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***2022 5-Year Review of the
Caloosahatchee River and Estuary
Basin Management Action Plan***

**Division of Environmental Assessment and Restoration
Water Quality Restoration Program
Florida Department of Environmental Protection**

with participation from the
Caloosahatchee River and Estuary Stakeholders

November 2022

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Acknowledgments

The *Caloosahatchee River and Estuary Basin Management Action Plan*, originally adopted in November 2012 with an update adopted in January 2020, was prepared as part of a statewide watershed management approach to restore and protect Florida's water quality. This *2022 5-Year Review of the Caloosahatchee River and Estuary Basin Management Action Plan* was prepared in partial fulfillment of section 373.4595(4)(b), Florida Statutes. These documents were prepared by the Florida Department of Environmental Protection with participation from the Caloosahatchee River and Estuary stakeholders identified below.

Type of Governmental or Private Entity	Participant
Local Governments	Charlotte County Collier County Glades County Hendry County Lee County City of Cape Coral City of Clewiston City of Fort Myers City of LaBelle City of Moore Haven
Community Development Districts	Lucaya Mirada Moody River Estates Port LaBelle Portico River Hall Sail Harbour Sugarland Verandah East Verandah West
Special Districts	Barron Water Control District Clewiston Water Control District Collins Slough Water Control District County Line Drainage District Cow Slough Water Control District Devil's Garden Water Control District Disston Island Conservancy District Flaghole Drainage District Gerber Groves Water Control District Hendry-Hilliard Water Control District Lehigh Acres Municipal Services District Sugarland Drainage District
Agencies	Florida Department of Agriculture and Consumer Services Florida Department of Environmental Protection Florida Department of Transportation District 1 South Florida Water Management District

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List of Acronyms and Abbreviations

BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CDD	Community Development District
DEP	Florida Department of Environmental Protection
DO	Dissolved Oxygen
EJ	Environmental Justice
EPA	U.S. Environmental Protection Agency
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDOT	Florida Department of Transportation
F.S.	Florida Statutes
FSAID8	Florida Statewide Agricultural Irrigation Demand Version 8 (Geodatabase)
LA	Load Allocation
LA-MSID	Lehigh Acres Municipal Services Improvement District
lbs/yr	Pounds Per Year
MDL	Minimum Detection Level
mg/L	Milligrams per Liter
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NPDES	National Pollutant Discharge Elimination System
OSTDS	Onsite Sewage Treatment and Disposal System
POR	Period of Record
SFWMD	South Florida Water Management District
STAR	Statewide Annual Report
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TRA	Targeted Restoration Area
USGS	U.S. Geological Survey
WBID	Waterbody Identification (number)
WCD	Water Control District
WIN	Watershed Information Network (Database)
WLA	Wasteload Allocation
WWTF	Wastewater Treatment Facility
WY	Water Year

Executive Summary

Background

In 2005, after years of water quality data collection and analysis, the Florida Department of Environmental Protection (DEP) identified the Caloosahatchee Estuary as impaired for dissolved oxygen (DO) and nutrients. Using this and additional information, DEP adopted a science-based water quality restoration goal for the Caloosahatchee Estuary, called a total maximum daily load (TMDL), in December 2009. This TMDL established a reduction target for total nitrogen (TN) in the Caloosahatchee Estuary downstream of the Franklin Lock and Dam. In 2005, 2010, and 2016, DEP identified five tributaries to the Caloosahatchee River as impaired for DO. In late 2019, DEP adopted TN, total phosphorus (TP), and biochemical oxygen demand (BOD) TMDLs for these tributaries.

To achieve restoration, DEP developed a comprehensive restoration plan in collaboration with local stakeholders. This plan, called a Basin Management Action Plan (BMAP), identifies projects and strategies designed to achieve the required reductions. The plan is reviewed annually to track changes in water quality as a result of those projects.

DEP first adopted the Caloosahatchee Estuary BMAP in November 2012 to implement the TN TMDL in the Caloosahatchee Estuary downstream of the Franklin Lock and Dam. BMAPs are designed to be implemented in a phased approach and, at the end of each five-year phase, a review is completed and submitted to the Legislature and Governor. In November 2017, DEP and the local stakeholders completed the first 5-Year Review to evaluate implementation at the end of the first phase and make recommendations for future phases of the BMAP. The information gathered as part of the 2017 5-Year Review was used to develop the updated BMAP for the Caloosahatchee River and Estuary Watershed, which expanded the watershed to include the impaired tributaries. DEP adopted the BMAP update in January 2020.

This 2022 5-Year Review provides updates on the status of implementation through the second phase of the BMAP and makes recommendations for future BMAP phases.

Summary of Load Reductions

Through December 31, 2021, 206 projects are completed and ongoing that are estimated to achieve total reductions of 727,315 pounds per year (lbs/yr) of TN, or 80% of the reductions needed to meet the estuary TMDL. This 80% reduction meets the 10-year milestone established in the BMAP update. An additional 110 projects are underway or planned.

Reductions for completed and ongoing projects in the impaired tributaries have achieved:

- S-4 Basin TMDL — 645 lbs/yr of TN and 137 lbs/yr of TP reductions.
- C-19 Canal TMDL — 102 lbs/yr of TN and 15 lbs/yr of TP reductions.
- Lake Hicpochee TMDL — 44 lbs/yr of TN and 6 lbs/yr of TP reductions.

- Long Hammock Creek TMDL — 155 lbs/yr of TN and 32 lbs/yr of TP reductions
- Townsend Canal TMDL - 0 lbs/yr of TN and 0 lbs/yr of TP reductions.

Figure ES-1 shows progress toward the estuary TN and tributaries TN and TP TMDL load reductions.

