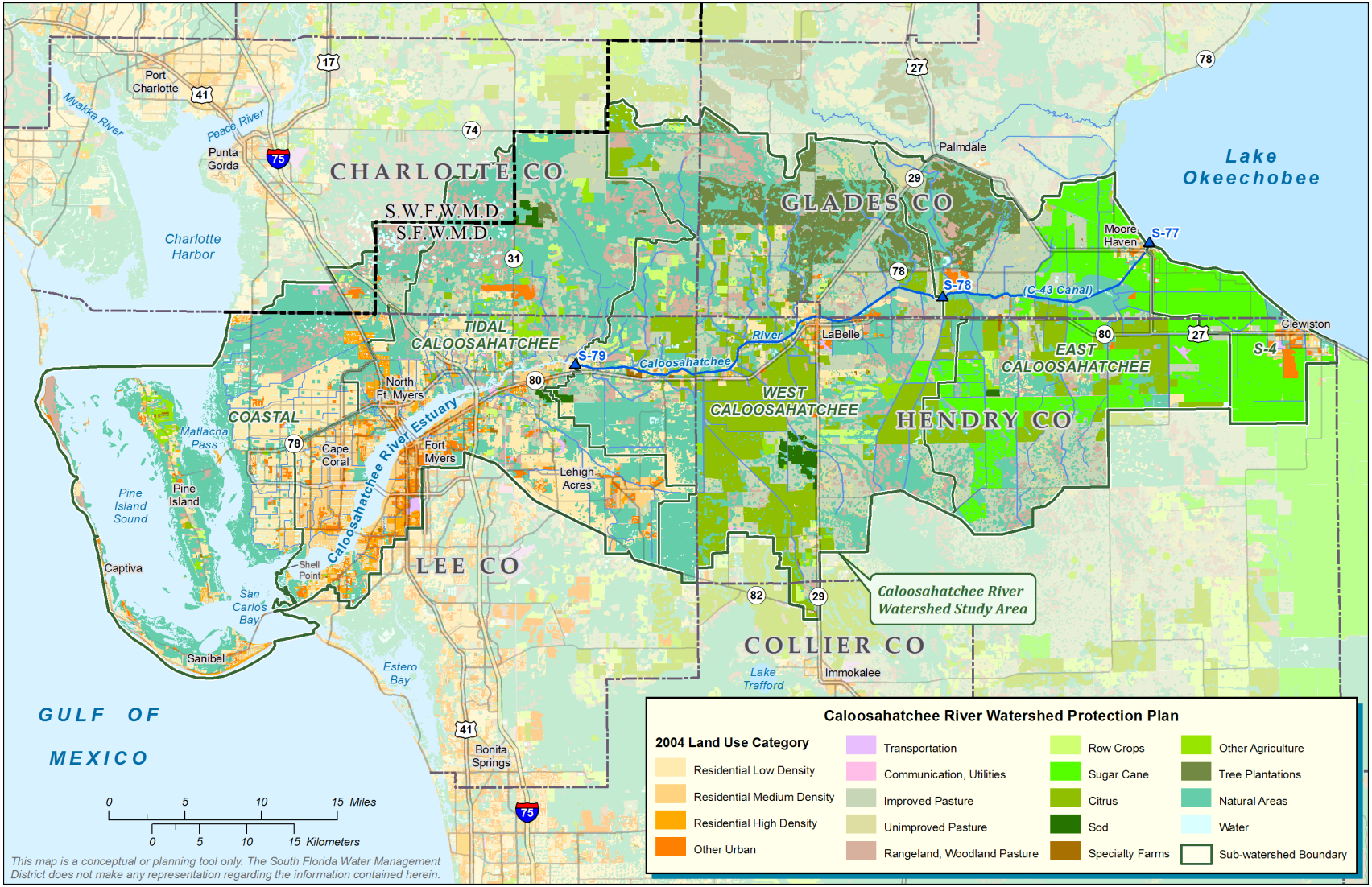

Figure 6. Land use within the Caloosahatchee River Watershed as of 2004.

POLLUTANT SOURCE CONTROL PROGRAM

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The Pollutant Source Control Program is a multi-faceted approach for improving the management of pollution sources within the Northern Everglades watersheds. It includes source control programs being implemented by the coordinating agencies, including BMPs, on-site treatment technologies, stormwater and wastewater infrastructure upgrades and master planning, and regulatory programs focused on water quality and quantity. Chapter 4 of this volume provides a detailed update on the implementation of the regulation and BMP elements of the Northern Everglades source control programs including the Caloosahatchee River Watershed. The status of program elements based on the 2009 CRWPP objectives is summarized below.

1. **Implementation of non-point source BMPs on agricultural and non-agricultural lands to ensure that the amount of nutrients discharged offsite are minimized to the greatest possible extent**
    - The District and the FDEP are granted the authority to implement Environmental Resource Permitting (ERP) programs. The ERP program requires that new activities or modifications of existing activities provide reasonable assurances that they will not cause adverse water quality such that state water quality standards will be violated, cause adverse flooding or water quantity impacts, or harm wetland or other surface water systems. Currently, 38 percent of agricultural and non-agricultural acreage in the Caloosahatchee River Watershed have been issued an ERP permit by the District.
    - The FDEP is proposing Statewide Environmental Resource Permit legislation in coordination with the Office of Fiscal Accountability and Regulatory Reform (OFARR). This legislation addresses the adoption of statewide environmental resource permitting rules to govern the construction, alteration, operation, maintenance, repair, abandonment, and removal of surface water management systems. These new rules will rely primarily on the rules of the FDEP and the water management districts that are currently in effect, reconciling any differences for a statewide approach. Differing physical and natural conditions will be accounted for. The applicant's handbook, adopted as a part of this rule, will include a discussion of stormwater quality and quantity criteria.
    - The FDACS works with agricultural producers to develop, adopt, and implement voluntary and incentive-based BMPs specific to various operations. To date, BMP manuals for citrus, vegetable and row crop, container nursery, sod, cow/calf, and specialty fruit and nut operations have been adopted, while the equine manual is nearing adoption. As of March 2011, BMP enrollment of agricultural lands in the Caloosahatchee River Watershed is 44 percent.
    - The statewide Urban Fertilizer Rule [Rule 5E-1.003(2), F.A.C.] became effective in December 2007. Fertilizer application must comply with the statewide rule, unless the area is subject to a stricter local ordinance.
    - The FDEP has been delegated the authority to issue MS4 permits to prevent harmful pollutants from being discharged into water bodies. MS4 permits include a stormwater management plan. The FDEP issued the third cycle of the Lee County NPDES MS4 permit on September 4, 2011. Hendry and Glades counties were issued Phase II MS4 permits in 2010. All reissued Phase I permits include a

new section on TMDL implementation and require enhanced tracking of load reductions achieved through implementing the permit's stormwater management program including nutrient load reductions from street sweeping activities.

- Since 2009, the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Florida Yards and Neighborhood Program has been expanded from the original homeowner approach to include a broader audience. Beginning January 1, 2014, this certification program will be required for any person applying commercial fertilizer to an urban landscape.
- The 2009 Florida legislature created or amended Sections 373.185(3)(a),(b) and (c), F.S., which promote the use of Florida-friendly landscaping to conserve and protect the state's water resources. To date, those with known Florida-friendly landscaping ordinances, or those known to be in the process of passing ordinances, in the Caloosahatchee River Watershed include Charlotte County, Cape Coral, Fort Myers, Lee County, Fort Myers Beach, and the City of Sanibel.
- According to NEEPP, refinement of existing regulations and development of BMPs complementing existing regulatory programs is a basis for achieving and maintaining compliance with water quality standards. Chapter 40E-61 and Chapter 40E-63, F.A.C., are long-standing regulations that establish criteria to ensure that discharges from nonpoint sources meet legislative objectives for water quality protection. The District will coordinate with the OFARR prior to initiating rule development to amend Chapter 40E-61, F.A.C., to expand the regulatory source control program to encompass phosphorus and nitrogen loading reductions in the St. Lucie and Caloosahatchee River watersheds. The program will include water quality performance measure methods for collective source controls.

2. Ensuring that domestic wastewater residuals within the river and estuary watersheds do not contribute to nutrient loadings in the watershed

The biosolids rule, Chapter 62-640, F.A.C, was revised on August 29, 2010. Revisions include new requirements for site permitting, nutrient management plans, registration of distributed and marketed Class AA biosolids as fertilizer, and prohibition of land application of other types of biosolids (Class B) in the Northern Everglades watersheds unless a nutrient balance demonstration is completed by the applicant and approved by the FDEP. In 2011, there were five active biosolids application sites in the Caloosahatchee River Watershed. By January 1, 2013, all sites are required to be permitted in accordance with the revised rule.

3. Coordination with the Florida Department of Health (FDOH) to ensure that septage disposal within the watershed is under an approved agricultural use plan limiting applications based on nutrient loading limits established in the proposed revisions to SFWMD's 40E-61 Regulatory Nutrient Source Control Program

Sections 373.4595(4)(a)2.f, F.S. and 373.4595(4)(b)2.f, F.S., require that all entities disposing of septage within the river watersheds develop and submit to the FDOH, an agricultural use plan that limits applications based upon nutrient loading. At this time, there are no FDOH-regulated septage disposal sites in the Northern Everglades watersheds. If any entities were to apply septage in the Caloosahatchee River Watershed, they would be required to do so in accordance with an agricultural use plan that limits applications based on nutrient loadings, and proposed amendments to the rule (Chapter 40E-61, F.A.C.) would require that the concentrations originating from these locations do not exceed established limits proposed by an amended rule. In addition, on June 4, 2010, the Florida legislature approved a bill directing the FDOH to create and administer a statewide five-year cycle septic tank evaluation

program. The FDOH will not restart rule development until they receive approval by the Legislative Budget Commission.

4. **Ensuring that entities utilizing land-application of animal manure develop a resource management system level conservation plan**

   The animal manure application rule became effective in February 2009. Provisions of this rule were modified slightly and incorporated into recent revisions of Chapter 5M-3, F.A.C.

5. **Implementation of a source monitoring program to measure the collective performance and progress of the coordinating agencies' programs, support adaptive management within the programs, identify priority areas of water quality concern and BMP optimization, and provide data to evaluate and enhance performance of downstream facilities**

   The District has evaluated the existing water quality monitoring networks for the Caloosahatchee River Watershed and identified network improvements to capture all nutrient loading contributions. An assessment of historical levels of total phosphorus, total nitrogen, inorganic nitrogen, and flow data for the watershed was also completed. Synoptic monitoring programs to identify future priority monitoring sites are ongoing.

Other pollutant source control activities implemented by the coordinating agencies pursuant to their respective authorities include outreach activities, planning, and issuance and oversight of NPDES and Concentrated Animal Feeding Operation (CAFO) permits for point sources, and Comprehensive Everglades Restoration Plan Regulation Act (CERPRA) project permits. Further detail is provided in Chapter 4 of this volume.

CONSTRUCTION PROJECT AND OTHER RELATED PROJECTS

Pinar Balci, Lesley Bertolotti, Kelly Cranford and
Benita Whalen

CONSTRUCTION PROJECT

Reducing nutrient loading and high discharges to the Caloosahatchee Estuary requires action at the regional, sub-regional, and local level. The Construction Project of the CRWPP focuses on water quality and storage projects at each of these spatial scales with components that will improve hydrology, water quality, and aquatic habitats within the watershed and estuary. The Construction Project component of the CRWPP builds upon the Source Control Program and includes a variety of activities including water quality projects, local stormwater retrofits, reservoirs, habitat restoration projects. Other related activities include the dispersed water management program, the Lake Okeechobee Protection Plan (LOPP) Update, Herbert Hoover Dike (HHD) Restoration, Adaptive Protocols for Lake Okeechobee, and the Caloosahatchee Water Reservation. This section provides an update on the water quality and storage features associated with the Construction Project over the last three years. Specific projects that are part of the Construction Project are described in Attachment A.

Regional and Sub-Regional Project Updates

Regional and sub-regional projects are critical components to achieving the water quality and storage goals of the CRWPP, and include the Caloosahatchee River (C-43) West Basin Storage Reservoir Project, Four Corners/Spanish Creek Initiative, and C-43 Water Quality Treatment and Testing Facility Project (BOMA Property).

Caloosahatchee River (C-43) West Basin Storage Reservoir Project

The Comprehensive Everglades Restoration Plan (CERP) Caloosahatchee River (C-43) West Basin Storage Reservoir Project (CRE-W) is planned to provide a significant portion of the total water storage requirement for the C-43 Basin, which will help ensure a more natural, consistent flow of freshwater to the estuary. The project consists of an aboveground reservoir [170,000 acre-feet (ac-ft) capacity] located south of the CRE and west of the Ortona Lock (S-78). Excess basin stormwater runoff and regulatory releases from Lake Okeechobee are expected to be captured and stored in the reservoir and released slowly, as needed, to restore and maintain the estuary. The reservoir is also intended to improve the Caloosahatchee Estuary's salinity balance by controlling peak flows during the wet season and providing essential flows during the dry season. To date, all needed land has been acquired, pre-construction test cells have been completed and monitored, project design was completed, and all permits have been obtained. A Record of Decision was issued by the U.S. Army Corps of Engineers (USACE) in April 2011 and an approved Project Implementation Report was submitted in April 2011 to the U.S. Congress for authorization.

Spanish Creek/Four Corners Initiative

The Four Corners area encompasses portions of Glades, Charlotte, Hendry, and Lee counties, and includes the Cypress Creek, Spanish Creek, and Jacks Branch tributary watersheds (**Figure 7**). Water flow to the CRE via these watersheds has been substantially modified through development and agricultural practices and has directly affected water quality and storage. Several studies to address these issues have been conducted resulting in the Spanish Creek/Four

Corners Initiative (CRE 44). This is a collaborative initiative among the District, Lee County, and Hendry County to develop regional approaches for improving water quality and storage in the Caloosahatchee River Watershed. The goal is to expand upon existing conceptual plans to address conveyance, attenuation, and treatment of stormwater runoff from the Spanish Creek and Jacks Branch (County Line Ditch) watersheds using wetland flow-ways. Under this initiative, there are two projects: Spanish Creek Restoration and Jacks Branch (County Line Ditch).

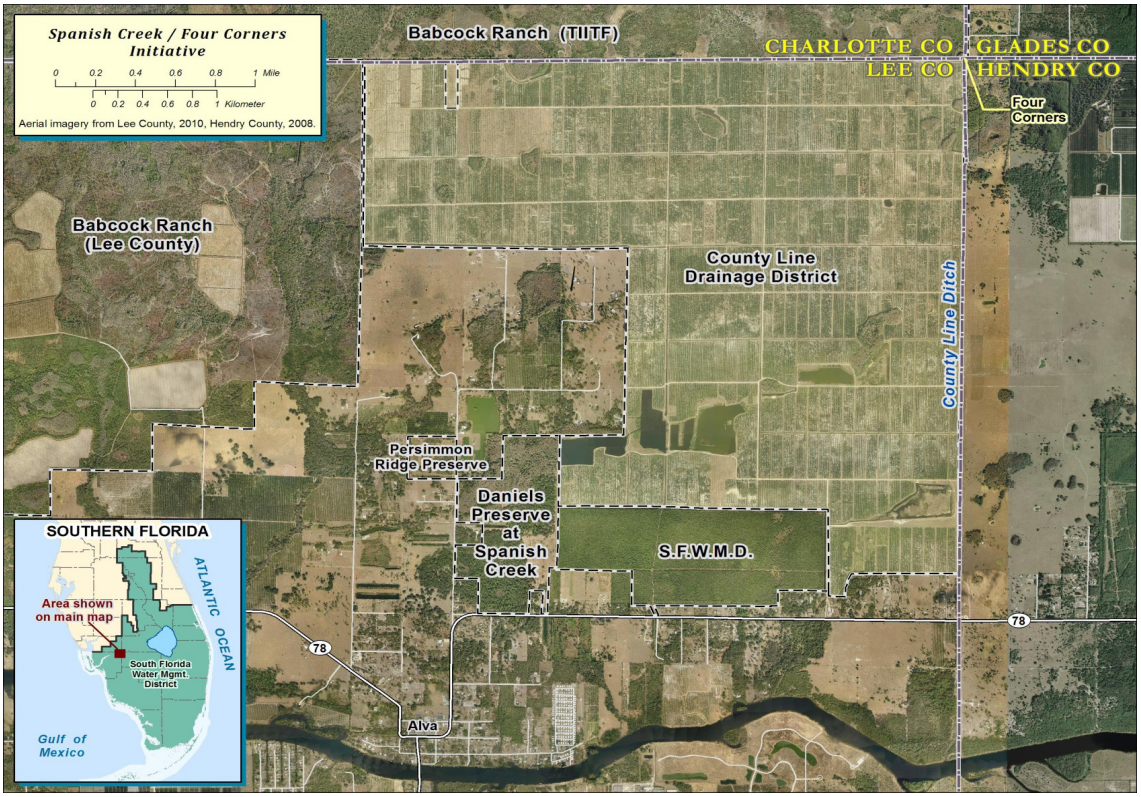


Figure 7. Spanish Creek/Four Corners Initiative area within the Caloosahatchee River Watershed.

- **Spanish Creek Restoration.** Lee County has been pursuing a project to create wetland flow-ways that will serve to rehydrate the Ruby Daniels Preserve, Bob Jane's Preserve, and Spanish Creek. The county is pursuing the acquisition of approximately 640 acres of citrus grove adjacent to Bob Jane's and Ruby Daniels preserves and investigating the appropriate use of former farm fields within preserve property. The project is planned to redirect stormwater flows to a more natural pathway, provide water storage in the watershed, and offer stormwater treatment prior to entering the preserves, creek, and Caloosahatchee River. In Fiscal Year 2012 (FY2012) (October 1, 2011–September 30, 2012), the District plans to provide funds to Lee County for the project's initial design; project construction will be addressed in the future pending availability of funds.
- **Jacks Branch (County Line Ditch).** To date, Hendry County has developed 30 percent design plans in collaboration with the District for improvements to County Line Ditch, which conveys stormwater flows from Jacks Branch Watershed to the Caloosahatchee River. Utilizing 3.5 miles of right-of-way

acquired by Hendry County, the project is intended to improve the conveyance by widening the ditch, adding shallow littoral areas, and providing weirs for increased storage and treatment. In FY2012, the District plans to provide funds to Hendry County for developing 100 percent design plans; project construction will be addressed in the future pending availability of funds.

C-43 Water Quality Treatment and Testing Facility Project (BOMA Property)

The District is partnering with Lee County on the development and implementation of the C-43 Water Quality Treatment and Testing Facility Project (CRE 10). The project's purpose is to investigate and test new strategies for reducing TN in the C-43 Canal to improve water quality in downstream estuarine ecosystems. The adopted TMDL for Caloosahatchee Estuary is based on TN; however, available data shows that 70–80 percent of TN in the Caloosahatchee River is in the form of dissolved organic nitrogen (DON). Existing data from STAs mostly indicates that current designed wetland treatment systems are not optimized to reduce TN, especially DON. Although existing wetland treatments can remove dissolved inorganic nitrogen (DIN) with high efficiency, DIN only accounts for, at most, 20 percent of the TN present in the CRE system. Therefore, to reduce the TN to achieve the water quality standards of the system, DON must be considerably reduced. However, there are many unknowns and uncertainties regarding available DON treatment technologies and additional data are needed to improve this understanding.

To date, project lands (1,773 acres) have been acquired with funds from the District, state, and Lee County. Other completed or ongoing efforts include initial data collection and TN reduction technologies assessment, water quality studies, site surveys, and testing facility conceptual design. To ensure that the best available science is considered as the project moves forward, in 2010 an expert panel review of the conceptual design and its scientific basis was conducted. The District is prepared to proceed forward in FY2012 with conceptual design of a testing facility that incorporates the peer-review panel's recommendations. This conceptual design is expected to include both mesocosms and test cells that aim to effectively reduce or remove TN from the Caloosahatchee River, based on sound science as well as being implementable and cost effective on a larger scale. The District also anticipates that the project will generate strategies that can be applied to other regional estuaries.

Local Water Quality Projects

Local projects (e.g., stormwater and wastewater projects) are local government initiatives that provide benefits on a local scale individually but collectively can provide benefits on a sub-regional or regional scale. This section provides updates to the local projects included in the 2009 CRWPP and to new local projects identified since 2008. It is anticipated that future plan updates will incorporate the local construction project list and associated load reductions that the FDEP is currently developing for the Caloosahatchee BMAP.

Nonpoint source pollution results from the accumulation of contaminants from land surfaces, erosion of soils, debris, increased volumes of stormwater runoff, atmospheric deposition, suspended sediments, dissolved contaminants, and other anthropogenic contaminants. Nonpoint sources can contribute greater amounts of pollution than point sources, as more stringent regulations apply to point sources (SFWMD, 2002), highlighting the critical need for better management of non-point sources.

One of the key issues contributing to nutrient loading from the Caloosahatchee River Watershed is older developments lacking updated stormwater management systems or with failing septic tank systems. This results in runoff of untreated and un-attenuated stormwater and seepage of septage into lakes, canals, wetlands, rivers, and even the estuary, which disrupts the balance of physical, chemical, and biological processes in these systems. Local water quality

projects are critical to reducing nutrient loading to the CRE through stormwater and wastewater retrofits. Local water quality project updates are described below. An overview of project descriptions and updates on all CRWPP projects and programs, as well as project/activity sheets for new/revised projects, are included in Attachment A; all other project sheets are included in Appendix B of the 2009 CRWPP.

Local Stormwater Projects

Stormwater runoff from developed areas is greater than undeveloped areas because there is very little to no attenuation or detention with impervious surfaces (e.g., paved areas) compared to permeable surfaces (e.g., vegetated areas). In the past, stormwater was conveyed off-site in the shortest time possible; however, today more emphasis is placed on the environmental effects of drainage systems and urbanization in general, and stormwater systems associated with new developments are required to provide a certain level of retention, detention, and treatment prior to off-site discharge. One way to help address non-point pollution is through implementation of local stormwater projects. Such projects in the CRWPP include installation or upgrades to urban stormwater management systems (flow-through filtration marshes, wet detention ponds, baffle boxes, replacement/installation of weirs and other structures) that increase retention/detention capacity, remove sediments, and provide flood protection.

Billy Creek Filter Marsh Project

An example of a successful local water quality project is the Billy Creek Filter Marsh Project (CRE 45) in Fort Myers (**Figure 8**), which was completed in spring 2010. This project furthered local community and SFWMD efforts to protect and restore the Caloosahatchee River Watershed as well as provide valuable educational, recreational, and aesthetic benefits for area residents and visitors. The Billy Creek Filter Marsh is a 50-acre water quality improvement park with cycling and pedestrian trails adjacent to the Billy Creek Canal. The system consists of a weir, which diverts flows from the channelized portion of Billy Creek into an 8-acre lake and 13.4 acres of constructed filter marshes. The lake removes suspended solids and the filter marsh uptakes nutrients via wetland vegetation. The cleaner water then flows back to Billy Creek, which discharges into the Caloosahatchee River. The District partnered with the City of Fort Myers and Lee County and contributed approximately $977,000 to this project.

Mirror Lakes Storage/Rehydration Project

The Mirror Lakes Storage/Rehydration Project (CRE 122), located in southern Lehigh Acres near State Road (S.R.) 82, is a component of the East County Water Control District (ECWCD) Comprehensive Watershed Management Plan. The comprehensive plan's purpose is to better manage local hydrology by reducing stormwater discharges, increasing groundwater recharge, and improving water quality throughout the Lehigh Acres area. The Mirror Lakes Preserve Area, formerly known as Halfway Pond, is a large wetland system at the headwaters of the Estero River Watershed. The pre-development wet season elevation of Halfway Pond was likely in the range of 30 feet National Geodetic Vertical Datum (ft NGVD). The channelization of Lehigh Acres reduced the water table in the vicinity of Halfway Pond and directed runoff away from the Estero River and into the Orange River Watershed. Subsequently, a weir (S-ML-4) was constructed to control water levels in Mirror Lakes, and the weir control elevation is 28 ft NGVD. S-ML-4 discharges to Canal 57-7-4, a tributary of Yellowtail Canal, which flows into Able Canal, a tributary to the Orange River. The entire drainage system within Lehigh Acres was constructed without any stormwater detention facilities and lacks water storage and treatment. As surrounding canals are maintained at an elevation of 26.5 ft NGVD, the Mirror Lakes Preserve rarely reaches 28 ft NGVD and the wetlands within the preserve are highly impacted.

Figure 8. Aerial view of the Billy Creek Filter Marsh, Fort Myers (photo by the SFWMD).

This project is a multiyear pilot test of an overall plan that is intended to rehydrate Mirror Lakes, reduce peak flow discharges to the Orange River (which has flooding issues), and restore flows to the Estero River headwaters in the vicinity of the Green Meadows wellfield, which is owned and operated by Lee County Utilities. Phase I involves a pilot test to pump stormwater into Mirror Lakes to rehydrate preserve areas north of S.R. 82; permitting for this phase is under way. If the pilot test provides anticipated benefits, it may be expanded to deliver water south of S.R. 82 to existing ECWCD preserves (Phase II), with subsequent delivery to wetlands in the vicinity of Green Meadows wellfield (Phase III). All phases are depicted in **Figure 9**. Phase I is expected to provide 1,000 ac-ft storage while Phases II and III will result in additional 500 ac-ft and 2,000 ac-ft of storage, respectively. While Phase I is being implemented, the remaining phases need additional funding. The total estimated cost for the project is $1.7 million, with an anticipated storage benefit of 3,500 ac-ft. Discussions are under way with the Florida Department of Transportation to facilitate additional conveyance under S.R. 82 and the Lee County Port Authority, who own mitigation lands south of Lehigh Acres and adjacent to the Green Meadows wellfield.

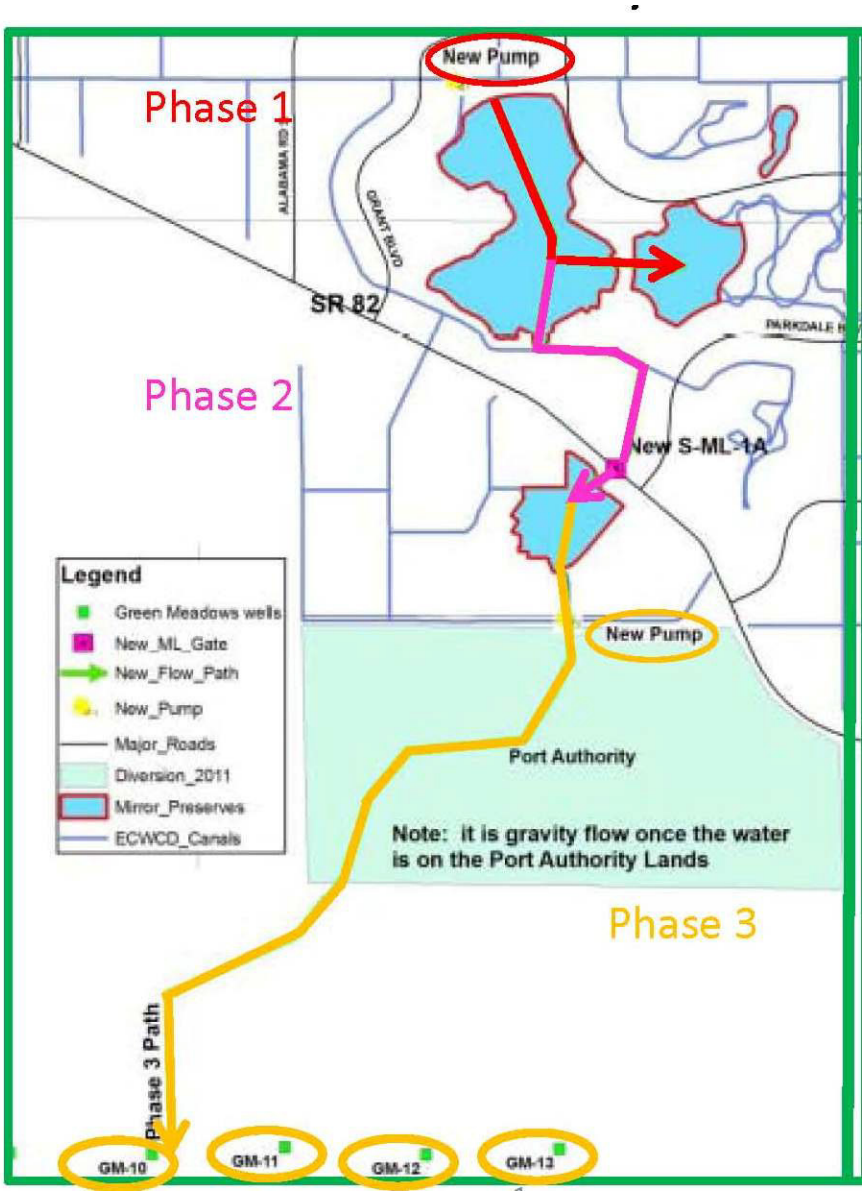


Figure 9. Proposed Mirror Lakes Storage/Rehydration Project: Phase I (red line), Phase II (pink line), and Phase III (yellow line) flow paths.

Other Local Stormwater Projects

This update includes 14 new stormwater projects identified in the Caloosahatchee River Watershed since 2008. Project description sheets for these new projects are provided in Attachment A. In addition to the Billy Creek Filter Marsh and the Mirror Lakes Storage/Rehydration projects, the following local stormwater projects have had significant progress made since 2008 (see Attachment A, Table A-1, for related project information and updates):

- Harns Marsh Improvements (CRE 18, 19, and 142) – phases I and II completed;
- Yellowtail Structure Construction (CRE 20) – completed

- Aquifer Benefit and Storage for Orange River Basin (ABSORB) (CRE 30) – recently designed and permitted
- Manuel's Branch Silt Reduction Structure (CRE 48) – completed
- North Fort Myers Surface Water Restoration (CRE 59) – flow-way constructed
- City of Labelle Stormwater Master Plan Implementation (CRE 121) – C-5 portion completed
- West Arcade Avenue Drainage and Water Quality Improvement (CRE 132, new) – completed
- Ventura Avenue Stormwater Improvement and Drainage Upgrade (CRE 133, new) – completed
- Hickey Creek Canal Widening (CRE 135, new) –design recently completed
- Kickapoo Creek Stormwater System Analysis – Feasibility Study (CRE 137, new) –completed
- Pollywog Creek (CRE 138, new) – construction underway
- Ford Canal Filter Marsh (Ford Street Preserve) (CRE 139, new) – design recently completed
- Greenbriar Preserve (CRE 143, new) – permitted
- Pop Ash Creek Preserve Restoration (CRE 145, new) – construction completed
- Powell Creek Filter Marsh (CRE 146, new) – construction commenced in 2011

Local Wastewater Projects

Another key issue contributing to nutrient loading from the Caloosahatchee River Watershed is failing septic tank systems. The Lehigh Acres Wastewater Treatment and Stormwater Retrofit Project (CRE 29) involves the conversion of high-density septic tanks to centralized wastewater treatment. Nearly 100 single family homes in Lehigh Acres have been connected to the centralized wastewater treatment plant since 2009.

Restoration Projects

Restoration projects focus on restoring or creating wildlife and aquatic habitats (e.g., muck/sediment removal, oyster habitat creation, wetland restoration, and land management, restoration and conservation) but also often have ancillary water quality and storage benefits. The following local restoration projects have had significant progress since 2008 and few new projects were also added (see Attachment A, Table A-1, for related project information and updates):

- Caloosahatchee Creeks Preserve Hydrological Restoration (CRE 53) – completed
- Columbus G. McLeod Preserve Shoreline Restoration (CRE 134, new) – completed
- Deep Lagoon Preserve Restoration (CRE 136, new) –completed
- Fitcher's Creek Restoration (CRE 140, new) – in permitting
- Powell Creek Restoration Dredging (CRE 148, new) – permits recently acquired
- Tape Grass (*Vallisneria americana*) Plantings Upstream of S-79 (CRE 150, new) – tape grass transplanted, cages installed and monitored in the summer of 2011

DISPERSED WATER MANAGEMENT PROGRAM

The Northern Everglades watersheds are roughly seven times larger than the surface area of Lake Okeechobee. Runoff enters the lake and estuaries at rates much higher than under historical conditions, which has several undesirable results (e.g., increased nutrient loading, excess discharges of fresh water to tide). Therefore, coordinated efforts are underway to retain excess water before it enters Lake Okeechobee, the Caloosahatchee River, or the St. Lucie River. Currently, there is unprecedented unified stakeholder support to implement collaborative projects on public, private, and tribal lands, including paying landowners for water retention and water quality improvement services. These efforts complement water management of planned regional facilities and could be implemented more expeditiously.

Dispersed water management (DWM) projects typically spread excess water across the landscape and distribute it at shallow depths using relatively simple structures. Such projects optimize the use of existing facilities and require less new construction to retain cumulatively larger volumes of water. The coordinating agencies are aggressively pursuing DWM implementation and expansion in the Northern Everglades by working with other agencies, non-profit organizations, Florida Native American tribes, and public and private landowners; a key example is the Northern Everglades–Payment for Environmental Services (NE-PES) solicitation discussed in this section. It is widely acknowledged that DWM Program components (easements, cost-share, and payment for services) are promising near-term options to reduce excess water and improve water quality in natural systems.

Overall, the long-term goal for the DWM Program is to provide 450,000 ac-ft of retention/ storage throughout the Northern Everglades watersheds. Regional projects (e.g., reservoirs, aquifer storage and recovery projects, deep injection wells) and other state initiatives are still critical to reaching the storage goals for the region. Significant progress in the DWM Program has been made through cooperative efforts with other agencies, local governments, and private land owners—while efforts to investigate the use of additional public lands, implement more projects on private and tribal lands, and optimize the projects currently in place continue. A total of 131,539 ac-ft of water storage has been achieved in the Northern Everglades and connected watersheds through partnerships that have provided water management alternatives since 2005 (Note that this total includes local projects in the watershed that are not listed in **Table 5**). Completed DWM projects in the Caloosahatchee River Watershed provide 5,625 ac-ft of water storage/retention, and an additional 42,493 ac-ft is expected from completion of near-term and long-term projects (**Table 5**). The majority of this planned storage/retention is attributed to the Nicodemus Slough Water Management Project (34,000 ac-ft) which will help reduce excessive discharges to the Caloosahatchee River, as outlided below in more detail. For some local wetland restoration projects, where water storage and habitat improvement is the primary goal, water quality is often a secondary benefit. Additional projects are under development as part of the DWM Program through utilizing public lands, payment for environmental services, easements, and cost-sharing in the Northern Everglades. Once a landowner has successfully participated in one type of program, there is often further participation in other, longer-term programs, with the potential to retain and reduce even more nutrients and retain larger amounts of runoff.

The purpose of the following section is to provide an overview of the DWM Program, its components, and the status of implementation in the Northern Everglades. The majority of these efforts have taken place in the Lake Okeechobee Watershed to increase the water storage, which ultimately provides benefits to the estuaries by reducing harmful discharges. However, multiple dispersed water management projects have recently been initiated or were completed in the Caloosahatchee River Watershed (**Table 5**). In addition, the District also initiated a water farming pilot project in the Caloosahatchee River Watershed that intends to utilize fallow/out-of-production citrus lands to store water and attenuate nutrients as described further below.

Table 5. Dispersed water management (DWM) projects in the Caloosahatchee River Watershed.

Project Name	Project Area (ac)	Drainage Area (ac)	Estimated Storage (ac-ft)	Completion Date	Status
I. Operational					
FDACS BEST MANAGEMENT PRACTICE (BMP) PEEPLES	1	250	10	Feb-11	Operational
WETLAND RESERVE PROGRAM PROJECT/NRCS: SPIRIT OF THE WILD WMA	1,252	7,486	615	-	Operational
BARRON WATER CONTROL DISTRICT C-2 WATER STORAGE PROJECT (AWDS)	3	6,129	5,000	Jun-08	Operational
Subtotal			**5,625**		
II. Funded Through Construction					
CLEWISTON SITE (Alternative Storage / Rehydration Project)	752	752	1,448	n/a	Designed or Permitted
FDACS BMP: CLEGHORN	-	766	150	n/a	Preliminary Design
NE–PAYMENT FOR ENVIRONMENTAL SERVICES (New MM)	TBD	TBD	TBD	n/a	Preliminary Design
BOMA INTERIM LANDS	TBD	900	60	n/a	Preliminary Design
NICODEMUS SLOUGH WATER MANAGEMENT PROJECT	-	16,000	34,000	-	Preliminary Design
Subtotal			**35,658**		
III. Potential Projects, Construction Unfunded					
POPASH CREEK PRESERVE	-	307	115	n/a	Designed or Permitted
FDACS BMP: COUSE	-	TBD	TBD	n/a	Preliminary Design
FDACS BMP: LUNDY	TBD	TBD	TBD	n/a	Preliminary Design
FDACS BMP: MUDGE	TBD	TBD	TBD	n/a	Preliminary Design
CALOOSAHATCHEE AREA LAKES RESTORATION (LAKE HICPOCHEE)(CRE 04)	-	4,730	2,290	n/a	Feasibility Study Complete
CALOOSAHATCHEE AREA LAKES RESTORATION (LAKE BONNET)	-	1,200	2,400	n/a	Feasibility Study Complete
CALOOSAHATCHEE AREA LAKES RESTORATION (LAKE FLIRT)	-	1,000	2,000	n/a	Feasibility Study Complete
CALOOSAHATCHEE EAST & WEST PROPERTY (TIITF)	-	54	30	n/a	Feasibility Study Complete
Subtotal			**6,835**		
TOTAL		**32,590**	**48,118**		

Payment for Services

NEEPP legislation encourages and supports the development of creative public-private programs (such as water retention and quality improvement on public, private, and tribal lands) to further facilitate restoration and protection of the Northern Everglades watersheds. As such, several state agencies are expanding opportunities for DWM whereby landowners manage water on parts of their property to provide water retention or nutrient (TP or TN) load reduction. These opportunities include the Florida Ranchlands Environmental Services Project (FRESP), NE-PES solicitation, water farming (assessment of utilizing fallow citrus lands), the Nicodemus Slough Water Management Project, and other payment for services opportunities to store or dispose of excess surface water

Florida Ranchlands Environmental Services Project

FRESP is a five-year pilot project to develop and field test the NE-PES Program. Of the eight pilot projects, seven of which are located in the Lake Okeechobee Watershed and one (Alderman–Deloney Ranch) in the St. Lucie Watershed. These pilot projects consist of working ranches retaining excess stormwater runoff or providing water quality improvement for contracted payments. The pilot projects were implemented from 2005 through 2007 and remain in operation, but are phasing into other programs. Using data collected from these pilot sites, FRESP showed that expanding the number of projects on ranchlands in the Northern Everglades can complement existing and planned regional water storage and treatment projects. This provides valuable information to demonstrate proof-of-concept and NE-PES Program viability (see **Table 6**).

Service estimation tools and streamlined regulatory processes were identified through the implementation of FRESP as being critical to the next step of transitioning from the pilot project to the DWM PES Program. These processes include (1) defining the service payment approach (implementing a market-driven competitive solicitation), (2) quantifying "above and beyond" baseline required water management (estimation of amount of retention provided from Northern Everglades BMP implementation – a service payment is above this amount), (3) obtaining program federal authorization regarding expansion of wetlands and post-contract hydrologic reversion to a baseline (the USACE developed a Regional General Permit), and (4) developing a U.S. Fish and Wildlife Service (USFWS) and U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) consultation key for threatened and endangered species to aid in returning to baseline hydrologic conditions. FRESP partners include eight local ranchers, the SFWMD, World Wildlife Fund, Florida Cattlemen's Association, FDACS, FDEP, UF/IFAS, USDA-NRCS, and the MacArthur Agro-ecology Research Center. Using market-based concepts, FRESP has demonstrated the potential of DWM on ranchlands to contribute to the delivery of essential environmental services while encouraging ranchers to maintain cattle production. The pilot projects have been phasing into other programs; two FRESP pilot participants (C.M. Payne and Williamson Ranch) have converted to permanent Wetland Reserve Program (WRP) easements. The WRP design will utilize many of the facilities constructed under FRESP and it is anticipated that a greater quantity of water management and treatment will be provided. All FRESP projects are located north of Lake Okeechobee.

Table 6. Annual average estimate of Florida Ranchlands Environmental Services Project water management alternative (WMA) acres, water retention, and total phosphorus (TP) retention.

	WMA Inundated Area (ac)	WMA Service Area (Including Inundated Influenced Acres) (ac)	PWRM Estimate of Incremental Retention Post WMA (ac-ft)	Annual Estimated TP Reductions Post WMA (lbs)	Annual Estimated TP Reductions Post WMA (mt)
Rafter T Ranch	942	1624	850	795	0.36
Lightsey XL Ranch	364	364	227	295	0.13
Payne & Sons Ranch	367	367	164	295	0.13
Syfrett Ranch	521	2197	939	878	0.40
Williamson Ranch	241	659	303	139	0.06
Alderman – Deloney Ranch	49	322	138	40	0.02
Buck Island Ranch	3,748	3,748	2,411	3,434	1.56
Total Across Water Retention WMAs	**6,232**	**9,281**	**5,032**	**5,876**	**2.7**
Lykes West Waterhole Pasture	2,500	2,500	NA	7,220 (2008) 18,520 (2010)	3.3 8.4
Total Across TP Reduction WMA	**2,500**	**2,500**	**5,600**	**7,220 (2008) 18,520 (2010)**	**3.3 (2008) 8.4 (2010)**
Total All WMAs	**8,732**	**11,781**	**10,632**	**13,096 (2008) 24,396 (2010)**	**6 (2008) 11 (2010)**

Source: World Wildlife Fund

Notes: PWRM = Potential Water Retention Model

Northern Everglades – Payment for Environmental Services

Northern Everglades ranchers are participating in a new payment for environmental service contracting program with the District to increase water retention or improve water quality on their lands. The District is responsible for administering the NE-PES Program in collaboration with the FDEP, FDACS, and USDA-NRCS. The NE-PES solicitation establishes relationships via contracts with private landowners to obtain water and nutrient retention water management services to reduce flows and nutrient loads to the Lake Okeechobee, St. Lucie River, and Caloosahatchee River watersheds. Benefits of the program include the following:

- **Cost-effectiveness for the public.** Encourages innovation in providing needed ecosystem services from working cattle ranches as a complement to the construction of public works projects.
- **Economic sustainability for ranchers.** Creates a new commodity that ranchers can produce along with cattle and other activities that helps strengthen the ranches' overall economic stability by retaining private land ownership.
- **Environmental benefits.** Aids in meeting Northern Everglades water retention and nutrient reduction goals and providing enhanced habitat for multiple species at a watershed scale. Also, enhanced profitability reduces the pressure to convert ranchlands to development or other agricultural uses that could exacerbate water problems and habitat loss. On-ranch implementation also provides for earlier environmental results, ahead of public works construction schedules.

- **Practical to implement and administer**. Offers an open and competitive process, fixed-term contracts, and clear documentation procedures to ensure that participating ranchers, if selected, have the opportunity to demonstrate positive environmental stewardship while receiving payment for such valued services.

Fourteen proposals were submitted in response to the NE-PES solicitation released in January 2011. The District and FDEP evaluated and ranked the proposals. In July 2011, the District's Governing Board approved entering into negotiations with the respondents. Eight NE-PES contracts were approved by the Governing Board in October 2011. These contain provisions for data collection and monitoring to document the services to be provided. The majority of the landowners participating in this program are located in the Lake Okeechobee Watershed and one site is located in the St. Lucie Watershed. A future solicitation for additional projects in the Northern Everglades including the St. Lucie and Caloosahatchee watersheds is anticipated.

Water Farming Pilot Project

Another PES approach has been coined "water farming". This approach will utilize fallow or out-of-production citrus lands to store water and attenuate nutrients allowing storm water to be used as an alternative water supply. The result of water farming will be reduced releases and improved water quality to the St. Lucie and Caloosahatchee estuaries. To determine the overall feasibility of the water farming concept, information with respect to environmental benefits gained compared to the cost estimates associated with on-site construction, infrastructure improvements, environmental assessments, and facility maintenance needs to be evaluated. As a result, the District has entered into a cooperative agreement with the Indian River Citrus League and is discussing an agreement with Gulf Citrus Growers Association to assess the feasibility of water farming. Under the cooperative agreement and utilizing guidelines developed jointly among the District and these entities, a "typical" citrus grove will be selected to gather pertinent scientific and engineering data and other information to determine the costs and benefits associated with the water farming concept. This portion of the pilot project will be considered Phase I – Information Gathering, which is necessary to support Phase II – Project Implementation.

Nicodemus Slough Water Management Project

Lake Okeechobee restoration planning efforts have included searching for potential private partners to implement cost-effective water resource projects to meet program restoration goals. The Nicodemus Slough Water Management Project is located within Glades County. The project concept is for the District, as a lessee, in conjunction with the private landowner, to construct facilities and implement an operational plan to utilize the property as a regional water management facility. Water resource benefits from the project include: reducing high stages in Lake Okeechobee and Fisheating Creek; reducing excessive freshwater discharges to the Caloosahatchee River Estuary; restoring hydrology to the site in a manner that is beneficial to existing drained wetlands and former creek floodplain habitat; improving the quality of water delivered to the Caloosahatchee River Estuary and Lake Okeechobee; and conserving water for beneficial uses that would have otherwise been lost to tide.

The Nicodemus Slough Water Management Project is uniquely located with existing connections to Lake Okeechobee (via the C-5 structure) and the Caloosahatchee River (via the C-19 Canal). These existing connections provide the opportunity for multi-purpose water management operations, which will vary as hydrologic conditions change throughout the year. In addition to the site's unique location, the project provides an opportunity for the District, through a lease/project agreement, to cost-effectively and significantly expand its water resource management facilities to benefit the public and natural systems in a relatively short time. The site

currently has a significant amount of existing infrastructure, including 15.7 miles of existing perimeter levees. It is identified in the Lake Okeechobee Watershed Construction Project Phase II Technical Plan as an alternative water storage project. Modeled simulations from a 2008 design report (Metcalf & Eddy and AECOM, 2008) indicate that the potential water storage capacity of the site is approximately 33,860 ac-ft.

Easements

USDA-NRCS Wetland Reserve Program

The USDA-NRCS' WRP offers technical and financial support to land owners whom voluntarily agree to protect, restore, and enhance wetlands on their property by placing them in a long-term or permanent conservation easement. Restoration objectives are to maximize habitat for wetland-dependant wildlife and to reestablish the original vegetated community and hydrology to the extent practical. As an ancillary result of the program, the amount of surface water leaving lands from participating landowners will be reduced due to infiltration and evapotranspiration (ET), and the timing of the discharge will more closely match historical patterns. As such, nutrient concentrations entering the public water management system and ultimately the Northern Everglades will be reduced as a secondary benefit of the restoration.

Since 1997, $471 million has been allocated for standard WRP projects in Florida. Of the 80 standard easements covering 199,905 easement acres, approximately 24 easements are in the restoration phase. An additional $89 million was invested in the Fisheating Creek Special WRP Project, located in the Lake Okeechobee Watershed, to restore 26,000 acres of habitat within the Northern Everglades. The District executed a Memorandum of Understanding in October 2010 to assist the USDA-NRCS by providing technical assistance in implementing their WRP projects. The District is currently assisting in developing the Fisheating Creek Special WRP Project restoration plan. Additionally, in August 2011, the USDA-NRCS announced additional resources ($100 million) for the WRP in the Northern Everglades. Additional lands will be acquired with permanent conservation easements and hydrology restored to altered wetlands.

Other Programs

The District continues to identify other opportunities to store or dispose of excess surface water until the planned regional facilities become operational. For example, the District has acquired easements from landowners for restoration projects, such as the Lake Okeechobee Isolated Wetland Program.

Cost Share

Historically, most cooperative landowner efforts have fallen under the cost-share agreement approach. With this approach, a portion of the project is funded by the landowner and the other portion by another entity. Typically, the landowner assumes responsibility for the long-term operation and maintenance of the cost-shared water management facilities. Cost-share partners typically have included landowners, SFWMD, FDACS, USDA-NRCS, and local governments.

USDA-NRCS Environmental Quality Incentive Program

Implementation of certain FDACS BMPs has increased water retention within the watershed. The USDA-NRCS' Environmental Quality Incentive Program promotes environmental quality and agricultural production as compatible goals. In the Lake Okeechobee Watershed, the FDACS and USDA-NRCS work closely together and improvements are often jointly funded. Since October 2005, an estimated 2,160 ac-ft of retention has been created over 105,348 acres (as of July 1) on projects participating with the FDACS.

Interim Lands (District- and State-Owned Lands)

The District also continues to evaluate the use of publicly owned lands for water management projects. Parcels scheduled to become regional restoration projects present an opportunity to provide water retention through interim, low-cost alterations to the existing surface water management systems. These parcels would then play an interim role of contributing to the watershed restoration effort while the final designs are completed and approved. If the public lands are being leased, then water management strategies will be jointly developed with the lessees to reduce discharges while not adversely affecting flood protection (including adjacent properties) and water quality. New language to retain more storm water on District lands has been developed for incorporation into all new and renewed leases.

The BOMA property is an interim land site in the Caloosahatchee River Watershed scheduled for design and implementation of DWM projects in FY2012. The interim project involves rehabilitating the existing pump to utilize current water management system components, including the three on-site detention areas, to provide water quality improvement and retain stormwater runoff to reduce discharges to the CRE.

Related State and Federal Restoration Efforts

Caloosahatchee Water Reservation Rulemaking Initiative

The Water Resources Development Act of 2000 (WRDA 2000) requires the State of Florida to reserve water for the natural systems associated with implementation of CERP projects. The SFWMD initiated rule development for a water reservation in December 2009 to fulfill its project assurance commitments for the CERP Caloosahatchee River (C-43) West Basin Storage Reservoir Project. The purpose of the Water Reservation is to identify and reserve water from consumptive use for the CERP Caloosahatchee River (C-43) West Basin Storage Reservoir Project to provide the intended benefits to the Caloosahatchee River. The Water Reservation rule will require consumptive use permit applicants to demonstrate that their proposed use of water will not withdraw water reserved for the natural system.

The identified quantity of water to be reserved will be presented to the District's Governing for consideration, and ultimately will be adopted as a rule. Based on the current schedule for rule development, it is anticipated that the District's Governing Board could consider adopting the Water Reservation rule in 2012. The options for the next phase of water resource protection for the Caloosahatchee River will be determined at a future date. For more information regarding the water reservation and construction of the CERP Caloosahatchee River (C-43) West Basin Storage Reservoir Project please see Appendix G of the Lower West Coast Water Supply Plan. Further details on Water Reservations rules are available on the District's website at www.sfwmd.gov/reservations. Additional information regarding water reservations can be found in Chapter 40E-10, Florida Administrative Code.

Lake Okeechobee Protection Plan Update

The LOPP is a companion NEEPP document to both the Caloosahatchee and St. Lucie River Watershed Protection Plans, which are all available at www.sfwmd.gov/northerneverglades. The LOPP was originally developed under the Lake Okeechobee Protection Act (now NEEPP), and was subsequently updated in 2004, 2007, and 2011. Submitted to the Florida legislature on March 1, 2011, the 2011 LOPP Update (SFWMD et al., 2011) provides the most recent information available on the coordinating agencies' efforts towards meeting defined TP reduction and storage goals in the Lake Okeechobee Watershed and defines current and future proposed TP reduction and storage projects that will require funding for implementation. It includes updates to the Lake Okeechobee Watershed Construction Project Phase II Technical Plan elements and additional

NEEPP components designed to benefit the lake ecosystem. The lake can contribute significant freshwater flows and nutrient loads to the estuary and the LOPP aims to minimize these impacts through nutrient reduction strategies and storage north of the lake. The primary goals of the LOPP are to provide storage north of Lake Okeechobee and to meet the Lake Okeechobee TP TMDL (105 mt of TP loading from the watershed to the lake). Key highlights of the 2011 LOPP Update are as follows:

- Enrolled approximately 1.3 million acres (77 percent) of agricultural lands in the FDACS-adopted BMP Program, in which landowners are applying owner-implemented BMPs focused on reducing TP loads to Lake Okeechobee. Almost two-thirds of the agricultural acreage with owner-implemented BMPs (838,780 acres) has also administered cost-share BMPs.
- Constructed more than 30 TP reduction projects including isolated wetland restoration projects, Dairy Best Available Technology projects, former dairy remediation projects, and public-private partnership projects.
- Implemented seven Hybrid Wetland Treatment Technology (HWTT) projects including the Grassy Island site, which was brought on-line in 2011; six of the seven sites are currently operational.
- Completed construction of two regional STAs (Taylor Creek and Nubbin Slough) and began construction on an additional STA (Lakeside Ranch, Phase I)
- Removed approximately 1.9 million cubic yards of muck from Lake Okeechobee, exposing thousands of acres of natural lake bottom sand and promoting the return of native plant species. In addition, the project is estimated to have removed 142 mt of TP from the lake.
- As of March 2011, achieved a total of 129,143 ac-ft of water storage in the Northern Everglades, and connected watersheds through partnerships that have provided water management alternatives since 2005. A total of 89,664 ac-ft is within the Lake Okeechobee Watershed. Additional water storage sites are being developed as part of the DWM Program.
- Adopted revisions to Chapter 62-640, F.A.C., effective on August 29, 2010. The revisions are designed to improve application and management of Class B biosolids as well as to improve the distribution and marketing of Class AA biosolids. By 2013, no Class B biosolids application will be permitted in the Lake Okeechobee Watershed unless a nutrient balance demonstration is completed by the applicant and approved by the FDEP.

Herbert Hoover Dike Restoration

Water management decisions regarding Lake Okeechobee are highly dependent upon the Herbert Hoover Dike (HHD), an approximately 70-year-old earthen levee that was constructed around a major portion of Lake Okeechobee for flood control purposes. For decades, it has served this purpose; however, it is in need of rehabilitation and was classified by the USACE as one of the nation's dams in most need of repair. Until the rehabilitation is complete, the USACE's goal is to manage Lake Okeechobee water levels between 12.5 and 15.5 ft throughout the year, which is considered a safe range for the dike (USACE, 2008).

Since 2007, the USACE has substantially funded the HHD Restoration Project each fiscal year: $56 million in 2008, $80 million in 2009, $124 million in 2010, and $107 million in 2011. The federal FY2012 budget for HHD is $85 million. The 2000 HHD Major Rehabilitation Report divided the 143-mile dike into eight reaches with the initial focus on Reach 1 (Port Mayaca to Belle Glade). The USACE is replacing this reach-by-reach approach with a system-wide risk-

reduction approach as required for safety modifications to dams. A Dam Safety Modification Report will detail and prioritize features to be implemented.

The USACE's initial rehabilitation effort is the construction of a cut-off wall in Reach 1, which is intended to block existing piping (internal erosion) pathways and prevent additional erosion through the dike. Of the 21.4 miles of cut-off wall planned for Reach 1, all are under contract and 15.6 miles are complete. The USACE is implementing a plan to replace or remove the 32 federally owned culverts on the HHD. Contracts to execute this work are anticipated within five years, if funds are available. Two culvert replacement contracts were awarded in FY2011. Coordination with the SFWMD and permitted users has been ongoing to ensure maintenance of drainage and water supply capabilities.

Adaptive Protocols for Lake Okeechobee Operations

The Final Adaptive Protocols for Lake Okeechobee Operations document (SFWMD, 2010) is intended to provide operational guidance to the District's staff and Governing Board. As local sponsor for the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project), the agency interacts with the USACE on Lake Okeechobee operations within the confines of the federally adopted lake regulation schedule. Lake Okeechobee is a central component of the C&SF Project and the interconnected regional aquatic ecosystem. It has multiple functions, including flood control, agricultural and urban water supply, fulfilling Seminole Tribe water rights, navigation, recreation, and fish and wildlife preservation and enhancement. As such, operation of the lake affects a wide range of environmental and economic issues. Lake operations must carefully consider the entire and sometimes conflicting needs of the C&SF Project. A key goal of implementing adaptive protocols for Lake Okeechobee operations is to improve water supply, flood protection, and ecosystem benefits within the constraints of the approved Lake Okeechobee Regulation Schedule (LORS) and water control plan.

The Final Adaptive Protocols for Lake Okeechobee Operations document describes the process for SFWMD staff and Governing Board recommendations to the USACE concerning 2008 LORS and Water Control Plan (USACE, 2008) provisions while considering the District's multiple statutory objectives and responsibilities outlined in Chapter 373, F.S. These adaptive protocols are intended to be used for the lake stage in the Low, Baseflow, and Beneficial Use sub-bands to provide guidance to water managers for discretionary releases for ecosystem benefits or to improve conditions related to C&SF Project purposes. The document provides operational guidance in support of District recommendations but is not intended to establish, dictate, or regulate water levels or operations. Full discretion of the USACE to operate the C&SF Project is retained, as provided in the Water Control Plan.

The analyses conducted for the final version of the adaptive protocols were based on assumptions regarding how water would be released by the USACE in the Low, Baseflow, and Beneficial Use sub-bands. The performance gains demonstrated by the analyses are a result of both components of the release guidance: (1) releases in the Baseflow and Beneficial Use sub-bands, and (2) the strategy to request the USACE limit the Low sub-band maximum release rates during the early part of the dry season. This second component helps conserve early dry season water to increase its potential availability for later in the dry season when the demand is typically the highest. However, it should be noted that the USACE is not mandated to follow this second component per the Final Supplemental Environmental Impact Statement for the Lake Okeechobee Regulation Schedule (USACE, 2007). Looking ahead, it is anticipated that the adaptive protocols will be periodically assessed and adjusted, as necessary, to deal with potential issues not accounted for in the current document and to reflect new knowledge gained as the protocols are implemented. Also, there are inherent uncertainties in how the system will be operated that may require adjustments to the application of the established guidance.

CALOOSAHATCHEE RIVER WATERSHED RESEARCH AND WATER QUALITY MONITORING PROGRAM

Chris Buzzelli, Teresa Coley, Peter Doering, Chenxia Qiu[1],
Detong Sun, Yongshan Wan and Fawen Zheng

The Caloosahatchee River Watershed Research and Water Quality Monitoring Plan (RWQMP) builds upon the District's existing research program and is intended to carry out, comply with, or assess the plans, programs, and other responsibilities created by the CRWPP. The program includes an assessment of the water volumes and timing from Lake Okeechobee and the Caloosahatchee River Watershed and their relative fresh water and nutrient contributions to the estuary. One of the objectives of this component is to track progress towards achieving the CRWPP's water quality and storage targets. In addition, the RWQMP adopts a resource-based management strategy to evaluate the health of several key resources, known as valued ecosystem components (VECs) including (1) oyster populations, and (2) freshwater, brackish and marine submerged aquatic vegetation (SAV). Multiple research and modeling efforts to increase understanding of the ecosystem and reduce uncertainties are also undertaken as part of this component.

To assess the Caloosahatchee Estuary's health and evaluate management and restoration efforts, the District has maintained a monitoring program since the early 1990s. Several physical and chemical parameters, such as freshwater inflows, salinity, nutrients, chlorophyll *a* and dissolved oxygen, have been monitored on a monthly or bimonthly basis at designated locations and additional programs have been developed to assess changes in abundance and distribution of VECs (**Figure 10**). The current status of the estuary and the long-term trends in these parameters and VECs are evaluated, in addition to updates on the District's estuary research and modeling efforts. The RWQMP is divided into several parts as follows:

- **Ecosystem Status.** Summarizes overall status of the ecosystem in recent years, including rainfall, hydrology, water quality and VECs on a water year basis (May 1-April 30).
- **Long-Term Trends.** Evaluates for long-term trends in flows, water quality, and submerged aquatic vegetation on a calendar year basis from 1995–2010.
- **Research Project Updates.** Provides status updates on the Nutrient Budget, Dissolved Oxygen Dynamics, Low Salinity Zone, and Light Attenuation in San Carlos Bay research projects.
- **Modeling Plan Status.** Provides status updates on watershed and estuary hydrology, and hydrodynamic and water quality modeling tools used to predict and evaluate progress toward plan objectives.
- **Monitoring Update:** Provides updates on water quality and VEC monitoring efforts.

[1] Contributed as SFWMD staff during the draft SFER production cycle.

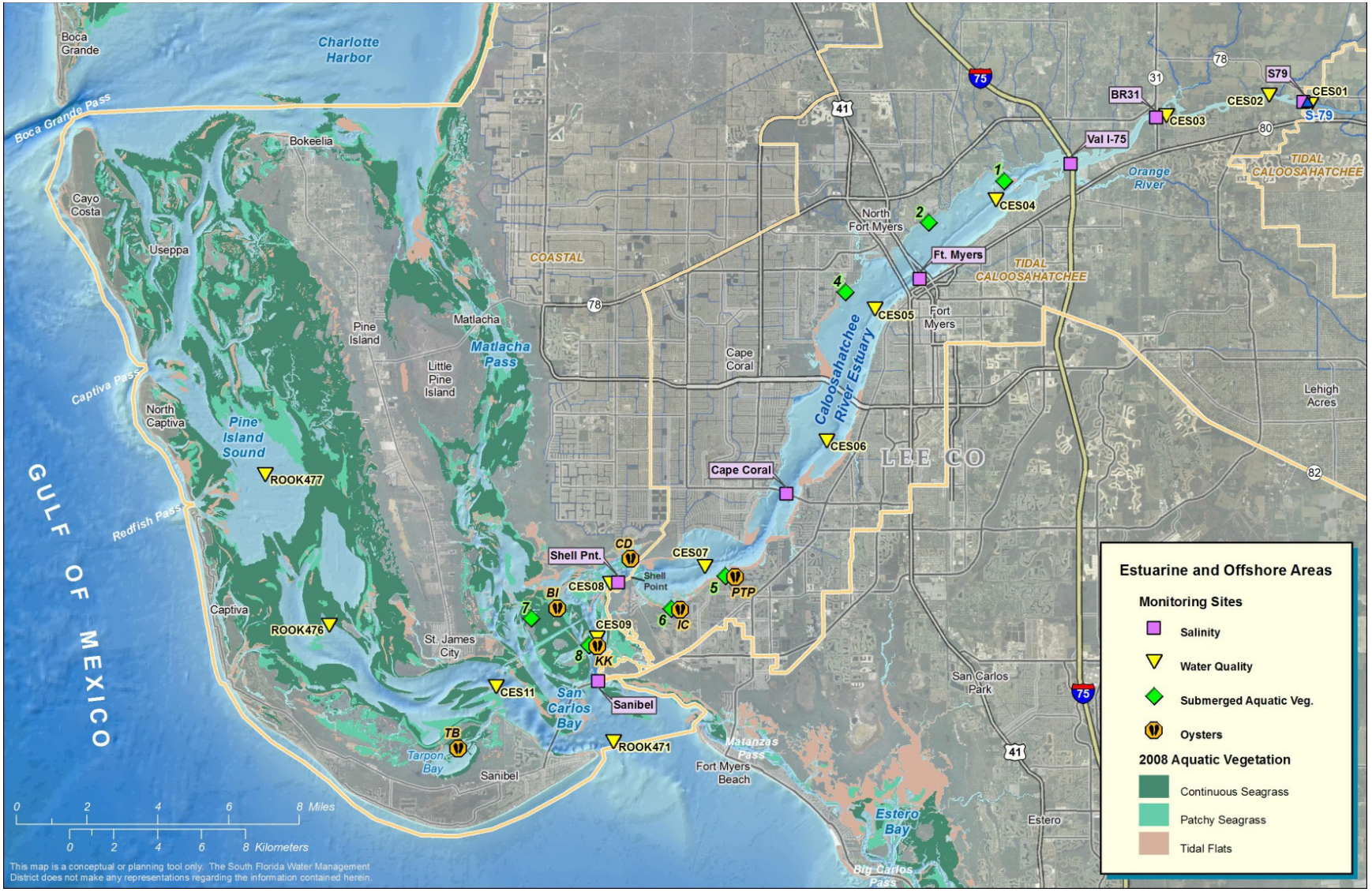


Figure 10. Locations of District monitoring stations in the Caloosahatchee.

BACKGROUND

Historically, the Caloosahatchee River, its estuary, and its watershed have been highly altered by human intervention and engineering. The Caloosahatchee River was once a sinuous river originating near Lake Flirt, about 3.2 km (2 mi) east of LaBelle at Fort Thompson (**Figure 1**). Since the 1880s, the river has been connected to Lake Okeechobee, straightened and deepened, and three water control structures have been added (Antonini et al., 2002). The last water control structure, S-79, was added in part to act as a salinity barrier. No longer free flowing, the river is operated as two pools: one at an elevation of about 3.3 m (11 ft) between S-77 and S-78, and the other at an elevation of about 0.9 m (3 ft) between S-78 and S-79. The river provides irrigation water, drainage, potable water, and conveyance of regulatory releases of water from Lake Okeechobee.

Modifications to the Caloosahatchee River allowed development in the watershed. A network of secondary and tertiary canals now overlays the Caloosahatchee River Watershed. This network conveys both drainage and irrigation water for citrus groves, sugarcane, cattle grazing, and urban development. The estuarine portion of the Caloosahatchee River west of S-79 has also been significantly altered (Chamberlain and Doering, 1998a). Early descriptions characterize it as barely navigable due to extensive shoals and oyster bars (Sackett, 1888). A navigation channel was dredged and, in the 1960s, a causeway was built across the mouth of San Carlos Bay.

ECOSYSTEM STATUS

This section provides the flows and loads from the watershed and the lake to the CRE over the long-term period (WY1995–WY2008) and the past three water years (WY2009–WY2011) and provides a snapshot of the health of the estuary over these time periods. It begins with discussions of rainfall, which drives watershed runoff, and freshwater inflows and nutrient contributions to the CRE, which are directly correlated to water quality in the estuary. The water quality data within the estuary is then presented, followed by the status of VECs, which are greatly affected by salinity and water quality.

Rainfall

The South Florida sub-tropical aquatic landscape is driven by climate and weather on multiannual, seasonal, and daily time scales. The sub-tropical climate is characterized by a wet season from May 1 to October 31 and a dry season from November 1 to April 30. Annual precipitation varies from extremely wet to extremely dry years on a three to five-year cycle. Much of the intra- and interannual variations in rainfall are related to the El Niño Southern Oscillation (ENSO; Childers et al., 2006). During the oceanic warming phase of the ENSO, El Niño, the South Florida peninsula experiences increased rainfall during the dry season. In the oceanic cooling period for ENSO, La Niña, rainfall in the southeastern United States is reduced.

A summary of rainfall within the Caloosahatchee River Watershed is provided in **Table 7**. (Note: NEXRAD data was not available for WY1995). Total rainfall in WY2009 (49.5 inches) was similar to the long-term annual average (49.7 inches from 1996–2008), but the wet season was relatively wetter and the dry season relatively drier. Due to El Niño (**Figure 11**), rainfall during the dry season of WY2010 was nearly double that of the long-term average. In WY2011 drought conditions prevailed due to La Niña.

Table 7. Total rainfall (inches) by water year and season in the Caloosahatchee River Watershed. NEXRAD data were available for all sub-watersheds, WY1996–2011.

Period of Record	Season		Total Annual Rainfall
	Dry	Wet	
WY1996–2008	12.1	37.6	49.7
WY2009	5.9	43.6	49.5
WY2010	21.4	38.4	59.8
WY2011	2.0	29.9	31.9

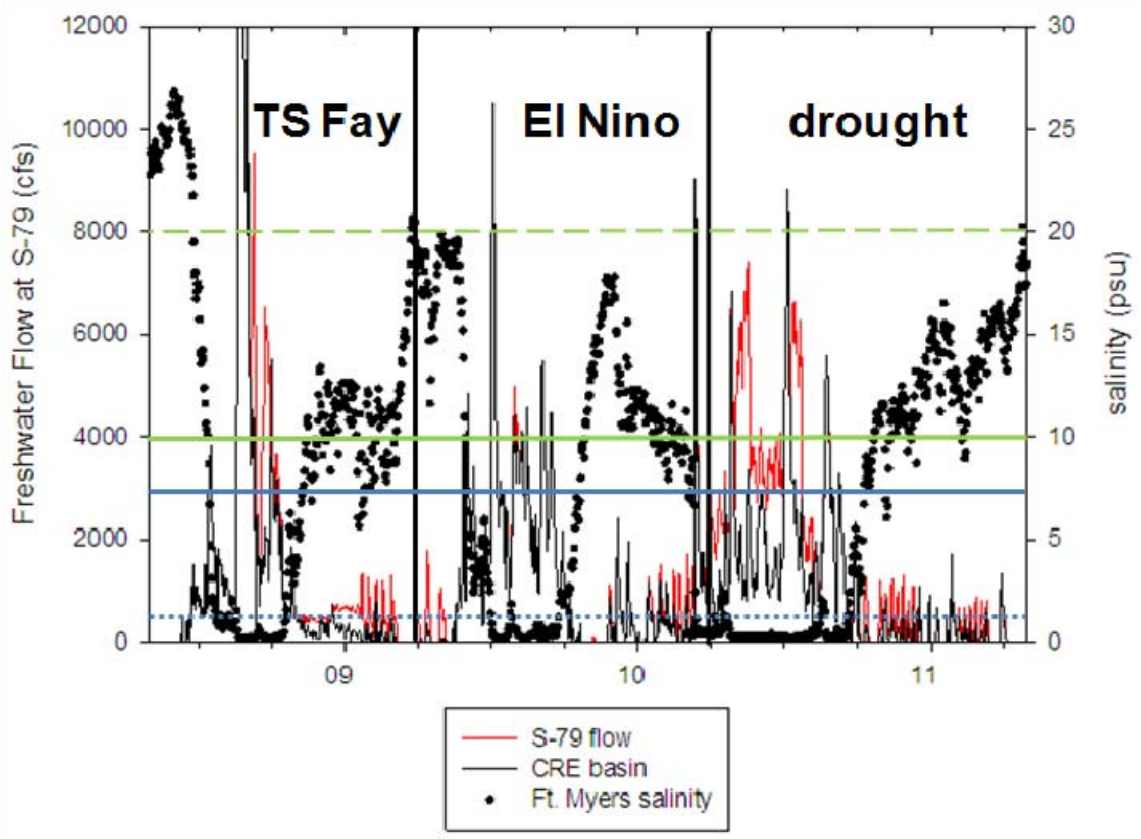


Figure 11. Time series of daily water discharge at S-79 (red line), inflow from the tidal basin downstream of S-79 (black line), and salinity observed at Ft. Myers (filled circles) forWY2009 (May 1 2008 to April 30 2009) through WY2011. Differences between the S-79 and the CRE Basin flows represent flows from lake releases. Solid and dotted blue lines represent high and low ranges of the preferred mean monthly flow regime from S-79. Solid and dashed green lines represent the 30-day and daily average critical salinity criteria, respectively.

Freshwater Inflow

Freshwater inflow to the estuary has a high seasonal variance. During the wet season, extreme flows can drive the system entirely fresh, causing mortality of marine organisms in the lower estuary and San Carlo Bay. By contrast, the lack of flows during the dry season can allow saltwater to intrude up to the S-79 structure, sometimes reaching 20 practical salinity units (psu), which causes mortality of brackish water organisms that normally inhabit this area.

Discharge at S-79 is a combination of runoff from the C-43 Basin and releases from Lake Okeechobee to manage water levels and provide water supply. Therefore, total discharge in **Table 8** reflects both watershed runoff and lake releases. Discharge from the tidal and coastal sub-watersheds are characterized by numerous tributary discharges to the estuary and a less extensive monitoring network. Therefore, total sub-watershed flows and loads have not been measured for these areas.

During WY2009–WY2011, discharge at S-79 was lower than the long-term average as would be expected during drought conditions. As shown in **Figure 11**, in 2009, wet season discharge was dominated by Tropical Storm Fay (which occurred on August 19, 2008), while dry season discharges were dominated by releases from Lake Okeechobee. Due to the El Niño, dry season discharges at S-79 in WY2010 were driven by runoff from the watershed (**Table 8**). During WY2011, the contribution (percent) of the lake to the total discharge at S-79 was higher than in the previous two years and the long-term average due to the drought.

In addition, Minimum Flows and Levels (MFLs) were established for the CRE in 2001 (SFWMD, 2000) and updated in 2003 (SFWMD, 2003). Further details on the MFLs and preferred freshwater inflows at S-79 are available in the *2009 South Florida Environmental Report* (SFER) – *Volume I, Chapter 12* (SFWMD, 2009).

Table 8. Total annual freshwater flow [10^6 acre-feet (ac-ft) per year] observed at S-79 by water year and source. Numbers in parentheses are percent of total annual discharge contributed by C-43 Basin and Lake Okeechobee, respectively.

Period of Record	Source					
	C-43		Lake Okeechobee		Total at S-79	
	Dry	Wet	Dry	Wet	Dry	Wet
WY1995–WY2008	0.18 (30.7%)	0.71 (67.7%)	0.41 (69.3%)	0.34 (32.3%)	0.6 (35.3%)	1.1 (64.7%)
WY2009	0.06 (35.2%)	0.72 (83.9%)	0.10 (64.8%)	0.14 (16.1%)	0.2 (18.2%)	0.9 (81.8%)
WY2010	0.29 (72.6%)	0.69 (98.4%)	0.11 (27.4%)	0.01 (1.6%)	0.4 (36.4%)	0.7 (63.6%)
WY2011	0.02 (45.9%)	0.62 (59.1%)	0.03 (54.1%)	0.43 (40.9%)	0.1 (9.1%)	1.0 (90.9%)

Nutrient Loads

The annual loading of TN and TP at the S-79 structure is directly proportional to variations in total freshwater inflow. Both TN and TP loading were highly correlated to inflow (r^2 = 0.96 and 0.75, respectively). Higher loading during the wet season of WY2006 corresponds with Hurricane Wilma and low loading during WY2007 and the beginning of WY2008 corresponds with subsequent drought years (**Figure 12**).

As shown in **Table 9**, the average TN and TP loads through S-79 for the long term average (WY1995–WY2008) were 2,915 and 240.9 mt/yr, respectively. The magnitude of TN loading was approximately 10 times that of the TP load. TN and TP loads during past three water years were less than the long-term average, which is reflective of lower discharges, with the exception of TP loading in WY2009 for an unknown reason.

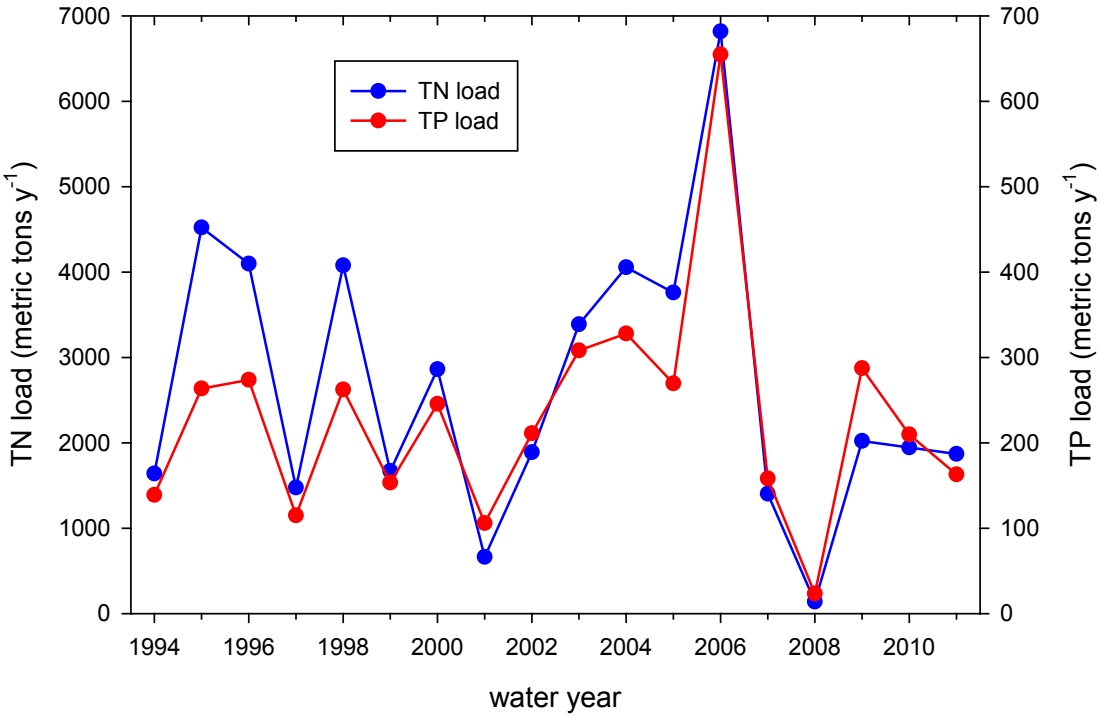


Figure 12. Annual loads of total nitrogen (TN) and total phosphorus (TP) in metric tons per year (mt/yr) to the CRE measured at the Franklin Lock and Dam (S-79).

Table 9. Annual loading of TN and TP (mt/yr) calculated for S-79.

Period of Record	TN Load	TP Load
WY1995–WY2008	2,915.0	240.9
WY2009	2,020.1	287.3
WY2010	1,945.7	209.8
WY2011	1,869.8	162.9

Estuarine Salinity and Water Quality

Two of the main influences affecting the ecological health of the estuary are undesirable high salinity conditions during the dry season from lack of dry season freshwater inputs and excessive freshwater discharges during the wet season causing exaggerated seasonal and short-term fluctuations in salinity throughout the estuary (SFWMD et al., 2009). Critical salinity criteria have been established at Ft. Myers and at the I-75 Bridge to protect valuable resources and to assist implementation of the Lake Okeechobee Regulation Schedule. The Ft. Myers location has two salinity criteria: maintaining daily salinity averages of not more than 20 psu and 30-day salinity averages of not more than 10 psu. Critical salinity criteria at I-75 is not more than 5 psu. The location of monitoring stations that record salinity at these two areas (Ft. Myers and Val-I75) are shown in **Figure 10**, while exceedances of the critical salinity criteria are provided in **Table 10**. Salinity in the estuary is inversely related to flows from the S-79 structure (**Figure 11**). During the past three water years (WY2009–WY2011) exceedances of the 30-day criterion at Ft. Myers were greater than the long-term average (WY1995–WY2008). Exceedances of the criteria were greater at both sites in WY2009 compared to WY2011 despite the WY2011 drought. This may reflect the management of water in Lake Okeechobee since total rainfall was 36 percent less in WY2011 than WY2009 (**Table 7**).

Excess TN and TP in estuaries is a local and worldwide problem. Excessive chlorophyll *a* (Chl*a*) and low dissolved oxygen (DO) are considered indicators of nitrification (excessive nutrients). Therefore, these constituents are commonly monitored in estuarine systems. Water column concentrations of TN, TP, and Chl*a* were generally sampled monthly at multiple stations in the CRE (**Figure 10**). The results of three representative stations, one located upstream of S-79 (CES01) and two downstream of S-79 (CES04 and CES06), are presented in **Figure 13**. Key findings of these results are as follows:

- Both TN and TP varied seasonally with annual maxima during the wet season when freshwater discharge is high. For TN, seasonality was most pronounced at the most downstream station (CES06). A large, unexplained peak in TN occurred at CES04 in March 2010, and a similar peak was observed for TP. Additionally, dry season TN peaks well outside of the long-term median occurred at CES01 and CES04 in WY2009 that was not as evident at the downstream CES06 station.
- Water column Chl*a* concentrations (measured in micrograms per liter, or µg/L) also exhibited seasonal peaks, with maximum values generally occurring between March and July.
- Although the highest single Chl*a* values occurred downstream at CES06, annual average Chl*a* exceeded the Chl*a* threshold for impaired waters of 11 µg/L (Rule 62.303, F.A.C.) further upstream at CES04 (**Table 11**). Station CES01 is east of the S-79 structure and considered a freshwater station. The impaired waters threshold for fresh water is 20 µg/L, which was not exceeded at CES01.

Table 10. Exceedances of critical salinity criteria at Ft. Myers and tape grass (*Vallisneria americana*) sampling site at the I-75 bridge (Val-I75). (Note: values provided are the percentage of days that exceed criteria for the daily average of WY1995–WY2008 and WY2009, WY2010, and WY2011.)

Period of Record	Ft. Myers Daily	Ft. Myers 30 Day	Val-I75
WY1995-WY2008	8%	28%	n/a
WY2009	16%	54%	43%
WY2010	0%	39%	27%
WY2011	<1%	45%	38%

Table 11. Average annual chlorophyll *a* (Chl*a*) concentrations (micrograms per liter, or µg/L) observed at CES01, CES04, and CES06. (Note: there were insufficient data from 1995–2008 to calculate long-term averages, therefore only WY2008 is used as a reference period for Chl*a* concentration status in WY2009, WY2010, and WY2011; there were Chl*a* no data available for the CES01 site in WY2011.)

Period of Record	CES01	CES04	CES06
WY2008	14.2	10.8	6.2
WY2009	8.1	12.1	8.0
WY2010	11.8	13.3	9.5
WY2011	n/a	9.0	6.8

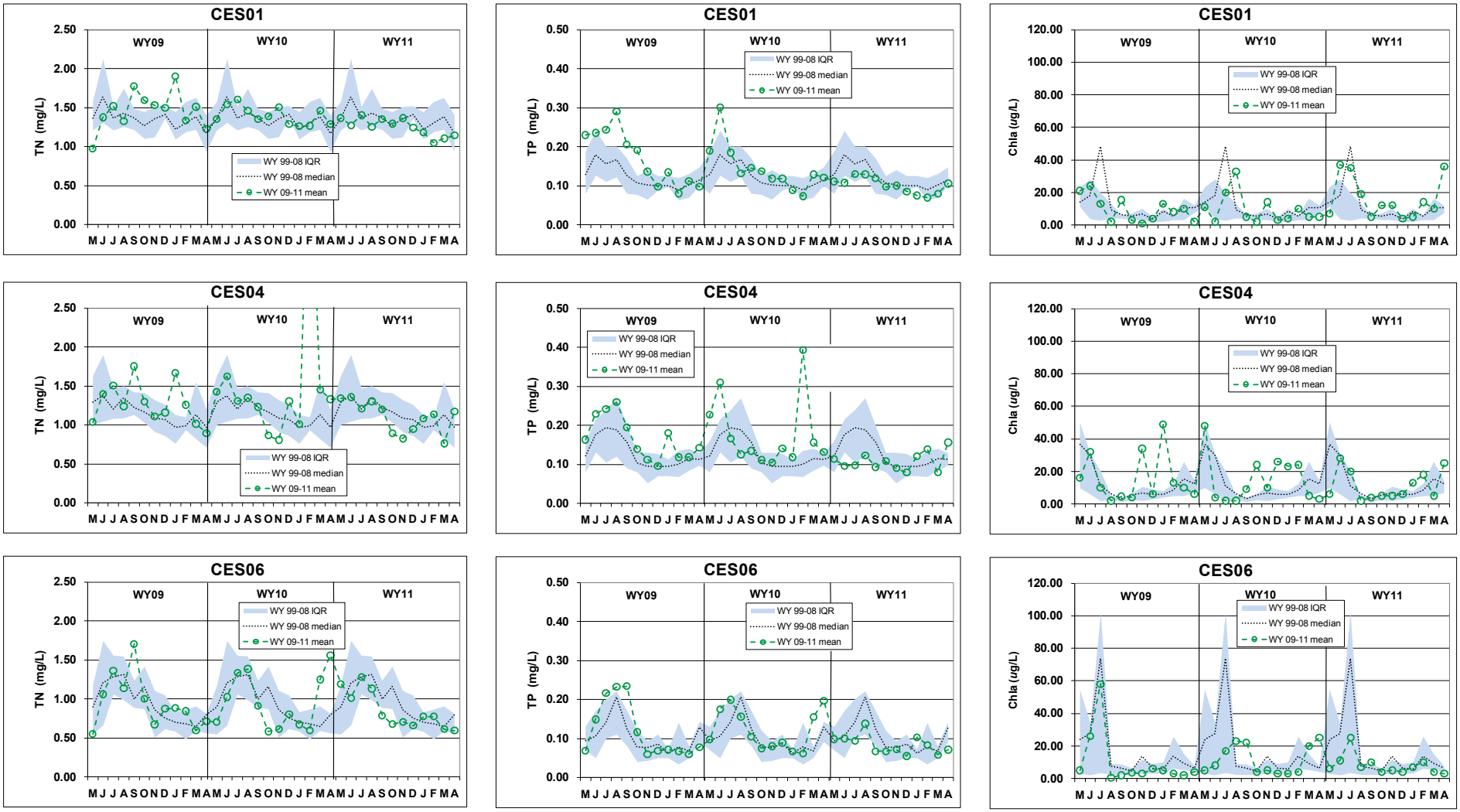


Figure 13. TP, TN, and Chl*a* concentrations at CES01, CES04, and CES06. (Note: includes monthly means from WY2009–WY2011, monthly median from WY1999–WY2008, and interquartile range of the data from WY1999–WY2008.)

Submerged Aquatic Vegetation

While SAV grows throughout the CRE, a spatial gradient in species composition exits. Two salt-tolerant freshwater species, tape grass and widgeon grass (*Ruppia maritima*), are typically found in the upper estuary (Stations 1, 2, and 4) (**Figure 10**). Further downstream, true seagrasses including shoal grass (*Halodule wrightii*) occur in Iona Cove (Stations 5 and 6), while a mixture of shoal grass and turtle grass (*Thalassia testudinum*) extends into San Carlos Bay (Stations 7 and 8) and beyond.

Although tape grass has been monitored in the upper estuary since 1998, regular monitoring of SAV throughout the estuary began in 2004. Initially, community composition and shoot densities were monitored at seven stations from 2004–2010 (**Figure 10**). Changes to the empirical methods used to monitor the abundance of SAV at Stations 1–8 in the CRE began in 2008 and were formalized in 2009. Rather than shoot counts leading to shoot density estimates, the new methods count the percentage of nested sampling grids occupied by a particular species or community (**Figure 14**). Overall, monitoring results show that the relative abundances of both tape grass and widgeon grass increased in 2010 at upstream Stations 1 and 2. Roughly 20–40 percent and 60–80 percent of sampling grid squares held shoal grass at Stations 6 and 5, respectively. While the abundance of shoal grass fluctuated between about 70–100 percent at Stations 7 and 8, turtle grass increased steadily from 2008–2011 to approximately 80 percent (**Figure 14**). Shoal grass cover declined in the dry season of WY2011 at both Stations 7 and 8.

Considering longer-term trends, shoot density data results from 2004–2010 reveal significant fluctuation in SAV throughout the CRE and San Carlos Bay. Shoot density is a measure of standing crop and showed fluctuations which appear to be related to freshwater discharges. High freshwater discharges, such as those occurring in 2005 (Hurricane Wilma) and 2009 (Tropical Storm Fay), caused a notable decline in shoal and turtle grass densities at the marine end of the system (Iona Cove and San Carlos Bay). By contrast during the drought in 2007–2008, the density of marine seagrass increased while densities of tape grass in the upper estuary declined to zero (**Figure 15**). Subsequent to this drought, tape grass began recovering in 2010 (**Figure 15**).

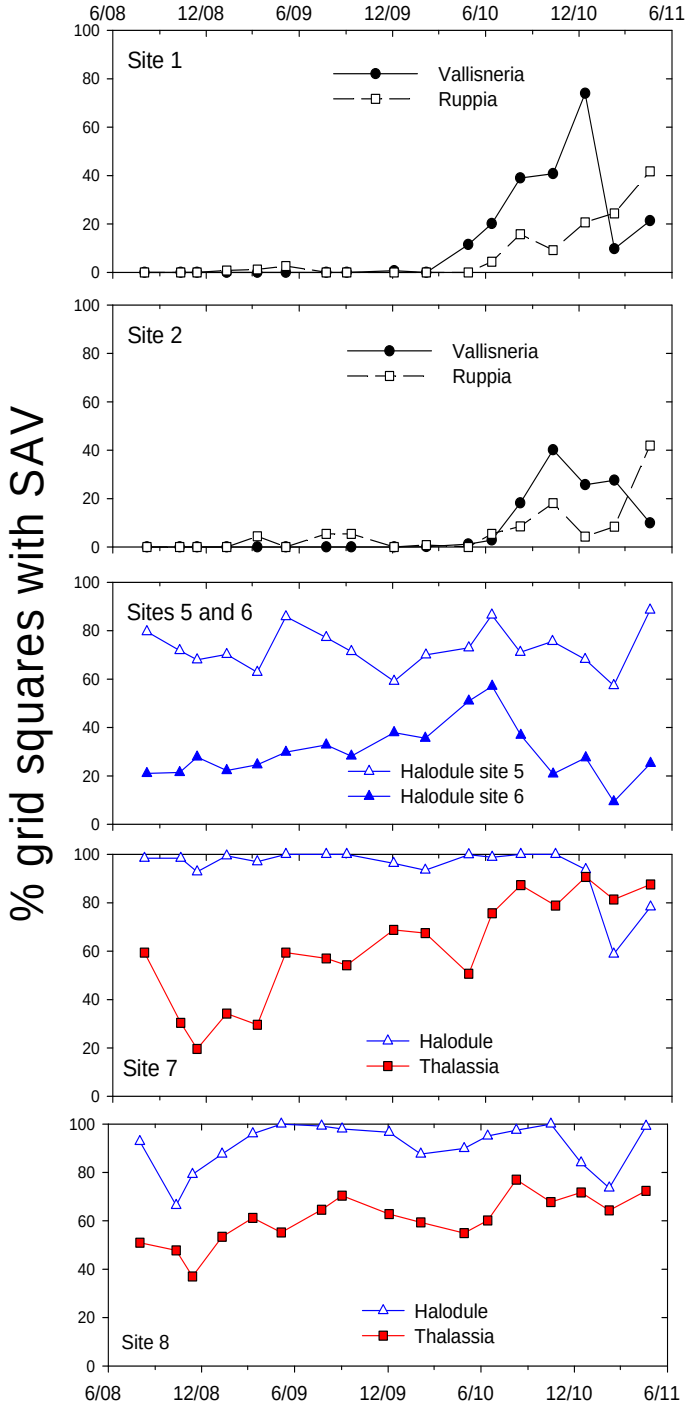


Figure 14. Submerged aquatic vegetation (SAV) abundance in the CRE (see station locations in **Figure 10**). (Note: field monitoring methods changed in 2009; results indicate percentage of 25 sampling grid squares in which each SAV species occurred.)

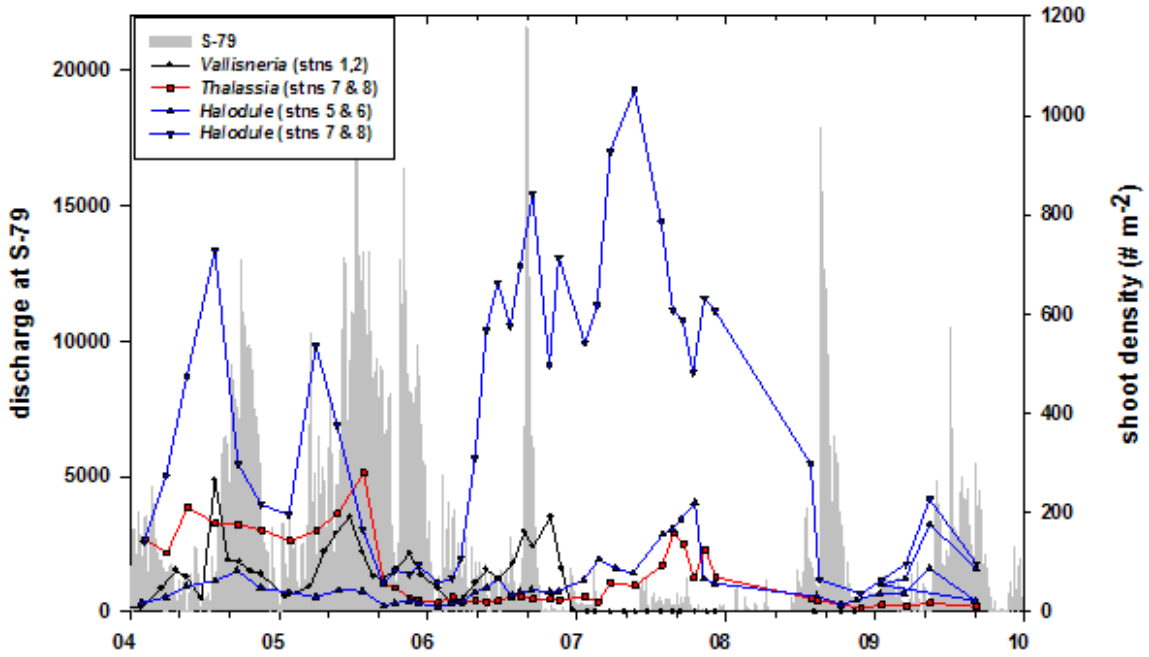


Figure 15. SAV shoot density (shoots per square meter) and salinity from 2004–2009. [Note: averages were derived from all transects sampled at seasonal intervals; the shaded area shows.

Eastern Oyster

Eastern oyster (*Crassostrea virginica*) monitoring has been conducted at several stations in the lower CRE since 2006 (**Figure 10**). Measurements have included condition index (CI; gdw oyster gdw shell^{-1}), prevalence and intensity of the oyster parasite *Perkinsus marinus* (Dermo; 0–5 intensity scale), larval settlement (spat; # shell^{-1} month^{-1}) and the density of live adult eastern oysters (# m^{-2}). The lower salinity threshold of oysters is generally accepted to be 10 psu (Woodward-Clyde, 1998) with salinities below 10 psu leading to harm and mortality. The upper salinity threshold is more ambiguous and is related to disease and increased sensitivity to predation (Woodward-Clyde, 1998). Environmental conditions are generally good for oysters in the lower CRE. Over the past five years, live densities have ranged from less than 100 oysters per square meter (m^2) at Cattle Dock in 2006 to more than 3,000 oysters/m^2 at Bird Island in 2010 (**Figure 16**). Overall, oyster densities were greatest at Bird Island in 2006, 2009, and 2010.

The condition index of the oysters oscillated seasonally at all sites (BI, IC, KK, TB) ranging mostly from 2.0 in the wet season to 4.0 in the late dry season (**Figure 17**). The increase in the late dry season (e.g., February–April) is due to the increase in gonadal tissue within the oyster as they prepare to spawn. While IC and TB appeared to exhibit the greatest variability in condition index, BI and KK were more consistent throughout the time series. There has been a significant downward trend in condition index at the BI site from September 2000–2010 (Seasonal Kendall τ, slope = -0.05; ρ = 0.03). This suggests a slight degradation of oyster condition during this period that could be associated with a variety of environmental factors and biological processes (temperature, salinity, disease, predation, reproduction).