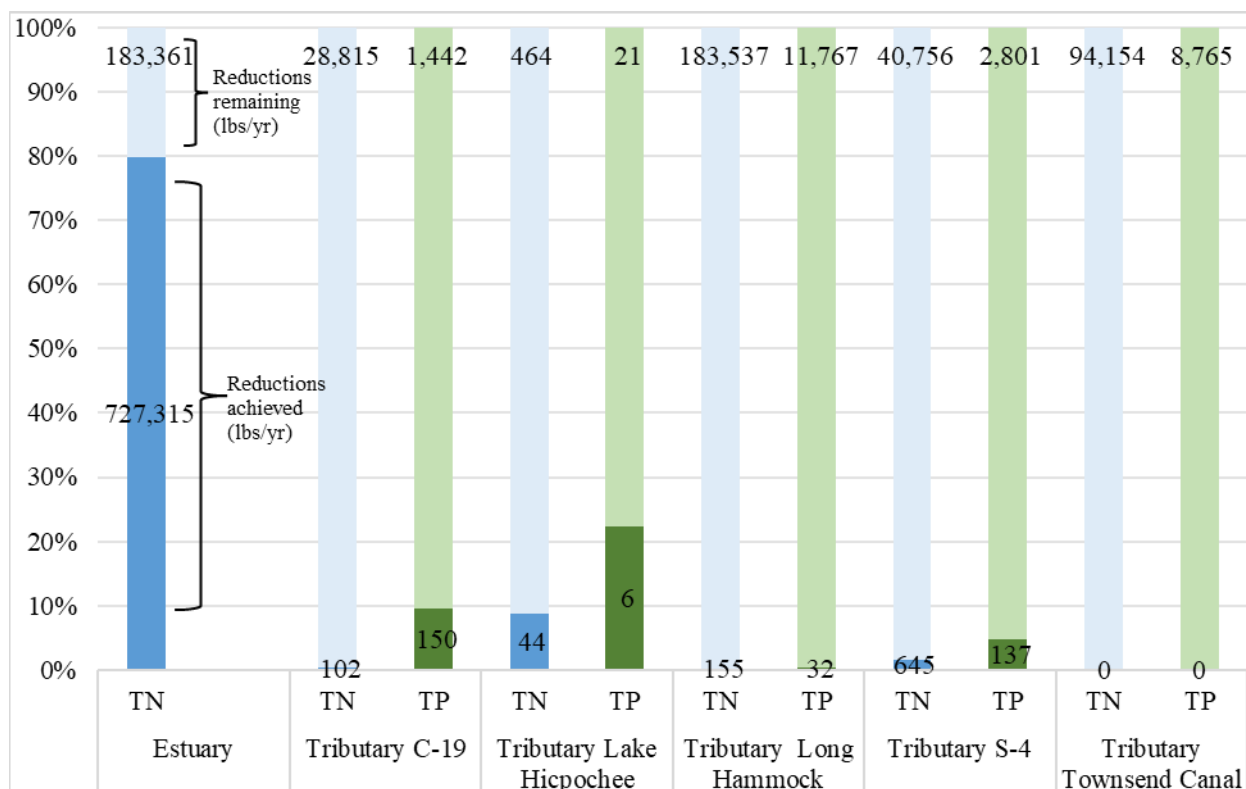


Figure ES-1. Estimated progress towards meeting required TN and TP reductions in the Caloosahatchee Estuary and tributaries from projects completed and ongoing through December 31, 2021

Water Quality and Biological Monitoring

The existing Caloosahatchee BMAP monitoring network consists of stations monitored by numerous stakeholders, including both state and local entities. These stations are organized into a 3-tier system to prioritize stations used to track water quality trends in the BMAP. In addition, South Florida Water Management District (SFWMD) conducts biological sampling for oysters and seagrass, and DEP conducts quarterly sampling for seagrass as part of the BMAP monitoring plan.

To help track implementation progress for the Caloosahatchee BMAP, a water quality evaluation was completed using data available as of May 31, 2022. Trend analyses were conducted as part of the 5-Year Review to track changes in basins throughout the Caloosahatchee River

Watershed. In the Tidal Caloosahatchee Subwatershed, a decreasing trend for TN and TP was identified in the Billy Creek/Manuel Branch Basin, and an increasing trend in TN and TP was identified for the Orange Basin. In the West Caloosahatchee Subwatershed, increasing trends for TN were identified for the Bedman/Dog and Cypress Creek basins. Insufficient monitoring data were gathered for 13 basins but, of those, five basins have newly established monitoring that will provide sufficient data for a trend analysis in coming years.

Recommendations for Future Implementation

The BMAP implements phased TN reductions according to section 403.067(7)(a)1., Florida Statutes (F.S.), for the portion of loading generated in the Tidal Caloosahatchee Subwatershed, downstream of S-79. The purpose of this 2022 5-Year Review is to evaluate implementation activities that have taken place during the second 5-year BMAP phase and make recommendations for future implementation activities that may be incorporated into a revised BMAP.

The first and second BMAP phases included significant restoration efforts by stakeholders, and the implementation will continue to help meet the TMDL. This 2022 5-Year Review recommends updating the nutrient loading to the Caloosahatchee River Watershed based on the data provided by SFWMD and updating stakeholder allocations. Updating the loading will also require a modification of the milestones set by the BMAP. This review also recommends that compliance within the BMAP be stated as allowable nutrient loads, rather than the percent reductions that were determined by the TMDLs. In addition, small modifications to the water quality monitoring network are recommended to fill in gaps that constrain analyses. Finally, the next BMAP update will include actions from the wastewater and onsite sewage treatment and disposal system (OSTDS) remediation plans being prepared by local governments. The update will be completed no later than July 1, 2025, in accordance with the Clean Waterways Act, Chapter 2020-150, Laws of Florida.

Chapter 1. Background Information

1.1 Water Quality Standards and Total Maximum Daily Loads (TMDLs)

Florida's water quality standards are designed to ensure that surface waters fully support their designated uses, such as drinking water, aquatic life, recreation, and agriculture. Currently, most surface waters in Florida, including those in the Caloosahatchee River Watershed, are categorized as Class III waters, meaning they must be suitable for recreation and must support fish consumption and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. **Table 1** lists all designated use classifications for Florida surface waters.

Table 1. Designated use attainment categories for Florida surface waters

¹ Class I, I-Treated, and II waters additionally include all Class III uses.

* Class I-Treated waters designation is not yet approved by the U.S. Environmental Protection Agency (EPA).

Classification	Description
Class I¹	Potable water supplies
Class I-Treated^{1*}	Treated potable water supplies
Class II¹	Shellfish propagation or harvesting
Class III	Fish consumption; recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife
Class III-Limited	Fish consumption, recreation or limited recreation, and/or propagation and maintenance of a limited population of fish and wildlife
Class IV	Agricultural water supplies
Class V	Navigation, utility, and industrial use (<i>no current Class V designations</i>)

Section 303(d) of the federal Clean Water Act requires that each state must identify its impaired waters every two years, including estuaries, lakes, rivers, and streams, that do not meet their designated uses. Florida Department of Environmental Protection (DEP), Division of Environmental Assessment and Restoration is responsible for assessing Florida's waters for inclusion on the Verified List of Impaired Waters (when a causative pollutant for the impairment has been identified) and Study List (when a causative pollutant for the impairment has not been identified and additional study is needed). These lists are then provided to EPA as an update to the state's 303(d) list.

As part of the regular watershed assessment process, in 2005 DEP identified the Caloosahatchee Estuary as impaired for chlorophyll *a* caused by excessive nutrients. In 2005, 2010, and 2016 DEP identified various tributaries to the Caloosahatchee River, including the S-4 Basin (waterbody identification [WBID] number 3246), C-19 Canal (WBID 3237E), Lake Hicpochee (WBID 3237C), Long Hammock Creek (WBID 3237B), and Townsend Canal (WBID 3235L) as impaired for dissolved oxygen (DO).

1.1.1 Caloosahatchee River and Estuary TMDLs

A TMDL is the maximum amount of a specific pollutant that a waterbody can assimilate while maintaining its designated uses. The Caloosahatchee Estuary TMDL was adopted in 2009 for

total nitrogen (TN). The TMDL included three segments with WBID numbers 3240A, 3240B, and 3240C. **Table 2** lists the TMDL and pollutant load allocations as a percent reduction and in pounds per year (lbs/yr) implemented by rule (Rule 62-304.800, Florida Administrative Code [F.A.C.], effective August 13, 2009) for the Caloosahatchee Estuary (based on updates to the watershed loading effective November 28, 2012). The 23% reduction required by the TMDL was used as the basis for the basin management action plan (BMAP) targets and allocation calculations.

In July 2019, DEP adopted DO TMDLs for TN, total phosphorus (TP), and biochemical oxygen demand (BOD) for five tributaries in the upper Caloosahatchee River Basin (effective August 13, 2019). **Table 3** lists the TMDL components for nutrients in the Upper Caloosahatchee River Basin Tributaries. For the S-4 Basin, C-19 Canal, Lake Hicpochee, Long Hammock Creek, and Townsend Canal, the TMDLs are expressed as a 7-year rolling average load not to be exceeded.

Figure 1 shows the locations of the estuary and tributary WBIDs with nutrient TMDLs.

Table 2. Caloosahatchee River Watershed tidal TMDLs

NPDES = National Pollutant Discharge Elimination System.

TMDL covers WBIDs 3240A, 3240B, and 3240C.

¹ From Table 6.1 in the 2009 Final TMDL report.

Parameter	Wasteload Allocation (WLA) for Wastewater (lbs/yr)	WLA for NPDES Stormwater (% Reduction)	Load Allocation (LA, % Reduction)	Margin of Safety	TMDL (lbs/yr)	Current Loading (lbs/yr) ¹
TN	Permitted loads	23	23	Implicit and explicit	9,086,094	11,800,122

Table 3. Caloosahatchee River Watershed tributary TMDLs

¹The TMDL represents a 7-year rolling average of annual loads, not to be exceeded, including loads from upstream basins. Dividing by 365 yields daily TMDL loads.

²The required percent reductions listed in this table represent the reduction from all sources.

³Margin of Safety is implicit.

N/A = not applicable.

WBID	Parameter	TMDL (maximum 7-year average load in lbs) ¹	WLA Wastewater (% reduction) ^{2, 3}	WLA NPDES Stormwater (% reduction) ^{2, 3}	LA (% reduction) ^{2, 3}
S-4 Basin (3246)	TN	430,844	N/A	N/A	23
S-4 Basin (3246)	TP	28,622	N/A	N/A	27
S-4 Basin (3246)	BOD	664,946	N/A	N/A	28
C-19 Canal (3237E)	TN	78,114	N/A	N/A	48
C-19 Canal (3237E)	TP	5,167	N/A	N/A	48
C-19 Canal (3237E)	BOD	186,354	N/A	N/A	48
Lake Hicpochee (3237C)	TN	4,175,743	N/A	N/A	2
Lake Hicpochee (3237C)	TP	227,423	N/A	N/A	2
Lake Hicpochee (3237C)	BOD	5,768,701	N/A	N/A	3
Long Hammock Creek (3237B)	TN	330,381	N/A	N/A	42

WBID	Parameter	TMDL (maximum 7- year average load in lbs) ¹	WLA Wastewater (% reduction) ^{2, 3}	WLA NPDES Stormwater (% reduction) ^{2, 3}	LA (% reduction) ^{2, 3}
Long Hammock Creek (3237B)	TP	25,384	N/A	N/A	42
Long Hammock Creek (3237B)	BOD	773,946	N/A	N/A	42
Townsend Canal (3235L)	TN	300,564	N/A	37	37
Townsend Canal (3235L)	TP	28,749	N/A	38	38
Townsend Canal (3235L)	BOD	673,151	N/A	37	37

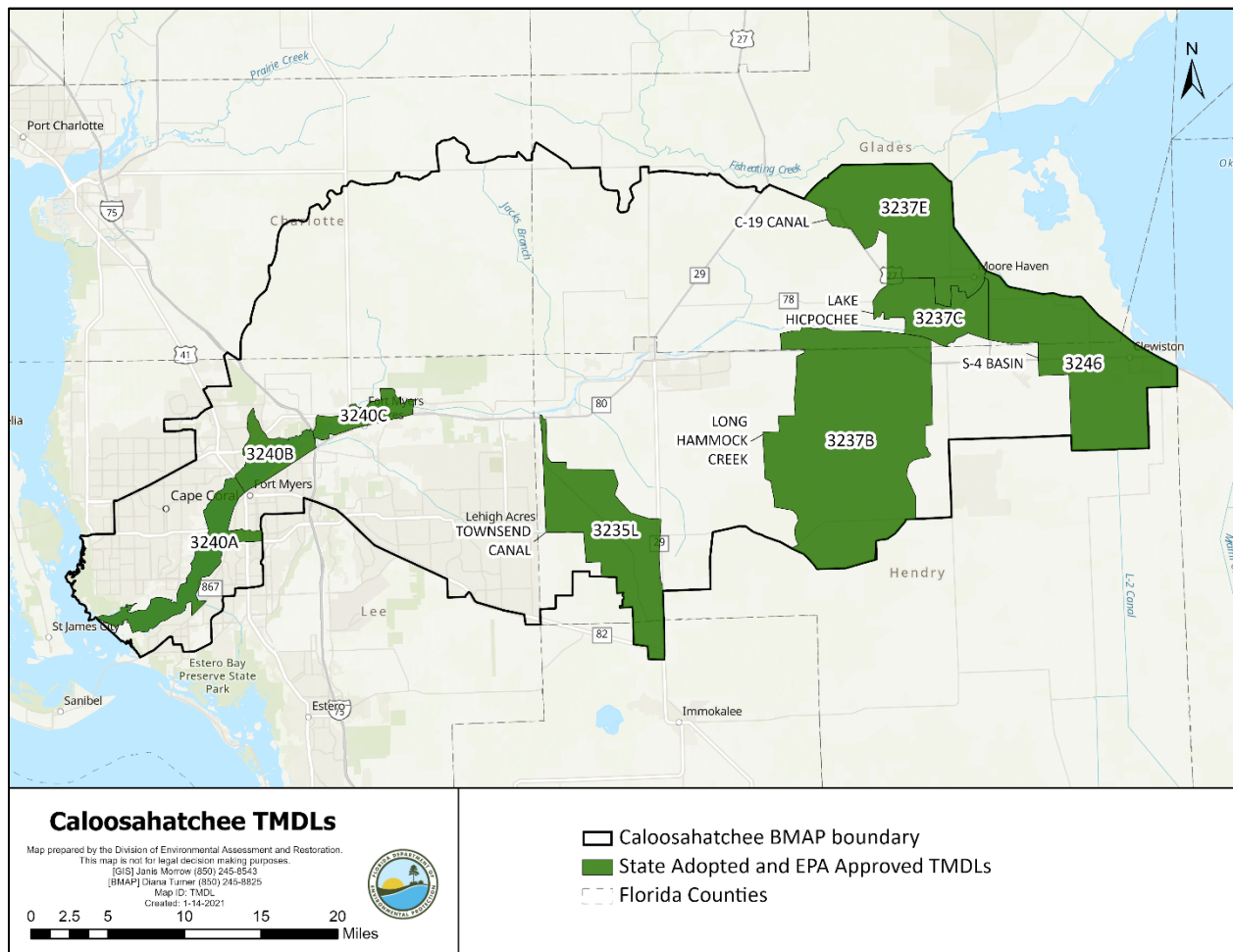


Figure 1. Caloosahatchee River Watershed TMDL WBIDs

1.2 Caloosahatchee River and Estuary BMAP

DEP implements TMDLs through permits and BMAPs; the latter contain strategies to reduce and prevent pollutant discharges through various cost-effective means. During the watershed restoration process, DEP and the affected stakeholders jointly develop BMAPs or other

implementation approaches. Stakeholder involvement is critical to the success of the watershed restoration program and varies with each phase of implementation to achieve different purposes. The BMAP development process is structured to achieve cooperation and consensus among a broad range of interested parties, including the South Florida Water Management District (SFWMD), Florida Department of Agriculture and Consumer Services (FDACS), and stakeholders representing other agencies, governments, and interested parties. The Florida Watershed Restoration Act, subparagraph 403.067(7)(a)1., Florida Statutes (F.S.), establishes an adaptive management process for BMAPs that continues until the TMDLs are met. This approach allows for incrementally reducing loads through the implementation of projects and programs, while simultaneously monitoring and conducting studies to better understand water quality dynamics (sources and response variables) in each impaired waterbody. The original Caloosahatchee River and Estuary BMAP was adopted in November 2012, and the first 5-Year Review was completed in November 2017. Section 373.4595, F.S., calls for a review of the BMAP to be completed and submitted to the Legislature and Governor every five years. This adaptive management process will continue until the TMDLs are met.