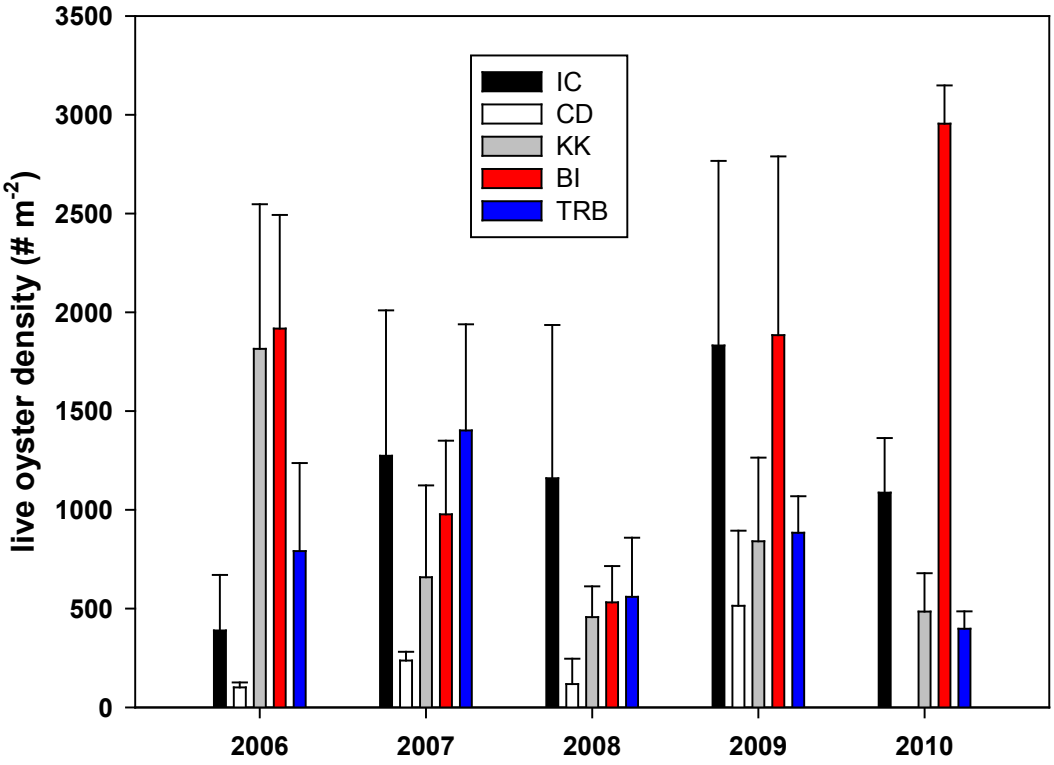


Figure 16. Average live eastern oyster densities (with standard error per square meter) from spring 2006–spring 2010.

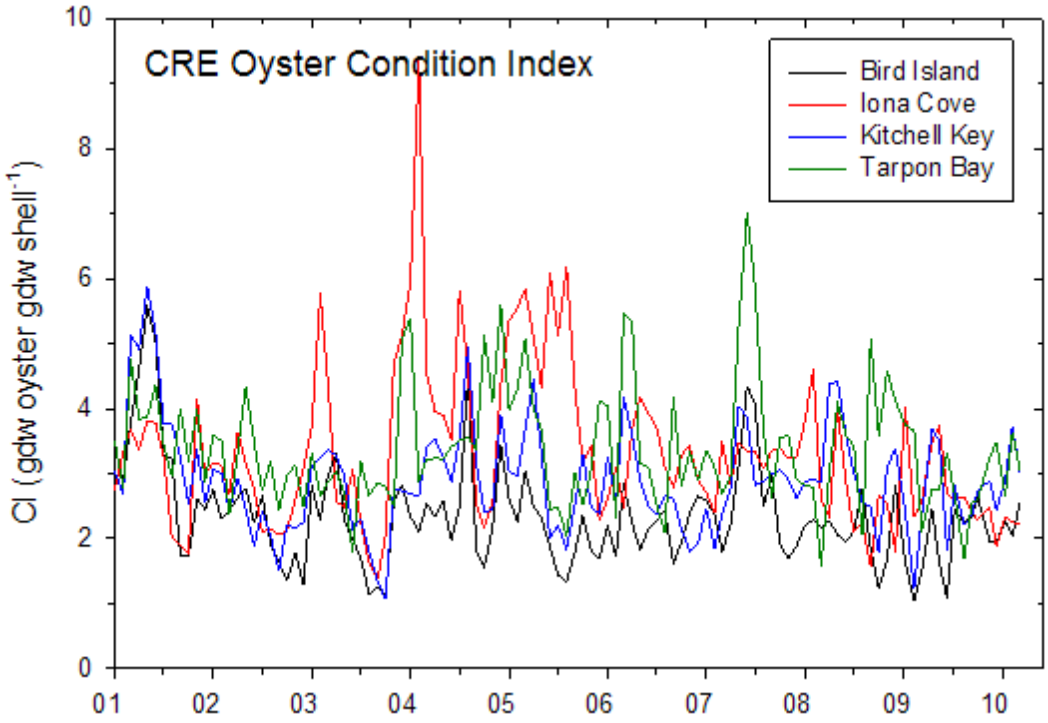


Figure 17. Average monthly condition index (CI) for eastern oysters sampled from sites in the lower CRE since January 2001. [Note: gdw is gram dry weight.]

LONG-TERM TRENDS (1995–2010)

This section focuses on identifying possible long-term trends of rainfall, freshwater inflow, estuarine water quality, and aquatic habitat in the CRE. The POR for these analyses was 1995–2010, except when monitoring was initiated more recently. While identifying long-term trends was the overall objective, datasets were split into two periods (1995–2005 and 2006–2010) for comparisons between antecedent and contemporary conditions.

Rainfall

Based on NEXRAD rainfall data, annual total rainfall in the watershed ranged from just below 40 inches in 2000 and 2006 to almost 70 inches in 2005 (**Figure 18**), with no obvious long-term trend. NEXRAD Caloosahatchee units are shown in **Figure 19**. Average annual rainfall in both the dry seasons (12.6–14.7 inches) and wet seasons (34.1–40.8 inches) was similar among the sub-watersheds for the long-term period (1996-2005) (**Table 12**). There was notably more variation during the wet season for the period 2006-2010 (30.5–43.6 inches), with the highest average rainfall occurring in the CCC NEXRAD unit. Average annual rainfall was lower during 2006–2010 than the 1996–2005 period in all basins draining into the CRE.

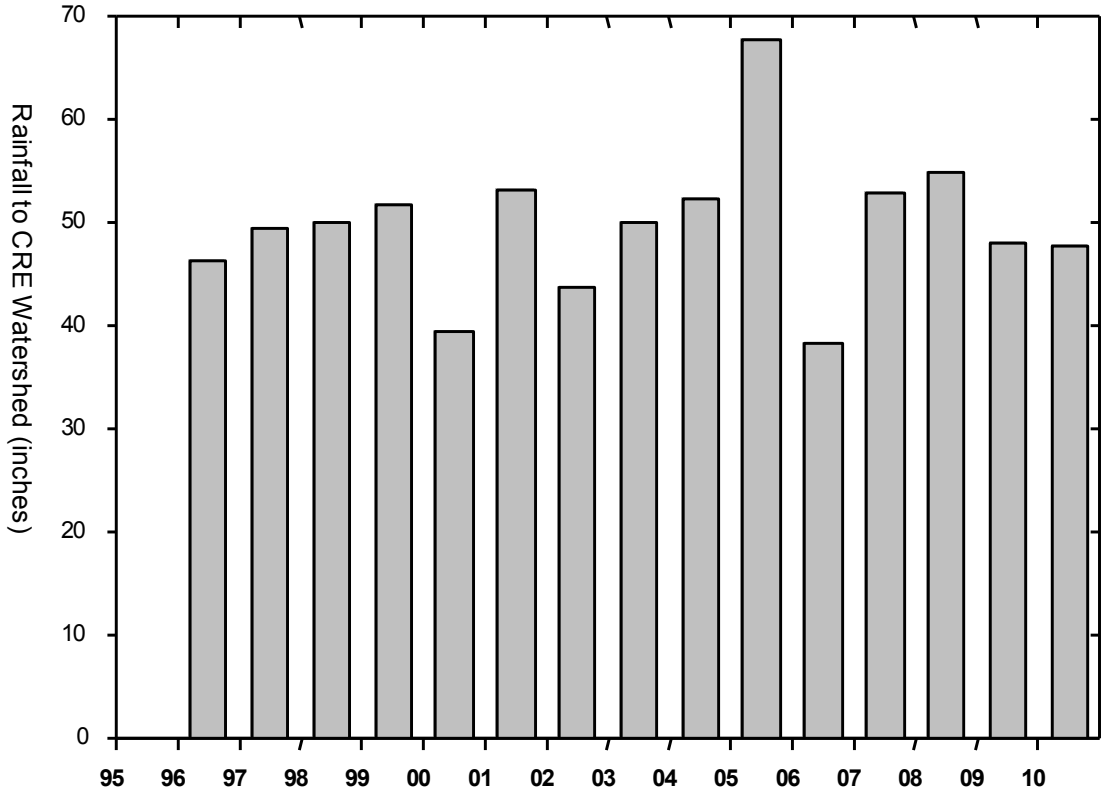


Figure 18. Annual average rainfall in the Caloosahatchee River Watershed derived from NEXRAD data available since 1996.

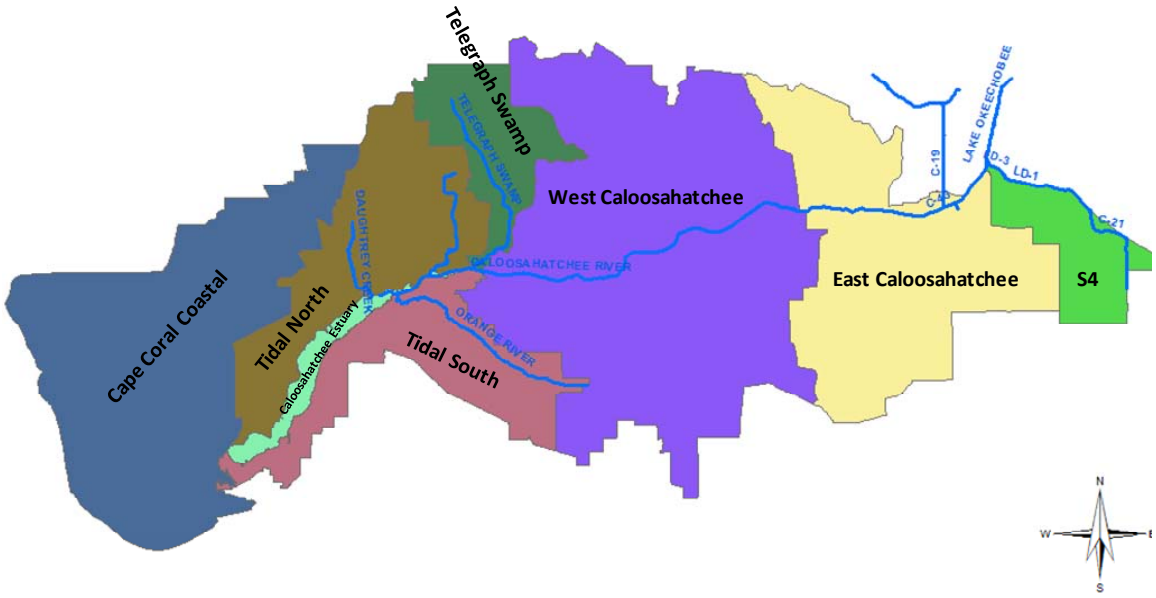


Figure 19. NEXRAD Caloosahatchee units used for estimates of rainfallderived from NEXRAD data, available since 1996.

Table 12. Total monthly rainfall (inches) during 1996–2005 and 2006–2010 for the NEXRAD units; westward from Lake Okeechobee, the sub-watersheds include S4, East Caloosahatchee (EC), West Caloosahatchee (WC), Tidal Caloosahatchee[1] (TC), and Cape Coral Coastal[2] (CCC) components.

	S4		EC		WC		TC		CCC	
	1996–2005	2006–2010	1996–2005	2006–2010	1996–2005	2006–2010	1996–2005	2006–2010	1996–2005	2006–2010
Jan	1.5	1.1	1.2	0.8	1.5	0.8	1.4	1.7	1.0	0.8
Feb	1.7	2.3	1.6	1.9	2.0	1.8	1.9	2.2	1.5	2.2
Mar	2.6	2.5	2.9	2.5	4.0	3.1	3.1	2.7	2.3	2.0
Apr	1.9	2.5	2.2	2.3	1.7	2.3	2.0	2.5	1.8	3.0
May	5.1	4.9	4.0	4.2	3.8	3.7	3.3	4.3	4.2	4.2
Jun	9.7	7.0	8.8	7.9	7.3	4.4	8.1	7.2	8.2	9.7
Jul	6.8	9.1	7.2	7.9	6.8	7.8	6.1	7.2	6.8	9.0
Aug	7.4	6.7	7.7	9.4	8.1	9.6	7.3	7.7	8.0	8.7
Sep	8.6	9.8	7.5	6.4	7.7	5.7	7.1	6.1	8.9	10.3
Oct	5.5	3.8	3.8	2.5	3.8	2.2	3.7	3.0	5.7	4.6
Nov	2.9	1.6	2.4	0.8	3.3	0.7	1.8	1.3	1.8	1.3
Dec	1.8	1.6	1.4	2.1	1.4	2.8	2.5	1.7	1.8	1.7
Average Dry	14.7	14.9	13.3	13.8	14.5	14.6	14.2	15.0	12.6	13.9
Average Wet	40.8	37.9	37.4	34.9	37.1	30.5	34.1	32.4	39.3	43.6
Average Annual	55.5	52.8	50.7	48.7	51.5	45.1	48.4	47.5	51.9	57.5

[1]The Tidal Caloosahatchee NEXRAD unit includes Telegraph Swamp, Tidal North, and Tidal South units.
[2]The Cape Coral Coastal NEXRAD unit drains west of the CRE.

Freshwater Inflow

Sources and volumes in acre-feet of annual discharge and annual inflows to the CRE are provided in **Figure 20 and Table 13**, respectively. For the period between 1995 and 2010, total annual discharges to the CRE from Lake Okeechobee outflow, C-43 watershed upstream of S-79, and tidal basin downstream of S-79 combined ranged from less than 1 million ac-ft to more than 4 million ac-ft. Between 2006–2010, the CRE experienced a 24 percent decrease in total inflow relative to 1995–2005, with a reduced contribution from all sources. The major source of discharge to the CRE is the C-43 Basin (comprising the East Caloosahatchee, West Caloosahatchee, and S-4 sub-watersheds). The percent contribution of the C-43 Basin and the Tidal Caloosahatchee Basin were relatively higher during the 2006–2010 period, while the lake contributions were lower over this period.

To better manage inflows to the estuary, the District has established preferred flow ranges for discharges at S-79 using freshwater SAV as an indicator (Chamberlain and Doering, 1998a; Chamberlain and Doering, 1998b; Doering et al., 2002). District research has established that mean monthly flows between 450 and 2,800 cubic feet per second (cfs) at S-79 are generally protective of the estuarine ecology from S-79 to Shell Point (**Figure 11**). A considerable amount of work has demonstrated that these flows are not harmful to other components of the ecosystem including fish and shellfish, zooplankton, and ichthyoplankton (Chamberlain and Doering, 1998b; SFWMD, 2003; Volety et al., 2003). Average daily discharges from S-79, averaged by month, are compared to these flow targets in **Table 14**. Flows on a monthly basis from 2006–2010 remained within the preferred flow ranges for 24 months (40 percent). Compared to the long term POR (1995–2005), the contemporary POR had a lower percentage of high flow months (exceeding 2,800 cfs)(8 months or 13 percent), but a higher percentage of months when the low flow target was not met (28 months or 47 percent) due to the 2006–2008 drought conditions.

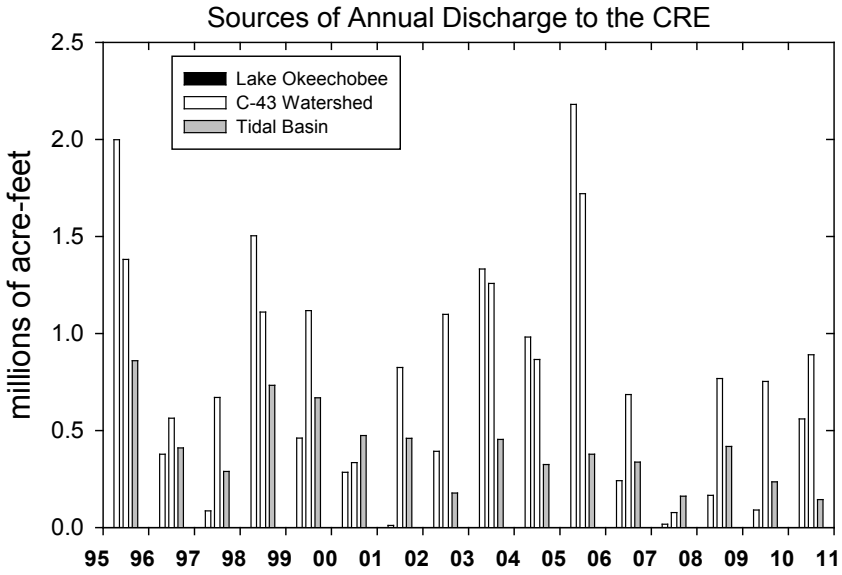


Figure 20. Contributions to total annual inflow [10^6 acre-feet (ac-ft)] to the CRE.

Table 13. Annual inflows (10^6 ac-ft) to the CRE by period of record (POR; 1995–2005 and 2006–2010) and source (Lake Okeechobee, C-43 watershed, CRE tidal basin). [Note: tidal basin flows were estimated using a linear reservoir model.]

Period of Record	Total Inflow	% Lake Okeechobee	% C-43 Watershed	% CRE Tidal Basin
1995–2005	2.1	30.9	44.9	24.2
2006–2010	1.6	17.0	51.7	31.3

Table 14. Daily discharge at S-79 (cubic feet per second, or cfs) averaged by month for 1995–2010. Cells are color-coded to represent five different levels of freshwater inflow (<450; 450-2,800; 2,800-4,500; 4,500-6,500; >6,500).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	5406	2348	68	5632	665	809	154	490	3870	1651	1401	769	238	59	635	484
Feb	3819	331	472	8296	98	17	0	454	1887	1902	1183	1558	253	43	496	566
Mar	2681	267	250	10156	7	342	30	693	738	902	3074	1146	0	36	179	2135
Apr	1274	1017	458	6376	780	1351	32	237	714	642	2531	1028	0	124	311	2789
May	124	696	357	2095	301	2914	126	431	1958	267	3410	625	0	0	713	4591
Jun	1731	4304	832	477	3601	494	474	3753	5904	700	8634	625	218	330	1791	3267
Jul	3394	3813	1401	821	3185	1029	2115	5441	3591	582	11593	1039	255	1516	3438	4721
Aug	8287	1012	2500	3195	2690	486	2999	2795	7469	4040	8873	2816	171	5780	2751	2430
Sep	9357	389	2009	2759	3961	1816	5454	5024	8962	5518	4900	5495	312	4744	2572	1322
Oct	10391	1037	884	1024	4853	798	1657	1709	4692	9356	4087	71	84	1727	213	264
Nov	6785	24	394	2578	4170	148	447	766	1369	3918	9187	17	7	417	146	516
Dec	2708	272	2840	296	1779	0	311	2816	1695	991	5903	265	43	523	597	0

< 450 cfs
> 450 and < 2800 cfs
> 2800 cfs
> 4500 cfs
> 6500 cfs

Nutrient Loading at S-77 and S-79

Monthly average concentrations of TN and TP observed at S-77 and S-79 from 1995–2005 and 2006–2010 were assessed using comparative box plots to illustrate temporal patterns and variability. As depicted in **Figure 21**, TN concentrations were similar between the periods at both S-77 and S-79 and there was little evidence of seasonality. The box plots indicate that TP concentrations overall were highest during the wet seasons. TP concentrations from the S-77 structure for the current period were higher in the summer months than for 1995–2005. Mann-Whitney u-test analysis revealed that TP concentrations at S-77 were significantly greater in the 2006–2010 interval ($p<0.05$) in March, May, September, and overall than during 1995–2005. A similar trend of overall higher TP concentrations existed from the S-79 structure. Lower flows during 2006–2010 could have contributed to the higher TP concentrations during this period.

Long-term trends in TN and TP loading at S-77 and S-79 were analyzed using the non-parametric seasonal Kendall-τ statistic (**Table 15**). Overall there were no statistically significant long-term trends in loading for either nutrient at S-77 or S-79. This result was obtained irrespective of the period examined.

Table 15. Analyses of long-term trends in TN and TP loading at S-77 and S-79. [Note: monthly loads provided the input data. Seasonal Kendall-τ analysis was used to detect trends at each location for two periods (1995–2005 and 1995–2010), with the second interval representative of the total trend from 1995–2010. Kendall-τ results included the slope and ρ-value.]

S-77		TN_{load}		TP_{load}	
	N	slope	ρ-value	slope	ρ-value
1995-2005	132	5801.3	0.33	386.1	0.16
1995-2010	192	-335.1	0.62	-2.63	0.92
S-79		TN_{load}		TP_{load}	
	N	slope	ρ-value	slope	ρ-value
1995-2005	132	10118.5	0.27	891.8	0.12
1995-2010	192	-2528.4	0.49	-92.0	0.73

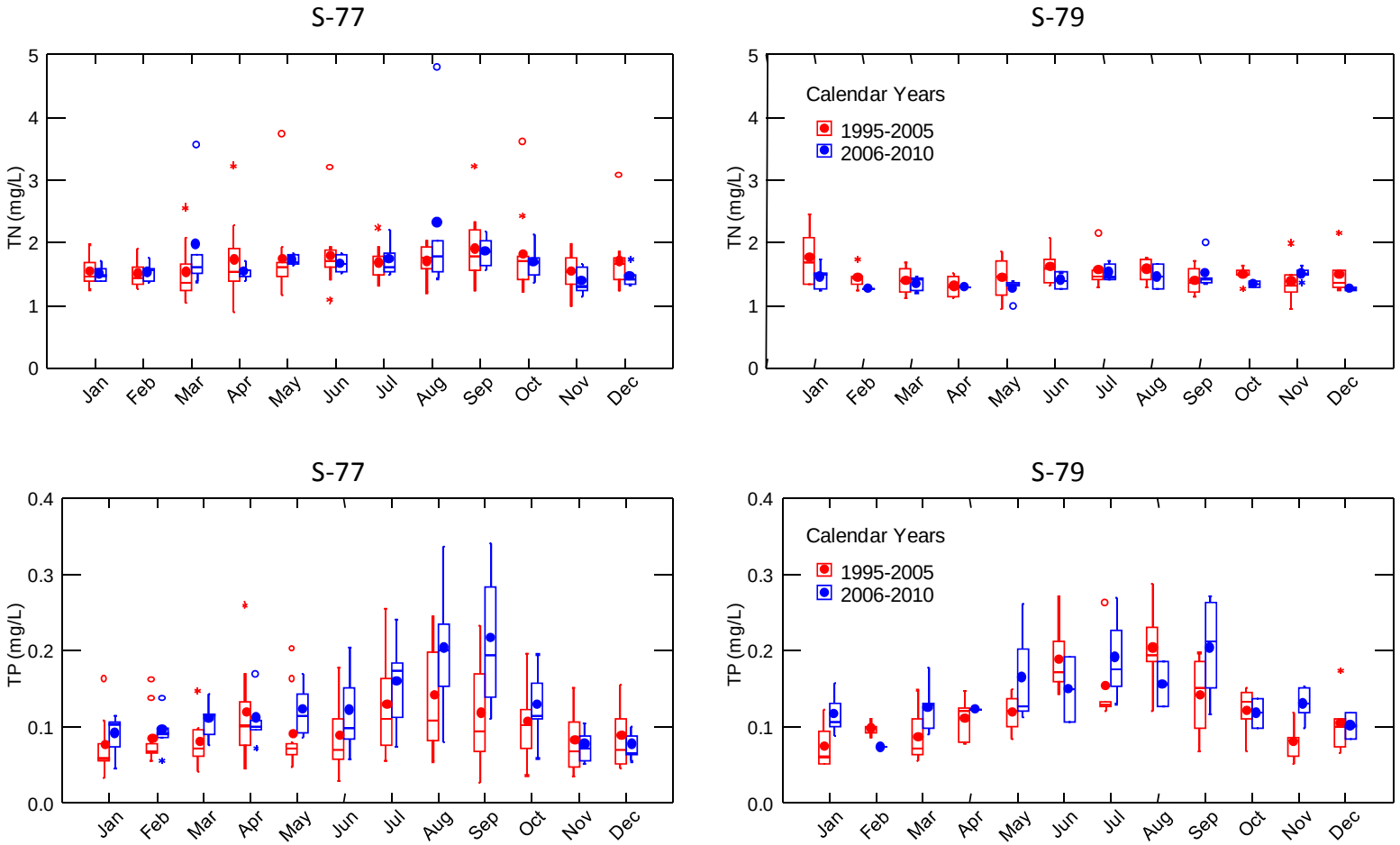


Figure 21. Comparative box plots for TN and TP concentrations by month at S-77 (left panels) and S-79 (right panels) for 1995–2005 (red) and 2006–2010 (blue).

Estuarine Salinity

Salinity observations were recorded in surface and bottom layers at five stations along the CRE from 1995–2010. Stations were located at S-79, Route 31 Bridge (BR31), Interstate 75 Bridge (I75), Ft. Myers (FM), Shell Point (SP), and Sanibel Island (SB) (**Figure 10**). It should be noted that not all stations have contiguous data throughout the POR due to instrumentation service or loss during storm (e.g., the SB monitor during Hurricane Wilma in 2005). As such, while each station holds two in situ data recorders fixed near the water surface and near the bottom, stations S-79, BR31, and FM had the most complete data to identify salinity trends. Overall, findings show that median salinity increased downstream (**Figure 22**). For both periods, monthly salinities were greatest from April–June and lowest from July–October, indicating sub-tropical seasonality of South Florida estuaries. Increased salinity values observed from 2006–2010 compared to 1995–2005 were due to reduced freshwater inflow since the fall of 2005.

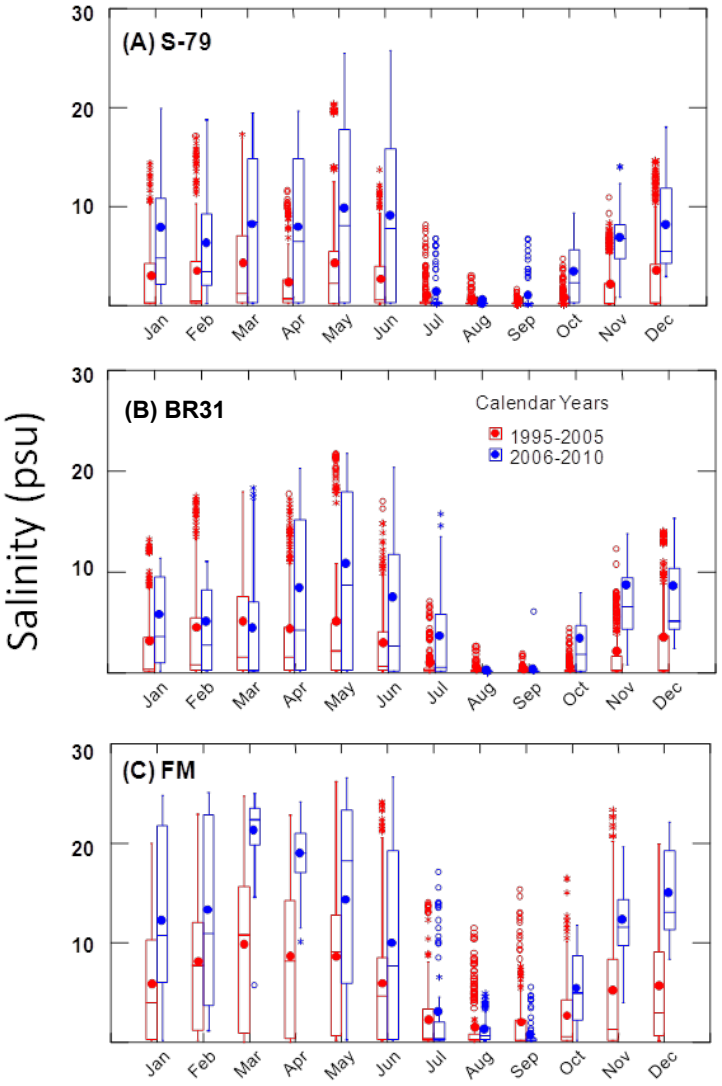


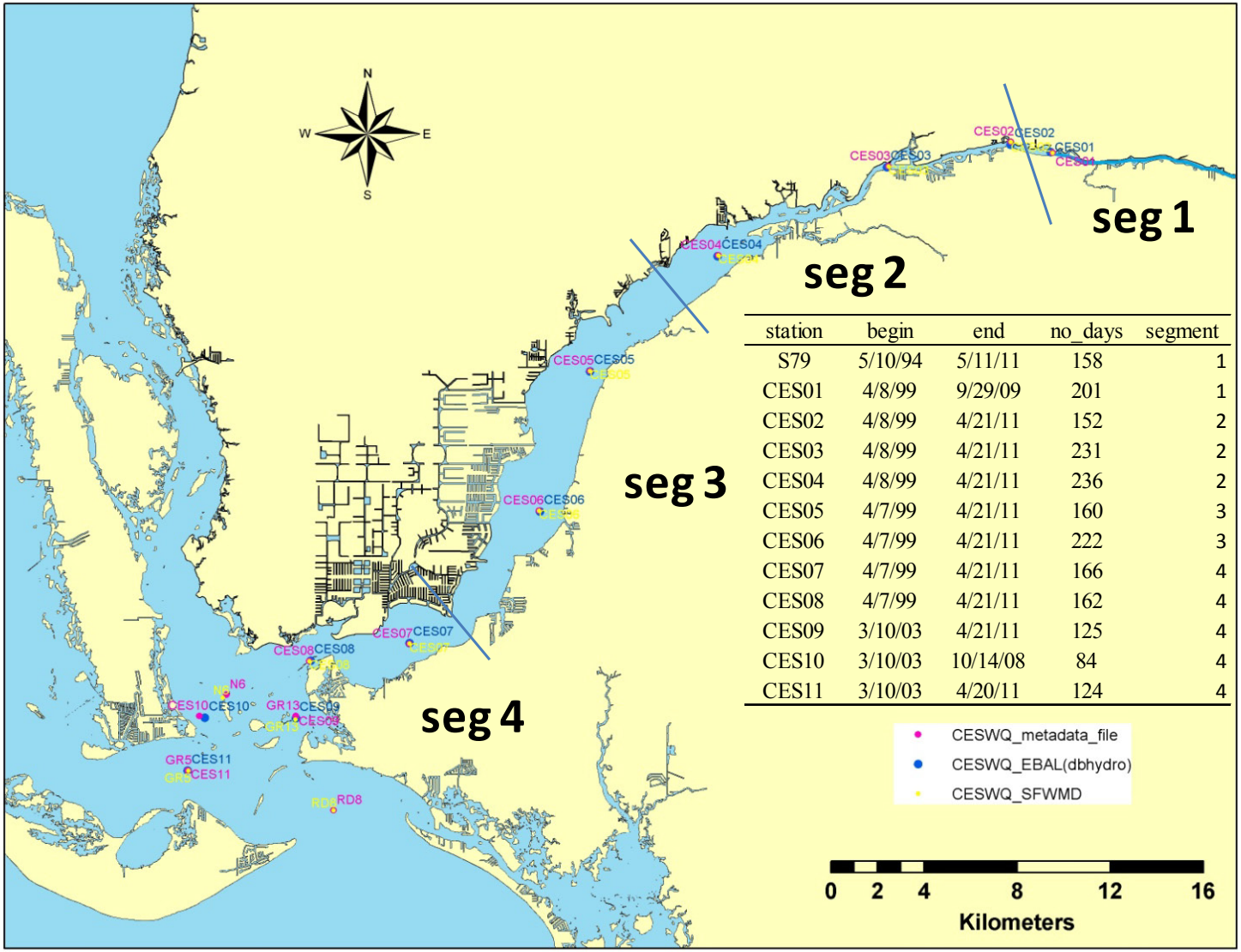
Figure 22. Box plots showing monthly salinity distributions from continuous monitoring in the CRE: (A) S-79, (B) Bridge 31 (BR31), and (C) Ft. Myers (FM). Salinity distributions from 1995–2005 are shown in red, and those from 2006–2010 are shown in blue.

Estuarine Water Quality Trends

The District, along with other agencies, supports water quality monitoring in the CRE. The 12 primary monitoring sites span the entire water body from S-79 to San Carlos Bay (**Figure 23**), with varying temporal coverage for different variables. From historical monitoring, there were 222 to 236 sampling days at stations CES03, CES04, and CES06, but only 84 to 166 days at the downstream stations of CES07–CES11. Temporal patterns of average water column salinity (S), DIN, dissolved inorganic phosphorus (DIP), TN, TP, colored dissolved organic matter (measured as COLOR), DO, and Chl*a*) were analyzed only for stations CES03, CES04, and CES06. Data from the stations were assigned segment designations along the length of the CRE (segments 1–4) (**Figure 23**) to examine variability and establish baseline levels for key statistics (minimum, maximum, interquartile range, median, arithmetic mean, and standard deviation).

As stated earlier, flows are inversely related to salinity; however, direct relationships between flows and TP, TN, and Chl*a* concentrations are not as evident because of the significant influence of biological processes on these constituents. For example, the effect of the drought, which started in 2006 and continued through 2008, was evident as flows decreased and salinity increased (**Figure 24**). In contrast, TP concentrations were generally higher in 2007–2009 with evidence of seasonality. TN concentrations over this time remained within a narrow range of approximately 0.6–1.5 milligrams per liter (mg/L) and did not exhibit the larger fluctuations present in the remainder of the POR. Water column Chl*a* exhibited greater magnitude and variability from 2006–2010 than the previous wetter period of 2004–2005. Chl*a* concentrations were approximately 70, 45, and 50 µg/L among the three stations during the dry seasons of 2008–2009. While these values were comparatively high, they are difficult to relate to a single factor such as inflow or salinity as submarine light penetration, inorganic nutrient availability, transport, and grazing all interact to modulate phytoplankton biomass production.

Salinity averaged 0.3, 3.7, 8.7, and 22.5 psu from upstream segment 1 to downstream segment 4, respectively (**Table 16**). Both DIN and DIP concentrations were variable within and among the segments, with mean values ranging from 0.016–0.264 and 0.030–0.086 mg/L from segment 4 to segment 1, respectively. TN and TP were generally less variable than DIN and DIP, but also decreased in the downstream direction. Water column COLOR is introduced with freshwater inflow and therefore was inversely correlated to salinity. Chl*a* averaged 9.2, 10.7, 12.5, and 4.6 µg/L across segments 1–4, respectively. Seasonal Kendall Tau analyses of TN, TP, and Chl*a* concentrations at CES03, CES04, and CES06 showed no statistically significant trends ($p>0.05$) at any station for any water quality parameters, irrespective of the period examined (1995–2005 or 1995–2010).



station	begin	end	no_days	segment
S79	5/10/94	5/11/11	158	1
CES01	4/8/99	9/29/09	201	1
CES02	4/8/99	4/21/11	152	2
CES03	4/8/99	4/21/11	231	2
CES04	4/8/99	4/21/11	236	2
CES05	4/7/99	4/21/11	160	3
CES06	4/7/99	4/21/11	222	3
CES07	4/7/99	4/21/11	166	4
CES08	4/7/99	4/21/11	162	4
CES09	3/10/03	4/21/11	125	4
CES10	3/10/03	10/14/08	84	4
CES11	3/10/03	4/20/11	124	4

Figure 23. Water quality stations along with associated historical sampling time and frequency.

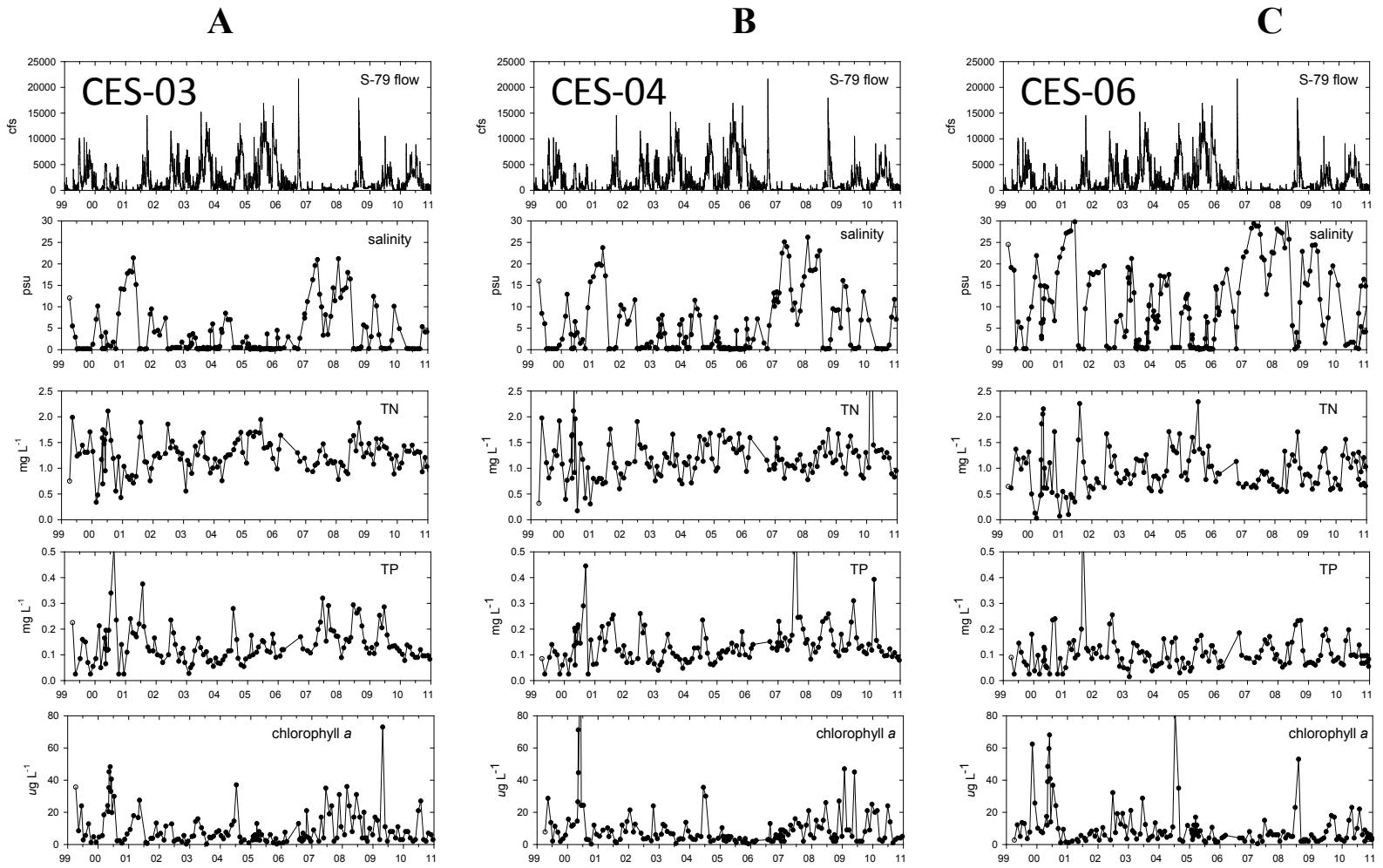


Figure 24. Time series of S-79 flow, salinity (psu), TN (mg/L), TP (mg/L), and Chl*a* (µg/L) at (A) CES03, (B) CES04, and (C) CES06.

Table 16. Descriptive statistics for water quality variables grouped by segment.

Segment 1	**S**	**DIN**	**DIP**	**TN**	**TP**	**COLOR**	**DO**	**Chl*a***
N of Cases	178	359	256	347	335	212	324	147
Minimum	0	0	0.002	0.286	0.015	31	1.2	0.25
Maximum	4.72	0.89	0.262	2.45	0.301	268	12.2	73.8
Interquartile Range	0.27	0.233	0.059	0.278	0.06	57.3	3.015	6.957
Median	0.257	0.251	0.078	1.36	0.117	71	6.183	4.935
Arithmetic Mean	0.342	0.264	0.086	1.375	0.126	90.755	6.139	9.163
Standard Deviation	0.373	0.175	0.047	0.275	0.055	52.312	2.043	11.786
Segment 2	**S**	**DIN**	**DIP**	**TN**	**TP**	**COLOR**	**DO**	**Chl*a***
N of Cases	547	619	332	354	352	338	546	397
Minimum	0.1	0	0.001	0.173	0.025	22	1.815	0.25
Maximum	26.2	0.733	0.336	4.971	0.689	386.5	13.3	163
Interquartile Range	5.695	0.24	0.06	0.406	0.075	66	2.707	9.025
Median	0.5	0.03	0.069	1.2	0.121	68	5.862	5
Arithmetic Mean	3.742	0.125	0.08	1.216	0.137	88.796	5.73	10.651
Standard Deviation	5.562	0.155	0.053	0.4	0.078	56.854	1.771	15.94
Segment 3	**S**	**DIN**	**DIP**	**TN**	**TP**	**COLOR**	**DO**	**Chl*a***
N of Cases	334	382	196	207	206	200	334	235
Minimum	0.1	0	0.001	0.03	0.015	10	2.28	0.25
Maximum	32.5	1.075	0.232	2.692	0.63	256.5	12.1	119
Interquartile Range	14.78	0.045	0.04	0.532	0.063	50.625	1.895	8.576
Median	6.579	0.007	0.042	0.846	0.091	46	7.015	6
Arithmetic Mean	8.711	0.061	0.054	0.935	0.105	66.827	6.923	12.521
Standard Deviation	8.689	0.123	0.042	0.432	0.064	52.284	1.536	17.81
Segment 4	**S**	**DIN**	**DIP**	**TN**	**TP**	**COLOR**	**DO**	**Chl*a***
N of Cases	517	661	199	208	207	138	546	255
Minimum	0.17	0	0.002	0.03	0.016	6	2.743	0.15
Maximum	38.075	0.505	0.171	2.465	1.035	206	12.7	51.1
Interquartile Range	13.371	0.011	0.019	0.32	0.041	22	1.71	3.475
Median	24.952	0	0.024	0.46	0.053	23.5	6.613	3
Arithmetic Mean	22.458	0.016	0.03	0.506	0.075	33.703	6.589	4.602
Standard Deviation	9.61	0.048	0.026	0.323	0.089	33.552	1.275	5.546

RESEARCH AND WATER QUALITY MONITORING PLAN STATUS

Research Project Updates

Research projects included in the RWQMP are intended to address key uncertainties in nutrient load targets (i.e., TMDLs), flow and salinity envelopes, and operational rules for infrastructure. The latter is particularly important because water management practices influence nutrient delivery to and salinity variability in the downstream estuary.

The 2009 Caloosahatchee RWQMP outlines research projects in three main areas: nutrient budget, the low salinity zone, and light attenuation in San Carlos Bay (**Table 17**). A brief description of the objectives, salient results, and other key information of projects falling under these research areas are provided in **Table 18**. The nutrient budget and light attenuation in San Carlos Bay research areas are related to water quality, nutrient loads, and estimating nutrient cycling rates. Projects under these areas support the development of models to predict responses of estuarine water quality to the nutrient load reductions. Projects in the low salinity zone area aim to quantify the influence of freshwater discharge on this critical estuarine nursery habitat for commercially and recreationally important finfish and shellfish species. Low salinity zone projects support the refinement of salinity and flow envelopes as well as development of operational rules for dry season freshwater discharges from canals and water treatment and storage projects. Additional project details are also covered in the 2009 and 2010 SFERs – Volume I, Chapter 12, and 2009 CRWPP (Chapter 5, Appendix E).

Estuarine Nutrient Budget Project

Nutrient budget projects assist in determining appropriate nutrient reduction approaches and in evaluating and optimizing project effectiveness. Because a nutrient budget comprises both controllable and uncontrollable sources of nutrients, it provides the basic information required to quantify the achievable limit of improvement. Including internal cycling terms as constraints (such as the regeneration of nutrients by bottom sediments) allows for estimating the time scale of system response to external load reductions. Project results are intended to support water quality modeling efforts, reduce the uncertainty of the appropriate targets, and increase the capability to predict effects of various nutrient reduction strategies.

Overall, five research projects have been conducted since 2009 that support a nutrient budget for the CRE and are discussed below.

Measurements of Primary Production in the Caloosahatchee Estuary

The ultimate goal of many nutrient reduction programs is to improve water quality (e.g., water clarity, DO) by reducing the magnitude and frequency of phytoplankton blooms. Understanding the factors that control phytoplankton growth and quantification of the growth rate itself is central to predicting the results of nutrient reduction. In March 2009, a project was initiated to measure primary productivity and to establish an empirical model that relates phytoplankton productivity to Chl*a* biomass and light intensity. The work quantifies productivity through a simulated, in situ incubation technique that measures DO changes at several light levels. It also provides guidance for the calibration of a water quality model for the CRE system (Phlips and Mathews, 2009), which can be utilized for water management decisions.

Table 17. Research areas identified in the 2009 CRWPP.

Research	Purpose	Management Objectives	Applications
Nutrient Budget	Identify and understand the origin, magnitude, and management of controllable, problematic nutrient loads in CRE	This research supports CRWPP goal of achieving the nutrient TMDL for CRE	Quantify nutrient loads from various sources, and support water quality modeling to reduce the uncertainty of the TMDL and increase the capability to predict effects of various management measures
Low Salinity Zone	Characterize and quantify the effects of freshwater discharges on production in, and utilization of, the low salinity zone in the CRE	This research supports CRWPP goal to minimize the occurrence of undesirable salinity ranges in CRE	Refine the CRE salinity envelope and provide environmental guidelines for delivery of freshwater to the estuary
Light Attenuation in San Carlos Bay	Characterize and quantify the effects of freshwater flows on the relative importance of three components of water clarity in San Carlos Bay: turbidity, COLOR, and Chl*a*	This research supports achieving a water clarity goal in San Carlos Bay through nutrient load reduction; the project tests whether this objective is achievable	Information from this study will better define controls on light attenuation in San Carlos Bay and the relationship between the TMDL and its resource goal; results can be used to determine when, and under what conditions, resource light attenuation goals may be met

Table 18. Research projects reported annually for the 2009 CRWPP.