In January 2019, Executive Order 19-12, section 1,C included a requirement to update and secure all restoration plans, within one year, for waterbodies impacting south Florida communities, including the Caloosahatchee River and Estuary BMAP, which was then finalized in the January 2020 BMAP update. The BMAP update expanded the boundary to include all three subwatersheds, revised allocations and estimated reductions based on model updates, incorporated both the targeted restoration area (TRA) evaluation and basinwide sources approach, and set limitations to nutrient discharges from domestic wastewater treatment facilities (WWTFs), among other policy decisions. **Figure 2** shows the expanded Caloosahatchee River and Estuary BMAP area with the subwatershed divisions, and **Figure 3** shows the basins within the BMAP area.

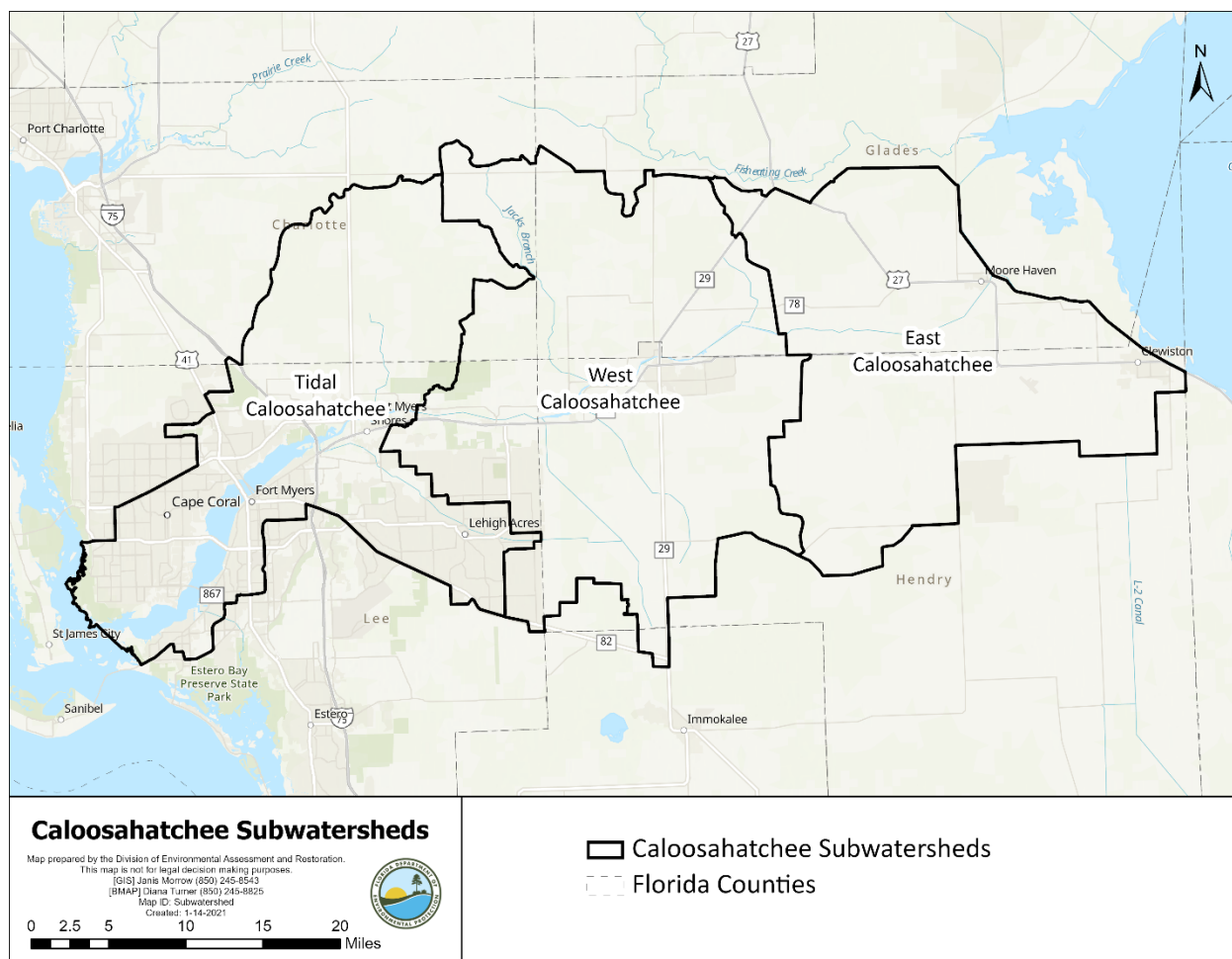


Figure 2. Subwatersheds within the Caloosahatchee River and Estuary BMAP

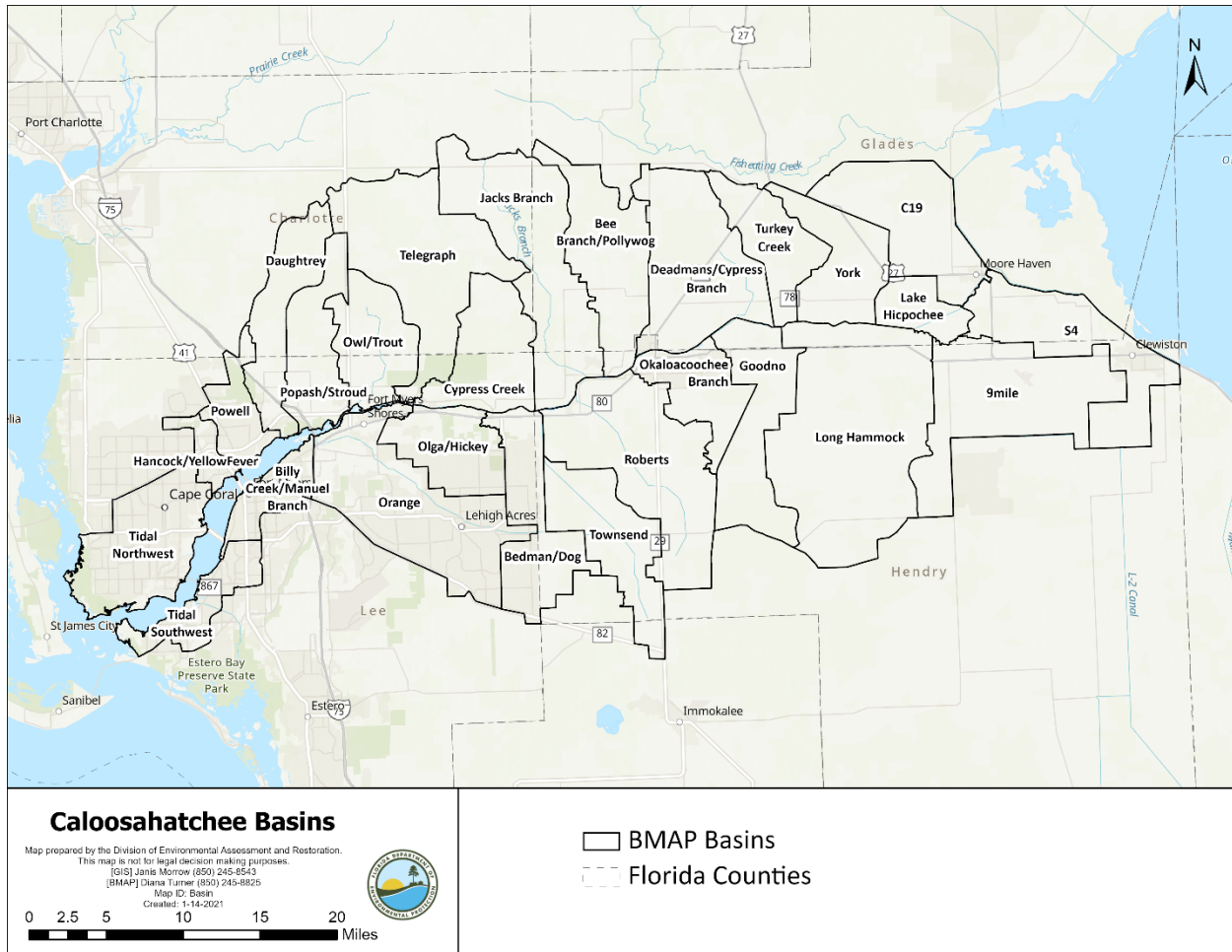


Figure 3. Basins within the Caloosahatchee River and Estuary BMAP

1.2.1 BMAP Pollutant Reductions and Discharge Allocations

As part of Executive Order 19-12, recommendations from the 2017 5-Year Review, and to incorporate the tributary TMDLs, the Caloosahatchee River and Estuary BMAP was updated in 2020. The BMAP update included revised reductions and allocations for the estuary TMDL and added allocations for the tributary TMDLs.

The allocations were calculated in a two-step process. The first step was to determine the existing or starting TN loads to the estuary (lbs/yr) for each entity within the entire watershed by following a series of geographic information system processing steps. The 23% required reduction in TN from the estuary TMDL was applied to the entire watershed load to determine the total TN required reduction of 910,676 lbs/yr. A portion of this reduction was assigned to each entity based on their percentage of the total starting load. For example, if an entity was 10% of the starting load, they received 10% of the TN required reductions for the estuary.

The second step in the process was to determine the existing or starting TN and TP loads for each entity in the tributaries with adopted TMDLs. For each tributary, the TMDL TN and TP percent required reductions were applied to the total starting load and the required load reduction

was assigned to each entity within that tributary based on their percentage of the starting load for that tributary. The required TN and TP reductions for each entity were added up to determine one overall TN and one overall TP required reduction for the tributaries. For the tributary entities, their TN allocations for the estuary and tributaries were compared to determine which reduction was higher, and therefore more protective. The higher reduction was assigned as their total TN required reduction. The other stakeholders all received their TN allocation based on the calculation for the estuary. In addition, for the tributary entities, the TP allocations calculated for the tributaries were assigned to them.

Table 4 and **Table 5** show the TN and TP load required reductions by entity, respectively.

Table 4. TN load required reductions by entity (lbs/yr)

Note: Grey highlighting and boldface type indicate jurisdictions meeting the classification requirements for low priority.

Entity	C-19 Canal	Lake Hicpochee	Long Hammock	S-4 Basin	Townsend Canal	Tributaries Total	Estuary	Assigned TN Reduction
Agriculture	27,737	490	177,197	36,459	93,544	335,426	707,723	707,723
Lee County	N/A	N/A	N/A	N/A	N/A	N/A	59,229	59,229
Lehigh Acres Municipal Services Improvement District (LA-MSID)	N/A	N/A	N/A	N/A	N/A	N/A	40,791	40,791
City of Cape Coral	N/A	N/A	N/A	N/A	N/A	N/A	38,965	38,965
City of Fort Myers	N/A	N/A	N/A	N/A	N/A	N/A	19,493	19,493
Hendry County/Port LaBelle Community Development District (CDD)	N/A	N/A	5,821	2,135	262	8,218	16,132	16,132
Florida Department of Transportation (FDOT)	282	1	223	230	318	1,054	6,358	6,358
Glades County	898	17	452	622	N/A	1,990	7,149	7,149
Charlotte County	N/A	N/A	N/A	N/A	N/A	N/A	5,816	5,816
City of LaBelle	N/A	N/A	N/A	N/A	N/A	N/A	2,950	2,950
River Hall CDD	N/A	N/A	N/A	N/A	N/A	N/A	1,676	1,676
City of Clewiston	N/A	N/A	N/A	1,955	N/A	1,955	1,630	1,955
Verandah West CDD	N/A	N/A	N/A	N/A	N/A	N/A	824	0
Verandah East CDD	N/A	N/A	N/A	N/A	N/A	N/A	533	0
City of Moore Haven	N/A	N/A	N/A	N/A	N/A	N/A	452	0
Moody River Estates CDD	N/A	N/A	N/A	N/A	N/A	N/A	424	0
Portico CDD	N/A	N/A	N/A	N/A	N/A	N/A	303	0

Entity	C-19 Canal	Lake Hicpochee	Long Hammock	S-4 Basin	Townsend Canal	Tributaries Total	Estuary	Assigned TN Reduction
Sail Harbour CDD	N/A	N/A	N/A	N/A	N/A	N/A	127	0
Lucaya CDD	N/A	N/A	N/A	N/A	N/A	N/A	88	0
Collier County	N/A	N/A	N/A	N/A	30	30	15	0
Total	28,917	508	183,6923	41,401	94,154	348,673	910,678	908,237

Table 5. TP load required reductions by entity (lbs/yr)

Note: Grey highlighting and boldface type indicate jurisdictions meeting the classification requirements for low priority.

Entity	C-19 Canal	Lake Hicpochee	Long Hammock	S-4 Basin	Townsend Canal	Total
Agriculture	1,276	25	11,106	1,782	8,623	22,811
FDOT	48.2	0	57	45	82	232
City of Clewiston	N/A	N/A	N/A	316	N/A	316
Glades County	133	2	51	199	N/A	386
Hendry County/Port LaBelle CDD	N/A	N/A	585	596	54	1,235
Collier County	N/A	N/A	N/A	N/A	6	0
Total	1,457	27	11,799	2,938	8,765	24,980

There are various sources of pollution in the Caloosahatchee River Watershed. Nonpoint (i.e., diffuse) sources in the watershed contribute the majority of TN and TP loads and include urban and agricultural stormwater runoff. The BMAP included an assessment of basinwide sources that also considers nutrient input from onsite sewage treatment disposal systems (OSTDS) and WWTFs. Recommendations to address these sources are discussed in Chapter 3.

Chapter 2. Assessing Progress

2.1 Projects to Achieve the TMDL

DEP annually reviews each entity's progress toward completing projects listed in the BMAP and achieving the assigned allocations based on the details described in the current TMDLs and BMAP. Detailed project information can be found in the Statewide Annual Report (STAR), published online (DEP 2021).

2.1.1 Estuary TMDL Projects

Table 6 outlines the number of projects that each entity has committed to in the BMAP and annual reports, along with the status of those projects as of December 31, 2021.