Research	Project	Project Objectives	Conclusions/Applications
Nutrient Budget	Measurements of Primary Production	Establish an empirical model that relates phytoplankton productivity to Chl*a* biomass and light intensity in CRE	Provides guidance for the calibration of a water quality model for CRE system that will be used to assess the benefits of the CRWPP
	Nutrient Limitation of Phytoplankton Growth	Determine which nutrient (nitrogen or phosphorus) should be reduced to alleviate eutrophication in CRE	Results will be used in a water quality model to simulate phytoplankton biomass responses to freshwater flows and nutrient loads throughout CRE
	Susceptibility of Dissolved Organic Nitrogen to Remineralization	Determine if and to what extent dissolved organic nitrogen is a source of biologically available nitrogen in tidal and freshwater CRE	Provides guidance for the design of certain management measures aimed at removing total nitrogen such as the C-43 Water Quality Treatment and Testing Facility
	Dry Season Benthic Flux Measurements	Characterize and quantify nutrient exchange between sediments and water column in CRE during dry season and drought conditions Quantify the role of the sediment-water interface in biogeochemical cycling in CRE during the dry season of 2008	Results will be used to provide the low range for internal nutrient cycling between the sediment and water column in a water quality simulation model Wet season measurements of sediment-water column exchange of nutrients are needed to provide the upper range of these rates of nutrient input/removal
	Caloosahatchee Estuary Nutrient Budget	Estimate/quantify major source and sink terms for nutrient inputs to CRE, such as external and internal loads	A rudimentary budget for dissolved inorganic nitrogen and dissolved inorganic phosphorus has been constructed to examine retention/export of nutrients under various freshwater inflow regimes; results are being analyzed

Table 18. Continued.

Research	Project	Project Objectives	Conclusions/Applications
Low Salinity Zone	Plankton in the Caloosahatchee	Quantify relationships between freshwater inflow and temporal and spatial distribution and abundance of fish larvae and other important zooplankton in CRE	Results will be used to support establishing Water Reservations, refine flow and salinity envelopes, and provide guidelines for delivery of freshwater to CRE
	Estuarine Turbidity Maximum (ETM)	Characterize and understand structure of Caloosahatchee ETM zone: salinity/density structure, turbidity structure, suspended sediment distribution, DO, and Chl*a*	Results will be used to inform operations decisions based on behavior of the ETM as a result of complex interactions between factors including changing freshwater inflow and changing tidal forcing
	Groundwater Seepage Study	Identify locations of potential groundwater discharge into CRE and quantify advective groundwater influxes	Additional data is needed to understand the contribution of groundwater to freshwater inflows to the tidal reach of CRE; study took place during drought and, therefore, derived values are at the lower estimates of groundwater inflows; wet season measurements are required to provide high range estimates of groundwater seepage rates.
Light Attenuation in San Carlos Bay	Colored Dissolved Organic Matter	Determine how relative contributions to total light attenuation of Chl*a*, CDOM, and turbidity vary with season/freshwater inflow in San Carlos Bay	Results will better define controls on light attenuation in San Carlos Bay and relationship between TMDL and its resource goal; results can be used to determine when, and in what conditions, resource light attenuation goals may be met

Using the data collected, depth-integrated gross primary productivity (GPP) in the CRE could be modeled as a function of daily incident light (I), photic zone depth (z), and Chl*a* biomass (B). The linear regression between depth-integrated GPP and the composite parameter (B*z*I) was statistically significant (r^2 = 0.85). The slope of the regression was 0.78, similar to values calculated for other systems (Cole and Cloern, 1987). While a full year of data would be most desirable, this equation can be used to calculate GPP from measured water quality data and compare it to the output from a water quality model (Brush et al., 2002).

Nutrient Limitation of Phytoplankton Growth

The purpose of this project was to test whether nitrogen or phosphorus is most likely to limit phytoplankton growth in the CRE. Knowing which nutrient limits phytoplankton production can guide decisions regarding the nutrient that should be managed to control eutrophication. Four sites in the CRE were sampled every three months from May 2006–February 2008. Traditional bioassays, adding nitrogen alone, phosphorus alone, and nitrogen and phosphorus in combination were conducted. Results indicated that nitrogen most often limited phytoplankton growth. This limitation was strongest during the wet season when blooms normally occur.

Susceptibility of Dissolved Organic Nitrogen to Remineralization

In many estuaries, including the CRE, the composition of total nitrogen in the water column is dominated by dissolved organic nitrogen (DON). Although some DON can be taken up directly by phytoplankton, in general DON must be remineralized to inorganic forms (DIN) before it can become available for biological uptake. A maximum of about 20 percent of the TN load at the S-79 structure is DIN and can be easily removed. Much of the remainder (80 percent or more) is DON. Understanding to what extent bacteria and other processes, such as photolysis (breakdown by ultraviolet light), can remove the DON fraction will guide the design of water quality projects.

Assays measuring the susceptibility of DON to bacterial remineralization were conducted at the same four sites used for the Nutrient Limitation of Phytoplankton Growth project (Loh, 2008a). Study results indicate the following: (1) although the results were variable, 20 to 60 percent of the DON present in the CRE was susceptible to bacterial remineralization, with the majority of remineralization occurring within 14–18 days; (2) subsequent uptake of regenerated DIN indicated the presence of an active microbial loop that may compete with autotrophs for nitrogen. In a separate study conducted in the dry season, DON present in fresh water upstream of the Franklin Lock and Dam was examined (Loh, 2008b). Although some photolysis was evident, DON did not appear to be susceptible to bacteria. However, results showed a rapid recycling between DIN and DON, again implying an active microbial loop in the CRE. This experiment should be repeated in the wet season when DON may more labile.

Benthic Nutrient Fluxes

In shallow coastal estuarine systems, such as the CRE, the water column and sediments can be tightly coupled with respect to the biogeochemical cycles of nitrogen and phosphorus. Sediment can function as a sink (i.e., permanent burial) or a source (i.e., input of nutrients to the estuary) through the transfer, or flux, of nutrients between the water column and sediments. Inorganic nutrients are produced during the microbial remineralization of organic matter within the sediments. Loads of nutrients from sediments can contribute significantly to the total nutrient load in subtropical estuaries. A recent study of benthic fluxes in an estuary in northwestern Florida identified sediments as a significant source of inorganic nitrogen and phosphorus to the water column relative to inputs from the main freshwater source during drought conditions (DiDonato et al., 2006).

Due to a lack of information about benthic nutrient fluxes for this system, two studies were conducted in February 2008 to estimate benthic fluxes of nitrogen and phosphorus. The goals of the first study were to (1) provide estimates representative of system-wide benthic nutrient flux rates in the CRE, (2) identify "hot spots" of benthic nutrient fluxes, and (3) provide data to support current and future water quality modeling efforts (Howes et al., 2008). System-wide estimates were based on measurements from sediment cores collected from 50 sites distributed throughout the estuary. Study results revealed the following information on internal cycling between the water column and sediments in the CRE:

- Levels of organic matter in the sediments were higher in the upper estuary compared to the lower estuary. This likely accounted for the higher rates of oxygen update, denitrification, and nutrient flux measured in the upper estuary.
- The lower estuary had higher levels of benthic Chl*a*, suggesting organic matter input through in situ processes such as phytoplankton deposition or benthic microalgae.
- The importance of benthic phototrophs in the lower basin was observed as reductions in rates of sediment oxygen uptake and nutrient release in light incubations was greater than in dark incubations (**Figure 25**).
- The uptake of nutrients by benthic phototrophs tends to make the sediment nutrient cycles more closed and decreases their role in water column nutrient enrichment.
- The low rates of oxygen uptake throughout the system, but particularly in the lower estuary should reduce the likelihood of significant bottom water oxygen depletion during the dry season (Howes et al., 2008).

The goals of the second study were to identify the contribution of diffusive and advective fluxes in the CRE by comparing fluxes measured from cores in the laboratory with fluxes measured in the field with chambers (Cornwell et al., 2008), with the following key results:

- No evidence of advective fluxes was found during this study.
- Microalgae living on the sediment surface act as an important filter, intercepting nutrients before they reach the overlying water. Therefore, light levels are an important factor regulating the exchange of nutrients across the sediment-water interface.
- Most water quality models do not account for this microalgal filter, and any simulation of water quality in the CRE should include this component.

Data were further analyzed to quantify the role of the sediments in oxygen metabolism. While sediments generally consumed oxygen in the dark, when light levels exceeded 20 percent of surface irradiance, the sediments produced oxygen, again highlighting the importance of benthic microalgae in this system. During this dry season study, about 70 percent of the estuary bottom received more than 20 percent of surface irradiance. These results further highlight the importance of benthic microalgae in this system.

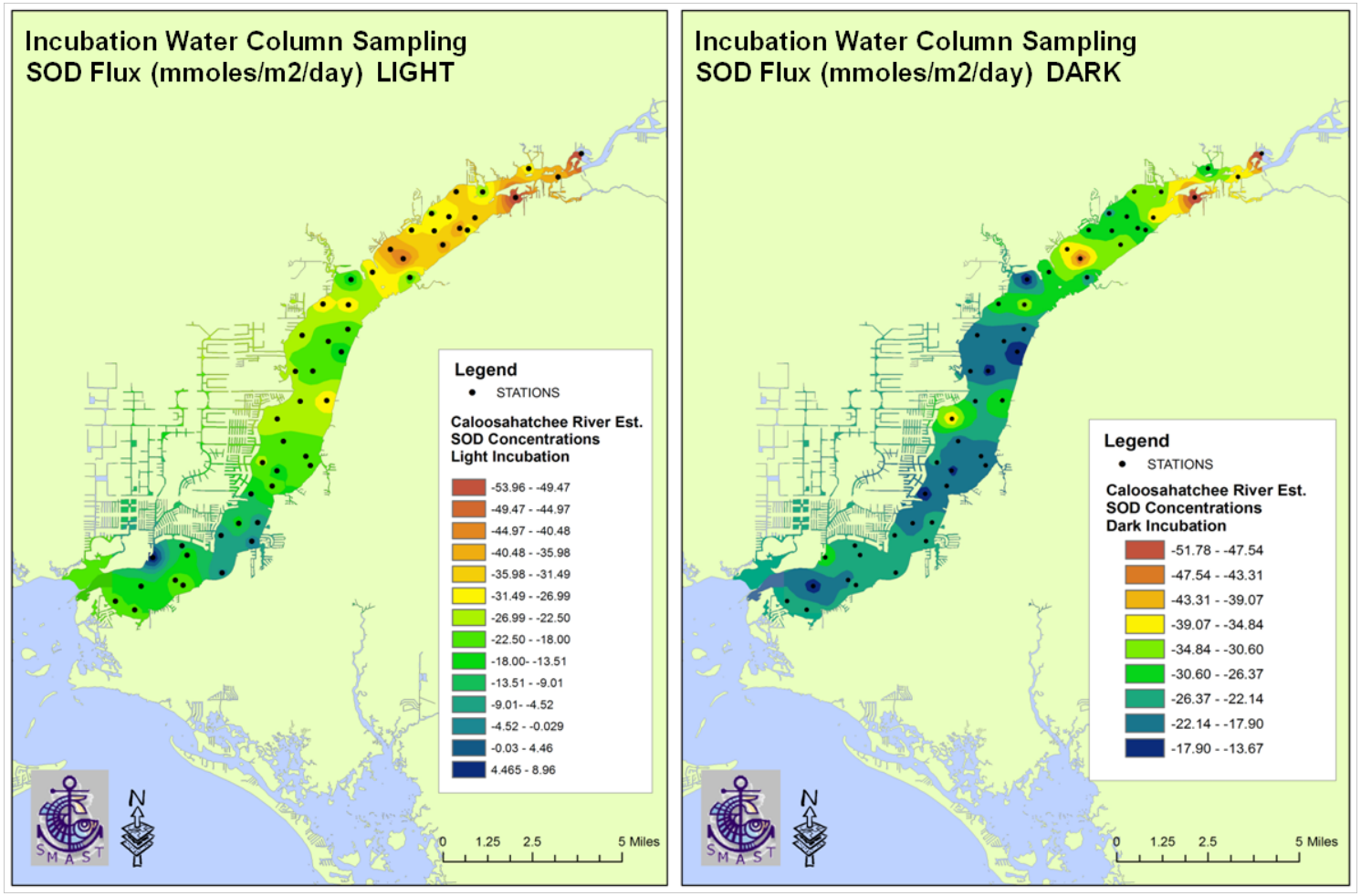


Figure 25. Distribution of sediment oxygen uptake under light (left) and dark (right) conditions throughout the CRE in early February 2008. Net oxygen production was measured in the shallow areas of the lower region of the lower basin. Values are in millimoles per square meter per day (mmol/m^2/d) (from Howes et al., 2008).

Caloosahatchee Estuary Nutrient Budget

The objectives of this study, initiated in 2011 and currently in progress, are to (1) identify major nutrient pathways using an appropriate conceptual model based on available data and best knowledge, (2) estimate and quantify major nutrient source and sink terms such as external and internal loads, and (3) identify possible data gaps and uncertainties. An empirical data analysis approach is being used for this effort. The level of detail in empirical budgets varies as a function of the number of terms included in the model (SFWMD et al., 2009). As a first step, the Land Ocean Interactions at the Coastal Zone (LOICZ) approach (Gordon et al., 1996) was applied. This simple approach treats the entire estuary as a "black box" with only external inputs (e.g., atmosphere, stormwater runoff) and outputs (no defined internal processes). Preliminary results indicate that the CRE is a net source of DIN (i.e., internal production of DIN is greater than the internal consumption of DIN), and that internal production of DIN increases with increasing external loads of DIN to the estuary. This suggests that the CRE generates excess DIN either by remineralizing organic nitrogen that is imported by fixation from the atmosphere or by runoff from the land.

Low Salinity Zone Project

The Low Salinity Zone Project examines the effects of freshwater discharges on the production of fish larvae and utilization of the low salinity nursery zone in the CRE. Information from this project supports refinement of salinity and flow envelopes and provides the basis for environmentally sensitive deliveries of water to the low salinity nursery zone. Recent studies related to this project include plankton in the CRE; estuarine turbidity maximum, a prominent, highly productive feature of the low salinity zone; and groundwater seepage, a potentially important source of fresh water to the estuary.

Plankton in the Caloosahatchee

The ultimate goal of this project was to quantify relationships between freshwater inflows and the temporal and spatial distribution and abundance of fish larvae and other important plankton in the Caloosahatchee. Results can be applied to help establish Water Reservations, refine flow and salinity envelopes, and provide guidelines for delivery of fresh water to the CRE. Researchers from Florida Gulf Coast University conducted the study (Tolley et al., 2010). In brief, 14 stations were sampled on a monthly basis from May 2008–April 2010, with the following key findings:

- Phytoplankton biomass can accumulate or proliferate under various inflow scenarios, with inflow playing a role in determining both phytoplankton location and composition. At flows of less than 1,000 cfs, diatoms accumulated in the upper estuary. At flows greater than 1,500 cfs, smaller cyanobacteria tend to bloom in the lower estuary. With flows greater than 3,500 cfs, phytoplankton is flushed from the estuary to coastal waters.
- Concentrations of Chl*a* in the water column were typically greater upstream, especially during the dry season. In the wet season, freshwater species dominate the plankton in this region. In the dry season, several important estuarine species move into this upstream region (e.g., juvenile anchovies and their prey).
- Juvenile bay anchovy and their prey (such as mysid, *Americamysis almyra*) are blocked from moving farther upstream during the dry season by S-79. This pattern indicates habitat compression for these organisms and may lead to greater competition for food and exposure to predation. Preliminary analysis suggests that flows at S-79 of 200 to 500 cfs would release these organisms from the impingement caused by the structure.

- Numerous estuarine species collected during this study (including fishes, mysids, shrimp, and isopods) responded to reduced freshwater inflow by moving upstream into the narrow portion of the tidal CRE above Beautiful Island. This movement into a more restricted area represents a potential second source of habitat compression. Preliminary analysis indicates that most of these species would move downstream of this restricted portion of the tidal river at inflows of 500 to 1,000 cfs at S-79.
- Gelatinous predators can negatively impact fish populations by feeding directly on developing eggs and larvae or by competing with larvae for zooplankton prey. Populations of hydromedusa (*Clytia* sp.) and ctenophore (*Mnemiopsis leidyi*) were centered near or just downstream of S-79, respectively, during the dry season when abundances were high. Several estuarine zooplankton also moved into the upper tidal river during the dry season. Flows from S-79 around 500 cfs would achieve separation between these predators and their potential prey.

Estuarine Turbidity Maximum

Suspended sediment concentrations and the associated light attenuation in the CRE are important factors affecting the health of various organisms, including oysters, clams, and seagrasses (e.g., Lawson et al., 2007; Wilbur and Clarke, 2001). Estuaries typically trap sediment in high concentrations in localized areas called the estuarine turbidity maximum (ETM). The ETM is a unique, dynamic habitat that provides protection and nutrients to planktonic and larval fish (North and Houde, 2003; Roman et al., 2005). The physical factors of mixing and stratification that contribute to the ETM dynamics affect DO levels in the water column. The objective of this project was to identify and evaluate the vertical and horizontal density and turbidity structure(s) (i.e., estuary turbidity maxima) of the CRE system. Four longitudinal transects of the CRE were completed under a range of tidal conditions (spring versus neap, slack after flood, and slack after ebb) during the dry season. With the data collected at the four transects from this study and six more transects funded by other agencies, the location of the ETM in relation to the freshwater discharge was derived, as shown in **Figure 26**.

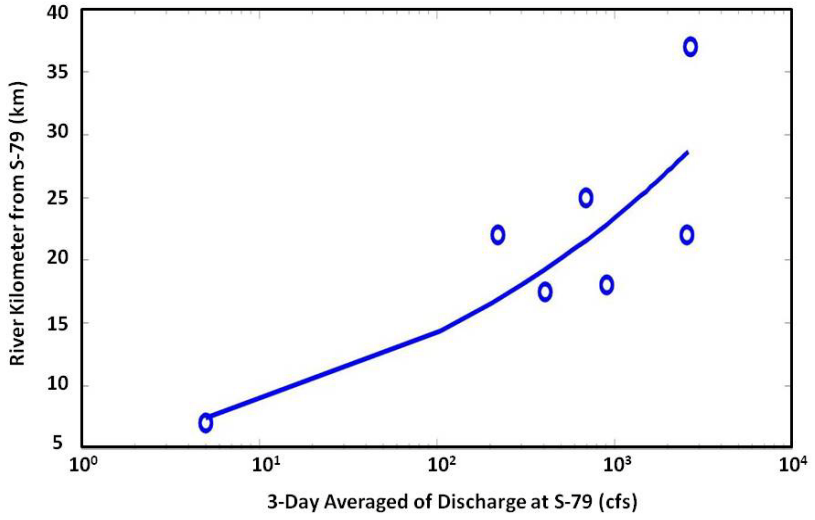


Figure 26. Estuarine turbidity maximum location compared to the three-day average discharge at the S-79 structure.

Groundwater Seepage Study

Completed in March 2009, the objective of this pilot study was to identify locations of potential groundwater discharge into the estuary and to quantify advective groundwater influxes to the estuary using the radon tracer method and the current resistivity profile (CRP) method (Reich, 2009). Continuous surface water radon isotope (^{222}Rn) mapping is designed for qualitative investigations of coastal areas where groundwater discharges into the surface water (observed as an increase in ^{222}Rn). Radon was mapped from near the mouth of the Caloosahatchee River (Little Shell Island) upstream to the S-79 structure. Approximately 130-line-km of radon data were collected over three days. Resulting values ranged from 1 to 2 disintegrations per minute per liter (dpm/L) near the mouth of the river to 12.7 dpm/L along the narrow river section, east of I-75. The data suggests that the tidal reach of the river can be broken into the three areas (**Figure 27**) with radon activity increasing from area 1 (downstream) to area 3 (upstream). These results indicate a greater groundwater component in the upper reach compared with the lower sections of the river.

Groundwater discharge rates were estimated using a mass balance approach on data collected from time-series radon monitor stations at two locations along the river. At the mouth of Whiskey Creek (southern region of the river), radon monitoring was performed over 4 days. The average estimated groundwater advective flux for this site was 5.7 ± 6.4 cm/day. The second radon monitor time-series station was established near S-79, but was only performed for eight hours. The advective flux estimated was 66.7 ± 151 cm/day. This value is most likely an overestimate due to the high radon at the beginning of the time-series and its short duration. A more reasonable estimate would be to average the smaller peaks that ranged from 0 to 93 cm/day (average = 12.3 ± 21.9 cm/day). The increase in surface water radon upstream from I-75 indicates that groundwater is discharging into the narrow section of the river at a higher rate than in the wider, downstream section of the river. An increase in resistivity values in the subsurface confirms that fresher groundwater underlies the upper part of the CRE.

Looking ahead, any future work should consider (1) establishing two time-series monitoring sites in area 1, one in area 2, and one in area 3; (2) using a longer time series (4 to 5 days) to better estimate over tidal cycles and lock and dam releases (note that eight-hour radon time-series near the S-79 site gave an important first-order approximation of groundwater advective fluxes); (3) having additional pore-water radon measurements at all time-series sites, which are critical to advective flux calculations; and (4) collecting cores in the river and pore-water chemistry (salinity) to ground-truth the resistivity data (Reich, 2009).

Light Attenuation in San Carlos Bay

A resource-based method (Corbett and Hale, 2006) was used to establish nutrient TMDLs in the CRE. Nutrient load reductions are based on achieving water clarity in San Carlos Bay that allows enough light for seagrasses to grow to a depth of 2.2 m. This approach assumes that reductions in nutrient loading will reduce water column concentrations of chlorophyll enough to prevent shading of seagrasses. Three major water quality constituents have been identified that attenuate light in the Southern Charlotte Harbor: turbidity, CDOM, and Chl*a* (McPherson and Miller, 1994). In San Carlos Bay, existing evidence suggests that in some years CDOM may account for most of the light attenuation, while chlorophyll may dominate in others (Dixon and Kirkpatrick, 1999; Doering et al., 2006). This light attenuation research study will determine how relative contributions to total light attenuation of Chl*a*, CDOM, and turbidity vary with season and freshwater inflow in San Carlos Bay. Information from this study will better define controls of light attenuation in San Carlos Bay and the relationship between the TMDL and its resource goal. Results can be used to determine when, and under what conditions, resource light attenuation goals may be met.

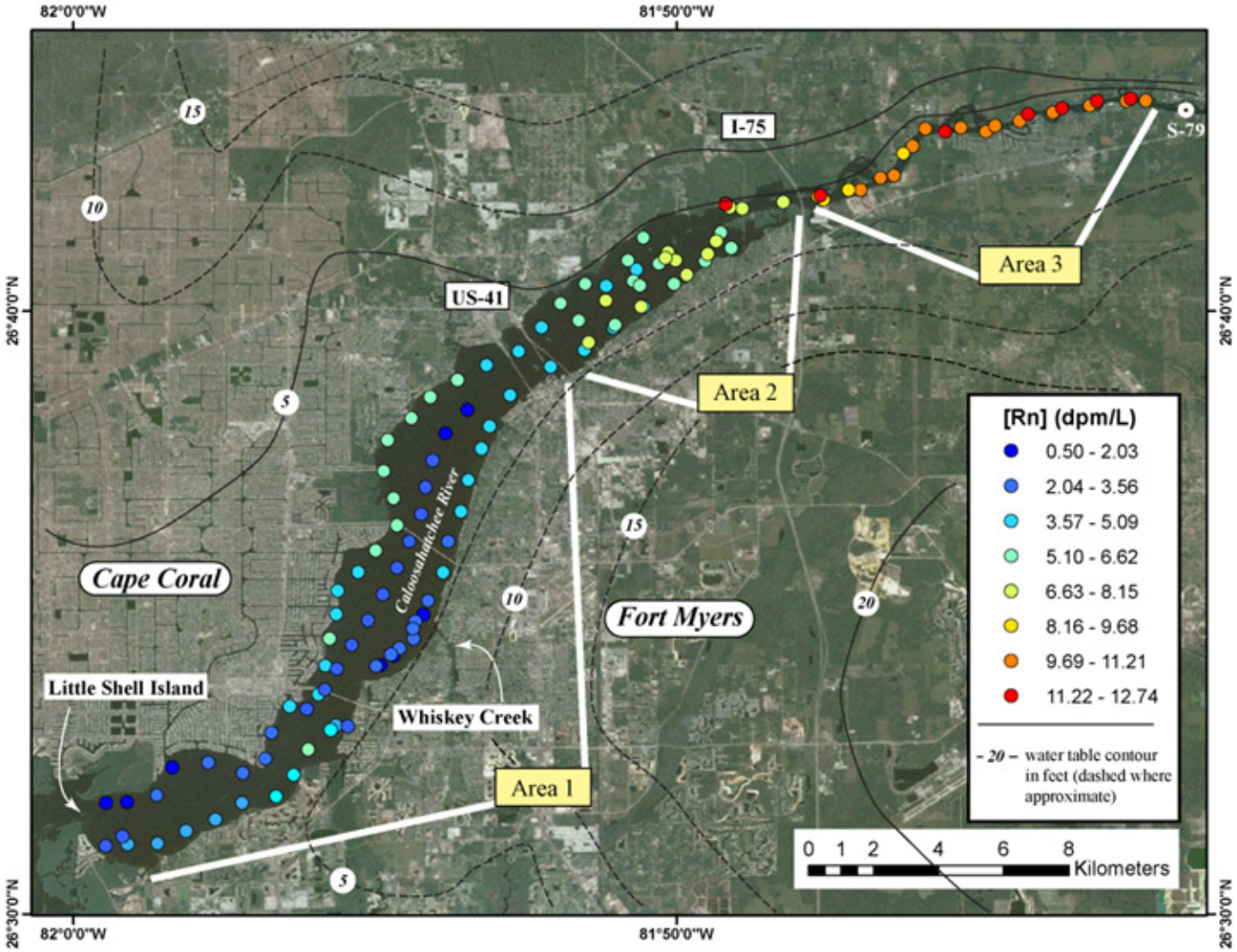


Figure 27. Continuous radon isotope (^{222}Rn) map showing an increase in radon activity from near the mouth of the river up to S-79. Isotope activities (in disintegrations per minute per liter, or dpm/L) are at 10-minute intervals. The river downstream of S-79 is broken into three areas based on ^{222}Rn activities. Water table elevations are shown on the map (modified from Krulikas and Geise, 1995).

MODELING PLAN STATUS

Predictive or numeric modeling tools are essential to forecast and evaluate progress toward the CRWPP objectives. These tools can be used to evaluate and quantify the nutrient load reduction achieved by construction projects or operational modifications and progress toward restoring natural hydrology and targeted water quality; and evaluate the effectiveness of collective source control programs developed by the SFWMD, FDEP, and FDACS. An integrated modeling framework combining the resource-based Valued Ecosystem Component (VEC) approach and linked watershed and estuarine models is described in the 2009 CRWPP. The models included in the 2009 CRWPP are summarized in **Table 19**. It was envisioned that these models, when applied individually or collectively, will serve as adaptive management tools to help achieve or refine the protection plan goals. The integrated modeling framework proposed in the 2009 CRWPP partitions available models into three categories: (1) regional and watershed hydrology and water quality models, (2) estuarine hydrodynamic and water quality models, and (3) estuarine ecological models. This section summarizes the model refinements or applications according to the modeling categories. Future modeling needs and recommendations are described along with proposed research projects in the *Caloosahatchee River Watershed Strategies* section.

Table 19. Model inventory for the CRE.

	Model	Model Domain	Model Outputs	Model Simulation Period	Responsible Agency	Past Applications
Watershed Model	AFSIRS/ WATBAL	C-43 Basin	Basin runoff and irrigation demands	1965–2005	SFWMD	CERP, Water Supply Plans
Watershed Model	Lin-Res	Tidal Caloosahatchee Basin	Flow	1965–2010	SFWMD	MFLs, Lake Okeechobee Adaptive Protocols, Water Reservations
Watershed Model	NERSM	Lake Okeechobee and C-43 Watershed	Flow	1970–2005	SFWMD	NE
Watershed Model	MIKESHE	C-43 Watershed and Tidal Caloosahatchee Basin	Flow and stage	1986–1996	USACE	CERP
Watershed Model	HSPF	Caloosahatchee River Estuary Watershed	Flow and water quality	1995–2005	FDEP	TMDLs
Estuarine Hydrodynamic Model	CH3D	Caloosahatchee River Estuary Watershed	Water level, flow velocity, salinity	1965–2010	SFWMD	CERP, MFLs, C-43 Reservoir, Lake Okeechobee Adaptive Protocols, Water Reservations
	EFDC	Caloosahatchee River Estuary Watershed	Water level, flow velocity, salinity	2003-2004	FDEP	TMDL
Estuarine Flow and Salinity Regression Model	L8MM	Caloosahatchee River Estuary Watershed	Salinity and water demand for salinity management	1965–2010	SFWMD	CERP, MFLs, C-43 Reservoir, Lake Okeechobee Adaptive Protocols
Estuarine Water Quality Model	EFDC Model	Caloosahatchee River Estuary Watershed	Hydrodynamic, salinity, and water quality	2003–2004	FDEP	TMDLs
Tape grass	Val-3	Caloosahatchee River Estuary Watershed	Tape grass growth, shoot count, shoot density	Multiple-year simulation	SFWMD	MFLs, Water Reservations
Oyster/ Seagrass	HIS	Caloosahatchee River Estuary Watershed	Suitability Index	Multiple-year simulation	SFWMD	CERP

Regional and Watershed Hydrology and Water Quality Modeling

Northern Everglades Regional Simulation Model

The Northern Everglades Regional Simulation Model (NERSM) was used to guide the formulation and evaluation of alternative plans during the CRWPP process. Key information about the model, model simulations, and application of simulation output was presented in Section 6 of the 2009 CRWPP, with additional details from the modeling exercise as appended. It simulates the interaction of the Caloosahatchee River Watershed with other components of NEEPP (i.e., Lake Okeechobee and St. Lucie River watersheds) and operations of the Lake Okeechobee and project features defined in the CRWPP.

Recent work on the NERSM involves adding the Everglades Agricultural Area (EAA) into the model domain. The purpose of the work is to represent the entire South Florida water management system while providing tradeoff in water deliveries among basins around Lake Okeechobee, in particular between the St. Lucie and Caloosahatchee River watersheds and the EAA. The 2008 Lake Okeechobee Regulation Schedule (2008 LORS) is also incorporated into the latest NERSM whereas the 2000 Water Supply/Environmental Regulation Schedule (2000 WSE) was used in the 2008 RWPP. Another objective of this update is to add flexibility and robustness to the model so that water quality treatment efficiency of the Everglades STAs in the EAA can be evaluated. These functionalities, similar to the DMSTA Model, can potentially be applied to future plan updates to evaluate the nutrient reduction efficiency of proposed STAs, such as the C-43 Water Quality Treatment Area.

Tidal Caloosahatchee Basin Model

Flows from the Tidal Caloosahatchee Basin were identified as a major data gap when evaluating total freshwater inflows and nutrient loading into the CRE. The Linear Reservoir (LinRes) Model has been applied to simulate tidal basin flow contributions to the estuary (see **Table 19**). The latest flow data collected in the tidal basin allows for refinement and calibration of the model (Konyha and Wan, 2011). In addition to root zone storage and three drainage pools in the original model (Konyha, 2002), version 3 of LinRes incorporates additional parameters representing land use, monthly ET, and runoff from impervious surfaces. The model was calibrated using three years of flow data collected at five stations in the tidal basin. The calibration results were considered satisfactory with the Pearson correlation coefficient ranging from 0.8 to 0.9 (r^2: 0.64–0.81). Example calibration graphs are shown in **Figure 28** for Orange River and Whiskey Creek. The calibrated LinRes Model was set up for eight regions in the tidal basin for long-term simulation (1965–2005).

To account for the interaction between surface water and groundwater and nutrient loading from the tidal basin, the District initiated an in-house effort to develop a distributed watershed hydrology and water quality model on the WaSh modeling platform, which has been applied in the St. Lucie River Watershed (Wan et al., 2003; Wan and Zheng, 2009). The initial phase of the modeling work is to calibrate the hydrology using the three years of measured flow data collected at five locations in the tributaries and two locations in the main channel. Preliminary model calibration is finished and the statistics of model output are promising (r^2: 0.59–0.89). After the model is calibrated, a long-term simulation from 1965–2010 will be conducted. The initial phase of model calibration was completed in 2011 using the existing data. Additional data collected in the next couple of years will be used to refine the model calibration.

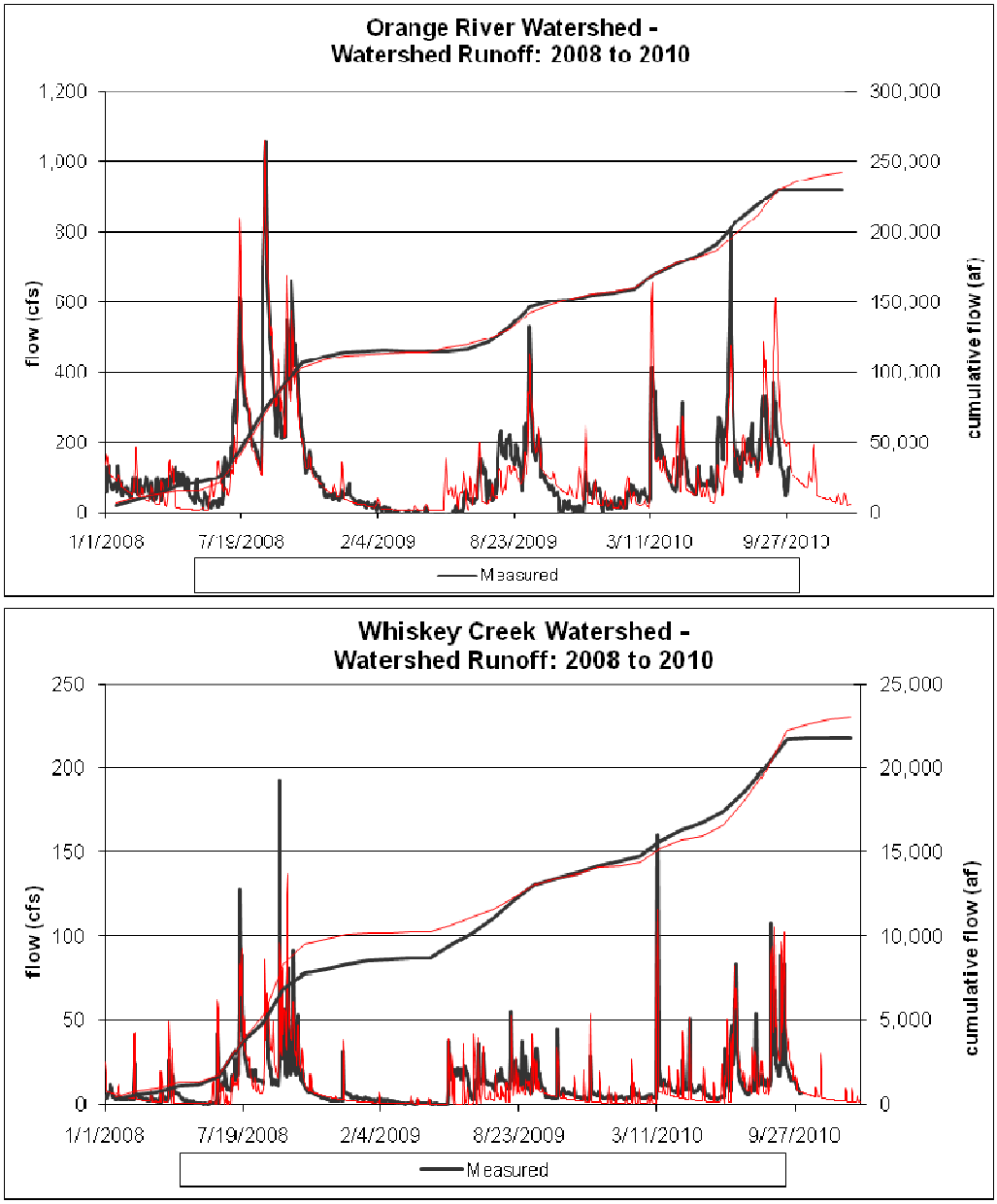


Figure 28. Calibration of the Linear Reservoir (LinRes) Model with comparisons of measured (black line) and modeled (red line) flows at Orange River (top) and Whiskey Creek (bottom) stations in the Tidal Caloosahatchee Basin.

Hydrologic Simulation Program – Fortran Model

The Hydrologic Simulation Program – Fortran (HSPF) Model funded and maintained by the FDEP simulates flow and water quality in the Upper Caloosahatchee River Watershed (C-43 Basin) and the Tidal Caloosahatchee Basin (downstream of S-79). The model simulates flow and water quality constituents such as temperature, five-day biological oxygen demand (BOD), nitrogen, phosphorus, Chl*a*, and DO. The hydrologic component of the HSPF model was calibrated using data from 2001–2005 and validated using data from 1997–1999. The water quality component of the model was calibrated using the ambient water quality data from 2004–2005 and validated using data from 2002–2003. The FDEP is currently refining the model with

flow and water quality data collected in the Tidal Caloosahatchee Basin during the past three years. To use the newly collected data for model calibration, the simulation period will need to be extended beyond 2005 by incorporating the latest NEXRAD rainfall and ET data. After being fully calibrated, this model is expected to serve as a critical tool to simulate nutrient loading into the estuary.

Estuarine Hydrodynamic and Water Quality Modeling

Estuarine hydrodynamic and water quality models are required to simulate (1) the salinity distribution in the CRE under different freshwater inflow conditions; and (2) water quality conditions in the estuary and its response to nutrient loading reductions as defined by the CRWPP and TMDLs. Existing tools meeting these criteria include the Caloosahatchee Hydrodynamic Model and the Caloosahatchee Water Quality Model.

CH3D Model Enhancement and Applications

The Caloosahatchee Hydrodynamic Model is a comprehensive, three-dimensional estuarine hydrodynamic model based on the Curvilinear Hydrodynamics Three-Dimensional (CH3D) code (Qiu et al., 2007). Previous applications of the model include the 2003 update of the Caloosahatchee River MFLs (Qiu, 2003), the Southwest Florida Feasibility Study, and the C-43 Reservoir Project. Recently, in an effort to support the development of the Lake Okeechobee Adaptive Protocols and the Caloosahatchee River and Estuary Water Reservation Project, calibration of the CH3D model was extended to a full 20-year data collection period (January 1992–April 2011) at seven monitoring stations across the entire estuary. **Figure 29** compares the simulated and measured salinity at the Ft. Myers station. The calibrated model was applied for long-term simulations (41-year period spanning from 1965–2005) representing varying flow scenarios. The computation time for long-term simulations was substantially shortened due to improvements of processor speed and a parallel computing algorithm implemented in the CH3D model, making the model an ideal tool for application to evaluate operational modifications and progress toward restoration of natural hydrology. Recently, the model was applied for developing a family of flow-salinity curves in the estuary for environmental operation, and calculating residence time in the estuary.

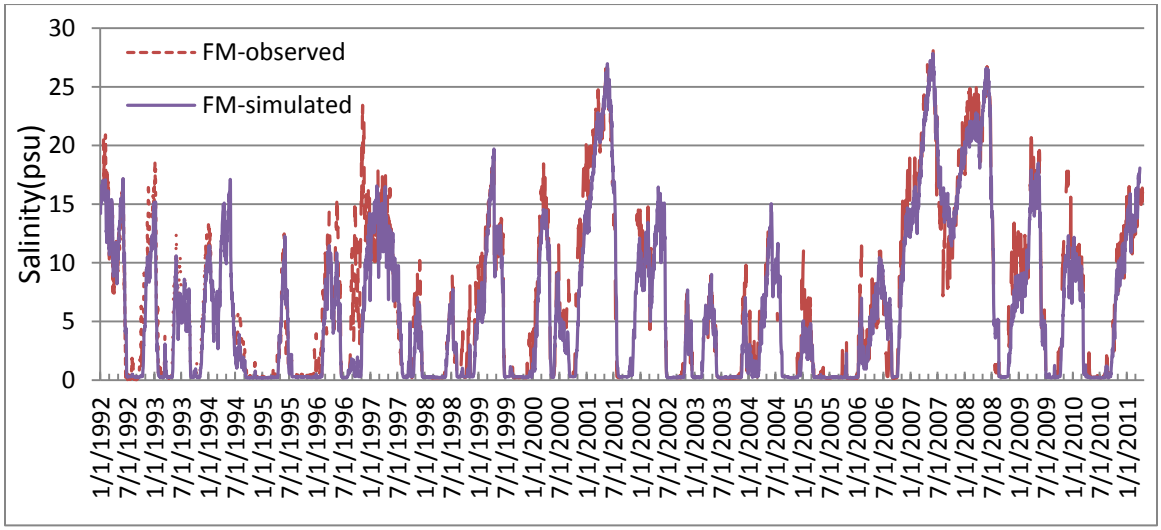


Figure 29. Measured and simulated salinities (psu) of the surface layer at the Ft. Myers station from 1992–2011.

Caloosahatchee Estuarine Water Quality Model Enhancement

The Caloosahatchee Estuarine Water Quality Model (EFDC) was developed by the FDEP in support of TMDL development for the CRE. The model used water quality data collected in 2003 for calibration and 2004 for validation. As the model domain covers the CRE and only portions of Matlacha Pass (**Figure 30**), the FDEP plans to extend the model grid near San Carlos Bay. Eventually, the EFDC Model will be linked with the HSPF Model to simulate DO and nutrient compliance for TMDL development. The FDEP also plans to introduce the WASP Model for water quality in EFDC and HSPF.

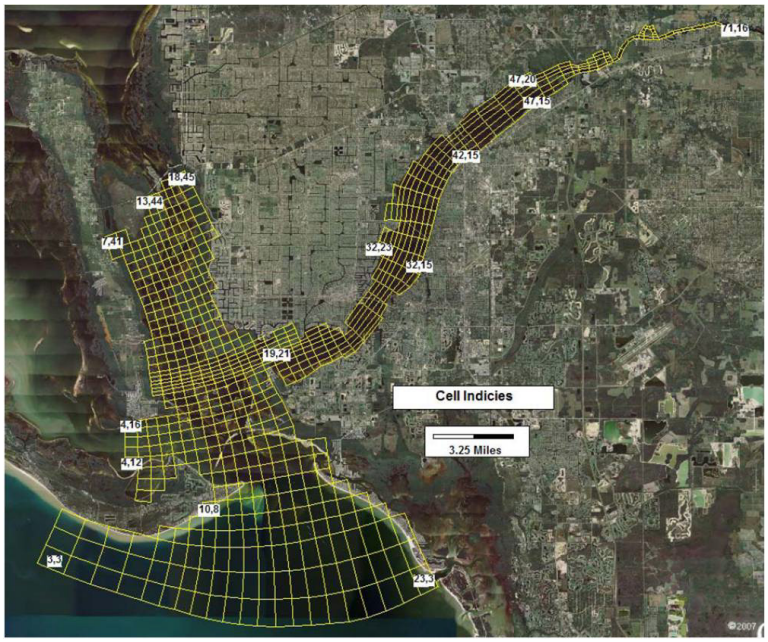


Figure 30. Modeling grids of the Caloosahatchee Estuarine Water Quality Model.

Estuarine Ecological Modeling

Estuarine ecological models are required to evaluate the ecological response to nutrient load reduction or operational modifications and progress toward restoration of natural hydrology, and to refine the salinity envelopes and flow targets. As part of this effort, the tape grass model was refined for application in the Caloosahatchee River and Estuary Water Reservation Project. The initial model formulation (Val-1) relied on light relationships reported in the literature from populations in climates dissimilar to Florida because region-specific data was not available. The latest model update incorporated experimental mesocosm work using tape grass from the CRE to formulate site-specific light relationships (Hunt, 2007; Hunt et al., 2011). Additionally, new field data were available, enabling the model validation period to be extended by three years. Evaluation of light and its influence on growth with the Val-3 model illustrate the importance of considering water clarity goals in the context of inflow management for the continued survival of tape grass (Hunt, 2007; Hunt et al., 2011). The importance of a multiyear calibration and validation period that includes a range of environmental variables and the impact of multiple environmental stressors is also demonstrated in Val-3 applications. Looking ahead, model enhancements in progress since 2010 will help develop flow targets and other evaluations associated with the establishment of Water Reservations for the CRE. It is expected that new modeling features (e.g., new temperature algorithm) will allow assessment of flow as it relates to factors contributing to light reduction in the Upper CRE and allow the development of flow-based targets for the CRE water reservation that include salinity, light, and temperature.

Monitoring Update

Several entities are performing water quality, oyster and/or seagrass monitoring in both the watershed and estuary portions of the Caloosahatchee including the District, FDEP, Florida Fish and Wildlife Conservation Commission, the USACE, local governments and other non-governmental organizations. The 2009 CRWPP included an inventory of these monitoring efforts, updates to which are provided in Attachment D. Since the release of the 2009 CRWPP, the District reevaluated and reengineered its monitoring network in the Caloosahatchee. The interagency reengineering project team identified four relevant District projects for examination:

- Project CR, which monitored the Caloosahatchee River bimonthly from S-79 to the east.
- Project CESWQ, which monitored four stations monthly from S-79 west into the estuary and a suite of other stations in response to S-79 releases.
- Project CCHM, which monitored the estuary west of S-79 collecting five samples per month using a randomized grid design to pick stations.
- Project Rook, which monitored seven stations in San Carlos Bay monthly.

Following review of these projects and taking into account the Northern Everglades and Estuary Protection Program and the Caloosahatchee River Watershed Protection Plan, a series of recommendations were made. These included (1) merging monitoring at S-79 (i.e., one station would be used for the collection of samples for the CR, CESWQ, and CRFW projects); (2) increasing the number of estuarine stations monitored monthly from four stations to seven; (3) maintaining existing monitoring within San Carlos Bay; (4) discontinuing release monitoring; (5) eliminating Project CCHM because of its redundancy; and (6) standardizing the parameter list to meet the majority of CRWPP recommendations.

The reengineering recommendations were approved by District management and the transition from the existing monitoring to the new plan was carried out in FY2010. The monitoring network from S-79 through the estuary and into San Carlos Bay now consists of 13 stations sampled monthly (**Figure 10**).

CALOOSAHATCHEE RIVER WATERSHED STRATEGIES

Pinar Balci, Lesley Bertolotti and Tim Liebermann

ISSUES AND ACTIONS

The health of the CRE has been affected over the years by many factors including natural system alterations, population growth, leaky septic tanks, and the timing and quantity of freshwater discharges from both the Lake Okeechobee and Caloosahatchee watersheds, which have a direct effect on the salinity balance and water quality within the estuary. Given the diverse and complex challenges facing the CRE, an integrated approach is required at the source, local, sub-regional, and regional levels to achieve the TN load reductions required by the state's TMDL Program as well as to meet desirable salinity ranges for the estuary. As part of NEEPP, the Caloosahatchee River Watershed Protection Plan is being implemented by the coordinating agencies in collaboration with local governments. To date, approximately $31.4 million in state and SFWMD funds have been invested to implement CRWPP activities and projects. In addition, $100 million has been invested towards the Comprehensive Everglades Restoration Plan (CERP) Caloosahatchee River (C-43) West Basin Reservoir project.Significant achievements over the past three years include:

- FDEP adoption of a total nitrogen TMDL target for the Caloosahatchee Estuary in 2009.
- Continued cost-share investments by the state, the SFWMD, and area counties and municipalities. Since 2004 the SFWMD has supported over 80 local water quality improvement projects.
- Jointly purchased (SFWMD, state, and Lee County) 1,773 acres of land in Glades County to construct a water quality tratement and nitrogen removal testing facility to reduce nutrient loading to the CRE.
- Initiated the new NE-PES solicitation program in 2011 in partnership with interested private landowners to obtain water management services of water and nutrient retention, thereby reducing flows and nutrient loads to Lake Okeechobee and downstream estuaries.
- Expanded surface water storage on private, public, and tribal lands in the Northern Everglades to 131,539 ac-ft. A total of 5,625 ac-ft are located in the Caloosahatchee River Watershed. Additional sites on fallow citrus land are being tested under the water farming pilot program.
- Completed key technical review and data evaluation activities to help develop a future regulatory source control program in the Caloosahatchee River Watershed. The District will coordinate with the OFARR prior to initiating rule development to amend Chapter 40E-61, F.A.C.
- Adopted revisions to Chapter 62-640, F.A.C., which took effect in August 2010, designed to improve application and management of Class B biosolids and enhance distribution and marketing of Class AA biosolids. By 2013, no Class B biosolids application will be permitted in the Northern Everglades watersheds without an FDEP approved nutrient balance. To address stakeholders' concerns about Class AA biosolid spreading in the Northern Everglades, various measures were adopted during the rulemaking process, including the prohibition of having

more than one dry ton of unapplied Class AA biosolids on one's property without proper storage and more stringent reporting requirements.