Table 6. Projects submitted to achieve the estuary TMDL

Entity	Completed and Ongoing	Planned	Underway	Total
Barron Water Control District (WCD)	2	3	0	5
Charlotte County	1	0	0	1
City of Cape Coral	17	1	1	19
City of Clewiston	5	0	1	6
City of Fort Myers	12	3	1	16
City of LaBelle	0	2	3	5
City of Moore Haven	1	1	0	2
Clewiston Drainage District	2	3	0	5
Collins Slough WCD	2	3	0	5
County Line Drainage District	4	0	1	5
Cow Slough WCD	2	3	0	5
Devil's Garden WCD	2	3	0	5
Disston Island Conservancy District	2	3	0	5
FDACS	6	0	0	6
FDOT District 1	28	0	3	31
Flaghole Drainage District	2	3	0	5
Gerber Groves WCD	2	3	0	5
Glades County	2	0	2	4
Hendry County	0	1	3	4
Hendry-Hilliard WCD	2	3	0	5
LA-MSID	15	1	2	18
Lee County	42	6	5	53
Lucaya CDD	2	0	0	2
Mirada CDD	2	0	0	2
Port LaBelle CDD	0	1	0	1
Portico CDD	4	0	0	4
Sugarland Drainage District	2	3	0	5
Verandah East CDD	1	0	0	1
Verandah West CDD	1	0	0	1
SFWMD - Coordinating Agency	2	4	1	7
Total	165	50	23	238

Table 7 summarizes the required reductions for each entity within the BMAP and the total reductions associated with projects completed by each entity as of December 31, 2021. **Figure 4** shows the progress made towards the TN reduction targets as of December 31, 2021.

Table 7. Reductions toward the TMDL

* Reductions to date include estimated TN reductions associated with projects completed and ongoing as of December 31, 2021.

Entity	TN Required Reduction (lbs/yr)	Estimated TN Reduction to Date* (lbs/yr)	% Toward Required Reduction
Agriculture	707,723	428,449	61
Lee County	59,229	147,314	249
LA-MSID	40,791	37,132	91
City of Cape Coral	38,965	81,015	208
City of Fort Myers	19,493	18,234	94
Hendry County/Port LaBelle CDD	16,132	0	0
FDOT	6,358	11,495	182
Glades County	7,149	1,564	26
Charlotte County	5,816	1,272	22
City of LaBelle	2,950	0	0
River Hall CDD	1,676	0	0
City of Clewiston	1,955	298	33
Verandah West CDD	0	180	N/A
Verandah East CDD	0	117	N/A
City of Moore Haven	0	175	N/A
Moody River Estates CDD	0	0	N/A
Portico CDD	0	66	N/A
Sail Harbour CDD	0	0	N/A
Lucaya CDD	0	4	N/A
Collier County	0	0	N/A
Total	908,237	727,315	80

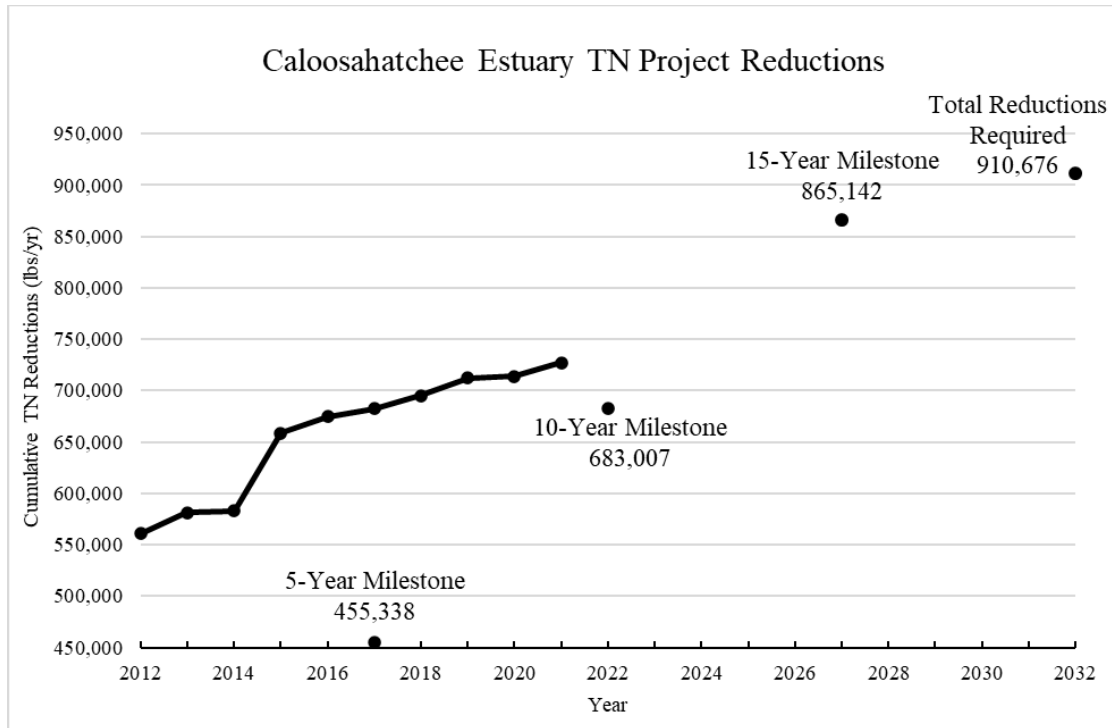


Figure 4. Progress towards Caloosahatchee Estuary TN reduction targets

2.1.2 Tributaries TMDL Projects

Table 8 outlines the number of projects that each entity has committed to in the BMAP and annual reports, along with the status of those projects as of December 31, 2021. **Table 9** summarizes the required reductions for each entity within the BMAP and the total reductions associated with projects completed by each entity as of December 31, 2021.

Table 8. Projects submitted to achieve the Tributary TMDLs

Entity	Completed and Ongoing	Planned	Underway	Total
Barron WCD	2	3	0	5
City of Clewiston	5	0	1	6
City of Moore Haven	1	1	0	2
Clewiston Drainage District	2	3	0	5
Collier County	0	0	0	0
Collins Slough WCD	2	3	0	5
Cow Slough WCD	2	3	0	5
Devil's Garden WCD	2	3	0	5
Disston Island Conservancy District	2	3	0	5
FDACS	10	0	0	10
FDOT District 1	1	0	1	2
Flaghole Drainage District	2	3	0	5
Glades County	5	0	2	7
Hendry County	0	0	0	0
Hendry-Hilliard WCD	2	3	0	5
Port LaBelle CDD	0	1	0	1
Sugarland Drainage District	2	3	0	5
SFWMD - Coordinating Agency	1	3	1	5
Total	41	32	5	78

Table 9. Reductions toward the TMDLs

* Reductions to date include estimated TN and TP reductions associated with projects completed and ongoing as of December 31, 2021.

Lead Entity	TN Required Reduction (lbs/yr)	TN Reductions (lbs/yr)	% Toward Required Reduction	TP Required Reduction (lbs/yr)	TP Reductions (lbs/yr)	% Toward Required Reduction
Barron WCD	0	TBD	N/A	0	TBD	N/A
City of Clewiston	1,955	385	20	316	105	33
City of Moore Haven	0	1,436	N/A	0	0	N/A
Clewiston Drainage District	0	TBD	N/A	0	TBD	N/A
Collier County	30	0	0	0	0	N/A
Collins Slough WCD	0	TBD	N/A	0	TBD	N/A
Cow Slough WCD	0	TBD	N/A	0	TBD	N/A
Devil's Garden WCD	0	TBD	N/A	0	TBD	N/A
Disston Island Conservancy District	0	TBD	N/A	0	TBD	N/A
FDACS	335,426	TBD	TBD	22,811	TBD	TBD
FDOT District 1	1,054	168	16	232	48	20
Flaghole Drainage District	0	TBD	N/A	0	TBD	N/A
Glades County	1,990	1,589	80	386	66	17
Hendry County	8,218	0	0	1,235	0	0
Hendry-Hilliard WCD	0	TBD	N/A	0	TBD	N/A
Port LaBelle CDD	0	TBD	N/A	0	TBD	N/A
SFWMD - Coordinating Agency	0	TBD	N/A	0	TBD	N/A
Sugarland Drainage District	0	TBD	N/A	0	TBD	N/A
Grand Total	348,673	3,578	1	24,980	219	0.8

2.2 Other Coordinating Agency Efforts

FDACS and SFWMD are coordinating with DEP to focus their efforts on achieving the TMDL and maintaining compliance with state water quality standards. These efforts are briefly summarized below.

2.2.1 Agriculture/FDACS' Office of Agricultural Water Policy

All agricultural nonpoint sources in the Caloosahatchee River and Estuary BMAP area are statutorily required either to implement FDACS-adopted best management practices (BMPs) or to conduct water quality monitoring prescribed by DEP or the applicable water management district. Under paragraph 403.067(7)(c), F.S., the implementation of FDACS-adopted, DEP-verified BMPs, in accordance with FDACS rules, provides a presumption of compliance with state water quality standards for the pollutants addressed by the BMPs.

The Florida Statewide Agricultural Irrigation Demand (Version Eight) (FSAID8) data set was used to identify the agricultural lands. As of December 31, 2021, 377,358 agricultural acres are enrolled in the BMP program, which is 85% of the total 444,635 agricultural acres within the Caloosahatchee River Watershed. The types of agriculture enrolled include Citrus, Cow/Calf, Dairy, Fruit/Nut, Nursery, Poultry, Row/Field Crop, and Sod. The acreages for the Conservation Plan are counted in the enrolled acres.

Beyond enrolling producers in the BMP program, FDACS is working with DEP to improve the data used to estimate agricultural lands. FDACS performs an "unenrolled agricultural lands" characterization analysis which provides an indication of areas that are more likely (or unlikely)

to have enrollable agricultural activities occurring on them. Of the remaining 67,277 acres categorized as agricultural land in FSAID8, 13,966 acres are unlikely enrollable due to entity ownership (e.g., not a commercial agricultural entity) or agricultural type (e.g., aquaculture or silviculture). An additional 16,568 acres are within state-owned properties and/or surface water project areas that are initially deemed low priority with the presumption that they are not agricultural lands. Using this adjusted agricultural acreage, 91% of agricultural acres within the Caloosahatchee River Watershed have been enrolled. FDACS will continue to characterize the land uses with agricultural production that are consistent with FDACS' BMP Program and provide this information to DEP.

As part of the implementation of the Clean Waterways Act, Chapter 2020-150, Laws of Florida, FDACS is required to undertake implementation verification site visits on properties enrolled in the BMP program at least every two years, and to review the required records that producers must maintain to demonstrate compliance with the BMPs. The addition of section 403.067(7)(d)3., F.S. also requires FDACS to retain records related to the application of nitrogen and phosphorus fertilizers by enrolled landowners and producers. FDACS has implemented the Nutrient Application Record Form to standardize and collect this information. The act further identifies the Caloosahatchee River and Estuary BMAP as one of the priority areas for FDACS to conduct implementation verification site visits.

FDACS' Office of Agricultural Water Policy is also working with producers to identify and implement a suite of agricultural projects and research agricultural technologies on properties where they are deemed technically feasible and where funding can be made available. The implementation of these projects would require funding as well as more detailed design based on site-specific information, such as applicable acreages and willing landowners. Since June 2017, FDACS has provided \$4,437,215 in cost-share assistance to enrolled producers in the Caloosahatchee River Watershed. A total of 173 projects were completed in areas of nutrient and irrigation management, and water resource protection.

Further details on these updates and BMP implementation and verification can be found in the FDACS report *Status of Implementation of Agricultural Nonpoint Source Best Management Practices* (FDACS 2022), which is available on the FDACS Office of Agricultural Water Policy's web page.

2.2.2 SFWMD

State-appropriated funds coupled with SFWMD resources were used to advance numerous restoration activities in the Caloosahatchee River Watershed during the BMAP reporting period. Regional projects with both water storage and water quality benefits progressed. Key highlights of SFWMD-led projects in the Caloosahatchee River Watershed through December 31, 2021, are summarized in **Table 10** and depicted in **Figure 5**.

Overall, Mudge Ranch Dispersed Water Management and Lake Hicpochee Hydrologic Enhancement (Phase I) projects were operational during the 2021 reporting period. Construction on the Comprehensive Everglades Restoration Plan Caloosahatchee River (C-43) West Basin

Storage Reservoir (C-43 Reservoir) continued and is planned to be completed in 2024. The C-43 Reservoir Water Quality Component, Lake Hicpochee Hydrologic Enhancement Expansion – Phase II, Boma Flow Equalization Basin, and C-43 Water Quality Treatment and Testing Facility – Phase II projects were under design. Further details on these projects can be found in Chapter 8D of the *Final 2022 South Florida Environmental Report – Volume I* (Taylor et al. 2022).