- To date, the District invested $100 million to purchase land, construct/monitor test cells, and complete project design of the CERP Caloosahatchee River (C-43) West Basin Storage Reservoir, which is intended to help store and manage Caloosahatchee Basin runoff for meeting estuary needs during the dry season. The reservoir is awaiting federal authorization and funding for construction.
- Updated the SFWMD's Adaptive Protocols for Lake Okeechobee operations to guide agency recommendations to the USACE on lake management. The revised guidance document works within the operational flexibility of the regulation schedule to improve environmentally beneficial lake releases to the Caloosahatchee River and Estuary during the dry season.
- The FDEP initiated the freshwater Basin Management Action Plan (BMAP) for the portion of the watershed located between S-79 and Shell Point and is continuing to work collaboratively with stakeholders on its development and identification of nutrient reduction projects.

2012 PLAN UPDATE – STRATEGIES

This 2012 CRWPP represents the three-year update to the original 2009 plan. This update includes strategic projects and activities for water quality and quantity improvements to benefit the Caloosahatchee River Watershed and Estuary, focusing on projects that the coordinating agencies will be implementing over the next three years (2012–2014).

Addressing Water Quality: Strategies and Next Steps

Addressing water quality issues in the Caloosahatchee River Watershed and achieving the level of TN load reduction required by the TMDL Program requires coordinated and integrated actions. Implementation of agricultural and urban BMPs, regulatory programs, and water quality improvement projects at different spatial scales are part of these integrated strategies. Continued research and improved understanding of nitrogen treatment are also essential to successfully achieve the proposed TN reduction goals. The following section describes the next steps in source control to address water quality issues in the CRE. It also includes a list of strategic construction projects and technologies as well as future research and modeling needs.

Source Control Program

As discussed in the *Pollutant Source Control Program* section of this report, source controls are integral to the success of the CRWPP. The integrated management strategy to achieve the load reduction goals is cost-effectively based on the foundation of regulatory nutrient source control programs. Further details on these source control programs and their status are covered in the *Source Control Program* section of this Update and Chapter 4 of this volume, with near-term highlights of planned efforts provided below.

District Regulatory Nutrient Source Control Program

- The District will optimize the existing monitoring network to maximize evaluation of source control performance across all sub-watersheds. The short-term objective, if technically and economically feasible, is to expand the monitoring network by implementing flow monitoring in three tidally influenced areas of the St. Lucie and Caloosahatchee watersheds (about 100,000 and 260,000 acres, respectively).

- The District will complete a preliminary proposal of performance measure methods to determine the collective performance of the source control programs at the sub-watershed level. Development of performance measure methods will be prioritized at the sub-watershed level and brought forward for peer and technical review by stakeholders. Next, the development of water quality monitoring requirements and performance measures will be considered at the individual level for sites with prior septage application and for agricultural sites where landowners opt not to participate in the FDACS BMP program.
- NEEPP directs the District to initiate rule development amending the Works of the District program in Chapter 40E-61, F.A.C., by developing a nutrient source control program utilizing BMPs for agricultural and non-agricultural lands for the St. Lucie and Caloosahatchee River watersheds. The District will coordinate with the OFARR prior to initiating rule development to amend Chapter 40E-61, F.A.C. Agricultural lands participating in the FDACS program will be recognized as meeting the intent of the proposed amended rule. It is expected that the proposed rule amendments will include incentives to participate in nutrient reduction demonstration and research projects to provide the data necessary for optimizing BMP performance.

FDACS Agricultural BMP Program

- The FDACS will continue to enroll agricultural lands, fund cost-share programs as funds are available, conduct implementation assurance activities, and adopt or update BMP Manuals, as needed. However, it should be noted that due to funding and resource constraints, the identification of cost-share BMPs within the Caloosahatchee River Watershed has been delayed. As funding becomes available, the FDACS will continue working with landowners to identify cost-share BMP opportunities. In addition, the FDACS will continue to work with the UF/IFAS to evaluate the effectiveness of BMPs.

FDEP Source Control Programs

- The FDEP will continue to develop the BMAP for the tidal Caloosahatchee in collaboration with stakeholders.
- The FDEP will complete reissuing all Phase I MS4 permits for the Caloosahatchee Watershed to include a new section on TMDL implementation and require enhanced tracking of load reductions achieved through implementation of the permit's stormwater management program, including nutrient load reductions from street sweeping activities.
- The FDEP-adopted amendments to Chapter 62-640, F.A.C., improve site accountability and management of Class B biosolids, which addressed several public concerns. The FDEP will continue to work with stakeholders to address their comments and concerns regarding the use of biosolids. As Section 373.4595, F.S., currently does not prohibit Class AA biosolids fertilizers, phasing out the use of Class AA materials would likely require additional legislation. However, as a fertilizer product, Class AA biosolids fertilizers would be subject to the same nutrient management BMPs as other fertilizers and soil and tissue testing is required by the FDACS BMP rule to justify the application of fertilizers in the Northern Everglades.
- The FDEP will continue to implement and enforce the NPDES permit program as delegated by the USEPA and implement the ERP program in accordance with

Chapter 373, F.S. The FDEP also will continue to support the FDOH in implementing their source control programs.

Strategic Construction Projects and Technologies

The following section describes strategic initiatives, projects, and activities that will help to improve water quality and increase storage in the Caloosahatchee River Watershed.

Caloosahatchee Basin Storage/Treatment Initiative

The District will focus its near-term efforts on construction projects identified by CRWPP. One example is the Caloosahatchee Basin Storage/Treatment Initiative. As part of the District's five-year reserve spend-down plan, $19 million is available for designing and constructing facilities that will provide stormwater storage and/or treatment on publicly owned lands within the Caloosahatchee Basin. In coordination with stakeholders, several options have been identified for this initiative and are currently undergoing further evaluation. These options include both local and regional projects included in the 2009 CRWPP. East County Water Control District's Mirror Lakes Storage/Rehydration Project (CRE 122) is the local project identified by stakeholders that proposes to better manage hydrology in the Lee County's Lehigh Acres area. The primary objective is to reduce stormwater peak flow discharges, increase groundwater recharge, and improve water quality. The project is split into three phases that collectively are intended to rehydrate Mirror Lakes, alleviate flooding along Orange River, and restore flows to the headwaters of the Estero River in the vicinity of Lee County's Green Meadows well field. The District will collaborate with the ECWCD on the Phase I portion of the project, which involves a pilot test to pump stormwater into Mirror Lakes to rehydrate preserve areas north of S.R. 82. Further details on this project are described in the *Local Stormwater Projects* section of this update.

The Caloosahatchee Area Lakes Restoration (Lake Hicpochee) Project (CRE 04) is a regional project included in the 2009 CRWPP. This project proposes to restore the north part of Lake Hicpochee. The primary benefit is habitat restoration, with some limited storage and water quality treatment benefits. Prior planning reports and stakeholder comments are under review to identify issues (e.g., permitting, recreational) for consideration during project design.

Activities in FY2012 will include completion of projects' identification in collaboration with stakeholders and completion of the basis of design report and preliminary design for the selected projects.

C-43 Water Quality Treatment and Demonstration Project

As previously noted, the FDEP has adopted a TMDL for total nitrogen—the main pollutant in the CRE— but many uncertainties still exist in the treatment of nitrogen, particularly DON, in the estuary. Existing STA data mostly indicate that currently designed wetland treatment systems are not optimized to reduce TN (especially DON, which accounts for most of the TN). The C-43 Water Quality Treatment and Demonstration Project (BOMA Property; CRE 10) is intended to provide the data necessary to increase understanding of nitrogen treatment. The District, in collaboration with Lee County, is prepared to proceed in FY2012 with the conceptual design of a testing facility, which will include both mesocosms and test cells that aim to effectively reduce or remove TN from the CRE based on sound science. This cost-effective approach is intended to be implementable on larger scales, and it is anticipated that the project will generate strategies that could be applied to other estuaries in South Florida.

Local Water Quality Projects

While the effects of individual local projects may be limited to a localized area for water quality improvements, stormwater attenuation, flood protection, and ecological habitat, collectively they provide sub-regional and regional benefits. Since 2004, investments by the state, SFWMD, and area counties and municipalities are supporting more than 80 local water quality improvement projects. Local projects in the CRWPP are estimated to provide an additional 0.87 and 3.5 mt/yr of TP and TN reductions, respectively, in the near-term (2012–2014). Additional projects will likely be identified during the FDEP's current BMAP efforts, in collaboration with stakeholders, to compile a comprehensive list of local water quality projects since 2000 and project-specific load reduction estimates. Once finalized, the FDEP's list and load reductions are expected to replace the current CRWPP list of local water quality updates and the end result will likely be a greater total load reduction from local projects than currently estimated. The District and FDEP recognize the importance of local water quality projects (stormwater and waste water retrofits and restoration projects), which is evident in the support provided in past years. It is anticipated that the coordinating agencies will continue to support local governments in such efforts as funding permits.

Alternative Nutrient Reduction Technologies

Chemical Treatment

Chemical treatment with aluminum sulfate, polyaluminum chloride, ferrous sulfate, or ferric chloride has been used for many years to reduce phosphorus levels in lakes and stormwater runoff (Wanielista, 1979; Wanielista et al., 1981; Harper et al., 1982; Lind 1997). Currently, multiple types of chemical treatment technologies exist that can be applied both in-stream and in off-line treatment systems. Chemical treatment is not just a stand-alone method; it is anticipated that it can also be used with other control strategies that reduce water discharge volumes or phosphorus concentration, thereby achieving further TP load reductions. Treatment costs vary depending upon influent water quality, volume of water treated, and level of treatment desired. The location of chemical addition (pre-treatment versus polishing) also plays a major part in determining total treatment cost.

Completed in July 2009, the Northern Everglades Chemical Treatment Pilot Project Phase I was conducted to (1) investigate available information on chemical treatment technologies that have been tested within other water bodies to reduce TP loads in stormwater runoff, and (2) identify technologies appropriate for use within the Lake Okeechobee Watershed. Results of the study concluded that various chemical treatment technologies are viable and represent effective options for reducing TP loads to the lake (Bottcher et al., 2009). Completed in October 2010, the District conducted Phase II of this project, which included implementation costs and site identification analysis for chemical treatment technologies in the Northern Everglades (SWET, 2010). Multiple areas identified as potentially appropriate for chemical treatment are located within the Caloosahatchee River Watershed, mostly in Caloosahatchee East and West sub-watersheds. The Phase II report recommends conducting further detailed site engineering assessments that include additional landowner contacts, site-specific monitoring, topographic surveys, detailed engineering designs, small-scale testing for efficacy of chemical dosing, and development of operation and maintenance plans. This analysis provided valuable information for possible future implementation of chemical treatment at various spatial scales. Additional information on chemical treatment in the Northern Everglades is covered in Section 5.1.3.2 of the 2011 LOPP Update.

New Alternative Technology Assessment

Assessment of new technologies is essential to successfully achieve nutrient reductions goals in the Northern Everglades. Also, the SFWMD is often approached by innovative firms with ideas for improving water quality, prompting a need for a more structured process to understand and assess these technologies. To streamline this process, the District designed the New Alternative Technology Assessment (NATA) Program, which aims to provide an opportunity for interested parties to demonstrate potential alternative technologies for the reduction of nitrogen or phosphorus external loading in water or sediments emanating from the Everglades watershed. While there is no dedicated funding for this effort, the District plans to provide a physical location for successful applicants to demonstrate their technologies' potential to reduce nutrients. This arrangement allows for cutting-edge water quality research specific to South Florida ecosystems to be conducted cost-effectively. Project proposals are vetted through a selection process with a predetermined set of evaluation criteria and evaluated by a District scientific team. Two current NATA projects include testing permeable reactive barriers to reduce nutrients from groundwater before entering surface waters and nutrient binding materials to remove nutrients from surface waters. Further testing of these technologies will provide a better understanding of their potential for expanded use in the Caloosahatchee River Watershed.

- **Permeable Reactive Barrier.** A nutrient reduction technology currently being tested in the Lake Okeechobee Watershed is called Permeable Reactive Barrier (PRB) technology. This project evaluates the incorporation of water treatment residuals or similar materials capable of intercepting and sequestering phosphorus in the Lake Okeechobee Watershed before the nutrient enters the rivers and canals leading to the lake. The SFWMD completed a laboratory study examining the feasibility of using PRB technology to reduce TP loads to the lake and testing of suitable materials for PRB construction and design for locations appropriate for the Lake Okeechobee Watershed. Currently, there is one PRB site in the Lake Okeechobee Watershed on private lands. The District is studying the effectiveness of this system, but due to drought conditions in 2011, sampling has just recently commenced. The preliminary results are promising and an additional site will be initiated during FY2012. If this is determined to be an effective nutrient reduction technology, then the feasibility of its application could be expanded to include the river watersheds.
- **Nutrient Binding Materials.** Two products currently tested by the District involve nutrient binding materials to remove nutrients from surface waters. These technologies are being assessed in dedicated treatment test cells within STA-1West. Both utilize proprietary clay-like materials that bind phosphorus and nitrogen. Concurrently, in-house staff is conducting phosphorus-flux studies on these two products, as well as a third similar bentonite product, to determine their ability to sequester phosphorus from soils in the Everglades Agricultural Area. Further testing of these technologies is expected to provide a better understanding of their potential for expanded use in the Northern Everglades.

Research and Modeling Strategies

Research Needs and Future Recommendations

Continued research, monitoring, and development of tools are important to track progress toward achieving water quality goals. Recent research indicates that the first priority area for further investigation in the Caloosahatchee River Watershed is the development of a nutrient budget that includes both the watershed and estuary. A well-constrained nutrient budget is needed

to identify and understand the origin, magnitude, and management of controllable, problematic nutrient loads to the CRE. The nutrient budget needs to include inputs and outputs from both the watershed and estuary. The high priority projects are as follows:

- **Identification and quantification of nutrient inputs and exports for the Caloosahatchee River Watershed.** A nutrient budget for the watershed will identify the major sources of nitrogen to the watershed, and locate areas of high nutrients and sites where major exports to the downstream receiving waters occur. This information will help guide the prioritization and placement of projects included in future updates to the CRWPP. Studies are needed to quantify nutrient inputs based on land use and rainfall, and exports to the atmosphere, groundwater, and estuary.
- **Reduction/Removal of Nitrogen.** The predominant form of nitrogen delivered from the watershed to the CRE is DON (roughly 80 percent of TN). Therefore, it is unlikely that the TMDL can be met without removing a substantial portion of DON. Studies are needed to determine to what extent the (1) DON component of nitrogen inputs to the estuary is biologically available (i.e., ecologically significant), and (2) biologically available nitrogen from the watershed can be reduced or removed by natural treatment technologies, prior to reaching the estuarine portion of the Caloosahatchee. Conceptual design of the C-43 Water Quality Treatment and Testing Facility, scheduled for FY2012, will include several nutrient removal technologies (i.e., "green" wetland and aquatic processes that rely more on solar and other natural energy inputs/plants and processes and less on the consumption of fossil fuels/chemicals) to reduce concentrations of bioavailable nitrogen and phosphorus compounds in the C-43 prior to discharge to the estuary.

Estuarine nutrient concentrations depend not only on external loads from the watershed but also on internal recycling in the water column and bottom sediments. The contribution of internal loads from the sediments on water column concentrations can be as significant as external loads from the watershed. The next two projects provide information necessary to include rates of internal nutrient cycling in the water quality model.

- **Characterization and quantification of nutrient (N and P) cycling within the CRE water column.** One approach to estimating nutrient uptake and regeneration rates in the water column is to measure the production and consumption of oxygen. These rates can be used directly to help calibrate parts of the water quality model that estimate the DO concentration. By assuming or measuring the nutrient composition of organic matter in the water column, rates of nutrient uptake and regeneration also can be estimated. These rates can be used to help calibrate those parts of the model that estimates nutrient concentrations.
- **Characterization and quantification of nutrient (nitrogen and phosphorus) cycling within the CRE between the sediments and water column.** Nutrient input from sediments could be extensive enough to delay the response of the estuary to nutrient reductions from the watershed. The 2008 dry season data has provided estimates of the lower boundary of these inputs. Wet season data are critical to quantifying the upper boundary of these inputs.

Modeling Needs and Future Recommendations

Modeling needs and recommendations presented in the 2009 CRWPP were revisited in light of the modeling progress summarized in the RWQMP and the sufficiency or capability of existing models to evaluate or define pollutant load reduction to achieve TMDLs, salinity envelopes, freshwater inflow targets, and environmental operations. Most of these recommendations still hold for future work, as follows:

- There remains a need for a watershed water quality model that can be used to evaluate loading reduction and source control programs. The FDEP's Hydrologic Simulation Program – FORTRAN Model can be applied for this purpose; however, the model will need to be further refined with additional calibration to better simulate nutrient cycling and DO dynamics in major canals and tidal basin. A longer period of calibration and validation is also needed.
- The Caloosahatchee Hydrodynamic Model has been well calibrated and applied in several critical projects; however, comparable water quality modeling work is still lacking. The FDEP's Environmental Fluid Dynamics Code Model for the estuary's TMDL for TN may be applied to fill this gap. In the future, the calibration period of the model needs to be extended with newly collected data in the estuary. To simulate the impact in the estuary from watershed loading reductions, model calibration and refinements on nutrient cycling processes, stratification, DO dynamics, and light attenuation when such data become available. The empirical relationships of important water quality processes and the control factors also need to be evaluated.
- Future efforts in estuarine ecological modeling will focus on quantifying responses of seagrasses (e.g., tape grass), oysters, and other key indicators to fluctuations in multiple environmental factors. Mathematical prediction of the distribution and status of these VECs offers a framework to measure the performance of watershed projects. Individual models for each VEC within the estuary will be linked spatially by hydrodynamics and water column processes. The resulting ecosystem models will be able to evaluate changes in depth, salinity, light, and nutrients on algal, macrophyte, and faunal survival. Habitat mapping, water quality monitoring, and ecosystem model output will be combined into a spatial database to contrast and visualize changes in VECs under different climatic and management scenarios.

Water Quality Evaluations: Estimated Nutrient Load Reductions

Water quality evaluations toward meeting the estuary's TMDL for TN were accomplished using algorithms in a Microsoft Excel® spreadsheet tool to estimate nutrient loads and load reductions that would result from implementing various management alternatives. This simplified approach was selected because of time constraints and, more importantly, limitations in the data needed to populate a more complex, process-based model. Initial estimates of runoff and loading for each sub-watershed were based on loading factors for TN and TP for 20 different land-use categories (Attachment B). For each sub-watershed, the area within each category was multiplied by the runoff and loading factors and summed for the sub-watershed. Initial estimates were calibrated to match the streamflow and nutrient loadings that were measured for the POR (1996–2005) at structures S-235, S-77, S-78, and S-79. For the Tidal Caloosahatchee Sub-watershed, no equivalent data was available, so the initial results were calibrated to the results of a recent model (Konyha and Wan, 2011). No equivalent measured data or modeling results were available for the Coastal Sub-watershed; therefore, those results were calibrated using the same multipliers as used for the Tidal Caloosahatchee.

Projects and activities that aim to reduce nutrient loads and increase water storage are defined in three distinct phases: (1) current (completed or constructed) implementation measures; (2) near-term implementation measures, which are anticipated to be initiated and/or completed from 2012–2014; and (3) long-term projects, which will be implemented or completed beyond 2014. A list of all activities and projects and their status are provided in Attachment A, Table A-1. The nutrient loading rates and reduction factors associated with BMPs and technologies for the Caloosahatchee River Watershed are described in Attachment B. Assumptions for BMP implementation rates are provided in Attachment C. Nutrient reductions associated with local, sub-regional, and regional projects are estimated based on available data and 2009 CRWPP evaluations. For the long-term phase, several anticipated parcel-based, chemical-treatment projects also were included. After totaling the TN and TP load reductions for a given phase, the equivalent concentrations were calculated for the runoff from each sub-watershed and were compared to the base concentrations of 0.80 parts per million (ppm) for TN and 80 parts per billion (ppb) for TP. The base concentration represents a minimum level for runoff within the Caloosahatchee River Watershed, below which further concentration reductions are not expected. If the combination of potential load reductions for a sub-watershed resulted in a concentration below this "minimum base level," then the concentration was adjusted to match the base level and the corresponding load was recalculated accordingly.

In this reporting, the POR from 1996–2005 is used to represent baseline water quality conditions. This POR was chosen to be consistent with the St. Lucie River Watershed Protection Plan Update, which uses this timeframe to align with the FDEP's BMAP efforts (i.e., ensuring consistency between both plan updates) and because the update uses 2004 land use coverage (which falls within this timeframe). The 2008 land use data was not available to incorporate into this update and therefore the 2004 land use data is the most recent available dataset occurring within the POR. The 2008 land use may be considered for the next (2015) update.

Estimated Nutrient Load Reductions from Current Activities

This section summarizes the existing nutrient loads to the estuary from the Caloosahatchee River Watershed and estimated TN and TP reductions anticipated from current projects and activities. It should be noted that although the focus of this plan is to reduce TN loads to the estuary, load reductions are also estimated for TP. From 1996–2005, the TN load from the watershed to the estuary was 2,536 mt/yr (not including loads from Lake Okeechobee). The estimated TN and TP load reductions from current activities are shown in **Table 20**. A summary of these activities is presented in Attachment A, Table A-1, with some examples below:

- **Urban and Agricultural BMPs.** Agricultural BMPs include two categories: owner-implemented and cost-share. Owner-implemented BMPs reflect those that would likely be implemented by land owners without incentives, while the cost-share BMPs are those that are more expensive to construct (culvert replacements, retention/detention, etc.) and could be reasonably funded through federal and state cost-share programs. The estimated nutrient load reduction from agricultural BMPs is 225.1 mt/yr for TN and 26.2 mt/yr for TP whereas urban BMPs resulted in load reductions of 8.8 mt/yr for TN and 0.4 mt/yr for TP.
- **Dispersed Water Management Projects.** These projects mainly provide water retention with ancillary water quality benefits and contribute to overall water storage improvement in the Caloosahatchee River Watershed. They include cost-share efforts such as the Barron Water Control District C-2 Water Storage and USDA-NRCS Wetlands Reserve Program projects. The estimated nutrient load reduction from these projects is 8.4 mt/yr for TN and 1.15 mt/yr for TP.

- **Local Water Quality Projects.** Thirteen local water quality projects had load reduction estimates included in the current phase. These are relatively small projects, mostly within the Tidal Caloosahatchee Sub-watershed, totaling estimated reductions of 11.3 mt/yr for TN and 2.56 mt/yr for TP.

Table 20. Current nutrient reduction activities in the Caloosahatchee River Watershed with lead agency(s) and estimated TN and TP load reductions.

	Total Nitrogen (mt/yr)	Total Phosphorus (mt/yr)	Lead Agency
Baseline Load	2,536.1	290.71	–
Baseline Concentration	*1.27 ppm*	*146 ppb*	–
Load Reductions from Current Activities			
Urban BMPs	8.8	0.37	FDEP
Agricultural BMPs	225.1	26.25	FDACS
Dispersed Water Management Projects	8.4	1.15	SFWMD, FDACS
Local Water Quality Projects	11.3	2.56	SFWMD, local governments
Regional/Sub-regional Projects	–	–	SFWMD, USACE
Total Reductions from Current Activities	253.5	30.33	–
Remaining Load	2,282.6	260.37	–
Remaining Concentration	1.15 ppm	131 ppb	–

Estimated Nutrient Load Reductions from Near-Term Activities

This section summarizes estimated TN and TP reductions anticipated from near-term projects and activities (**Table 21**). Collectively, these activities are expected to provide additional annual average load reductions of 147 mt/yr for TN and 24 mt/yr for TP over the next three years (2012–2014). A summary of these activities is presented in Attachment A, Table A-1, with some examples below:

- **Urban and Agricultural BMPs.** These BMPs are estimated to provide nutrient load reductions of 97.7 mt/yr for TN and 13.1 mt/yr for TP with a significant portion of it resulting from implementation of agricultural BMPs.
- **Dispersed Water Management Projects.** These include multiple planned projects such as the Clewiston Rehydration, cost-share, and NE-PES Program (note that load reductions benefits from this program are yet to be determined). These projects will provide ancillary water quality benefits, with an estimated load reduction of 2.2 mt/yr for TN and 0.24 mt/yr for TP.
- **Local Water Quality Projects.** Eight local water quality projects had load reduction estimates included in the near-term phase. These are relatively small projects, with modest loading reductions totaling about 3.5 mt/yr for TN and 0.87 mt/yr for TP.
- **Regional/Sub-Regional Projects**. The near-term phase includes two regional/ sub-regional projects. The larger project includes wetland restoration in the northern portion of Lake Hicpochee (CRE 04), which is expected to provide a

significant ancillary benefit for nutrient reduction. The estimated total loading reduction is 43.8 mt/yr for TN and 9.75 mt/yr for TP.

Table 21. Near-term nutrient reduction activities in the Caloosahatchee River Watershed with lead agency(s) and estimated TN and TP load reductions.

	Total Nitrogen (mt/yr)	Total Phosphorus (mt/yr)	Lead Agency
Load After Current Phase	2,282.6	260.37	–
Concentration After Current Phase	*1.15 ppm*	*131 ppb*	–
Load Reductions from Near-Term Activities			
Urban BMPs	20.5	3.38	FDEP
Agricultural BMPs	77.2	9.75	FDACS
Dispersed Water Management Projects	2.2	0.24	SFWMD, FDACS
Local Water Quality Projects	3.5	0.87	SFWMD, local governments
Regional/Sub-regional Projects	43.8	9.75	SFWMD, USACE
Total Reductions from Near-Term Activities	147.2	23.99	–
Remaining Load	2,135.4	236.39	–
Remaining Concentration	1.07 ppm	119 ppb	–

Estimated Nutrient Load Reductions from Long-Term Activities

Under the long-term activities, several management strategies are being considered to provide additional TN and TP reduction capability including additional urban and agricultural BMPs, additional potential sites under the DWM Program, chemical treatment at parcel and regional levels, and regional projects such as the CERP C-43 West Basin Reservoir Project and other regional storage/treatment facilities. Feasibility studies relating to these strategies will be performed and the most cost-effective projects will be implemented as possible. These future reduction projects are estimated to further reduce the loads to the estuary by approximately 442 mt/yr for TN and 52 mt/yr for TP (**Table 22**). A summary of each of these activities is presented in Attachment A, Table A-1. Long-term (2015 and beyond) nutrient load reduction strategies and projects include the following (note that some of these measures can be implemented sooner if funding permits):

- **Urban and Agricultural BMPs.** The estimated nutrient load reduction from urban and agricultural BMPs is 119 mt/yr for TN and 17 mt/yr for TP.
- **Dispersed Water Management.** Potential sites for additional DWM include Pop Ash Creek Preserve Restoration, Caloosahatchee Area Lakes Restoration (Lake Hicpochee), and cost-share projects. These will provide ancillary water quality benefits with an estimated load reduction of 11 mt/yr for TN and 0.76 mt/yr for TP.
- **Local Water Quality Projects.** Twenty local water quality projects had load reduction estimates included in the long-term phase. These include projects for centralized wastewater treatment, stormwater retrofit, and stormwater master

plan implementation, as well as several site-specific construction projects. The total loading reductions are estimated at 78.1 mt/yr for TN and 12.7 mt/yr for TP.

- **Regional/Sub-Regional Projects.** Eighteen regional and sub-regional projects are listed for the long-term phase. This includes the C-43 Water Quality Treatment and Demonstration Project (CRE 10); no load reductions have been estimated yet but the SFWMD will be completing a project conceptual design in FY2012 that will aid in such estimates. This also includes several other large-scale, water quality treatment projects [e.g., East Caloosahatchee Water Quality Treatment Area (CRE 05), Caloosahatchee Ecoscape Water Quality Treatment Area (CRE 11), West Caloosahatchee Water Quality Treatment Area (CRE 13)] as well as a conceptual element (recyclable water containment areas) within each of the sub-watersheds above Shell Point. If all these proposed projects are built, the total loading reductions are expected to be 219.7 mt/yr for TN and 19.25 mt/yr for TP, which would result in concentrations at or near the base levels in all sub-watersheds except S-4 for TN and Tidal Caloosahatchee for TP.
- **Chemical Treatment.** This involves implementing chemical treatment at the parcel level in the Caloosahatchee River Watershed. A study has been completed on implementation of chemical treatment at the regional and parcel level (SWET, 2010). Those study sites, mostly located in the East and West Caloosahatchee sub-watersheds, for parcel-level implementation are included in the long-term phase. The estimated nutrient load reduction from six potential chemical treatment sites is 13.8 mt/yr TN and 2.64 mt/yr for TP.

In summary, these activities collectively will reduce loads below the TMDL adopted for protection of the estuary. The estuary TMDL calls for a TN load reduction of 23 percent. The projects identified in this plan update are estimated to achieve approximately 33.2 percent TN load reduction (**Table 23**) and therefore are anticipated to meet the TMDL**.** As supporting information, the total load reduction for TP with full plan implementation is 36.7 percent.

Table 22. Long-term nutrient reduction activities in the Caloosahatchee River Watershed with lead agency(s) and estimated TN and TP load reductions.

	Total Nitrogen (mt/yr)	Total Phosphorus (mt/yr)	Lead Agency
Load After Near-Term Phase	2,135.4	236.39	–
Concentration After Near-Term Phase	*1.07 ppm*	*119 ppb*	–
Load Reductions from Long-Term Activities			
Urban BMPs	58.4	9.41	FDEP
Agricultural BMPs	60.6	7.57	FDACS
Dispersed Water Management Projects	11.0	0.76	SFWMD, FDACS
Local Water Quality Projects	78.1	12.71	SFWMD, local governments
Regional/Sub-regional Projects	219.7	19.25	SFWMD, USACE
Chemical treatment at Parcel Level	13.8	2.64	SFWMD, FDEP, USACE
Total Reductions from Long-Term Activities	441.5	52.33	–
Remaining Load	1,693.8	184.06	–
Remaining Concentration	0.86 ppm	94 ppb	–

Table 23. Summary of TN and TP load reductions for CRWPP implementation phases.

	Load Reduction (mt/yr)	Remaining Load (mt/yr)	Percent Reduction (%)	Remaining Concentration
Total Nitrogen				
Baseline	n/a	2,536.1	n/a	1.27 ppm
Current Activities (through 2011)	253.5	2,282.6	10%	1.15 ppm
Near-Term Activities (2012–2014)	147.2	2135.4	5.8%	1.07 ppm
Long-Term Activities (2015-beyond)	441.5	1,693.8	17.4%	0.86 ppm
Total Reduction	842.3	–	33.2%	–
Estimated Values for CRWPP at TMDL	583.3	1,952.8	23.0%	0.98 ppm
Total Phosphorus				
Baseline	n/a	290.71	n/a	146 ppb
Current Activities (through 2011)	30.33	260.37	10.4%	131 ppb
Near-Term Activities (2012–2014)	23.99	236.39	8.3%	119 ppb
Long-Term Activities (2015-beyond)	52.33	184.06	18%	94 ppb
Total Reduction	106.65	–	36.7%	–

Estimated Load Reductions by Sub-Watershed

The following section summarizes the estimated load and concentration reductions both for TN and TP by each sub-watershed in the CRE. **Figure 31** shows the TN loads for each planning phase: baseline, current, near-term, and long-term. Overall, the highest loadings originate in the West Caloosahatchee Sub-watershed, followed by the Tidal and East Caloosahatchee sub-watersheds. The contribution from the S-4 Sub-watershed is relatively small. The loading from each sub-watershed decreases from each phase to the next, as expected with the addition of new projects and activities that result in further load reductions. The relative concentrations for TN for each implementation phase by sub-watershed are shown in **Figure 32**. It should be noted that TN concentrations in water from the S-4 Sub-watershed are considerably greater than from the other sub-watersheds, and are expected to remain as such throughout the planning horizon, even though the total loading from the S-4 Sub-watershed is relatively small. For the main stem of the CRE, downstream from east to coastal, the concentration decreases. TN concentrations of 0.80 ppm indicate that, for several sub-watersheds, the cumulative effect of the project activities is large enough to reduce the final concentrations to the minimum expected natural background level.

As supporting information, **Figure 33** depicts the TP loads for implementation phases by sub-watershed. As with TN, the highest loadings are from the West and Tidal Caloosahatchee sub-watersheds, with the largest expected reductions occurring in the West Caloosahatchee Sub-watershed. The relative TP concentrations for each implementation phase by sub-watershed are shown in **Figure 34**. With the exception of the Coastal Sub-watershed, for which the TP concentrations are low, concentrations generally increase in the downstream direction likely because sugar cane and citrus (which are the dominant land uses in the upstream areas) contribute low concentrations of TP as compared to urban areas. As with TN, TP concentrations of 80 ppb indicate that for most sub-watersheds, the cumulative effect of the project activities is large enough to result in concentrations at the minimum natural background concentration level.

Figure 35 shows estimated TN loads, concentrations, and load reductions for each planning phase across the entire CRWPP study area. **Figure 35**, panel A, depicts total loads for TN; an estimate of the equivalent value for the TMDL is included for comparison, which was calculated as a 23 percent reduction from the baseline TN load for this study. The TN estimate for the long-term phase is below the estimated TMDL, suggesting that if all the CRWPP projects were implemented, the TMDL would most likely be met. It should also be noted that these are initial planning estimates and load reduction estimates for specific projects will be further refined during the FDEP's BMAP process. Ultimately, it is anticipated that the CRWPP will adopt these refined load estimates once they are available to adjust the load reduction estimates, if needed. A possible estimate of the tidal TN TMDL is included for comparison purposes. Percentage reductions are calculated from the 1996–2005 baseline period; cumulative percentages are the sum of current, near-term, and long-term reductions. **Figure 35**, panel B, presents the estimated TN concentrations over the course of the RWPP, with an equivalent TMDL concentration estimated from the baseline data. The final value of 0.86 ppm is the estimated TN concentration of all the waters that originate within the CRWPP study area, with full implementation of the plan. This value approaches the minimum expected concentration or 0.80 ppm, and is below the equivalent estimated concentration at the TMDL. **Figure 35**, panel C, shows the TN load reductions as a percentage of the baseline value. As previously noted, the cumulative reduction for the full implementation of the plan is 33.2 percent, which meets the estuary's TMDL for TN.

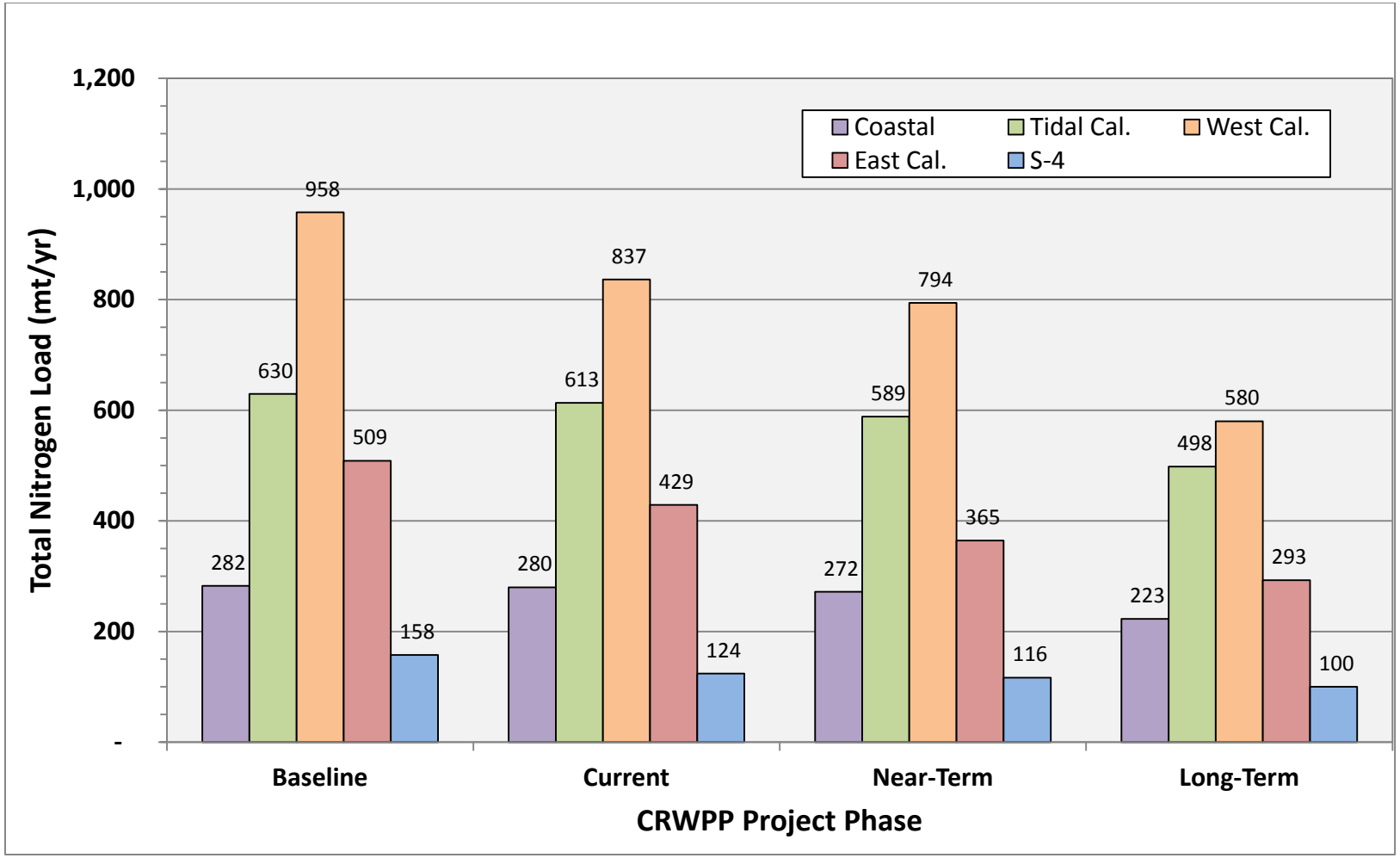


Figure 31. Estimated TN loads (mt/yr) by sub-watershed for each planning phase. [Note: bars represent loads for the sub-watersheds and are organized from left to right in their west to east order.]

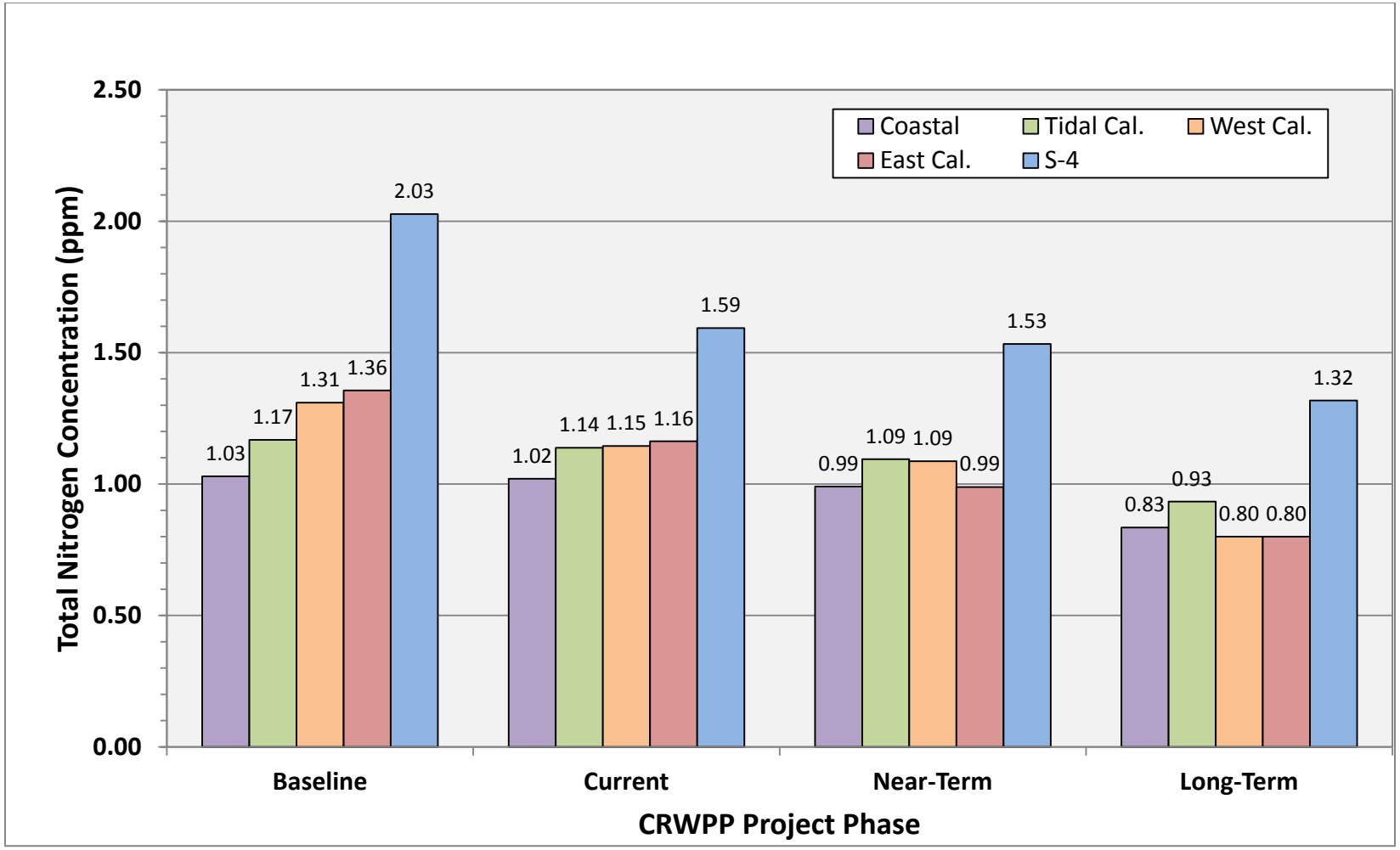


Figure 32. Estimated TN concentrations (mg/L, or ppm) by sub-watershed for each planning phase. [Note: bars represent loads for the sub-watersheds and are organized from left to right in their west to east order.]

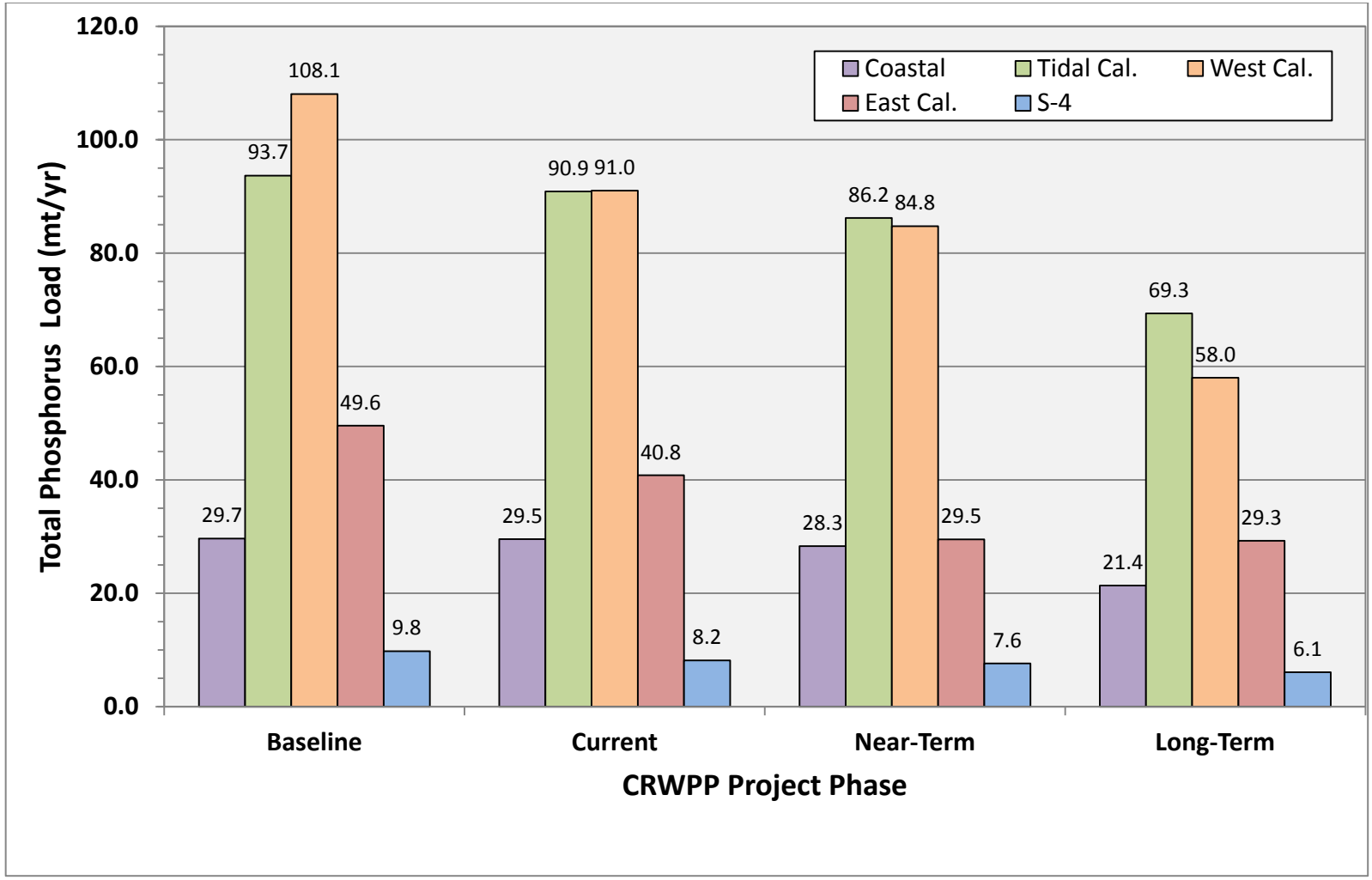


Figure 33. Estimated TP loads (mt/yr) by sub-watershed for each planning phase. [Note: bars represent loads for the sub-watersheds and are organized from left to right in their west to east order.]

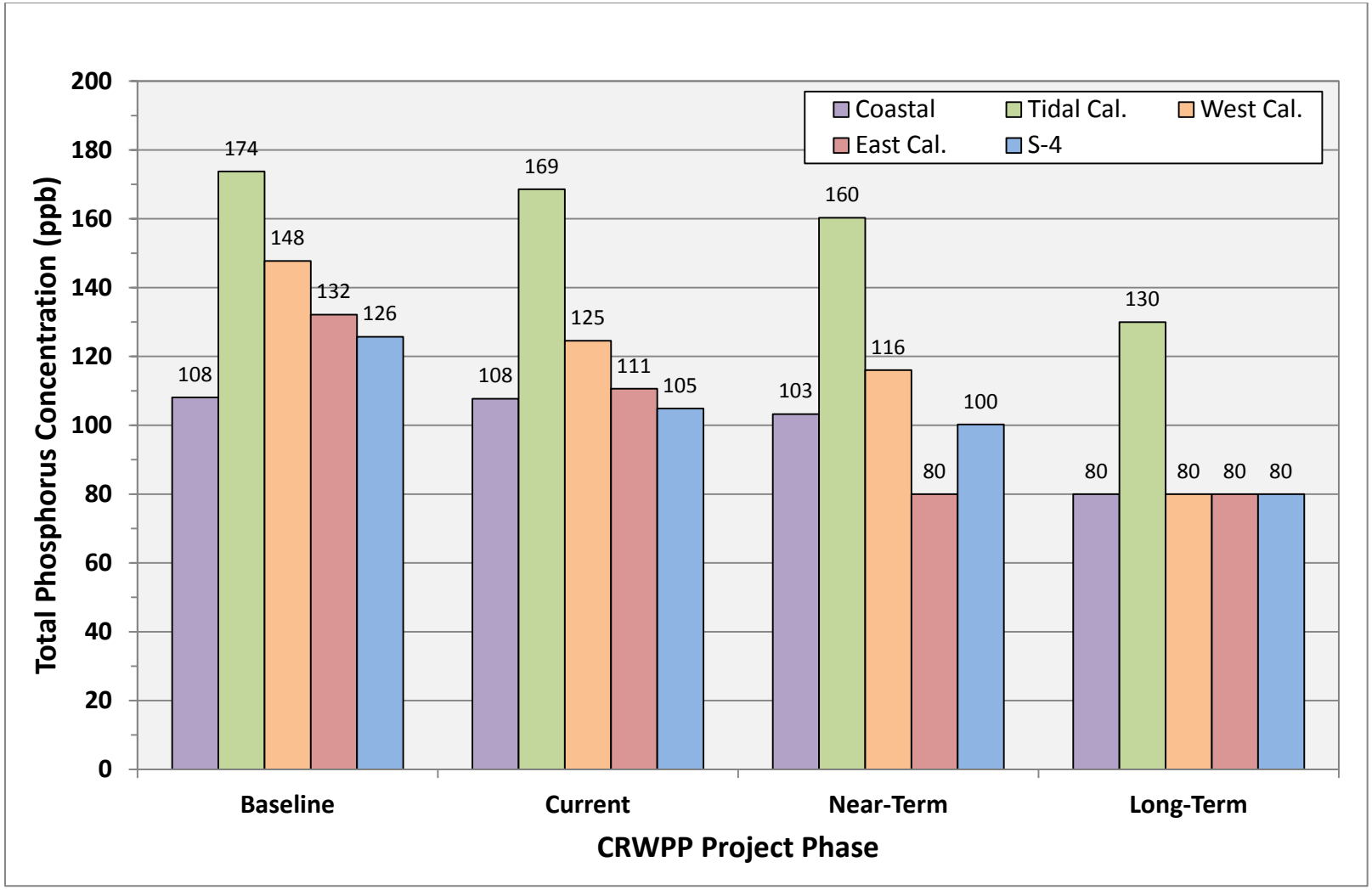


Figure 34. Estimated TP concentrations (µg/L, or ppb) by sub-watershed for each planning phase. [Note: bars represent loads for the sub-watersheds and are organized from left to right in their west to east order.]

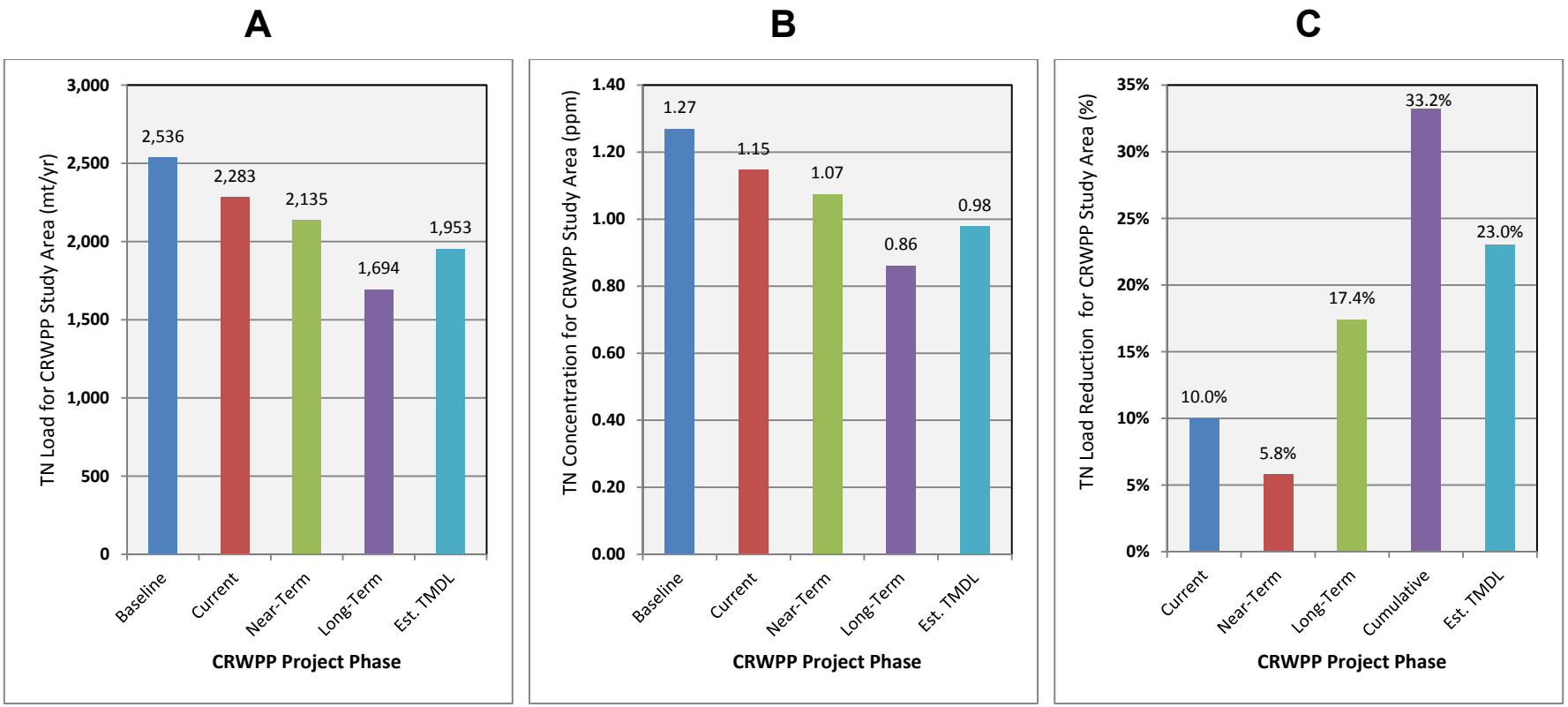


Figure 35. Estimates for each planning phases for the entire CRWPP study area: (a) TN loads (mt/yr), (b) TN concentrations (mg/L or ppm), and (c) TN load reduction (%).

Addressing Water Quantity: Strategies and Next Steps

Increasing water storage in the Caloosahatchee River Watershed will require a mix of regional and DWM projects. The coordinating agencies are aggressively pursuing DWM implementation and expansion in the Northern Everglades watersheds by working with other government agencies, non-profit organizations, Florida Native American tribes, and public and private landowners. Creating another opportunity for businesses to participate in and help implement solutions, the NE-PES DWM solicitation program was initiated in 2011. This program offers eligible cattle ranchers the opportunity to compete for contracts for water and nutrient retention. It is widely acknowledged that the components of the DWM Program (easements, cost-share, and payment for services) are the most promising options in the near-term to address a portion of the storage needs. Additional efforts have recently been initiated including implementation of water farming pilots, which will utilize fallow/out-of-production citrus lands to store water and attenuate nutrients allowing storm water to be used as an alternative water supply. The expected result of water farming will be reduced releases and improved water quality to the CRE. Currently, the District is discussing an agreement with the Gulf Citrus Growers Association to assess the feasibility of water farming and potential implementation of a pilot in FY2012. Also, utilizing publicly owned lands for interim storage until the large regional projects are built provides a short-term opportunity for water storage. Accordingly, the District will be implementing an interim DWM project on the former BOMA property in FY2012 that will involve rehabilitating the existing pump to utilize the existing water management system components, including three on-site detention areas, to provide water quality improvement and retain stormwater runoff. Another DWM project recently initiated by the District is the Nicodemus Slough Water Management Project located in Glades County. This project is expected to assist with reducing freshwater discharges to the Caloosahatchee River and was included as a retention project in the Lake Okeechobee Protection Plan.

Furthermore, USDA-NRCS will be providing opportunities for easements through the Wetland Reserve Program, which will ultimately increase water retention in the Northern Everglades. In August 2011, the USDA announced $100 million in financial assistance to acquire permanent easements from eligible landowners in Lee, Hendry, Okeechobee, and Highlands counties and assist with wetland restoration on nearly 24,000 acres of agricultural land in the Northern Everglades watersheds. The wetland restoration will reduce the amount of surface water leaving the land, slowing water runoff and lowering the concentration of nutrients entering surface waters and, ultimately, Lake Okeechobee and the river watersheds. This is the largest amount of funding Florida has ever received for projects in the same watershed through the Wetlands Reserve Program in a single year.

Overall, the ultimate goal for the DWM Program is to provide 450,000 ac-ft of storage throughout the Northern Everglades watersheds (Okeechobee, Caloosahatchee, and St. Lucie watersheds). However, regional projects (e.g., CERP C-43 West Basin Storage Reservoir) are also critical to reaching the storage goals for the Caloosahatchee River Watershed. Although regional storage and treatment projects remain part of the solution, implementation has been delayed due to lack of federal authorizations and funding constraints. The CERP C-43 West Basin Reservoir Project is expected to provide 170,000 ac-ft of storage when fully implemented.

Plan Implementation

The CRWPP Update will be implemented in multiple phases. The schedule and list of implementation measures take into account current fiscal challenges. The measures listed in **Table 24** are those that are most imminent and have the highest potential to be initiated or completed by the end of 2014. The entire list of implementation measures and their anticipated

phase is provided in Attachment A, Table A-1. It is presumed that the plan will be revisited and necessary adjustments will be made to the implementation measures and their phase in the next CRWPP Update.

Table 24. CRWPP projects that are planned to be initiated or completed in the near-term (2012–2014).

		Initiated	Completed
Source Control and Other Regulatory Activities	Agricultural and Urban BMPs*	✓	✓
	SFWMD's Regulatory Source Control Program (Chapter 40E-61, F.A.C) for Caloosahatchee River Watershed**	✓	
	Caloosahatchee Water Reservation Rulemaking Initiative	✓	✓
	FDEP's Caloosahatchee Freshwater TMDL		✓
	FDEP Caloosahatchee BMAP	✓	✓
Construction Project and Other Related Efforts	Caloosahatchee Basin Storage/Treatment Initiative	✓	✓
	Spanish Creek/Four Corners Initiative	✓	
	Dispersed Water Management Projects – Planned	✓	✓
	Northern Everglades Payment for Environmental Service Program Solicitation	✓	✓
	Interim Lands – BOMA	✓	✓
	Nicodemus Slough Water Management Project	✓	
	Water Farming Pilot Projects	✓	
	Alternative Nutrient Reduction Technologies (e.g., Permeable Reactive Barrier Technology and Chemical Treatment)	✓	
	Local Water Quality Projects	✓	✓
	Caloosahatchee Water Quality Treatment and Testing Project (BOMA Property)	✓	
Research and Water Quality Monitoring	Watershed and Estuarine Nutrient Budget Refinements	✓	
	New Alternative Technology Assessment	✓	
	Continue Tidal and Estuary Monitoring	✓	✓
	Tape Grass (*Vallisneria americana*) Plantings		✓
	Nitrogen Treatment Studies	✓	✓
	Watershed/Water Quality Modeling Collaboration with FDEP	✓	

*Completed partial implementation through a phased approach

** The District will coordinate with the Office of Fiscal Accountability and Regulatory Reform prior to initiating rule development to amend Chapter 40E-61, F.A.C.

Plan Implementation Challenges and Cost Estimates

Since its inception in 2007, the Northern Everglades and Estuaries Protection Program has faced many implementation challenges, the most significant being reduced funding. Federal, state, and local funds have drastically decreased over the last three years. The FDACS has also experienced a shortfall in expected BMP funding and the completion of cost-shared BMP programs has fallen behind schedule. Furthermore, ongoing litigation related to water quality in the Everglades Protection Area may result in additional legally mandated projects for the Southern Everglades. Construction of thousands of acres of additional water quality facilities within mandated deadlines will require funding commitments from the District that will have direct effects on implementation of the CRWPP. It is also important to note that the implementation of the CERP C-43 West (Caloosahatchee River) Reservoir Project is critical to the success of meeting the CRWPP storage goals. While the Chief's Report for the C-43 West (Caloosahatchee River) project, outlining the recommended plan for implementation, was signed by the USACE Chief of Engineers in March 2010, project authorization and funding are still pending. The District will continue to work collaboratively with the USACE on this project. Looking ahead, the coordinating agencies continue to work to overcome these challenges and remain committed to restoring and protecting the Northern Everglades and implementing the CRWPP. If additional funding sources are identified, then expedited implementation of the cost-share BMPs, local stormwater projects, DWM Program, C-43 Water Quality Treatment and Testing Project, and development of a nutrient budget are the recommended priorities.

Total estimated costs for the current and near-term projects implemented under the CRWPP Update were calculated in 2011 dollars (**Table 25**). All project costs were obtained from projected values or actual costs where available. The coordinating agencies will continue to pursue alternative funding sources including federal matching funds, other non-state funding, and public-private partnerships, wherever possible, to expedite implementation of this plan. As noted earlier, the economic downturn has had a substantial impact on the state's and District's funding capabilities, which will continue to affect the implementation of the projects and programs identified in the CRWPP.

Table 25. Total cost estimates for near-term CRWPP implementation.

Category of Cost	Cost Estimate
Watershed Source Control[1]	$3.4 M
Near-term Construction Projects (regional, sub-regional and local) [2]	$32.3M
Dispersed Water Management[3]	$12.0M
Research and Water Quality Monitoring[4]	$1.9 M
Total Cost	**$49.6 M**

[1]Includes FDACS Agricultural BMP cost share dollars and programmatic costs for SFWMD source control program. Urban BMP costs are not included.
[2]Includes costs for eight local water quality projects expected to be completed in near-term plus cost of regional projects (e.g., Caloosahatchee Basin Storage/Treatment Project, Spanish Creek/ Four Corners Initiative, C-43 Water Quality Treatment and Demonstration Project).
[3] Includes the Clewiston Site, Interim Lands BOMA Site, Nicodemus Slough Water Management Project, and the Caloosahatchee Water Farming Pilot Project. Does not include costs for future NE-PES solicitations.
[4] Includes costs for dry season tape grass planting, internal nutrient cycling and watershed nutrient budget studies, WASP Water Quality Model development, and biological/water quality monitoring.

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Attachment A: Caloosahatchee River Watershed Protection Plan Updates and New Project/Activity Sheets

Table A-1 provides a summary of project updates since the publication of the 2009 Caloosahatchee River Watershed Protection Plan (CRWPP) (SFWMD et al., 2009). Project description sheets (f/k/a management measure sheets) for new projects are provided in this attachment following the table. Project description sheets are not provided for three new projects listed in **Table A-1** [Dispersed Water Management Water Farming Assessment (CRE 152), Dispersed Water Management Interim Sites (CRE 153) and Clewiston Site Alternative Storage/Rehydration Project (CRE 154)]. Please see the *Dispersed Water Management Program* section of the report for details on these projects. See the 2009 CRWPP (SFWMD et al., 2009) for project descriptions of the remaining projects.

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE-LO 01,02,49	Agricultural BMPs – Owner Implemented, Funded Cost-Share, and Cost-Share Future Funding	Implements agricultural BMPs and water quality improvement projects to reduce the discharge of nutrients from the watershed.	Total agricultural acreage in the Caloosahatchee Watershed is approximately 476,568 acres. Approximately 44 percent of this acreage is enrolled in owner implemented BMPs and have cost-share type BMPs in place.	Ongoing[2]	Source Control	✓	-
CRE-LO 03	Urban Fertilizer Rule [Lake Okeechobee Estuary and Recovery (LOER)]	This is an FDACS rule that regulates the content of phosphorus and nitrogen in urban turf fertilizers to improve water quality.	No update.	Completed	Source Control	✓	-
CRE-LO 04	Biosolids Rule	NEEPP [Section 373.4595(4)(b)2.e, F.S.] requires that after December 31, 2007, the FDEP may not authorize the disposal of domestic wastewater residuals within the Caloosahatchee River Watershed unless the applicant can affirmatively demonstrate that the nutrients in the residuals will not add to nutrient loadings in the watershed.	The revised biosolids rule, Chapter 62-640, F.A.C, (August 2010) includes new requirements for site permitting, nutrient management plans, registration of distributed and marketed Class AA biosolids as fertilizer, and prohibition of land application of other types of biosolids (Class B) in the Northern Everglades watersheds unless a nutrient balance demonstration is completed by the applicant and approved by the FDEP. Current application of Class B is authorized under a facility's permit in the Caloosahatchee River Watershed until the permit expires; however, all application sites will have to be permitted by January 13, 2013, under the new rule. No authorizations for new residuals (Class B Biosolids) disposal sites have been issued since 2008.	Completed	Source Control	✓	-
CRE-LO 05	Florida Yards and Neighborhoods Program	Program provides education to citizens by promoting land use designs to minimize pesticides, fertilizers, and irrigation water.	Since 2009, the UF/IFAS Florida Yards and Neighborhood Program has expanded from a homeowner approach to cover a broader audience (e.g., builders, developers, architects).	Ongoing[2]	Source Control	✓	-
CRE-LO 07	Environmental Resource Permit (ERP) Regulatory Program	The District and the FDEP are authorized to implement the ERP program. It requires that new activities or modifications of existing activities provide reasonable assurances that they will not cause adverse water quality such that state water quality standards will be violated, cause adverse flooding or water quantity impacts, or harm wetland or other surface water systems.	No update.	Ongoing[2]	Source Control	✓	✓
CRE-LO 08	National Pollutant Discharge Elimination System (NPDES) Stormwater Program	Program targets reducing stormwater pollutant loads discharged to surface waters, particularly from existing land uses and drainage systems. This applies to the master drainage systems owned and operated by cities, counties, FDOT, and Chapter 298 water control districts; also helps reduce stormwater pollutant loads from existing industrial and new construction sites.	The FDEP is in the process of reissuing all Phase I MS4 permits for the Caloosahatchee River Watershed; Hendry and Glades counties were issued Phase II MS4 permits in 2010.	Ongoing[2]	Source Control	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE-LO 09	Coastal & Estuarine Land Conservation Program (CELCP)	Established in 2002 by NOAA, CELCP protects important coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values, or that may be converted from their natural or recreational state to other uses (CELCP Final Guidelines, 2003). In Florida, CELCP is coordinated through FDEP's Coastal Management Program.	No update.	Ongoing[2]	Land Management and Restoration	✓	✓
CRE-LO 12g	Alternative Water Storage Project (LOER) – Barron Water Control District	Project provides about 5,000 ac-ft of water storage on 6,129 acres; includes weir construction/ditch retention to enable water quality improvements and reuse by growers.	Project is operational.	Completed	Dispersed Water Management	✓	✓
CRE-LO 15	Proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program	Program implements a nutrient source control program utilizing BMPs for the Caloosahatchee River Watershed. Ongoing activities include revising Chapter 40E-61, F.A.C., to reflect NEEPP requirements and to expand the rule boundary to include the Caloosahatchee River Watershed as defined by the program.	In late 2009, the District initiated the activities and technical analyses necessary to develop these programs and initiate consultation with stakeholders and coordinating agencies. The District will coordinate with the OFARR prior to initiating rule development to amend Chapter 40E-61, F.A.C.	Near-term	Source Control	✓	✓
CRE-LO 40	West Lake Hicpochee Project	Project includes a reservoir and STA along the C-19 and C-43 canals, degradation of berms, and exotic removal/control; and has potential for 55,090 ac-ft of aboveground storage. Preliminary load reduction estimates for this project are 27.6 mt/yr TN and 2 mt/yr TP.	No update.	Long-term	Regional	✓	✓
CRE-LO 41	C-43 Distributed Reservoirs Project	Project involves storage reservoirs to capture excess runoff. Preliminary load reduction estimates for this project are 39.4 mt/yr TN and 2.6 mt/yr TP.	No update.	Long-term	Regional	✓	✓
CRE-LO 63	Wastewater & Stormwater Master Plans	Master Plans outline implementing urban stormwater retrofit or wastewater projects to achieve additional nutrient reductions and water storage basin-wide by working with entities responsible for wastewater/stormwater programs in the service area.	See the CRWPP Construction Project for the implementation status of urban stormwater retrofits and wastewater projects.	Ongoing[2]	Source Control	✓	✓
CRE-LO 68	Comprehensive Planning – Land Development Regulations	Basin-wide work with state agencies, cities, and counties to review current plans and ensure promotion of low impact design through coordinated comprehensive planning and growth management initiatives.	No update.	Ongoing[2]	Source Control	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE-LO 87c	Florida Ranchlands Environmental Services Project (FRESP)	FRESP is a five-year pilot project to develop and field test the Northern Everglades–Payment for Environmental Services (NE-PES) Program. The eight pilot projects, implemented and built from 2005–2007, consisted of working ranches retaining excess stormwater runoff or providing water quality improvements for contracted payments. Pilot data shows that expansion throughout the Northern Everglades can complement existing and planned regional water storage and treatment projects.	Pilot projects remain in operation but are phasing into other programs.	Completed	Dispersed Water Management	✓	✓
CRE-LO 91	Farm and Ranchland Partnerships	There are two USDA-NRCS farm and ranchland partnership programs: Farm and Ranchlands Protection Program, and Wetlands Reserve Program (WRP). Under these programs, landowners sell development rights to land and place it in a conservation easement that permanently maintains land as agriculture and open space.	The District executed a Memorandum of Understanding in October 2010 to assist USDA-NRCS by providing technical assistance in implementing their WRP projects. The USDA recently announced $100 million in financial assistance to acquire permanent easements from eligible landowners in four counties, including Lee and Hendry counties, and to assist with wetland restoration on nearly 24,000 acres of agricultural land in the Northern Everglades watersheds. This is the largest amount of funding Florida has ever received for projects in the same watershed through the WRP in a single year.	Ongoing[2]	Dispersed Water Management	✓	✓
CRE 01	Recyclable Water Containment Areas (RWCA) Project	Project utilizes agricultural lands for reducing nutrient loads into the CRE. Preliminary load reduction estimates for this project are 67.5 mt/yr TN and 14.3 mt/yr TP.	Project was included in the Southwest Florida Comprehensive Watershed Plan (formerly Southwest Florida Feasibility Study), which is in the process of being completed; however, there has not been any additional design or funding.	Long-term	Local	✓	✓
CRE 02	Centralized Recycled Water Containment Area in the S-4 Basin Project	Project uses agricultural or other lands to provide temporary storage, remove nutrients, and treat agricultural stormwater runoff from the S-4 Basin, which will help reduce nutrient loading to the CRE, provide aquifer recharge, and add a temporary back-up water supply for irrigation. Preliminary load reduction estimates for this project are 11.9 mt/yr TN and 2.41 mt/yr TP.	Project was included in the Southwest Florida Comprehensive Watershed Plan (formerly Southwest Florida Feasibility Study), which is in the process of being completed; however, there has not been any additional design or funding.	Long-term	Local	✓	✓
CRE 04	Caloosahatchee Area Lakes Restoration (Lake Hicpochee) Project	Project restores historical lake bed of Lake Hicpochee using 5,300 acres in footprint of state-owned lands, which will treat runoff from agricultural canals that flow into Lake Hicpochee and CRE. Preliminary load reduction estimates for this project are 100 mt/yr TN and 24 mt/yr TP.	No update.	Long-term	Regional	✓	✓
CRE 05	East Caloosahatchee Water Quality Treatment Area Project	Project consists of a constructed wetland designed for optimal removal of TN within Lake Hicpochee and CRE and to reduce nutrient pollutant loading downstream. Preliminary load reduction estimates for this project are 80.1 mt/yr TN and 19.2 mt/yr TP.	No update.	Long-term	Regional	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 10	C-43 Water Quality Treatment and Demonstration Project (BOMA Property)	Project consists of a constructed wetland designed for optimal removal of TN from the CRE and to reduce nutrient pollutant loading downstream.	As part of project planning, in 2010 the District conducted an expert panel review of the conceptual design and its scientific basis. The District is prepared to proceed in FY2012 with conceptual design of a testing facility that incorporates the panel's recommendations.	Long-term	Regional	✓	-
CRE 11	Caloosahatchee Ecoscape Water Quality Treatment Area Project	Project consists of a constructed wetland designed for optimal removal of TN from the CRE and to reduce nutrient pollutant loading downstream. Preliminary load reduction estimates for this project are 50.0 mt/yr TN and 12.0 mt/yr TP.	Project was included in the Southwest Florida Comprehensive Watershed Plan (formerly Southwest Florida Feasibility Study), which is in the process of being completed; however, there has not been any additional design or funding work performed.	Long-term	Regional	✓	✓
CRE 13	West Caloosahatchee Water Quality Treatment Area Project	Project consists of a constructed wetland designed to treat reservoir water to reduce nutrient concentrations from the CRE and nutrient pollutant loading downstream. Preliminary load reduction estimates for this project are 58.5 mt/yr TN and 13.9 mt/yr TP.	Project was included in the Southwest Florida Comprehensive Watershed Plan, which is in the process of being completed; however there has not been any additional design or funding.	Long-term	Regional	✓	✓
CRE 18	Harns Marsh Improvements, Phase I Project – East County Water Control District (ECWCD)	Phase I reduces flooding on the Orange River, improves water quality, and increases detention times to enhance recharge to the local groundwater aquifer. Gate improvements will improve operations and expand the area of the south marsh available for storage. This is expected to result in an incremental storage volume increase of 1,482 ac-ft and estimated load reductions are 1.5 mt/yr TN and 0.2 mt/yr TP.	Project was completed in 2011.	Completed	Local	✓	✓
CRE 19	Harns Marsh Improvements, Phase II Project – ECWCD	Project rebuilds structure S-OR-1 to improve operations; this will help improve utilization of the south marsh and result in an increased storage volume of 700 ac-ft. Estimated load reductions are 0.6 mt/yr TN and 0.1 mt/yr TP.	Project was completed in 2011.	Completed	Local	✓	✓
CRE 20	Yellowtail Structure Construction Project – ECWCD	Project replaces a failing broad crest weir with a new sheet pile weir with operable gates to allow better control of canal water quantity and quality and aid in water recharge. Preliminary load reduction estimates for this project are 0.32 mt/yr TN and 0.03 mt/yr TP.	Project was completed in 2009.	Completed	Local	✓	✓
CRE 21	Hendry County Storage Project – ECWCD	Project includes land acquisition for additional stormwater storage and treatment in the wet season and to provide base flows for ECWCD's outfalls along with additional groundwater recharge in the dry season. Preliminary load reduction estimates for this project are 2.72 mt/yr TN and 0.68 mt/yr TP.	Project was included in the ECWCD FY2010-FY2014 Capital Improvement Plan. ECWCD has three sites under consideration: Cornerstone, Tri-County Mine 3, and Duda property.	Long-term	Local	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 22 (revised)[1]	Hendry Extension Canal Widening (Construction) Project – ECWCD	Project provides additional water quantity storage within existing canal right-of-way to help provide more stormwater storage in the 5.5 mile section of Hendry Extension Canal. Estimated load reductions are 0.36 mt/yr TN and 0.1 mt/yr TP.	Project was included in the ECWCD FY2010-FY2014 Capital Improvement Plan.	Long-term	Local	✓	✓
CRE 29	Lehigh Acres Wastewater Treatment and Stormwater Retrofit Project	Project involves installing stormwater treatment features in Lehigh Acres, updating current stormwater management system, and converting high-density septic tanks to centralized wastewater treatment.	Nearly 100 single family homes in Lehigh Acres have been connected to the centralized wastewater treatment plant since 2009. Additional properties could be connected if funds are made available.	Ongoing[2]	Local	✓	-
CRE 30	Aquifer Benefit and Storage for Orange River Basin (ABSORB) Project – ECWCD	Project involves increasing stormwater storage capacity and Southwest Lehigh Acres groundwater recharge. Preliminary load reduction estimates for this project are 3.72 mt/yr TN and 0.37 mt/yr TP.	Project is designed and permitted; the ECWCD is awaiting construction funding. It is included in the ECWCD FY2010–FY2014 Capital Improvement Plan.	Long-term	Local	✓	✓
CRE 44	Four Corners/Spanish Creek Initiative	Initiative between the SFWMD and Lee and Hendry counties to develop regional approaches for improving water quality and water storage in the Caloosahatchee River Watershed. The County Line Ditch improvements are estimated to provide load reductions of 2.54 mt/yr TN and 0.64 mt/yr TP. The Spanish Creek improvements are estimated to provide load reductions of 3.6 mt/yr TN and 0.67 mt/yr TP.	There are two current initiative components: (1) Spanish Creek Restoration (Lee County and SFWMD) to create wetland flow-ways within existing citrus fields to rehydrate the Ruby Daniels Preserve, Bob Jane's Preserve, and Spanish Creek; and (2) Jacks Branch (County Line Ditch) (Hendry County and SFWMD) improve the County Line Ditch by widening the ditch, adding shallow littoral areas, and providing weirs for increased water storage and treatment.	Near-term	Regional	✓	✓
CRE 45	Billy Creek Filter Marsh, Phases I and II Project	Project includes constructing a filter marsh and water control structure to divert flows into the filter marsh facility, providing additional attenuation of stormwater flows in the channel. Preliminary load reduction estimates for this project are 2 mt/yr TN and 0.5 mt/yr TP.	Phase I and Phase II were completed in 2008 and 2010, respectively. The project land stewardship management plan is still pending.	Completed	Local	✓	✓
CRE 48	Manuel's Branch Silt Reduction Structure Project	City of Fort Meyers project involves installing a low-level weir/control structure within the Manuel's Branch existing channel section (downstream of Cortez Boulevard), and constructing native vegetative shelves in the existing channel section, between Cortez and the existing weir, to reduce the silt associated with stream bank scour, erosion, and degradation. Preliminary load reduction estimates for this project are 0.14 mt/yr TN and 0.11 mt/yr TP.	Project was completed in 2011.	Completed	Local	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 49	Manuel's Branch East and West Weirs Project	City of Fort Meyers project involves installing two weir water control structures in the existing canal and providing attenuation downstream to reduce peaking effects of past urbanization and storm sewer practices in the Fowler commercial corridor and easterly industrial area; intended to reduce nutrients, suspended solids and sediments and lessen erosion. Preliminary load reduction estimates for this project are 0.42 mt/yr TN and 0.16 mt/yr TP.	Project was completed in 2008.	Completed	Local	✓	✓
CRE 53	Caloosahatchee Creeks Preserve Hydrological Restoration Project	Project consists of culvert construction and plugging existing ditches to increase retention time on the Caloosahatchee Creeks Preserve to aid in wetland rehydration and water quality that will discharge downstream to the CRE; it is estimated that this will contribute 1,200 acres of storage capacity and a load reduction of 3.83 mt/yr TN and 0.96 mt/yr TP.	Hydrologic restoration was completed in 2010.	Completed	Local	✓	✓
CRE 59	North Fort Myers Surface Water Restoration Project	Lee County project reduces stormwater pollution through channel improvements, constructs weirs to control runoff from the Palermo development (golf course/residential), and incorporates a filter marsh to reduce contaminants. Preliminary load reduction estimates for this project are 0.68 mt/yr TN and 0.06 mt/yr TP.	Flow-way component of project was constructed in 2009.	Completed	Local	✓	✓
CRE 64	Yellow Fever Creek/Gator Slough Transfer Facility Project (#208509)	Project restores historical flows to Yellow Fever Creek, a CRE tributary; involves constructing an interconnection facility between Gator Slough Canal and Yellow Fever Creek to transfer surface waters during high flow. Flows are currently intercepted by Gator Slough Canal and redirected to Matlacha Pass.	Negotiations between Lee County and City of Cape Coral are under way.	Long-term	Local	-	✓
CRE 69	Cape Coral Wastewater Treatment and Stormwater Retrofit Project	City of Cape Coral project that is part of overall program to convert septic systems to gravity sewers and replace older stormwater inlets with newer inlets designed to assist storm water. Preliminary load reduction estimates for this project are 27 mt/yr TN and 5.4 mt/yr TP.	No update.	Long-term	Local	✓	-
CRE 77	Cape Coral Canal Stormwater Recovery by Aquifer Storage and Recover (ASR) Project	Project uses ASR wells in Cape Coral to overcome water shortfall in the dry season and provide flood attenuation in the wet season. Preliminary load reduction estimates for this project are 4.13 mt/yr TN and 0.82 mt/yr TP.	Three ASR wells were constructed in 2007; however, cycle testing has not started and construction of pumping stations and associated connections is not anticipated until 2015 due to budgetary constraints.	Long-term	Local	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 121	City of LaBelle Stormwater Master Plan Implementation	Project includes stormwater conveyance and water quality storage improvements in the City of LaBelle. Preliminary load reduction estimates for this project are 34.8 mt/yr TN and 5.8 mt/yr TP.	The C-5 portion of the city's 2004 Master Stormwater Plan (which identifies conveyance and water quality storage improvements) was completed in 2010. These stormwater management improvements included retrofitting stormwater catch basins and adding vegetative swale treatment.	Ongoing[2]	Local	✓	✓
CRE 122 (revised)[1]	Mirror Lakes Storage/Rehydration Project (formerly Rehydrate Lee County Well Fields, South of Highway 82)	Project is a multiyear pilot test of an overall plan intended to rehydrate Mirror Lakes, reduce peak flow discharges to the Orange River (which has flooding issues), and restore flows to the headwaters of the Estero River in vicinity of Green Meadows wellfield. Preliminary load reduction estimates for this project are 2.16 mt/yr TN and 0.21 mt/yr TP.	Phase I will be completed by the end of FY2012	Near-term (Phase 1); Long-term (Phases 2 & 3)	Local	✓	✓
CRE 123	North Ten Mile Canal Stormwater Treatment System Project	Project provides stormwater storage/detention for an urban and commercial area; estimated 12 ac-ft of storage and load reductions of 0.82 mt/yr TN and 0.33 mt/yr TP over three years.	FDEP permit is being reviewed for a modification.	Long-term	Local	✓	✓
CRE 124	Carrell Canal (FMCC) Water Quality Improvements Project	Project consists of an STA, settling ponds, and constructed marshes for stormwater treatment; estimated to reduce loading to the Carrell Canal by 0.42 mt/yr TN and 0.13 mt/yr TP.	No update.	Long-term	Local	✓	✓
CRE 125	Shoemaker-Zapato Canal Stormwater Treatment Project	Project includes installing weir/control structures to increase channel storage and provide peak flow attenuation, and also to reduce erosion and siltation into Billy Creek. Preliminary load reduction estimates for this project are 0.54 mt/yr TN and 0.14 mt/yr TP.	No update.	Long-term	Local	✓	✓
CRE 126	Fort Myers-Cape Coral Reclaimed Water Interconnect Project	Project includes installing a 20-inch diameter transmission line from Fort Myers Treatment Plant to Cape Coral Reclamation Treatment Plant; this is intended to help prevent discharging 9 mgd treated water into the CRE.	The feasibility study completed in 2010 found that constructing a disposal well was a less expensive near-term option; however, project is still desirable as a long-term option.	Long-term	Local	✓	✓
CRE 128	East Caloosahatchee Storage Project	Project includes constructing distributed reservoirs on 7,500 acres of private properties, with the potential to create 100,000 ac-ft of aboveground storage. Preliminary load reduction estimates for this project are 69 mt/yr TN and 5.2 mt/yr TP.	No update.	Long-term	Regional	✓	✓
CRE 128a	Caloosahatchee Storage – Additional Project	Project creates 50,000 ac-ft of aboveground storage in Caloosahatchee River Watershed. Preliminary load reduction estimates for this project are 58 mt/yr TN and 4.3 mt/yr TP.	No update.	Long-term	Regional	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 129	Wastewater Treatment Plant (WWTP) Upgrade and Reclaimed Water Project	Project upgrades existing wastewater treatment plants to reduce effluent loadings, with the potential for distribution as reclaimed water, and constructs future plants to higher treatment levels.	There is no regulatory mechanism to require WWTP upgrades, and this is not required by the Tidal Caloosahatchee BMAP. However, surface water discharge to the CRE from the Waterway Estates WWTP will be eliminated within the next two years due to FDEP enforcement action. This WWTP currently has a 1.0 mgd annual average permitted discharge to the tidal Caloosahatchee River, which will be eliminated. The new disposal method for this will be reuse and injection well.	Long-term	Regional	✓	✓
CRE 130	Animal Manure Application Rule	Landowners who apply more than 1 ton per acre of manure must develop conservation plans, approved by the USDA-NRCS that specifically address the application of animal wastes and include soil testing to demonstrate the need for manure application.	The animal manure application rule (Chapter 5M-3, F.A.C.) became effective in the Caloosahatchee River Watershed in February 2009.	Ongoing[2]	Source Control	✓	-
CRE 131	Application of Septage Rule	FDOH rule that regulates the application of septage in the Caloosahatchee and St. Lucie rivers. Entities disposing of septage within the watersheds must develop and submit an agricultural use plan to FDOH that limits applications based upon nutrient loading.	At this time, there are no FDOH-regulated septage disposal sites in the Northern Everglades watersheds.	Completed	Source Control	✓	-
CRE 132 (new)[1]	West Arcade Avenue Drainage and Water Quality Improvement Project – Clewiston	City of Clewiston project eliminates flooding and improves stormwater treatment in an area north of U.S. 27 and throughout neighborhoods located on West Arcade Avenue. Stormwater BMPs include installing catch basin inlets and grassed swales to provide water treatment.	Project was completed in 2008.	Completed	Local	✓	✓
CRE 133 (new)[1]	Ventura Avenue Stormwater Improvement and Drainage Upgrade Project – Clewiston	City of Clewiston project involves stormwater management improvements including curbs and gutters, retrofitted stormwater catch basins, vegetative swale treatment, and BMPs for street sweeping.	Project was completed in 2010.	Completed	Local	✓	✓
CRE 134 (new)[1]	Columbus G. McLeod Preserve Shoreline Restoration Project	Lee County project includes shoreline stabilization with native plants and other methods to reduce severe erosion on the north side of island in CRE and reduce sediment/ nutrient inflow to the CRE.	Project was completed in 2010.	Completed	Restoration	✓	-
CRE 135 (new)[1]	Hickey Creek Canal Widening Project – ECWCD	Project includes canal widening and construction of littoral zones along three miles of Hickey Creek Canal to increase storage, provide water quality treatment, and enhance habitat. Preliminary load reduction estimates for this project are 0.2 mt/yr TN and 0.05 mt/yr TP.	Project design is complete, and the ECWCD is awaiting funding.	Long-term	Local	✓	✓
CRE 136 (new)[1]	Deep Lagoon Preserve Restoration Project	Lee County project consists of hydrologic restoration, exotic removal, and farm and mosquito ditch degradation and plugging.	Project was completed in 2010.	Completed	Restoration	-	-

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 137 (new) [1]	Kickapoo Creek Stormwater System Analysis – Feasibility Study	Study to determine feasibility of enhancing existing stormwater system at the Lee County Civic Center; evaluates improvements to existing stormwater ponds to increase stormwater filtration and detention time. The two water quantity improvement projects for drainage and flood control improvements (Lake Interconnects Replacement and Replace/Add Control Structures projects) are complete. Preliminary load reduction estimates for this project are 0.34 mt/yr TN and 0.04 mt/yr TP.	Project was completed in 2008.	Completed	Local	-	✓
CRE 138 (new) [1]	Pollywog Creek Project	Project includes improvements to a 1.6-mile segment of C.R. 78 from Old C.R.78 to Crescent Road to increase the level of service (e.g., culvert replacement) for water quality; rehabilitation includes a sump to help with first-flush pollutants, which otherwise would discharge to the CRE. Preliminary load reduction estimates for this project are 0.01 mt/yr TN and 0.01 mt/yr TP.	Project is under way.	Near-term	Local	✓	-
CRE 139 (new) [1]	Ford Canal Filter Marsh (Ford Street Preserve) Project	City of Fort Myers project creates a filter marsh to improve overall quality of storm water discharging into Billy Creek; marsh is intended to work collectively with other treatment areas along Billy Creek and its tributaries. Preliminary load reduction estimates for this project are 0.54 mt/yr TN and 0.21 mt/yr TP.	Project design is complete, and land clearing commenced in 2011; project planned to be complete in FY2012.	Near-term	Local	✓	✓
CRE 140 (new) [1]	Fichter's Creek Restoration Project	Project provides ecosystem restoration through hydrologic and water quality improvements in Fichter's Creek, and provides flood protection for neighboring areas; components include 3.2 acres of lakes, three dry detention areas (7.1 acres), culvert installation/ replacement, filter marsh creation, and berm work. Preliminary load reduction estimates for this project are 0.09 mt/yr TN and 0.02 mt/yr TP.	Project is currently in permitting; construction is planned to begin in early 2013.	Near-term	Restoration	✓	✓
CRE 141 (new) [1]	Winkler Canal Treatment Marsh Project	Project creates a treatment marsh designed to divert and treat low flows from low-level rain events using a diversion weir. Preliminary load reduction estimates for this project are 0.2 mt/yr TN and 0.08 mt/yr TP.	Project has been permitted but is on-hold pending funding for land acquisition.	Long-term	Local	✓	✓
CRE 142 (new) [1]	Harns Marsh Improvements – Phase III (West Marsh) Project – ECWCD	Project involves a 578-acre ECWCD preserve and stormwater retention facility. Phase III includes designing the West Marsh, 230 acres recently purchased, to expand the marsh treatment facility.	Development of the management plan in cooperation with Lee County is complete and the design of the physical improvements will begin in 2012.	Near-term	Local	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 143 (new) [1]	Greenbriar Preserve Project	Project involves modifications within Greenbriar Swamp and to the connecting canal/swale system to increase surface water connectivity and storage within the swamp, thereby reducing freshwater discharge to the CRE. Preliminary load reduction estimates for this project are 1.45 mt/yr TN and 0.36 mt/yr TP.	Project is included in the ECWCD FY2010-FY2014 Capital Improvement Plan; project has been recently permitted.	Near-term	Local	✓	✓
CRE 144 (new) [1]	Section 10 Storage Project	Project includes modifying an existing mine pit to allow for additional surface water storage in the ECWCD Water Management System; also, includes improvements to the connecting canals, control structures, and a pump station. Preliminary load reduction estimates for this project are 1.63 mt/yr TN and 0.41 mt/yr TP.	No update.	Long-term	Local	✓	✓
CRE 145 (new) [1]	Pop Ash Creek Preserve Restoration Project	Lee County project improves drainage conditions along Pop Ash Creek and flooding conditions in Nalle Grade Road area; includes combination of wetland enhancement and creation, with utilization of berms and control structures to regulate water moving to and from the property. Preliminary load reduction estimates for this project are 1.4 mt/yr TN and 0.35 mt/yr TP.	Construction was completed in 2011. The filter marsh was recently brought on-line and is operational.	Current	Local	✓	✓
CRE 146 (new) [1]	Powell Creek Filter Marsh Project	Lee County project improves the natural function of Powell Creek by restoring and creating adjacent wetlands and reduces existing water quality impairments. Preliminary load reduction estimates for this project are 0.27 mt/yr TN and 0.08 mt/yr TP.	Construction began in fall 2011.	Near-term	Local	✓	✓
CRE 147 (new) [1]	Nalle Grade Stormwater Park Project	Lee County project proposes to restore/modify an existing degraded marsh system and design a stormwater retention facility to minimize flooding in the Bayshore Creek Watershed; ancillary benefits include restoration of hydrology, enhanced water quality and wildlife habitat, flood relief, and water conservation. Preliminary load reduction estimates for this project are 0.54 mt/yr TN and 0.14 mt/yr TP.	Project design and permitting is anticipated to begin in 2012.	Near-term	Local	✓	✓
CRE 148 (new) [1]	Powell Creek Restoration Dredging Project	Lee County project involves removing sediments from and restoring flows in Powell Creek, which has been negatively affected by the Powell Creek Bypass Channel, with diminished flows allowing sediments to settle on the creek bed.	An initial baseline/feasibility study identified creek areas needing maintenance dredging, and state/federal permits were acquired in 2009. Dredging is expected to begin in early 2012, and final construction plans are under development. Lee County is also preparing to permit and construct an addition to the existing weir structure in the Bypass Channel to raise its elevation and allow for additional water into the creek.	Near-term	Restoration	✓	-

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 149 (new) [1]	Northern Everglades – Payment for Environmental Services (NE-PES) Program	NE-PES solicitation is an innovative approach that allows cattle ranchers to deliver environmental services for water and nutrient retention. The goal is to establish relationships via contracts with private landowners to obtain water management services of water and nutrient retention to reduce flows and nutrient loads to Lake Okeechobee and the St. Lucie and Caloosahatchee rivers.	There are currently 14 applications under this solicitation that have been reviewed and ranked. In July 2011, the SFWMD Governing Board granted approval to negotiate with the respondents. Data collection and monitoring of approved projects will be performed by the World Wildlife Fund.	Completed	Dispersed Water Management	✓	✓
CRE 150 (new) [1]	Tape Grass (*Vallisneria americana*) Plantings Upstream of S-79 Project	District study helps reestablish viable tape grass seed stock for future populations in the upper CRE. The goal is to create a viable tape grass seed stock in the upper CRE; test two genetic strains of South Florida tape grass for survival, growth, and flower and seed production for two years; and determine how long enclosures need to remain in place to ensure survival.	In 2011, cages were monitored weekly in June and bimonthly in July and August; to date, cages are holding up well. The Lake Trafford plants/cages are showing significantly more growth at both sites compared to those in Lake Kennedy. In August, spread outside of the cages and new growth in the cages was observed at Site 2 for Lake Kennedy treatments.	Near-term	Restoration	-	-
CRE 151 (new)[1]	Nicodemus Slough Water Management Project	This site has existing connections to Lake Okeechobee (via the C-5 structure) and the Caloosahatchee River (via the C-19 canal) and a significant amount of existing infrastructure, including 15.7 miles of existing perimeter levees and, as proposed, it offers a significant level of water resource benefits. Modeled simulations from a 2008 conceptual design report indicate that the potential water storage capacity is approximately 33,860 ac-ft over the entire site. The project will reduce excessive freshwater discharges and improve the quality of water delivered to the Caloosahatchee River and Estuary.		Near-term	Dispersed Water Management	✓	✓
CRE 152 (new)[4]	Dispersed Water Management Water Farming Assessment	Utilize fallow/out-of-production citrus lands to store water and attenuate nutrients so storm water can be used as an alternative water supply. To determine the overall feasibility of the water farming concept, information with respect to environmental benefits gained compared to the cost estimates associated with on-site construction, infrastructure improvements, environmental assessments, and facility maintenance needs to be evaluated.	The District entered into a cooperative agreement with the Indian River Citrus League and Gulf Citrus Growers Association to assess the feasibility of water farming. If successful, water farming will continue to Phase II – Project Implementation.	Near-term	Dispersed Water Management	✓	✓

Table A-1. CRWPP project updates from 2009–2011.

ID	Project/Activity	Description	2012 Update (progress from 2009–2011)	Phase	Category	Benefits[3]	
						Water Quality	Water Quantity
CRE 153 (new)[4]	Dispersed Water Management Interim Sites	Parcels scheduled to become regional restoration projects present an opportunity to provide water retention through interim, low-cost alterations to the existing surface water management systems. These parcels would then provide an interim role of contributing to the watershed restoration effort while the final designs are completed and approved. If the public lands are being leased, then water management strategies will be jointly developed with the lessees to reduce discharges while not adversely affecting flood protection (including adjacent properties) and water quality.	Interim lands in the Caloosahatchee Watershed include BOMA	Near-term	Dispersed Water Management	✓	✓
CRE 154 (new)[4]	Clewiston Site Alternative Storage/Rehydration Project	Located north of the City of Clewiston. The objective is to pump excess water from the C-20/C-21 canal system into a 750-acre area to a maximum depth of 2 feet above average ground level when S-4 is discharging to Lake Okeechobee and/or when the S-235 structure is discharging into the Caloosahatchee River and Lake Okeechobee is making regulatory releases. This operation will reduce S-4 pumping to Lake Okeechobee and/or S-235 structure discharging into the Caloosahatchee River and will serve to rehydrate wetlands within the project area.	The project is currently finalizing design and operations while obtaining required permits prior to implementation. In the future the project is anticipated to be converted from a temporary diesel to a permanent electric pump, the design of which is anticipated to begin in 2012.	Near-term	Dispersed Water Management	✓	✓
CRE-W Res (new)[1]	C-43 West Basin Storage Reservoir Project	CERP component involves an above-ground reservoir (170,000 ac-ft capacity) located south of the CRE and west of the Ortona Lock (S-78); this will comprise a significant portion of total water storage requirement for the C-43 Basin. Preliminary load reduction estimates for this project are 97 mt/yr TN and 8 mt/yr TP.	In April 2011, a Record of Decision was issued by the USACE and an approved Project Implementation Report was submitted to the U.S. Congress for authorization.	Long-term	Regional	✓	✓
CRE 155 (new)[5]	Caloosahatchee Water Reservation Rulemaking Initiative	The purpose is to identify and reserve water from consumptive use for the CERP Caloosahatchee River (C-43) West Basin Storage Reservoir Project provides the intended benefits to the natural system.	The identified quantity of water to be reserved will be presented to the District's Governing for consideration, and then incorporated into a reservation rule. The options for the next phase of water resource protection for the Caloosahatchee River will be determined at a future date.	Near-term	Retional	-	✓

[1] Project Description Sheets (Management Measure Sheets) for new projects are included with this attachment. For other projects see the 2009 CRWPP.
[2] Projects denoted as "ongoing" have activity for all three phases: completed, near-term, and long-term.
[3] Larger checkmarks indicate a stronger benefit.
[4] Refer to the *Dispersed Water Management Program* section of this report for additional details.
[5] Refer to the *Related State and Federal Restoration Efforts* section of this report for additional details.

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: HENDRY EXTENSION CANAL WIDENING (CONSTRUCTION) - ECWCD (CRE 22, REVISED)

Description: Under the East County Water Control District **(**ECWCD), this project provides additional water quantity storage within existing canal right-of-way to help provide more stormwater storage in the 5.5 mile section of Hendry Extension Canal.

Revised Estimate of Water Quality Benefits:
Project description states the creation of a littoral zone along 5.5 miles of canal. Estimated width of littoral zone is 60 ft, giving a total littoral-zone area of 40 acres. From previous CRWPP, "typical reduction" for "in-canal WQ treatment" is estimated as 20 lb/ac/yr for TN and 5 lb/ac/yr for TP.

a. TN reduction: 40 ac x 20 lb/ac/yr = 800 lb/yr
b. TP reduction: 40 ac x 5 lb/ac/yr = 200 lb/yr

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: MIRROR LAKES STORAGE/REHYDRATION PROJECT (CRE 122, REVISED)

Description: The Mirror Storage/Rehydration Project, located in southern Lehigh Acres near S.R. 82, is a component of the ECWCD Comprehensive Watershed Management Plan. The purpose of the plan is to better manage the hydrology of the area by reducing stormwater discharges, increasing groundwater recharge, and improving water quality throughout the Lehigh Acres area. The Mirror Lakes Preserve Area was once referred to as Halfway Pond, a large wetland system at the headwaters of the Estero River Watershed. The pre-development wet season elevation of Halfway Pond was likely in the range of 30 ft NGVD. The channelization of Lehigh Acres reduced the water table in the vicinity of Halfway Pond and directed runoff away from the Estero River and into the Orange River watershed. A weir (S-ML-4) was constructed to control water levels in Mirror Lakes, and the weir control elevation is 28 ft NGVD. S-ML-4 discharges to Canal 57-7-4 (a tributary of Yellowtail Canal), which flows into Able Canal (a tributary to the Orange River). The entire drainage system within Lehigh Acres was constructed without any stormwater detention facilities and lacks water storage and treatment. Because the surrounding canals are maintained at an elevation of 26.5 ft NGVD, the Mirror Lakes Preserve rarely reaches 28 ft NGVD and the wetlands within the preserve are highly impacted.

Phase I involves a pilot test to pump stormwater into Mirror Lakes to rehydrate preserve areas north of S.R. 82. If this pilot test provides anticipated benefits, it may be expanded to deliver water south of S.R. 82 to existing ECWCD preserves (Phase II) with subsequent delivery to wetlands in the vicinity of Green Meadows wellfield (Phase III). Phase I is being implemented with ECWCD funds, and phases II and III need additional funding resources. Discussions are under way with the FDOT to facilitate additional conveyance under S.R. 82 and the Lee County Port Authority who own mitigation lands south of Lehigh Acres and adjacent to the Green Meadows wellfield.

Purpose: This project is a multiyear pilot test of an overall plan that is intended to (1) rehydrate Mirror Lakes, (2) reduce peak flow discharges to the Orange River (which has flooding problems), and (3) restore flows to the headwaters of the Estero River in the vicinity of the Green Meadows wellfield, which is owned and operated by Lee County Utilities.

Initiative Status: Pilot testing and permitting for Phase I is under way

Cost: TBD

Drainage Area (acres that will be treated): TBD

Estimate of Water Quality Benefits: Based on info provided by email on October 4, 2011, from Roger Copp (consultant), load reductions are based on removal of water either by groundwater recharge or trans-basin diversion.

Phase 1:
TN = 0.5 mg/L x 1,000 ac-ft/yr = 1,357 lb/yr
TP = 0.05 mg/L x 1,000 ac-ft/yr = 136 lb/yr
Phases 2 and 3 – using a net increase of 2,500 ac-ft/yr in water removal (out of 3,500 ac-ft/yr total)
TN = 0.5 mg/L x 2,500 ac-ft/yr = 3,397 lb/yr
TP = 0.05 mg/L x 2,500 ac-ft/yr = 339 lb/yr

Estimate of Water Quantity Benefits (Increased Storage in ac-ft):
- Minimum – 0 ac-ft/yr, 0 cfs peak flow
- Maximum – 8,000 ac-ft/yr 70 cfs peak flow
- Most Likely – 3,500 ac/ft/yr 30 cfs peak flow
- Level of Certainty – Level 4
- Assumptions leading to benefit estimate – (period of record flow/volume operational assumptions)

Level of Certainty:
- Level 4 – Implementation certainty unknown, and conceptual idea with rough order of magnitude costs and siting location

Proof of Concept: The work is proceeding as a pilot project with existing ECWCD resources. A temporary pump and observation wells have been installed and monitoring of the pilot project is under way. ECWCD has developed a comprehensive watershed management plan to better manage the hydrology of the area and to reduce stormwater discharges, increase groundwater recharge, and improve water quality. Several components of the plan are already being constructed. One component of the plan is to store stormwater runoff in the Mirror Lakes area in southern Lehigh Acres near S.R. 82. A pump station will be installed to direct runoff from ECWCD canals into Mirror Lakes. Initially, the runoff will be stored in existing areas of the Mirror Lakes Preserve Areas that are over drained and have been damaged by all-terrain vehicle (ATV) activity. When subsequent funds are available, elevated storage areas will be constructed so that additional runoff can be retained. Connections will be made to existing canals near Mirror Lakes at the southern limit of ECWCD, and a diversion structure will be constructed to divert flows south into drained wetlands in the Estero River watershed near the Lee County Green Meadows well field. The diversion into the Estero River will only be made during periods when the flows will be retained in the wetlands near the well field. Once the wetlands exceed their normal maximum depths such that they would discharge south to the Estero River, the diversion from Mirror Lakes will be curtailed. Prior ECWCD studies (supported partially by the SFWMD) have determined that the project could increase dry season surficial groundwater elevations in the vicinity of the Green Meadows well field by more than 1.5 feet. Diversions of 3,500 ac-ft/yr were simulated without increasing stormwater flows to the Estero River.

Other Unintended Impacts: None known at this time.

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: WEST ARCADE AVENUE DRAINAGE AND WATER QUALITY IMPROVEMENT (CRE 132, NEW)

Description: The project will eliminate flooding and improve stormwater treatment in an area north of U.S. 27 and throughout neighborhoods located on West Arcade Avenue. This area drains along West Arcade Avenue to Citrus Street and along Citrus Street to an outfall into Clewiston Drainage Ditch No. 3. Stormwater Best Management Practices built into the project included installing catch basin inlets and grassed swales to improve stormwater quality and eliminate flood conditions.

Purpose: The purpose of this project is to improve water quality and correct flood prone conditions within the City of Clewiston's Community Development Area north of U.S. 27 and throughout the neighborhoods located on West Arcade Avenue.

Location/Size/Capacity: North of U.S. 27 on West Arcade Ave. to Citrus St. draining to Clewiston Drainage Canal Ditch No. 3

Initiative Status: Completed in 2009

Cost: $252,960.76 (District contributed $249,185)

Drainage Area (acres that will be treated): Drainage basin is 8.85 acres

Estimate of Water Quality Benefits (TP Load Reductions in lbs or metric tons): Using Del Bottcher's 2011 loading estimates for high-density residential land of 3.54 lb/ac/yr for TP, the estimated TP load reduction is calculated as follows:

TP Reduction: 8.85-ac drainage basin x 3.54 lb/ac/yr x 20% TP reduction = 6.27 lb/yr

- Most Likely – 20% TP reduction estimated by Tommy Perry, Engineer for City of Clewiston
- Level of Certainty – Level 1
- Assumptions leading to benefit estimate – see above explanation of TP load reduction calculation

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons): Using Del Bottcher's 2011 loading estimates for high-density residential land of 12.32 lb/ac/yr for TN, the estimated TN load reduction is calculated as follows:

TN Reduction: 8.85-ac drainage basin x 12.32 lb/ac/yr x 10% TN reduction = 10.90 lb/yr

- Most Likely – 10% TN reduction estimated by Tommy Perry, Engineer for City of Clewiston
- Level of Certainty – Level 1
- Assumptions leading to benefit estimate – see above explanation of TN load reduction calculation

Level of Certainty: Level 1 – Already constructed or implemented, or construction or implementation is imminent

Proof of Concept: –

Other Unintended Impacts: None know at this time.

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: VENTURA AVENUE STORMWATER IMPROVEMENT AND DRAINAGE UPGRADE (CRE 133, NEW)

Description: This project provided urgently needed stormwater improvements on Ventura Avenue. The stormwater management improvements consisted of curbs and gutters, retrofitted stormwater catch basins, and vegetative swale treatment, which will significantly reduce water pollutants to Lake Okeechobee. This project is intended to provide efficient first-flush stormwater treatment in an older, densely populated neighborhood. The curbed street also allows the city to implement the Best Management Practice of regular street sweeping to remove trash and sediment from the roadway before entering the stormwater management system to enhance water quality. This project was the first of a planned multiphased stormwater improvement and drainage upgrade of Ventura Avenue.

Purpose: Construct a major stormwater improvement and drainage upgrade to Ventura Avenue, one of the City of Clewiston's main roadways.

Location/Size/Capacity: Ventura Avenue from Olympia St. to WC Owens Ave.; 3.87 acres

Initiative Status: Completed in 2010

Cost: $402,494 (District contributed $250,000)

Drainage Area (acres that will be treated): Drainage basin is 10.12 acres

Estimate of Water Quality Benefits (TP Load Reductions in lbs or metric tons): Using Del Bottcher's 2011 loading estimates for high-density residential land of 3.54 lb/ac/yr for TP, the estimated TP load reduction is calculated as follows:

TP reduction: 10.12-ac drainage basin x 3.54 lb/ac/yr x 10% TP reduction = 3.58 lb/yr

- Most Likely – 10% TP reduction estimated by Tommy Perry, Engineer for City of Clewiston
- Level of Certainty – Level 1
- Assumptions leading to benefit estimate – see above explanation of TP load reduction calculation

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons): Using Del Bottcher's 2011 loading estimates for high-density residential land of 12.32 lb/ac/yr for TN, the estimated TN load reduction is calculated as follows:

TN reduction: 10.12-ac drainage basin x 12.32 lb/ac/yr x 5% TN reduction = 6.23 lb/yr

- Most Likely – 5% TN reduction estimated by Tommy Perry, Engineer for City of Clewiston
- Level of Certainty – Level 1
- Assumptions leading to benefit estimate – see above explanation of TN load reduction calculation

Level of Certainty:

- Level 1 – Already constructed or implemented, or construction or implementation is imminent

Proof of Concept: –

Other Unintended Impacts: None known at this time.

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: COLUMBUS G. MCLEOD PRESERVE SHORELINE RESTORATION (CRE 134, NEW)

Description: This project consisted of exotic removal and shoreline stabilization with native plant species.

Purpose: Sediment control and restoration of island in the Caloosahatchee River near Tice, which was suffering from severe erosion. This project included stabilization of the shoreline with native plantings to reduce both erosion and nutrient inflow to the Caloosahatchee River.

Location/Size/Capacity: –

Initiative Status: Complete

Cost: –

Drainage Area (acres that will be treated): –

Estimate of Water Quality Benefits: No water quality nutrient reductions are expected.

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): –

Level of Certainty:
- Level 1 – Already constructed or implemented, or construction or implementation is imminent

Proof of Concept: N/A

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: HICKEY CREEK CANAL WIDENING (CRE 135, NEW)

Description: Construction (widening) and water quality improvements on three miles along Hickey Creek Canal by expanding into an existing right-of-way.

Purpose: Water quality improvements and water storage

Location/Size/Capacity: 59.2 acres (from permit)

Initiative Status: Included in the ECWCD FY2010-FY2014 CIP

Cost: $160,000 (estimate from CIP)

Drainage Area (acres that will be treated): –

Estimate of Water Quality Benefits: The creation of a littoral zone along 3.1 miles of canal with an estimated width of the littoral zone at 60 ft, giving a total littoral-zone area of 22.55 acres. "Typical reduction" for "in-canal water quality treatment" is estimated as 20 lb/ac/yr for TN and 5 lb/ac/yr for TP.

a. TN reduction: 22.55 ac x 20 lb/ac/yr = 451 lb/yr
b. TP reduction: 22.55ac x 5 lb/ac/yr = 113 lb/yr

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): –

Level of Certainty:
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, sitting location well defined

Proof of Concept: Permitted construction likely; depends on ability to sell excavated material

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: DEEP LAGOON PRESERVE RESTORATION (CRE 136, NEW)

Description: This project consisted of hydrologic restoration and exotic removal and farm and mosquito ditch degradation and plugging.

Purpose: Hydrologic restoration

Location/Size/Capacity: 51 acres

Initiative Status: Complete

Cost: $61,200

Drainage Area (acres that will be treated): –

Estimate of Water Quality Benefits: No water quality nutrient reductions are expected.

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): –

Level of Certainty:
- Level 1 – Already constructed or implemented

Proof of Concept: —

Other Unintended Impacts: none

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: KICKAPOO CREEK STORMWATER SYSTEM ANALYSIS – FEASIBILITY STUDY (CRE 137, NEW)

Description: The project provided an overall analysis of the Lee County Civic Center stormwater system and identified numerous water quality, flood control, and water conservation improvements. The Kickapoo

Creek is designated as an impaired water body for dissolved oxygen, nutrients, and fecal coliform. Water quality analysis was computed using a pollutant removal efficiency spreadsheet model developed by Dr. Harvey Harper. Water quantity modeling was conducted using the ICPR program from Streamline Technologies. The analysis indicates that subsequent to the construction of the improvements, the system will discharge storm water at or below allowable rates with an increased ability of the system to remove pollutants. The proposed water quality and water quantity improvements and their associated costs are listed in order of priority in the table below.

Kickapoo Creek Stormwater Analysis Proposed Water Quality & Quantity Improvements		
Description	**Type**	**Cost**
1. Lake Interconnects Replacement - Completed	Water Quantity	$178,072.60
2. Replace/Add Control Structures - Completed	Water Quantity	$29,111.10
3. TV Inspect Gravity Sewer System	Water Quality	$5,750.00
4. Lake Littorals	Water Quality	$8,535.30
5. Lake Aeration (will need modification if constructed before lakes are excavated)	Water Quality	$74,175.00
6. Redirect Stormwater Runoff to Lake 1	Water Quantity	$46,722.20
7. Lake Excavation	Water Quality	$144,440.00
8. New Connection to Old Bayshore	Water Quantity	$32,840.55
Total Cost		**$519,646.75**

Purpose: To conduct a study to identify existing water quality, flooding, and water conservation issues in the existing obsolete storm system at the Lee County Civic Center and to determine the feasibility of upgrading the system through potential water quality and water quantity improvements.

Location/Size/Capacity: The Lee County Civic Center is located in northeast Lee County at the intersection of S.R. 31 and S.R. 78 (Bayshore Road). The site straddles two watersheds, Kickapoo Creek (approximately 665 acres) and an unnamed creek to the east.

Size: The Lee Civic Center site covers an area of approximately 97 acres.

Capacity: –

Initiative Status: Tasks 1 and 2 (Lake Interconnects Replacement and Replace/Add Control Structures) water quantity improvements are complete. On July 7, 2011, Wanda Wooten of Lee County reported that none of the remaining recommendations are planned for construction/implementation at this time.

Cost: See table above

Drainage Area (acres that will be treated): The Lee County Civic Center site is divided into seven drainage basins totaling 102.2 acres.

Estimate of Water Quality Benefits: Using the Harper methodology, the pollution removal efficiency of the lakes was compared based on the increased depths for Lakes 2, 3, 4, and 6. The proposed calculated TP and TN pollutant removal efficiency improvement is shown in the table below (Note: This is from the Kickapoo Creek Storm Water Systems Analysis p. 6-1, Section 6.1, Table 6.1 – Pollutant Removal Efficiency Improvement.) As previously noted, these improvements are not planned at this time and could possibly be considered long-term beyond 2014.

Pollutant Removal Efficiency Improvement				
Parameter	**Proposed Discharge Off-site**	**Existing Sampled Discharge**	**Net Change (kg/yr)**	**Percent Change**
Total Phosphorus	7.21	50.64	- 43.42	-86%

Total Nitrogen	81.94	421.37	-339.43	-81%

Estimate of Water Quality Benefits (TP Load Reductions in lbs or metric tons):
- Most Likely – 43.42 kg/yr or 95.7 lb/yr for TP Load Reduction
- Level of Certainty – Level 4
- Assumptions leading to benefit estimate – calculated in the Kickapoo Creek Stormwater Systems Analysis (2008)

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons):
- Most Likely – 339.43 kg/yr or 748 lb/yr TN load reduction
- Level of Certainty –
- Assumptions leading to benefit estimate – calculated in the Kickapoo Creek Stormwater Systems Analysis (2008)

Level of Certainty:
- Level 1 – Already constructed or implemented, or construction or implementation is imminent

Proof of Concept: –

Other Unintended Impacts: None known at this time.

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: POLLYWOG CREEK (CRE 138, NEW)

Description: This project consists of improving the Level of Service (LOS) in the Pollywog Creek area. A Surface Water Master Plan has been developed for Hendry County. The components of the Master Plan include developing watershed boundaries, wetland maps, a conveyance element database, and detailed hydrologic-hydraulic studies for the northwest portion of the county. The hydrologic-hydraulic studies have been conducted to determine existing water surface profiles for selected study reaches within the county including the Pollywog Creek area. The areas where flooding exceeds the desired LOS criteria specified by Hendry County were identified. The Master Plan provides recommendations to improve the hydraulic conditions found in the areas of concern to meet the desired LOS. The replacement of undersized culverts in the problem areas is the preferred method outlined in the Master Plan to attain the desired LOS.

Specifically for this area of Hendry County, the county will be improving a 1.6-mile segment of C.R. 78 from Old C.R.78 to Crescent Road. These improvements consist of widening and resurfacing C.R.78, paved shoulders, a sidewalk, and drainage improvements at Pollywog Creek, Roy Brown Canal, Kell Mill Ditch, and three other minor culverts. Drainage improvements consist of culvert replacements or cleaning, roadside drainage improvements, and installation of additional culverts. The construction plans for the roadway drainage improvements have been divided into five phases. In Phase 1A, drainage improvements to the Pollywog Creek crossing will include a sump, which will be completed first.

Purpose: LOS improvements for all phases of surface water management system in the Pollywog Creek area to serve 15.1 acres of roadway.

Phase 1A: For water quality purposes the improvements will have an added component of a sump at Pollywog Creek crossing to help with first-flush pollutants, which would ultimately be released to the Caloosahatchee River. Runoff from approximately 15 sq mi collects at this crossing.

Location/Size/Capacity: Hendry County, FL within the Caloosahatchee Freshwater Northwest Basin

Initiative Status: Permits Obtained: ACOE SAJ-2010-02384 (NW-14-SJF), SFWMD Permit #26-01060-W, Permit # 22-00493P

Under Phase 1A, drainage improvements to Pollywog Creek crossing will include a sump; subsequently, Phases 1B–V will be completed once funds are available.

Cost: Phase 1A total cost: estimated $420,000

Partnering funding for the Phase 1A Sump: $26,745 from SFWMD, which Hendry County will match

Phases 1B–V: estimated $195,152

Drainage Area (acres that will be treated): 9,600 acres

Estimate of Water Quality Benefits:
- Most Likely – 5.7 kg of phosphorus and 9 kg of nitrogen removal
- Level of Certainty – 1
- Assumptions leading to benefit estimate – the size of the sediment basin is 7.5 feet wide, 38 feet long, and 2 feet deep, with a total volume of 570 cubic feet.

Assuming the dry weight of the material is 105 pounds per cubic foot and the basin is full, the weight of the sediment removal for one cleaning is 59,850 pounds, or 27,148 kg.

The Florida Stormwater Association in its 2011 report (p. 28) included the following information:

> ***Load Recovery Planning with Catch Basin Cleaning.*** *Assuming 100 lb PM recovery per catch basins, in order to recover 1 kg TP it is necessary to clean 53 catch basins and 33 for 1 kg TN recovery.*
>
> *Using one half of those values as much of this watershed is planted pines results in 1 kg of phosphorus per 10,600 pounds of sediment and 1 kg of nitrogen per 6,600 pounds of sediment. Another way to state this is that 0.21 kg of phosphorus and 0.33 kg of nitrogen are removed with each 1,000 kg of sediment.*

Estimate of Water Quantity Benefits (Increased Storage in ac-ft):
- Minimum – N/A
- Maximum- N/A
- Most Likely – N/A
- Level of Certainty – 1
- Assumptions leading to benefit estimate – N/A

Level of Certainty:
- Level 1 – Already constructed or implemented, or construction or implementation is imminent
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, siting location well defined

Proof of Concept: –

Other Unintended Impacts: –

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Phone: 863-675-5222

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: FORD CANAL FILTER MARSH (CRE 139, NEW)

Description: Once constructed, the Ford Canal Filter Marsh Project will reduce the characteristic pollutant of nutrients, suspended solids, and sediments associated with the contributory land uses, as well as reduce stream bank scour, erosion, and degradation of the water. The filter marsh will work collectively with other treatment areas along Billy Creek and its tributaries.

Purpose: Create a water quality filter marsh to enhance residence time and nutrient uptake within the Billy Creek Watershed to improve overall water quality of Billy Creek and stormwater discharges to the CRE.

Location/Size/Capacity: The location is within the City of Fort Myers along Billy Creek between Seaboard St., Michigan Ave., and Veronica Shoemaker Blvd; it is north of the City of Fort Myers Cemetery and east of the City of Fort Myers Central-Advanced Wastewater Treatment Facility. Size is 7 acres.

Initiative Status: The project is in the design and permitting phase and shall be constructed by the City of Fort Myers in 2011–2012. The city has funding from FDEP Land and Water and 319.

Cost: $1.5 million (estimated in Jan. 2008). The District contributed $30,000 for project design/permitting.

Drainage Area (acres that will be treated): The entire Ford Street Canal Sub-watershed of 830 acres (approximately 16 percent of total area within the Billy Creek Watershed of 5,300 acres).

Estimate of Water Quality Benefits (TP Load Reductions in lbs or metric tons): Sixteen percent of the watershed runoff flows to the treatment area and 38 percent of the input can be treated. The range of TP load reduction is 20–60 percent, so 40 percent is assumed as most likely. Using Del Bottcher's 2011 loading estimate for high density residential land use of 3.54 lb/ac/yr for TP, the estimated TP load reduction is calculated as follows:

TP Reduction: 5300 ac drainage basin x 3.54 lb/ac/yr x 16% x 38% x 40% = 456 lb/yr

- Minimum – T-P = (0.2*0.16*0.38) = 1% (min) - City of Fort Myers Stormwater Master Plan (2008)
- Maximum – T-P = (0.6*0.16*0.38 = 4% (max) - City of Fort Myers Stormwater Master Plan (2008)
- Level of Certainty – Level 2
- Assumptions leading to benefit estimate – see above explanation of TP reduction calculation

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons): Sixteen percent of the watershed runoff flows to the treatment area and 38 percent of the input can be treated. The range of TN reduction is 20–40 percent, so 30 percent is assumed as most likely. Using Del Bottcher's 2011 loading estimate for high density residential land use of 12.32 lb/ac/yr for TN, the estimated TN load reduction is calculated as follows:

TN Reduction: 5300 ac drainage basin x 12.32 lb/ac/yr x 16% x 38% x 30% = 1191 lb/yr

- Minimum - T-N = (0.2*0.16*0.38) = 1% (min) - City of Fort Myers Stormwater Master Plan (2008)
- Maximum - T-N = (0.4*0.16*0.38) = 2% (max) - City of Fort Myers Stormwater Master Plan (2008)
- Level of Certainty – Level 2
- Assumptions leading to benefit estimate – see above explanation of TN reduction calculation

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): not included in the Stormwater Master Plan Update

Level of Certainty:

- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, siting location well defined

Proof of Concept: Concept proposed in the City of Fort Myers Stormwater Master Plan Update

Other Unintended Impacts: None known at this time.

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: FICHTER'S CREEK RESTORATION (CRE 140, NEW)

Description: The Lee County Department of Natural Resources (LCDNR) and Community Engineering Services, Inc., are undertaking the Fichter's Creek Restoration Project. The goal of this project is to restore the appropriate hydroperiod and water quality within Fichter's Creek to maintain a functioning ecosystem. Additional benefits include alleviating risks of flooding of neighboring properties near the creek. A 31-acre dry prairie is targeted to hold an approximately 3.2-acre lake and three dry detention areas totaling approximately 7.1 acres associated with this project.

The restoration and stormwater management of Fichter's Creek will include:

- Elevating a portion of Fichter's Creek Lane and replacing the existing Fichter's Creek Lank Bridge where it crosses the creek with a 6 x10 ft box culvert and concrete spillway.
- Constructing a lake/aquascape and dry detention ponds totaling approximately (10.3 acres), including control structures, within the Caloosahatchee Regional Park.
- Replacing dilapidated outfall pipes along the northern portion of the park.
- Regrading the existing manmade ditch to create a filter marsh, replacing the existing 36-inch culvert in the manmade ditch at North River Road (C.R. 78) with a water control structure and double 36-inch culvert pipes under C.R. 78.
- Regrading the berm between the proposed filter marsh and Fichter's Creek Lane to west and filling existing braches.
- Creating a meandering swale connection, to divert part of the flow from the existing manmade ditch, where it ties into the Caloosahatchee River.
- Reconstructing exiting berms to block breaches between the park, creek, and filter marsh.

Purpose: Provide hydrologic restoration through water quality treatment and flood protection. The project is expected to provide ecological restoration and improved water quality through regulated hydroperiods, exotic plant removal, and addition of native plant species for treatment in the created filter marsh.

Location/Size/Capacity: Project area is 53.41± acres. The project is located within portions of Section 18, Township 43 South, Range 27 East, in Lee County. More specifically, the project site is located in North Fort Myers, within the state-owned and Lee County-managed, Caloosahatchee Regional Park**.**

Project Area in acres: 53.41acres

Total Estimated Storage (ac-ft): no estimate yet

Project Update: SFWMD Permit # 36-03165-P, Application No. 090504-3

Anticipated Start Date: January 2013

Anticipated Finish Date: July 2013

Initiative Status: LCDNR is currently in the process of acquiring all required permits and coordinating with adjacent landowners to gain necessary authorization to move forward with this project. Additional project details can be found in the Caloosahatchee Regional Park, Land Stewardship Plan, 2011-2021, prepared by the Land Stewardship Section, Lee County Department of Parks and Recreation (http://www.leeparks.org/pdf/CRP-Land-Stewardship-Plan-Copy-for-Public-Hearing.pdf).

Cost: $2.4 million, estimate per LCDNR, includes design and permitting

Drainage Area (acres that will be treated): Fichter's Creek Watershed has drainage area of 7.3 sq. mi.

[Note: At this time, LCDNR has not determined the water quality or quantity benefits.]

Estimate of Water Quality Benefits: Creation of a 3.2-acre shallow lake and 7.1-acre dry detention area. Assumes that the shallow lake will function as a constructed wetland and dry detention area will function as a constructed wetland for three months out of the year. From the 2009 CRWPP, "typical reduction" for "constructed wetland or filter marsh" is estimated as 40 lb/ac/yr for TN and 10 lb/ac/yr for TP.

- TN reduction: 3.2 acre x 40 lb/ac/yr + 7.1 x 40 lb/ac/yr x 3/12 = 199 lb/yr
- TP reduction: 3.2 acre x 10 lb/ac/yr + 7.1 x 10 lb/ac/yr x 3/12 = 50 lb/yr

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons): Undetermined

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): Undetermined

Level of Certainty:
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, siting location well defined. Permitting and Design activities are in process.

Proof of Concept: Maintenance Plan & Monitoring Plan with program has been devised

Other Unintended Impacts:

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Lee County's Prime Contractor:
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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: WINKLER CANAL TREATMENT MARSH (CRE 141, NEW)

Description: The Winkler Canal Treatment Marsh is a proposed planted, aquatic compact treatment marsh compartmentalized into four equally sized chambers (contoured depression areas). The STA treatment marsh is a proposed off-line system, including approximately 2.5 acres of planted aquatics on a 4.5-acre site, and is designed to divert and treat low flows from rain events using a diversion weir. The project will include the installation of a diversion weir in the canalized portion of Winkler Canal to divert flow into the system. High flows are designed to bypass the treatment system by topping over the proposed diversion weir. Treated water will outfall past the diversion weir back into the Winkler Canal, which outfalls to the Caloosahatchee River.

Purpose: Water quality

Location/Size/Capacity: Two property locations have been identified in the Winkler Canal Drainage Basin near Winkler Canal, east of the Caloosahatchee, west of Cleveland Avenue (Highway 41). One property, S35/T44/R24E, has been researched for zoning, existing uses, upland access, and other information related to proposed activities; however, a second location has been identified if this preferred property is unavailable. The other facility is roughly 4.5 acres, with a treatment component of 2.5 acres. Capacity will provide for low-flow events.

Initiative Status: SFWMD, Permit 36-06344-P; note that land purchase to build this project is not being considered at this time due to no availability of funds.

Cost: Land purchase to be determined; construction estimate $665,000

Drainage Area (acres that will be treated): The STA will treat approximately 500 ac of the watershed's total area of 820 ac, or approximately 60%.

Estimate of Water Quality Benefits (TP Reductions in lbs or metric tons): 60% of watershed runoff flows to the treatment area, and 24% of the input can be treated. The range of TP load reduction is 20% to 60%, so assume 40% as most likely. Using the Del Bottcher's loading estimate for high density residential land of 3.54 lb/ac/yr for TP, the estimated TP load reduction is calculated as follows:

- Most Likely – TP reduction: 820 ac x 3.54 lb/ac/yr x 60% x 24% x 40% = 167 lb/yr
- (60%*24%*40%=5.76% overall reduction)
- Minimum – TP = (0.2*0.6*0.24) = 3% (min)-City of Fort Myers Stormwater Master Plan (2008)
- Maximum – TP = (0.6*0.6*0.24) = 9% (max)-City of Fort Myers Stormwater Master Plan (2008)

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons): 60% of watershed runoff flows to the treatment area, and 24% of the input can be treated. The range of TN load reduction is 20% to 40%, so assume 30% as most likely. Using the Del Bottcher's loading estimate for high density residential land of 12.32 lb/ac/yr for TN, the estimated TN load reduction is calculated as follows:

- Most Likely – TN reduction: 820ac x 12.32 lb/ac/yr x 60% x 24% x 30% = 436 lb/yr
- (60% * 24% *30% = 4.32% overall reduction)
- Minimum – TN = (0.2*0.6*0.24) = 3% (min) - City of Fort Myers Stormwater Master Plan (2008)
- Maximum – TN = (0.4*0.6*0.24) = 6% (max) - City of Fort Myers Stormwater Master Plan (2008)

Assumptions leading to benefit estimates for TP & TN:

Per the City of Fort Myers Stormwater Master Plan Update (2008), an estimate of the project's anticipated effectiveness takes the following into consideration:

(1) The TMDL Protocol identifies the typical mass removal efficiencies of an STA for TN, TP, and total suspended solids (TSS) to be in the range of 20-40%, 20-60%, and 60-80%, respectively.

(2) The STA will treat approximately 500 ac of the watershed's total area of 820 ac, or approximately 60%.

(3) Due to the small size of the STA in relation to total up-stream area of the watershed, it can be assumed that the system will only effectively treat rain events between 0 and 0.5 inches. According to the Harper-Baker Study, this data range equates to approximately 84 rain events per year, or a total of approximately 12.5 inches per year, or approximately 24% of the yearly rainfall. Given the above reduction factors and using the conservative efficiency values provided in the TMDL Protocol, the estimated annual removal efficiency of the STA for each pollutant would be as follows:

T-N = (0.2*0.6*0.24) = 3% (min)	T-N = (0.4*0.6*0.24) = 6% (max)
T-P = (0.2*0.6*0.24) = 3% (min)	T-P = (0.6*0.6*0.24) = 9% (max)
TSS = (0.6*0.6*0.24) = 9% (min)	TSS = (0.8*0.6*0.24) = 12% (max)

Level of Certainty:

- Level 3 – Implementation certainty unknown, conceptual level of design/activity development complete, siting location may be defined

Proof of Concept: Concept proposed in the City of Fort Myers Stormwater Master Plan Update (2008)

Other Unintended Impacts: None known at this time.

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Literature Cited

ECT, Inc. 2008. City of Fort Myers, Stormwater Master Plan Update. Final Report (dated January 2008) prepared by Environmental Consulting & Technology, Inc. for the Public Works Department, Engineering Division, City of Fort Myers, FL. Available on-line at: http://my.sfwmd.gov/portal/page/portal/pg_grp_sfwmd_regionalserv/portlet%20-%20stormwater%20management/tab8996095/stormwater%20master%20plan%20update_0.pdf

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: HARNS MARSH IMPROVEMENTS, PHASE III (WEST MARSH) (CRE 142, NEW)

Description: Harns Marsh is an ECWCD regional surface water management system that helps provide water quality and attenuation of stormwater for Lehigh Acres. The marsh also provides ecological habitat and recreational opportunities. Phases I and II of the project, completed in 2011, are intended to correct issues identified with the system (gate improvements and replacement of structures). Phase III is a new project component involving design of the West Marsh, 230 acres recently purchased by the ECWCD.

Purpose: Necessary to expand the future capacity of Harns Marsh.

Location/Size/Capacity: –

Initiative Status: Included in the ECWCD FY2010-FY2014 CIP

Cost: $350,000

Drainage Area (acres that will be treated): –

Estimate of Water Quality Benefits: TBD**;** at this time the project has not been adequately defined to estimate load reductions.

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): TBD**;** at this time the project has not been adequately defined to estimate storage benefits.

Level of Certainty:
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, siting location well defined

Proof of Concept: –

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: GREENBRIAR PRESERVE (CRE 143, NEW)

Description: Modifications within Greenbriar Swamp and to the connecting Canal/Swale system to increase surface water connectivity and storage within the swamp, thereby reducing freshwater discharge to the CRE. The modifications include a pump station and conveyance improvements to allow for the diversion of water from Hickey Creek Canal to the swamp and improve surface water flow patterns through the swale system within the swamp.

Purpose: To reduce freshwater discharges to the CRE by increasing surface water storage in Greenbriar Swamp. This will mitigate peak stormwater flows and improve water quality of runoff leaving the ECWCD. The improvements will also restore hydroperiod and natural systems within Greenbriar Swamp.

Location/Size/Capacity: Sections 3–8, Township 44S, Range 27E, ECWCD Hickey Creek Basin; approximately 500 acres in Greenbriar Swamp and miles of swales/canals; capacity estimated 500 ac-ft.

Initiative Status: Included in the ECWCD FY2010-FY2014 CIP

Cost: $700,000 (estimate from CIP)

Drainage Area (acres that will be treated): Runoff will be treated from the ECWCD Hickey Creek Basin (approximately 12-14 square miles) and from the Orange River Basin (approximately 26-30 square miles

Estimate of Water Quality Benefits: ECWCD estimated TP load reduction as 800 lb/yr. For lack of additional information, TN load reduction was estimated as four times the TP reduction, or 3,200 lb/yr. This multiplier is consistent with the "typical" area-based estimates for this type of project.

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): 500 ac-ft

Level of Certainty:
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, sitting location well defined

Proof of Concept: Permitted construction likely; future construction depends on ability to sell excavated material.

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: SECTION 10 STORAGE (CRE 144, NEW)

Description: Modification of an existing 1 square mile mine pit to allow for additional surface water storage within the ECWCD Water Management System. In addition to modifications in Section 10 mine pit, this project also includes improvements to the connecting canals, control structures, and a pump station.

Purpose: Provides for water quality improvements and surface water runoff storage.

Location/Size/Capacity: Section 10, Township 44S, Range 27E

Initiative Status: Included in the ECWCD FY2010-FY2014 CIP

Cost: estimated $6.5M

Drainage Area (acres that will be treated): Dog Basin – approximately 9 square miles; Hendry Basin – approximately 12 square miles

Estimate of Water Quality Benefits: ECWCD estimated TP load reduction as 900 lb/yr. For lack of additional information, TN load reduction was estimated as four times the TP reduction, or 3,600 lb/yr. This multiplier is consistent with the "typical" area-based estimates for this type of project.

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): estimated 1200 ac-ft

Level of Certainty:
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, sitting location well defined

Proof of Concept: Permitted construction likely; future construction depends on ability to sell excavated material.

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: POPASH CREEK PRESERVE RESTORATION (CRE 145, NEW)

Description: This project will improve drainage conditions along Pop Ash Creek and flooding conditions within the area of Nalle Grade Road. Planned restoration includes a combination of wetland enhancement and creation, with utilization of berms and control structures to regulate the movement of water on and off the property. Wetland creation involves the removal of approximately 12,390 cubic yards of fill.

Purpose: Hydrological restoration and enhancement, water quality improvements, water conservation, wildlife habitat enhancement, recreation, and flood protection for surrounding property owners.

Location/Size/Capacity: Restoration work on Lee County 20/20 Conservation Lands, North Fort Myers, Lee County, FL; north of Nalle Grade Road and west of Nalle Road in North Fort Myers; 307.45 acres

Initiative Status: –

Cost: approximately $1.5 million (design, engineering, and construction)

Drainage Area (acres that will be treated): 10,055 acres

Estimate of Water Quality Benefits: Based on the project description, effective area of restored wetland will be 77 acres. Then applying the "typical" area-based estimates for a restored wetland would result in:

a. TN reduction: 77 acre x 40 lb/ac/yr = 3080 lb/yr
b. TP reduction: 77 acre x 10 lb/ac/yr = 770 lb/yr

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): 17 ac-ft

Level of Certainty:
- Construction completed in summer 2011.

Proof of Concept: –

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: POWELL CREEK FILTER MARSH (CRE 146, NEW)

Description: As of September 2011, Lee County is constructing a water quality project, Powell Creek Preserve Filter Marsh, on a portion of the Conservation 2020 Powell Creek Preserve land. The project includes created wetland areas, boardwalks, and trails and a stabilized crossing of Powell Creek. The main purpose of the filter marsh is to improve the natural function of Powell Creek by restoring and creating adjacent wetlands and reduce existing water quality impairments; this will also provide residence time for nutrient uptake that is currently not optimal in the watershed. Water from both Powell Creek and Powell Creek Canal will be diverted to the filter marsh via pump and then discharge into deeper marsh to allow sediment to settle out. Water will then flow through a series of shallow and deep wetland areas for treatment before discharging into Powell Creek via a control structure. The filter marsh has been designed with sinuous edges to lessen the impact to gopher tortoises that inhabit portions of the site and to provide a more natural appearance. Trails will be constructed adjacent to the marsh to promote access for educational purposes. A proposed low water crossing of Powell Creek will improve access to the western portion of the preserve site for recreation and maintenance. The existing wetland in the southeast corner of the Powell Creek Preserve property will be incorporated into the proposed filter marsh to improve its hydrology.

Purpose: Hydrological restoration and enhancement, water quality improvements, water conservation, wildlife habitat enhancement, resource based recreation, and flood protection for surrounding properties.

Location/Size/Capacity: North Fort Myers, Project Latitude: 26.691, Project Longitude: -81.872, Lee County, Size - 20.1 acres, Capacity - The minimum perimeter berm was set at 12.3 ft NAVD to keep Powell Creek flows from the 25-year event from entering the filter marsh. Powell Creek peak stages higher than this elevation will flow over the perimeter berm into the filter marsh. The project is partially located within Powell Creek floodplain. Historical storage calculations indicate the proposed project will store more water than the existing site at the peak of the 100-year, three-day storm event.

Initiative Status: Construction start in fall 2011.

Cost: approximately $1.9 million (design, engineering, construction)

Drainage Area (acres that will be treated): 7,525 acres

Estimate of Water Quality Benefits (TP Load Reductions in lbs or metric tons): 168 lbs/yr

Estimate of Water Quality Benefits (TN Load Reductions in lbs or metric tons): 602 lbs/yr

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): 35 ac-ft

Level of Certainty:
- Construction scheduled for completion in summer 2012.

Proof of Concept: Project design and SFWMD permits complete.

Other Unintended Impacts: Possible increase in localized wildlife/human interactions; also, may have localized effect on mosquito population.

Contact Information:
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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: NALLE GRADE STORMWATER PARK (CRE 147, NEW)

Description: The Bayshore Creek watershed contains approximately 15 square miles in northern Lee County and southern Charlotte County. This area is characterized by flat topography and experiences frequent flooding in low lying areas and in the vicinity of the creek. Lee County recently developed a North Fort Myers Surface Water Management Plan that recommends the construction of a 30-acre pond within an existing county park south of Nalle Grade Road and adjacent to Bayshore Creek. Lee County is proposing to restore/modify an existing degraded marsh system and design a stormwater retention facility. The marsh was originally the headwaters to Bayshore Creek but was cut off hydraulically when the creek was altered to its current condition as a manmade canal on the eastern perimeter of the property. Anticipated benefits of the project include hydrologic restoration, enhanced water quality and wildlife habitat, flood control, and water conservation. In addition, this project is being developed in cooperation with Lee County Parks and Recreation and is planned to include educational and recreational opportunities.

Purpose: Restoration, water quality improvements, water conservation, flood control, wildlife habitat, recreation, and education

Location/Size/Capacity: –

Initiative Status: –

Cost: $5.7 million

Drainage Area (acres that will be treated): –

Estimate of Water Quality Benefits: Based on the project description, the project will create the equivalent of a 30-acre filter mash. Then applying the "typical" area-based estimates for a filter marsh (same numbers as restored wetland) would result in: TN reduction of 30 acre x 40 lb/ac/yr = 1,200 lb/yr and TP reduction of 30 acre x 10 lb/ac/yr = 300 lb/yr

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): –

Level of Certainty:
- Level 1 – Design and permitting 2012

Proof of Concept: –

Other Unintended Impacts: –

Contact Information:
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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: POWELL CREEK RESTORATION DREDGING (CRE 148, NEW)

Description: The Powell Creek Restoration Dredging Project began as an effort to restore the health of this urban creek system. The construction of the Powell Creek Bypass Channel in 1986 resulted in diminished flow through the natural creek system. The slower flow has allowed sediments to settle out into the natural creek, further restricting the flow, and providing a foothold for aggressive invasive vegetation to infest the creek. An initial baseline/feasibility study in 2005 identified areas of the creek that needed maintenance dredging. The necessary state and federal permits to remove 5,000 cubic yards of sediment from the natural creek were acquired in 2009. In 2011, funding became available to conduct the sediment removal. The final construction plans are being developed in anticipation of bidding this work. Lee County anticipates that the work will begin in mid-2011. In conjunction with the dredging project, Natural Resources is also preparing to permit and construct an addition to an existing weir structure in the Bypass Channel. The addition will raise the elevation of the structure and allow for additional water into the natural creek.

Purpose: Hydrologic restoration and enhancement

Location/Size/Capacity: –

Initiative Status: –

Cost: –

Drainage Area (acres that will be treated): –

Estimate of Water Quality Benefits: Due to the nature of this project, water quality benefits were not estimated.

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): –

Level of Certainty:
- Level 1 – Construction scheduled in mid-2011.

Proof of Concept: –

Other Unintended Impacts: –

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CRWPP UPDATE – PROJECT DESCRIPTION SHEET: NORTHERN EVERGLADES – PAYMENT FOR ENVIRONMENTAL SERVICES (CRE 149, NEW)

Description: The South Florida Water Management District is administering the Northern Everglades – Payment for Environmental Services (NE-PES) Program in collaboration with the Florida Department of Environmental Protection, Florida Department of Agriculture and Consumer Services, and U.S. Department of Agriculture Natural Resources Conservation Service. The NE-PES solicitation under the

Dispersed Water Management Program is an innovative approach to delivering environmental services. The NE-PES Program offers eligible cattle ranchers in the Northern Everglades the opportunity to compete for contracts for either acre-feet of water retention or pounds of nutrient (phosphorus or nitrogen) removed.

Purpose: The goal of the NE-PES Program is to establish relationships via contracts with private landowners to obtain water management services of water retention and nutrient retention to help reduce flows and nutrient loads to the Lake Okeechobee, St. Lucie River, and Caloosahatchee River watersheds.

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: TAPE GRASS (*VALLISNERIA AMERICANA*) PLANTINGS UPSTREAM OF S-79 (CRE 150, NEW)

Description: This project is being conducted by the South Florida Water Management District to help reestablish viable tape grass (*Vallisneria americana*) seed stock for future populations in the upper CRE. The study's goal is to (1) create a viable tape grass seed stock in the upper CRE; (2) test two genetic strains of South Florida tape grass for survival, growth, and flower and seed production for two years; and (3) determine how long enclosures need to remain in place in order to ensure survival.

Purpose: Restoration and habitat enhancement

Contact Information:
South Florida Water Management District
3301 Gun Club Road, West Palm Beach, FL 33406
Phone: 561-686-8800

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: NICODEMUS SLOUGH WATER MANAGEMENT PROJECT (CRE 151, NEW)

Description: The project concept is for the District, as a lessee, in conjunction with the private landowner to construct facilities and implement an operational plan to utilize the property as a regional water management facility. Water resource benefits from the project include: reducing high stages in Lake Okeechobee and Fisheating Creek; reducing excessive freshwater discharges to the Caloosahatchee River Estuary; restoring hydrology to the site in a manner that is beneficial to existing drained wetlands and former creek floodplain habitat; improving the quality of water delivered to the Caloosahatchee River Estuary and Lake Okeechobee; and, conserving water for beneficial uses that would have otherwise been lost to tide. The site currently has a significant amount of existing infrastructure, including 15.7 miles of existing perimeter levees. It is identified in the Lake Okeechobee Watershed Construction Project Phase II Technical Plan as an alternative water storage project. Modeled simulations from a 2008 design report (Metcalf & Eddy and AECOM 2008) indicate that the potential water storage capacity of the site is approximately 33,860 ac-ft**.**

Purpose: Primary purpose if for water retention with ancillary water quality and habitat restoration benefits.

Location/Size/Capacity: It is located within in Glades County with existing connections to Lake Okeechobee (via the C-5 Structure) and the Caloosahatchee River (via the C-19 Canal)..

CRWPP UPDATE – PROJECT DESCRIPTION SHEET: C-43 WEST BASIN STORAGE RESERVOIR, (CRE-W RES NEW)

Description: The Comprehensive Everglades Restoration Plan (CERP) C-43 West Basin Storage Reservoir Project involves construction of an above-ground reservoir (170,000 ac-ft capacity) located south of the CRE and west of the Ortona Lock (S-78). Once built, this reservoir will comprise a significant portion of the total water storage requirement for the C-43 Basin.

Purpose: Water storage and flood control

Estimate of Water Quantity Benefits (Increased Storage in ac-ft): 17,000 ac-ft

Contact Information:
South Florida Water Management District
3301 Gun Club Road, West Palm Beach, FL 33406
Phone: 561-686-8800

Attachment B: Revised Nutrient Loading Rates and Reduction Factors Associated with Best Management Practices and Technologies

Del Bottcher[2] and Joyce Zhang

The 2004 land use data for the Caloosahatchee River Watershed were used in the recalibration effort, as shown in **Table B-1**. This table provides additional land use breakdown beyond the 20 primary land use categories required for the spreadsheet model. These additional data were used during the development of the unit loads but were integrated within the 20 categories for the final tables.

For the new baseline period from 1996–2005, measured data from the major structures on the Caloosahatchee River are shown in **Table B-2**. Because of the baseline period change, recalibration for runoff and total phosphorus (TP) and total nitrogen (TN) were performed using data from the Freshwater West basin between structures S-78 and S-79. Data between structures S-77 and S-78 (Freshwater East) were not considered due to unmonitored flow released from the Lake Okeechobee and discharges from Nicodemus Slough and the S-4 basin. Compared to the previous baseline data (1995–2005), the new baseline annual flow, TP, and TN loads were lowered by 8, 9, and 15 percent, respectively. The recalibration was initially done by adjusting the flow rate globally to produce new unit flow (**Table B-3**), and then adjusting both TP and TN with global factors. The adjustment for TN was greater than TP, but both were significant.

In the 2008 study (SWET, 2008a), the initial estimates of the unit nutrient loads were developed from the Lake Okeechobee Watershed provided in the Best Management Practices (BMPs) Letter Report (SWET, 2006), estimates for the state of Florida by Harper and Baker (2003 and 2007), nutrient load assessment by CDM (2007), and Watershed Assessment Model results for the USACE (SWET, 2008b). The final TP and TN unit loads for the Caloosahatchee River Watershed presented in **Table B-4** were developed as an iterative process. This process included initial unit loads estimates linked to a basin spreadsheet where the accumulative TP and TN loads from Freshwater West sub-watershed could be calculated by multiplying the land use acreage by the unit loads. The net TP and TN loads were then compared to the measured basin loads to verify if the net loads were at least in the ballpark and how the calculated and measured TP and TN loads for this basin compared (**Tables B-5** and **B-6**, respectively). In this update, both TP and TN unit loads were adjusted by changing a global multiplier factor to obtain reasonable matches to observed data. The TP and TN reduction factors under various BMPs are the same (**Tables B-7** and **B-8**, respectively).

[2] Soil and Water Engineering and Technology, Inc., Gainesville, FL

Table B-1. Land use (2004) distribution for the Caloosahatchee River Watershed. [Note: FLUCCS - Florida Land Use, Land Cover Classification System]

Land Use Category	Land Use Description	FLUCCS	Area (ac)	Percent	Area (ac)	Percent
Residential Low Density	Residential Low Density	1100	76,863	7.1%	76,863	7.1%
Residential Medium Density	Residential Medium Density	1200	33,396	3.1%	33,396	3.1%
Residential High Density	Residential High Density	1300	11,453	1.1%	11,453	1.1%
	Commercial and Services	1400	8,906	0.8%		
	Industrial	1500	2,648	0.2%		
	Extractive	1600	2,278	0.2%		
	Institutional	1700	3,675	0.3%		
Other Urban	Recreational	1800	6,062	0.6%	23,568	2.2%
Improved Pastures	Improved Pastures	2110	117,152	10.8%	117,152	10.8%
Unimproved Pastures	Unimproved Pastures	2120	23,827	2.2%	23,827	2.2%
	Woodland Pastures	2130	20,280	1.9%		
Woodland Pastures/Rangeland	Rangeland	3000	57,850	5.4%	78,130	7.2%
Row Crops	Row Crops	2140	9,656	0.9%	9,656	0.9%
Sugar Cane	Sugar Cane	2156	87,741	8.1%	87,741	8.1%
Citrus	Citrus	2210	96,684	9.0%	96,684	9.0%
Sod Farms	Sod Farms	2420	5,070	0.5%	5,070	0.5%
Ornamentals	Ornamentals	2430	861	0.1%	861	0.1%
Horse Farms	Horse Farms	2510	202	0.0%	202	0.0%
Dairies	Dairies	2520	56	0.0%	56	0.0%
	Field Crops	2150	5,326	0.5%		
	Mixed Crops	2160	17	0.0%		
	Fruit Orchards	2220	12	0.0%		
	Other Groves	2230	1,995	0.2%		
	Tree Nurseries	2410	971	0.1%		
	Specialty Farms	2500	165	0.0%		
	Aquaculture	2540	215	0.0%		
Other Areas	Fallow Crop Land	2610	2,209	0.2%	10,909	1.0%
Tree Plantations	Tree Plantations	4400	42,498	3.9%	42,498	3.9%
Water	Water	5000	130,368	12.1%	130,368	12.1%
	Upland Forests (not including 4400's)	4000	84,379	7.8%		
	Wetlands	6000	184,666	17.1%		
	Barren Land	7000	5,866	0.5%		
Natural Areas	Open Land	1900	49,378	4.6%	324,289	30.0%
Transportation	Transportation	8100	4,915	0.5%	4,915	0.5%
	Communications	8200	96	0.0%		
Communication/Utilities	Utilities	8300	2,063	0.2%	2,159	0.2%
Total			**1,079,796**	**100%**	**1,079,796**	**100%**

Table B-2. Summary of annual total phosphorus (TP) and total nitrogen (TN) flow and loads along the main stem of the Caloosahatchee River (C-43 Canal).

Calendar Year	S-77 (02292000)					S-78 (02292480)					S-79 (02292900)					Basin Between S78 and S79				
	Flow	TP Load	TP Conc.	TN Load	TN Conc.	Flow	TP Load	TP Conc.	TN Load	TN Conc.	Flow	TP Load	TP Conc	TN Load	TN Conc.	Flow	TP Load	TP Conc	TN Load	TN Conc.
	acre-feet	mtons	ug/L	mtons	mg/L	acre-feet	mtons	ug/L	mtons	mg/L	acre-feet	tons	ug/L	mtons	mg/L	acre-feet	mtons	ug/L	mtons	mg/L
1990	120,575	14	94	238	1.60	174,966	33	153	322	1.49	423,951	101	193	937	1.79	248,986	68	222	614	2.00
1991	63,594	7	93	136	1.74	288,783	72	202	670	1.88	922,265	193	170	1,891	1.66	633,481	121	155	1,221	1.56
1992	193,275	23	96	345	1.45	437,933	93	172	756	1.40	943,491	407	349	2,199	1.89	505,559	313	502	1,442	2.31
1993	500,243	31	50	1,382	2.24	645,118	68	86	972	1.22	1,230,588	182	120	2,334	1.54	585,470	114	158	1,362	1.89
1994	770,253	51	53	1,345	1.42	1,044,125	119	93	2,202	1.71	1,633,414	217	108	3,380	1.68	589,289	97	134	1,178	1.62
1995	2,110,116	113	44	4,311	1.66	2,381,744	186	63	3,244	1.10	3,379,883	314	75	5,482	1.32	998,139	128	104	2,238	1.82
1996	474,489	47	80	798	1.36	568,330	58	83	854	1.22	941,009	130	112	1,647	1.42	372,680	71	155	794	1.73
1997	158,049	16	83	394	2.02	290,448	36	101	661	1.85	756,311	115	123	1,413	1.51	465,864	79	137	752	1.31
1998	1,618,473	136	68	2,989	1.50	1,831,790	205	91	3,217	1.42	2,613,724	297	92	4,309	1.34	781,933	92	95	1,092	1.13
1999	564,104	52	75	945	1.36	848,093	124	118	1,602	1.53	1,578,821	324	166	3,042	1.56	730,729	201	222	1,440	1.60
2000	477,520	105	178	1,684	2.86	409,244	47	93	688	1.36	619,878	119	155	1,062	1.39	210,634	71	275	374	1.44
2001	72,771	9	101	172	1.92	176,661	66	303	463	2.12	835,815	233	226	1,695	1.64	659,154	167	205	1,232	1.52
2002	466,052	57	100	970	1.69	888,496	154	141	1,774	1.62	1,491,120	318	173	3,167	1.72	602,624	164	220	1,392	1.87
2003	1,396,713	101	59	2,454	1.42	1,745,887	209	97	3,239	1.50	2,589,761	335	105	4,529	1.42	843,874	126	121	1,290	1.24
2004	1,120,739	127	92	2,147	1.55	1,247,980	128	83	1,996	1.30	1,853,038	230	101	2,815	1.23	605,058	102	137	819	1.10
2005	2,266,435	385	138	4,598	1.64	2,898,397	476	133	5,822	1.63	3,734,684	578	125	6,740	1.46	836,287	101	98	918	0.89
2006	353,758	65	149	733	1.68	463,033	88	154	857	1.50	920,989	193	170	1,689	1.49	457,956	105	186	833	1.47
1996 to 2005	**861,534**	**104**	**97**	**1,727**	**1.63**	**1,124,917**	**156**	**112**	**2,100**	**1.51**	**1,717,801**	**264**	**124**	**3,058**	**1.44**	**592,884**	**108**	**148**	**958**	**1.31**

Table B-3. Runoff (in acre-feet, or ac-ft) to streams within the Caloosahatchee River Watershed.

FLUCCS	Caloosahatchee Estuary	Freshwater East	Freshwater West	Nearshore	North Coastal	S-4	Tidal	Grand Total
1100	40	6,326	31,199	8,888	50,535	1,150	63,141	161,279
1200	161	950	4,359	4,317	4,526	3,735	64,766	82,814
1300	46	180	1,215	3,000	4,377	235	25,899	34,955
1400	24	583	2,100	1,285	1,172	1,306	20,714	27,181
1500	-	765	1,443	19	75	4,099	2,182	8,587
1600	-	1,582	63	9	973	195	3,697	6,518
1700	-	300	701	260	1,359	609	7,282	10,515
1800	23	159	990	2,503	2,180	539	6,324	12,720
1900	2	4,649	47,777	996	13,251	389	27,125	94,189
2110	2	84,224	127,166	529	5,450	1,824	48,967	268,162
2120	-	10,972	24,294	57	832	-	9,295	45,450
2130	6	11,300	19,138	128	158	-	7,956	38,684
2140	-	2,884	16,968	969	609	-	4,358	25,786
2150	-	805	2,421	15	107	72	6,739	10,159
2156	-	120,748	4,711	-	-	75,382	-	200,840
2160	-	-	39	-	-	-	-	39
2210	-	60,872	157,960	442	-	151	1,886	221,311
2220	-	-	-	-	-	-	27	27
2230	-	-	121	4,104	14	-	327	4,567
2410	-	332	212	353	-	515	439	1,852
2420	-	662	6,746	-	-	-	4,196	11,605
2430	-	37	845	366	34	-	687	1,971
2500	-	-	151	-	-	32	130	315
2510	-	267	72	-	-	-	46	385
2520	-	34	-	-	-	-	72	107
2540	-	26	87	-	-	-	93	205
2610	-	304	2,573	183	156	-	1,838	5,056
3000	76	7,578	32,824	4,711	13,626	424	29,040	88,280
4000	58	8,917	27,231	3,887	12,453	411	43,615	96,572
4400	-	14,790	32,507	-	79	-	1,262	48,639
5000	6,020	786	1,388	35,940	2,613	274	2,715	49,736
6000	157	17,356	36,346	14,016	12,408	683	24,710	105,676
7000	-	5,465	6,421	192	1,305	1,931	1,471	16,784
8100	23	2,827	2,461	137	1,862	1,259	10,178	18,751
8200	-	42	50	-	21	-	88	201
8300	2	740	326	118	753	511	1,482	3,935
Grand Total	6,641	367,463	592,906	87,425	130,925	95,727	422,749	1,703,856

Verification Data for Freshwater West:

Calculated Runoff	592,906
Measured Runoff	592,883

Table B-4. Estimated runoff and unit TP and TN loads and concentrations in the Caloosahatchee River Watershed.

Land Use Category	Land Use Description	FLUCCS	Runoff (in/yr)	Unit TN Load (lbs/acre/yr)	TN Conc. (mg/L)	Unit TP Load (lbs/acre/yr)	TP Conc. (mg/L)
Residential Low Density	Residential Low Density[1]	1100	25.18	5.65	0.99	0.58	0.10
Residential Medium Density	Residential Medium Density[2]	1200	29.76	8.21	1.22	1.65	0.25
Residential High Density	Residential High Density[2]	1300	36.62	12.32	1.49	3.54	0.43
	Commercial and Services[2]	1400	36.62	11.29	1.36	1.65	0.20
	Industrial[2]	1500	38.91	10.27	1.17	2.83	0.32
	Extractive[2]	1600	34.34	7.19	0.93	0.78	0.10
	Institutional[2]	1700	34.34	7.19	0.93	2.83	0.36
Other Urban	Recreational[2]	1800	25.18	7.19	1.26	1.13	0.20
Improved Pastures	Improved Pastures	2110	27.47	11.40	1.83	1.65	0.27
Unimproved Pastures	Unimproved Pastures	2120	22.89	5.65	1.09	0.85	0.16
	Woodland Pastures	2130	22.89	4.21	0.81	0.71	0.14
Woodland Pastures/Rangeland	Rangeland	3000	18.31	4.21	1.02	0.21	0.05
Row Crops	Row Crops	2140	32.05	15.40	2.12	2.95	0.41
Sugar Cane	Sugar Cane	2156	27.47	8.21	1.32	0.47	0.08
Citrus	Citrus	2210	27.47	8.73	1.40	0.77	0.12
Sod Farms	Sod Farms	2420	27.47	9.24	1.49	2.39	0.38
Ornamentals	Ornamentals	2430	27.47	12.32	1.98	3.42	0.55
Horse Farms	Horse Farms	2510	22.89	16.43	3.17	2.15	0.42
Dairies	Dairies	2520	22.89	20.53	3.97	11.08	2.14
	Field Crops	2150	22.89	6.80	1.31	3.50	0.68
	Mixed Crops	2160	27.47	11.29	1.82	4.13	0.67
	Fruit Orchards	2220	27.47	9.24	1.49	2.72	0.44
	Other Groves	2230	27.47	9.24	1.49	2.72	0.44
	Cattle Feeding Operations	2310	27.47	55.50	8.93	10.58	1.70
	Poultry Feeding Operations	2320	27.47	10.27	1.65	1.77	0.29
	Tree Nurseries	2410	22.89	12.32	2.38	3.42	0.66
	Specialty Farms	2500	22.89	8.21	1.59	2.15	0.42
	Aquaculture	2540	11.45	10.27	3.97	0.83	0.32
Other Areas	Fallow Crop Land	2610	27.47	7.19	1.16	0.83	0.13
Tree Plantations	Tree Plantations	4400	13.73	3.18	1.02	0.18	0.06
Water	Water	5000	4.58	0.92	0.89	0.06	0.06
	Upland Forests (not including 4400's)	4000	13.73	2.57	0.83	0.08	0.03
	Wetlands	6000	6.87	1.54	0.99	0.01	0.01
	Barren Land	7000	34.34	7.19	0.93	0.89	0.11
Natural Areas	Open Land	1900	22.89	4.11	0.79	0.33	0.06
Transportation	Transportation	8100	45.78	9.45	0.91	1.95	0.19
	Communications	8200	25.18	6.16	1.08	0.57	0.10
Communication/Utilities	Utilities	8300	22.89	6.16	1.19	0.57	0.11

1. Assumed on Septic
2. Assumed 70% of discharge from wastewater treatment outside basin

Table B-5. Net TP loads (pounds per year, or lbs/yr) in the Caloosahatchee River Watershed.

FLUCCS	Caloosahatchee Estuary	Freshwater East	Freshwater West	Nearshore	North Coastal	S-4	Tidal	Grand Total
1100	11	1,745	8,605	2,451	13,937	317	17,414	44,480
1200	107	633	2,907	2,879	3,017	2,490	43,184	55,217
1300	53	209	1,410	3,483	5,081	273	30,066	40,578
1400	13	316	1,138	696	635	708	11,222	14,725
1500	-	669	1,261	17	65	3,583	1,908	7,506
1600	-	431	17	2	265	53	1,007	1,776
1700	-	298	694	258	1,346	604	7,214	10,416
1800	12	86	535	1,353	1,178	291	3,417	6,873
1900	0	806	8,283	173	2,297	67	4,702	16,328
2110	2	60,837	91,855	382	3,937	1,318	35,370	193,700
2120	-	4,891	10,830	26	371	-	4,144	20,261
2130	2	4,198	7,109	47	59	-	2,956	14,370
2140	-	3,189	18,760	1,072	673	-	4,818	28,509
2150	-	1,478	4,443	28	196	133	12,370	18,647
2156	-	24,920	972	-	-	15,557	-	41,449
2160	-	-	70	-	-	-	-	70
2210	-	20,414	52,974	148	-	51	633	74,220
2220	-	-	-	-	-	-	33	33
2230	-	-	144	4,870	16	-	388	5,419
2410	-	596	380	634	-	925	788	3,326
2420	-	689	7,030	-	-	-	4,373	12,095
2430	-	55	1,264	548	51	-	1,027	2,949
2500	-	-	170	-	-	37	146	355
2510	-	301	82	-	-	-	52	434
2520	-	199	-	-	-	-	421	620
2540	-	22	75	-	-	-	80	178
2610	-	110	929	66	56	-	664	1,826
3000	11	1,056	4,573	656	1,898	59	4,045	12,298
4000	4	644	1,967	281	900	30	3,150	6,976
4400	-	2,289	5,032	-	12	-	195	7,529
5000	932	122	215	5,563	404	42	420	7,698
6000	3	358	750	289	256	14	510	2,181
7000	-	1,692	1,988	59	404	598	455	5,196
8100	12	1,444	1,257	70	951	643	5,199	9,578
8200	-	11	14	-	6	-	24	54
8300	1	220	97	35	224	152	440	1,169
Grand Total	1,164	134,927	237,829	26,086	38,236	27,944	202,834	669,039

Verification Data for Freshwater West:

Calculated 237,829 lbs/yr

Measured 237,820 lbs/yr

Table B-6. Net TN loads (lbs/yr) in the Caloosahatchee River Watershed.

FLUCCS	Caloosahatchee Estuary	Freshwater East	Freshwater West	Nearshore	North Coastal	S-4	Tidal	Grand Total
1100	107	17,025	83,963	23,920	135,998	3,094	169,924	434,032
1200	534	3,146	14,439	14,300	14,990	12,370	214,522	274,300
1300	185	727	4,904	12,111	17,667	949	104,551	141,105
1400	90	2,157	7,770	4,755	4,337	4,834	76,650	100,581
1500	-	2,423	4,569	62	236	12,977	6,910	27,187
1600	-	3,974	158	22	2,444	489	9,285	16,372
1700	-	755	1,761	654	3,414	1,531	18,291	26,412
1800	79	546	3,392	8,574	7,467	1,847	21,661	43,567
1900	4	10,008	102,863	2,144	28,530	838	58,398	202,785
2110	11	419,328	633,123	2,633	27,135	9,083	243,790	1,335,102
2120	-	32,481	71,918	169	2,462	-	27,517	134,547
2130	13	24,937	42,233	282	349	-	17,558	85,368
2140	-	16,632	97,854	5,590	3,511	-	25,134	148,707
2150	-	2,869	8,628	54	381	258	24,021	36,211
2156	-	433,274	16,904	-	-	270,489	-	720,667
2160	-	-	192	-	-	-	-	192
2210	-	232,075	602,227	1,684	-	576	7,191	843,753
2220	-	-	-	-	-	-	111	111
2230	-	-	490	16,568	55	-	1,321	18,434
2410	-	2,144	1,368	2,279	-	3,326	2,834	11,963
2420	-	2,670	27,231	-	-	-	16,937	46,848
2430	-	197	4,546	1,971	185	-	3,696	10,608
2500	-	-	649	-	-	140	559	1,355
2510	-	2,300	624	-	-	-	394	3,318
2520	-	370	-	-	-	-	780	1,150
2540	-	277	934	-	-	-	996	2,207
2610	-	956	8,078	575	489	-	5,771	15,876
3000	210	20,904	90,545	12,995	37,586	1,170	80,106	243,517
4000	131	19,997	61,070	8,717	27,929	921	97,813	216,579
4400	-	41,131	90,400	-	220	-	3,511	135,261
5000	14,581	1,904	3,363	87,049	6,328	663	6,576	120,463
6000	424	46,708	97,813	37,720	33,391	1,837	66,501	284,394
7000	-	13,727	16,127	482	3,277	4,851	3,694	42,158
8100	57	6,999	6,092	340	4,609	3,117	25,201	46,425
8200	-	123	148	-	62	-	259	591
8300	6	2,390	1,053	382	2,433	1,651	4,786	12,708
Grand Total	16,432	1,365,155	2,107,429	246,030	365,485	337,011	1,347,248	5,784,855

Verification Data for Freshwater West:

Calculated 2,107,429 lbs/yr

Measured 2,107,380 lbs/yr

Table B-7. Land use (2004) categories, unit loads, and TP reduction factors in the Caloosahatchee River Watershed.

Land Use Category	Land Use Description	FLUCCS	Unit TP Load (lbs/acre/yr)	Estimated Phosphorus Reduction		
				Owner Implemented BMPs	Typical Incentive BMPs	Alternative Practices
Residential Low Density	Residential Low Density[1]	1100	0.58	5%	5%	70%
Residential Medium Density	Residential Medium Density[2]	1200	1.65	5%	5%	70%
Residential High Density	Residential High Density[2]	1300	3.54	5%	5%	70%
Other Urban	Commercial/Recreational[2]	1400-1800	1.75	5%	5%	70%
Improved Pastures	Improved Pastures	2110	1.65	11%	19%	49%
Unimproved Pastures	Unimproved Pastures	2120	0.85	7%	13%	44%
Woodland Pastures/Rangeland	Woodland/Range Pastures	2130/3000	0.34	4%	6%	35%
Row Crops	Row Crops	2140	2.95	30%	30%	50%
Sugar Cane	Sugar Cane	2156	0.47	10%	23%	52%
Citrus	Citrus	2210	0.77	12%	20%	42%
Sod Farms	Sod Farms	2420	2.39	20%	27%	50%
Ornamentals	Ornamentals	2430	3.42	32%	35%	50%
Horse Farms	Horse Farms	2510	2.15	20%	22%	49%
Dairies	Dairies	2520	11.08	9%	28%	48%
Other Areas	Field Crops/Fallow Crop Land	2150-2610	2.74	15%	25%	36%
Tree Plantations	Tree Plantations	4400	0.18	1%	10%	50%
Water	Water	5000	0.06	0%	0%	0%
Natural Areas	Forests/wetlands/Open	4000/6000	0.09	0%	0%	0%
Transportation	Transportation	8100	1.95	10%	23%	52%
Communication/Utilities	Communication/Utilities	8200/8300	0.57	5%	5%	50%

1. Assumed on Septic
2. Assumed all of discharge from wastewater treatment outside basin

Table B-8. Land use (2004) categories, unit loads, and TN reduction factors in the Caloosahatchee River Watershed.

Land Use Category	Land Use Description	FLUCCS	Unit TN Load (lbs/acre/yr)	Estimated Nitrogen Reduction		
				Owner Implemented BMPs	Typical Incentive BMPs	Alternative Practices
Residential Low Density	Residential Low Density[1]	1100	5.65	15%	15%	15%
Residential Medium Density	Residential Medium Density[2]	1200	8.21	25%	25%	15%
Residential High Density	Residential High Density[2]	1300	12.32	30%	25%	15%
Other Urban	Commercial/Recreatonal[2]	1400-1800	9.08	25%	25%	15%
Improved Pastures	Improved Pastures	2110	11.40	17%	10%	30%
Unimproved Pastures	Unimproved Pastures	2120	5.65	11%	8%	30%
Woodland Pastures/Rangeland	Woodland/Range Pastures	2130/3000	4.21	4%	6%	20%
Row Crops	Row Crops	2140	15.40	30%	30%	50%
Sugar Cane	Sugar Cane	2156	8.21	10%	23%	52%
Citrus	Citrus	2210	8.73	10%	20%	42%
Sod Farms	Sod Farms	2420	9.24	20%	27%	50%
Ornamentals	Ornamentals	2430	12.32	25%	25%	25%
Horse Farms	Horse Farms	2510	16.43	30%	22%	30%
Dairies	Dairies	2520	20.53	20%	40%	48%
Other Areas	Field Crops/Mixed Crop	2150-2610	7.91	15%	25%	36%
Tree Plantations	Tree Plantations	4400	3.18	5%	10%	25%
Water	Water	5000	0.92	0%	0%	0%
Natural Areas	Forrests/wetlands/Open	4000/6000	2.30	0%	0%	0%
Transportation	Transportation	8100	9.45	20%	23%	25%
Communication/Utilities	Communication/Utilities	8200/8300	6.16	5%	5%	50%

1. Assumed on Septic
2. Assumed 70% of discharge from wastewater treatment outside basin

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SWET. 2008a. Nutrient Loading Rates, Reduction Factors and Implementation Costs Associated with BMPs and Technologies. Letter Report to South Florida Water Management District, West Palm Beach, FL.

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Attachment C: Caloosahatchee Best Management Practices Assumptions

Agricultural Best Management Practices Assumptions. Implementation rates for agricultural Best Management Practices (BMPs), determined on a sub-watershed basis, were provided by the Florida Department of Agriculture and Consumer Services (FDACS) (**Table C-1**). Applicable practices under the "owner implemented" category are non-structural in nature. Typical BMPs in this category are nutrient and irrigation management, maintenance of vegetative buffers to protect water features from sediment runoff, and location of livestock feeding/mineral stations away from water features. Generally, this type of practice is already being implemented or is easily implemented in the first year. Applicable practices under the "cost-share" category are structural in nature. Typical BMPs in this category are surface water control structures, detention/retention structures, alternative watering facilities for livestock, and tail-water recovery ponds. Generally, these practices require significant investment by the landowner and require long-term planning and cost-share assistance for installation and maintenance.

Cost-share funding provided by FDACS, U.S. Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS), and South Florida Water Management District (SFWMD) has been available to agricultural producers in the watershed on a limited basis, and some agricultural producers have used those funds along with their own to install BMPs that help maintain or improve water quality. However, in the Caloosahatchee River Watershed some BMPs that fall under the "cost-share" category have been implemented without funding assistance, which is due to several factors. Agricultural land uses in South Florida such as citrus, vegetable, sugarcane, and sod production typically need surface water control systems for both irrigation and flood control; these systems also may be required by permit. Therefore, in some cases agricultural producers must, by necessity or regulation, install them regardless of whether cost-share is available. Other agricultural land uses, such as cattle production, have installed surface water control structures over time to improve forage production.

Current implementation rates for owner implemented BMPs, as of June 2011, were derived by taking estimates of current owner-implemented NOI enrollment (acres) in each sub-watershed divided by the total estimated agricultural acres in the sub-watershed. On the other hand, current implementation rates for cost share BMPs were derived from cost share BMP enrollment data and further investigations conducted by FDACS staff through GIS analyses and local knowledge of the area. These analyses indicated that landowners have been implementing cost-share type of BMPs (water control structures, retention/detention systems, etc.) at the same rates as the owner implemented BMPs by necessity or regulation, as described above. The near-term implementation rates are estimates of what is expected as reasonable to accomplish in the next three years (2012–2014). Long-term, owner-implemented BMPs were estimated at 100 percent with the assumption that the District's Regulatory Nutrient Source Control Program is expanded to encompass the Caloosahatchee River Watershed. There were no additional cost-share implementation rates applied for the long-term phase.

Table C-1. Caloosahatchee River Watershed agricultural BMP implementation rates.

Sub-Watershed	Owner-Implemented Agricultural BMPs (cumulative percent)		
	Current	Near-Term	Long-Term
Coastal	0.7%	30%	100%
Tidal Caloosahatchee	0.3%	30%	100%
West Caloosahatchee	55.5%	80%	100%
East Caloosahatchee	54.5%	80%	100%
S-4	75.8%	80%	100%
	Cost-Share Agricultural BMPs		
Coastal	0.7%	10%	n/a
Tidal Caloosahatchee	0.3%	10%	n/a
West Caloosahatchee	55.5%	65%	n/a
East Caloosahatchee	54.5%	65%	n/a
S-4	75.8%	90%	n/a

Urban Best Management Practices Assumptions. Urban BMP implementation rates were determined on a sub-watershed basis and applied to pervious areas. Additionally, cost-share urban BMPs were only applied to land that was not yet developed when the stormwater permitting rules went into effect (post-1988). Cumulative implementation rates of 10 percent for current, 35 percent for near-term, and 100 percent for long-term were applied for owner implemented urban BMPs. For the Caloosahatchee cumulative implementation rates of 10 percent for current, 30 percent for near-term, and 100 percent for long-term were applied.

Attachment D: Caloosahatchee Watershed and Estuary Monitoring Efforts

This attachment provides inventories of the monitoring efforts being conducted within the Caloosahatchee River Water Protection Plan study area, which includes the Caloosahatchee River Watershed and the Caloosahatchee Estuary, as of May 2011. **Tables D-1** and **D-2** contain a water quality monitoring inventory. **Tabled D-3** and **D-4** contain an aquatic program inventory.

Table D-1. Water quality monitoring inventory for the Caloosahatchee River Watershed and Tidal Basin study area (current as of May 2011).

Organization/ Program	Number of Stations	Location	Frequency	Period	Analytes
Caloosahatchee River Watershed					
Lee County	6 (fixed)	Caloosahatchee freshwater tributaries	Monthly	1990–present	Chl*a*, pheo, BOD, Cd, Cl, color, cond., Cu, DO, enterococci, fecal coliform, NH3, NO2, NO3, NOx, O-PO4, Pb, pH, SiO4, TP, temp, TKN, TN, TSS, turb., vel.
SFWMD/BGA	2 (fixed)	Caloosahatchee River	Sampled on request	2005–2007	Chl*a*, Chl*a* corrected, microcystin, DO, pH, Secci, temp., total depth
SFWMD/CRFW	4	Caloosahatchee River	Weekly	1979–present	alk., Ca, Cl, color, cond., DO, K, Mg, Na, NH3, NO2, NOx, O-PO4, pH, SiO2, SO4, temp., TKN, TP, TSS, turb.
SFWMD/CR	1 (fixed); (3 other stations overlap with CRFW)	Caloosahatchee River	Bimonthly	1979–present	alk., Ca, Cl, color, cond., DO, K, Mg, Na, NH3, NO2, NOx, O-PO4, pH, SiO2, SO4, temp., TKN, TP, TSS, turb.
SFWMD/PEST	5 (fixed) surface water; 3 (fixed) sediment	Caloosahatchee River	Quarterly for surface water; semiannually for sediments	1979–present; 1988–present	organophosphorus, organonitrogen, organochlorine compounds
SFWMD/X	8 (fixed)	Caloosahatchee River and Freshwater Tributaries	Biweekly	1973–present	alk., cl, color, NH3, NO2, NOx, O-PO4, TDS, TKN, TP, TSS, turb., DO, cond., water temp., pH
SFWMD/CESWQ	8 (fixed)	Caloosahatchee River and Freshwater Tributaries	Monthly	1999–present	Chl*a*, Chl*a* corrected, color, NO2, NO3, NOx, NH3, TKN, TN, TOC, TP, O-PO4, SiO2, TSS, turb., DO, cond., temp., pH, PAR, salinity, Secci depth, total depth
SFWMD/CESWQ Release	1 (fixed)	Caloosahatchee River	Sampled on request	2001–2008	Chl*a*, Chl*a* corrected, TN, TP, DO, cond., temp., pH, PAR, salinity, Secci depth, total depth
East County Water Control District	25 (fixed)	Caloosahatchee freshwater tributaries/canals	Quarterly – Monthly	1984–present	TN, TKN, NO2, NO3, NH3, TP, TSS, TDS, Cl, BOD, fecal streptococcus, fecal coliforms, cond., turb., DO, pH, vel., direction of flow, total depth, sample depth, air temp., water temp.
SCCF/RECON	3 in-situ sites-LOBOS	Ft. Myers, Shell Point and Moore Haven	30-minute intervals	2007/2008–present	NO3, chl, CDOM, cond., DO, oxygen saturation, turb., salinity, temp., depth

Organization/ Program	Number of Stations	Location	Frequency	Period	Analytes
Caloosahatchee Tidal Basin					
City of Cape Coral	31 (fixed)	Freshwater and Saltwater Canals within City	Monthly	1990–present	N, TN, DO, TP, turb., TDS, TSS, water temp., pH, cond., Secchi, fecal streptococcus, fecal coliforms, BOD
City of Ft. Myers	8 (fixed)	Caloosahatchee Tidal	Monthly	2005–present	BOD, Al, Cd, Cl, Cu, DO, enterococci, fecal coliform, NH3, NOx, O-PO4, Pb, pH, TDS, Temp., TKN, TN, TP, TSS, Zn
Lee County	49 (fixed)	Caloosahatchee freshwater tributaries	Monthly	1990–present	Chl*a*, pheo, BOD, Cd, Cl, color, cond., Cu, DO, enterococci, fecal coliform, NH3, NO2, NO3, NOx, O-PO4, Pb, pH, SiO2, TP, water temp., TKN, TN, TSS, turb., vel.

Al - aluminum
Alk. – alkalinity
BGA – blue green algae
BOD – biological oxygen demand
Ca – calcium
Cd – cadmium
CDOM – colored dissolved organic matter
Chla – chlorophyll a
Cl – chloride
Cond. – conductivity
CR – chromium
Cu – copper
DIN – dissolved inorganic nitrogen
DO – dissolved oxygen
F – fluoride
HAB – harmful algal blooms
K – potassium
Mg – magnesium
N – nitrogen
Na – sodium
NH3 – ammonia
NO2 – nitrite
NO3 – nitrate
NOx – nitrate + nitrite
O-PO4 – orthophosphate
PAR – photosynthetically active radiation
Pb – lead
PEST - pesticides
Pheo – pheophytin
SCCF – Sanibel-Captiva Conservation Foundation
SFWMD – South Florida Water Management District
SiO2 – silica
SO4 – sulfate
SRP – soluble reactive phosphorus
TDS – total dissolved solids
Temp. – temperature
TIN – total inorganic nitrogen
TKN – total Kjeldahl nitrogen
TN – total nitrogen
TOC – total organic carbon
TON – total organic nitrogen
TP – total phosphorus
TSS – total suspended solids
Turb. – turbidity
Vel. – velocity
Zn – zinc

Table D-2. Water quality monitoring inventory for the CRE study area (current as of May 2011).

Organization/ Program	Number of Stations	Location	Frequency	Period	Analytes
SFWMD – Reengineering	13	Caloosahatchee River through the estuary and into San Carlos Bay	Monthly	2010–present	TKN, NOX, NH3, TP, OPO4, TOC, Chl*a*, color, turb., TSS
SFWMD/CESWQ	3 (fixed)	Caloosahatchee River	Monthly	1999–mid-2009	Chl*a*, Chl*a* corrected, color, NO2, NO3, NOx, NH3, TKN, TN, TOC, TP, O-PO4, SiO2, TSS, turb., DO, cond. temp., pH, PAR, salinity, Secci, total depth.
SFWMD/CESWQ Release Monitoring	10(fixed)	Caloosahatchee River	Sampled on request	2001–mid-2009	Chl*a*, Chl*a* corrected, cond., temp., pH, salinity, DO, PAR
SFWMD/CESWQ Release Monitoring	10(fixed)	Caloosahatchee River	Sampled on request	2001–mid-2009	Chl*a*, Chl*a* corrected, cond., temp., pH, salinity, DO, PAR
SFWMD/FIU	8 (fixed)	San Carlos Bay and Pine Island Sound	Monthly	1999–mid-2009	salinity, temp., TP, NO2, NO3, NH3, total oxidized nitrogen, SiO2, DO, TOC, turb., NOx, DIN, TIN, TON, SRP, Chl*a*, specific cond.
SFWMD/BGA	6 (fixed)	Caloosahatchee River	Sampled on request	2005–2007	Chl*a*, Chl*a* corrected, microcystin, DO, pH, Secci, temp., total depth.
CHNEP/SFWMD	5 (random)	Tidal Caloosahatchee River	Monthly	2000–present	Chla, O-PO4, TP, TKN, TN, NOx, NH3, dissolved orthophosphate, cond., color, PAR, pH, TOC, DO, salinity, turb., Secchi, temp., TSS
CHNEP/Lee County	5 each (random)	Pine Island Sound and Estero Bay	Monthly	2002–present	
CHNEP/Cape Coral	5 (random)	Matlacha Pass	Monthly	2002–present	
CHNEP/City of Sanibel/Lee County	5 (random)	San Carlos Bay	Monthly	2002–2006 City of Sanibel; 2006–present Lee County	
CHNEP/FDEP/ Lee County	5 (random)	Bokkelia	Monthly	2002–present	
Lee County	14 (fixed)	Pine Island Sound & Matlacha Pass	Monthly	1990–present	NO2, NO3, NH3, TKN, TN, O-PO4, organic phosphorus, TP, turb., TDS, TSS, water temp., pH, cond., Secchi, fecal streptococcus, fecal coliforms, BOD

Organization/ Program	Number of Stations	Location	Frequency	Period	Analytes
City of Cape Coral	2 (fixed)	Caloosahatchee River	Monthly	1990–present	NO2, NO3, NH3, TKN, TN, O-PO4, organic phosphorus, TP, turb., TDS, TSS, water temp., pH; cond., Secchi, fecal streptococcus, fecal coliforms, BOD
FDEP/TMDL	8 (fixed)	Caloosahatchee River	Monthly	2008	DO, organic carbon, O-PO4, pH, temp., BOD, TOC, TKN, turb., cond.
FDEP/TMDL	4 (fixed)	Caloosahatchee River	Monthly	2008	Chla, DO, TP, O-PO4, pH, temp., TN, NOx, TKN, alk., TSS, F, BOD, TOC, turb., cond.
FDEP/TMDL	3 in-situ sites - (YSI) w/ monthly grab samples				YSI: cond., DO, temp, pH Surface WQ: Chl*a*; BOD, TP, O-PO4, total carbon, TKN, NOx, organic carbon, TSS, F, AH3, color (true)
SCCF/RECON	Monitor 8 sensors in the region from Lake Okeechobee to the Gulf of Mexico with 3 sites located in the CRWPP boundary. 3 in-situ sites - LOBOS	Ft. Myers; Shell Point; Blind Pass; Redfish Pass; Gulf of Mexico	30-minute intervals	2007/2008–present	Monitor stations at Moore Haven, Fort Myers and Shell Point for NO3, Chl, CDOM, cond., DO, oxygen saturation, turb., salinity, temp., depth
Florida Fish and Wildlife Research Institute/MARVIN	3 sites	Caloosahatchee River	3-hour intervals	Marvin 1: 2005–2008; Marvin 2: 2007–2008; Marvin 3 to be deployed in 2011 for 6-12 months	Chl*a*, nutrients (nitrogen and phosphorus), water temp., DO, pH, salinity, turb. Also records meteorological data including air temperature, precipitation, barometric pressure, relative humidity, and wind speed and direction.
City of Sanibel	12 (fixed)	Sanibel Island and Blind Pass	Monthly	2001–present	TSS, turb., NH3, TN, NOx, TKN, NO2, NO3, O-PO4, TP, Chl*a*, cond., salinity, TOC
FDEP – Charlotte Harbor Aquatic Preserve/Volunteer WQ Network	46 (fixed)	Lemon Bay, Charlotte Harbor southward to Estero Bay	Monthly	1998–present	DO, salinity, Chl*a*, turb., color, TP, TKN, NOx, NO2, NO3, fecal coliform, pH, temp., water depth, Secchi, tide stage, wind speed, wave height

Organization/ Program	Number of Stations	Location	Frequency	Period	Analytes
FDEP – Charlotte Harbor Aquatic Preserve Data Sonde Program	3 (fixed)	Matlacha Pass	15-minute intervals	2005–present	Depth, water temp, cond., salinity, pH, turb., DO
				2005–present	Chl*a*, TKN, NO2, NO3, TP, red tide and other HABs, Secchi, water depth
FDEP – Estero Bay Aquatic Preserve Data Sonde Program	3 (fixed)				Depth, water temp., cond., salinity, pH, turb., DO

Al - aluminum
Alk. – alkalinity
BGA – blue green algae
BOD – biological oxygen demand
Ca – calcium
Cd – cadmium
CDOM – colored dissolved organic matter
Chla – chlorophyll a
CHNEP – Charlotte Harbor National Estuary Program
Cl – chloride
Cond. – conductivity
Cu – copper
DIN – dissolved inorganic nitrogen
DO – dissolved oxygen
F – fluoride
FDEP – Florida Department of Environmental Protection
FIU – Florida International University
HAB – harmful algal blooms
K – potassium
Mg – magnesium
N – nitrogen
Na – sodium
NH3 – ammonia
NO2 – nitrite
NO3 – nitrate
NOx – nitrate + nitrite
O-PO4 – orthophosphate
PAR – photosynthetically active radiation
Pb – lead
Pheo – pheophytin
SCCF – Sanibel-Captiva Conservation Foundation
SFWMD – South Florida Water Management District
SiO2 – silica
SO4 – sulfate
SRP – soluble reactive phosphorus
TDS – total dissolved solids
Temp. – temperature
TIN – total inorganic nitrogen
TKN – total Kjeldahl nitrogen
TMDL – Total Maximum Daily Load
TN – total nitrogen
TOC – total organic carbon
TON – total organic nitrogen
TP – total phosphorus
TSS – total suspended solids
Turb. – turbidity
Vel. – velocity
WQ – water quality
Zn – zinc

Table D-3. Identification of organizations conducting SAV monitoring and purpose of their monitoring programs (current as of May 2011).

Organization Conducting Sampling	Sampling Program Name	Purpose of Sampling
RECOVER/USACE	Submerged Aquatic Vegetation Monitoring in the San Carlos Bay and Caloosahatchee River and Estuary	Typify changes in plant composition and abundance, range of aerial coverage, influence from freshwater inflow or water quality impacts, and provide supporting information for ecosystem model
FDEP-South District – Environmental Assessment and Restoration (EAR)	Caloosahatchee/San Carlos Bay Quarterly Seagrass Transect Monitoring	Determine changes over time in seagrass species composition, abundance, density, health and deep edge of bed; and link monitoring results to water quality
FDEP – Charlotte Harbor Aquatic Preserves (CHAP)	Charlotte Harbor Aquatic Preserves Seagrass Transect Monitoring	Determine changes over time in seagrass species, abundance, density, health and deep edge of bed; and link monitoring results to water quality
FDEP – Estero Bay Aquatic Preserve (EBAP)	Estero Bay Aquatic Preserve Seagrass Transect Monitoring	Determine changes over time in seagrass species composition, abundance, density, health and deep edge of bed; and link monitoring results to water quality
SFWMD	Hydroacoustic Monitoring of Submerged Aquatic Vegetation in the Caloosahatchee Estuary and Downstream Area	Quantify SAV spatial and temporal coverage along the salinity, depth, and water quality gradient of the estuary related to the influence of freshwater discharges
SFWMD	Aerial Mapping of Lower Charlotte Harbor and Tidal Caloosahatchee	Detect trends in area wide (spatially contiguous) SAV coverage, depth, and distribution

FDEP – Florida Department of Environmental Protection
RECOVER – Restoration Coordination and Verification
SAV – Submerged Aquatic Vegetation
SFWMD – South Florida Water Management District
USACE – U.S. Army Corps of Engineers

Table D-4. Parameters measured in RECOVER/USACE Oyster Monitoring Program in the CRE.

Medium	Parameters	Stations	Frequency	Collection
Water Quality	Dissolved Oxygen, pH, salinity, conductivity and temperature	All	Monthly	YSI / Hydrolab
Oysters-Adults	Density and size of living adults/square meter	All	Winter	Quadrat Counts and in situ measurements
Reproductive Condition	Gonadal Index, gonadal conditions	All	Monthly	Histology and image analysis from collected samples
Recruitment	Oyster spat settlement and growth	All	Monthly	Count and measure spat on oyster settling apparatus
Oyster Juveniles	Juvenile oyster growth and survival	All	Monthly	Measure 50 random juvenile oysters from wire mesh bag: examine percent survival of all juvenile oysters
Population (reef coverage)	Spatial coverage (acres)	Lower Estuary & San Carlos Bay area	Minimum – Every 5 years	Aerial photography and ground-truthing