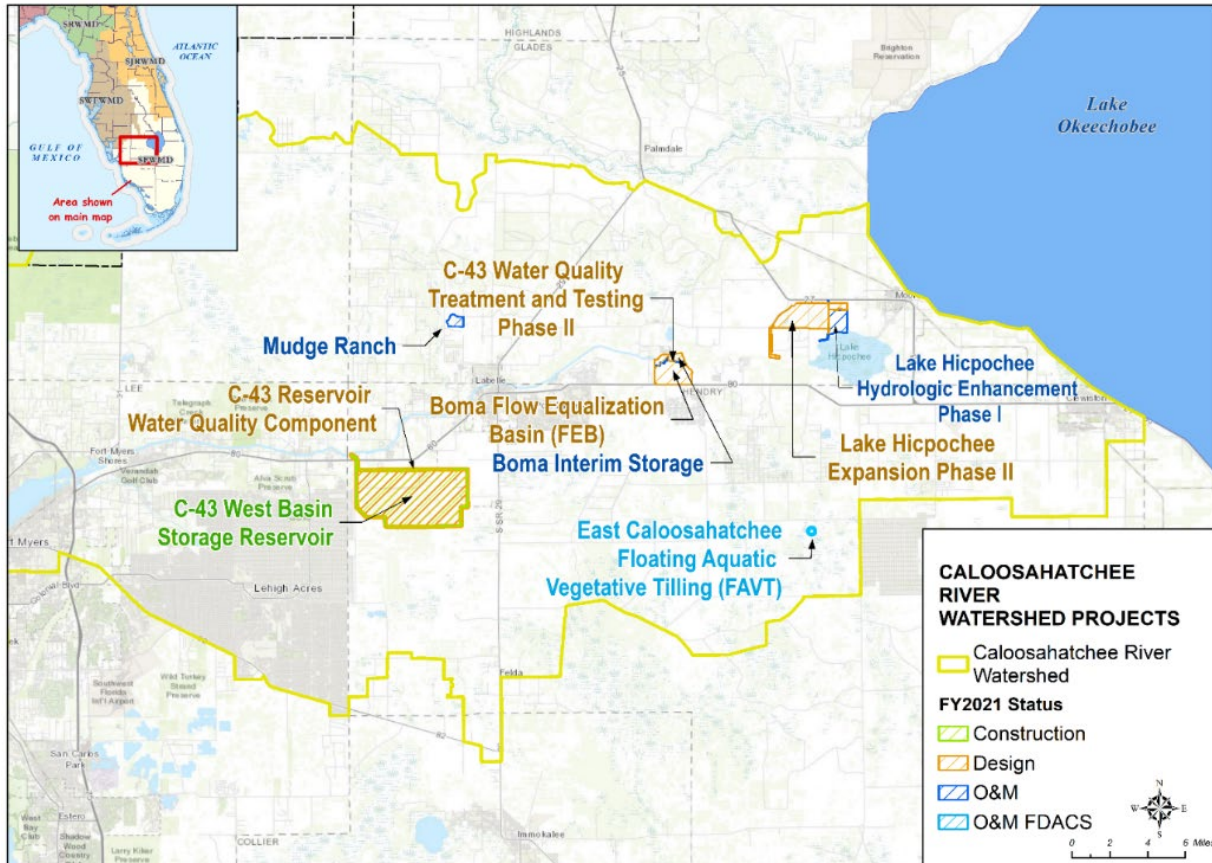


Figure 5. SFWMD-led projects in the Caloosahatchee River Watershed

Table 10. Current SFWMD-led projects in the Caloosahatchee River Watershed

Project Name	BMAP Project Number	Program Type	Project Type	Project Benefits	Project Area (acres)	Description	Basin	2021 Project Status	Construction Completion Date
C-43 West Basin Storage Reservoir	CA-01	District Lands	Hydrologic Restoration	Water Storage	10,700	Storage of 170,000 acre-feet of stormwater runoff and releases from Lake Okeechobee. It will reduce volume of lake discharges in wet season and provide freshwater flow to the estuary in dry season to aid in essential flows for more stable salinities.	West Caloosahatchee	Construction	2024
Lake Hicpochee Storage and Shallow Hydrologic Enhancement, Phase I	CA-02	District Lands	Hydrologic Restoration	Water Storage and Treatment	798	Provide shallow water storage, rehydrate a portion of lakebed to promote habitat restoration storage, and increase capacity for ancillary water quality benefit. Project will deliver excess stormwater runoff from C-19 canal to north end of lake as needed.	East Caloosahatchee	O&M	2019
Lake Hicpochee Storage and Shallow Hydrologic Enhancement Expansion, Phase II	CA-03	District Lands	Hydrologic Restoration	Water Storage and Treatment	2,494	Building on Phase I efforts, project will expand regional storage in the Caloosahatchee River Watershed and reduce flows lost to tide on over 2,600 acres of SFWMD lands.	East Caloosahatchee	Design	2025
Boma Flow Equalization Basin	CA-04	District Lands	Hydrologic Restoration	Water Storage	1,796	Expand regional storage in the Caloosahatchee River Watershed and reduce flows to the estuary on approximately 1,800 acres of SFWMD lands.	East Caloosahatchee	Design	2026
C-43 Water Quality Treatment and Testing Project (Phase II)	CA-05	District Lands	Study	Water Quality Research (Treatment)	80	Evaluate the effectiveness of wetland treatment systems in reducing nitrogen at a test-scale.	East Caloosahatchee	Design	2024

Project Name	BMAP Project Number	Program Type	Project Type	Project Benefits	Project Area (acres)	Description	Basin	2021 Project Status	Construction Completion Date
C-43 West Basin Storage Reservoir Water Quality Component	CA-06	District Lands	In Waterbody – Alum Injection System	Water Quality Treatment	To Be Determined	Construct and operate a water quality treatment component at the C-43 West Basin Storage Reservoir to reduce discharge of nutrients which may contribute to blue-green algal blooms.	West Caloosahatchee	Design	2023
Mudge Ranch	CA-07	Northern Everglades Payment for Environmental Services	Dispersed Water Management	Water Storage	304	Passive storage on a 304-acre project area, which has an estimated water storage benefit of 396 acre-feet/year.	West Caloosahatchee	Operations and Maintenance	2014

2.2.3 DEP

As part of the 2020 BMAP update, DEP implemented a basinwide sources approach. To support this approach, DEP has taken several actions to address the basinwide sources since the BMAP update was adopted.

The Clean Waterways Act, Chapter 2020-150, Laws of Florida, which was passed by the Florida Legislature in 2020, includes a requirement for local governments to develop master wastewater treatment feasibility analyses to address loads from existing and new septic systems. These plans are also required by the BMAP. DEP has been developing tools and templates to assist local governments in developing these plans, which will be incorporated into the next BMAP update (see **Section 3.4** for additional details).

The 2020 BMAP update also includes WWTF TN and TP effluent limits, based on the facility size and effluent discharge method. As the WWTF permits in the Caloosahatchee River Watershed come up for renewal, DEP is comparing the current effluent concentrations to the BMAP requirements. DEP is modifying the WWTF permits, as needed, during renewal to revise effluent limits to meet BMAP requirements.

To address stormwater sources, DEP and the water management districts initiated rulemaking as directed by Section 5 of the Clean Waterways Act, to update the stormwater design and operation regulations for environmental resource permitting. These rulemaking efforts are currently underway with proposed rule language modifications for several sections out for public review. Public workshops are ongoing. In addition, using the 2020 Census data, DEP is coordinating with EPA on whether additional local governments throughout the state meet the thresholds for a NPDES Municipal Separate storm sewer System (MS4). DEP is currently evaluating whether any potential new MS4 permittees will be designated. If any are identified in the Caloosahatchee River Watershed, those new MS4 permittees will be identified as part of the next BMAP update.

DEP also has several funding sources available to implement innovative technologies to help achieve nutrient load reduction goals. The Innovative Technologies Grant Program is available to local governments for projects that evaluate and implement innovative technologies and short-term solutions to combat algal blooms and nutrient enrichment, restore and preserve Florida waterbodies, and implement certain water quality treatment technologies. Eligible projects will prevent, mitigate, or clean-up harmful algal blooms, with an emphasis on projects that prevent blooms through nutrient reductions. Projects that improve the ability to predict and monitor harmful algal blooms are also considered for funding. In addition, the Resilient Florida Program includes a selection of grants that are available to counties, municipalities, water management districts, flood control districts, and regional resilience entities. The grants may be used to analyze and plan for vulnerabilities and implement projects for adaptation and mitigation to address the impacts of flooding and sea level rise that the state faces.

2.3 Water Quality Monitoring and Evaluation

The Caloosahatchee River and Estuary BMAP monitoring plan was designed to enhance the understanding of basin loads, identify areas with high nutrient concentrations, and track water quality trends. The information gathered through the monitoring plan measures progress toward achieving the TMDLs and provides a better understanding of watershed loading. The adopted BMAP monitoring plan consists of ambient water quality sampling, sampling at discharge structures, and flow monitoring. In addition, information on water quality throughout the watershed and within the estuary can be found in the latest South Florida Environmental Report, published annually by SFWMD.

2.3.1 Ambient Water Quality Monitoring

Focused objectives are critical for a monitoring strategy to provide the information needed to evaluate implementation success. The primary objective of the monitoring strategy for the Caloosahatchee River Watershed, described below, is to evaluate the success of the BMAP and provide information for potential future refinements.

Primary Objective

- To track trends in TN and TP loads and concentrations by subwatershed and basin.

Secondary Objective

- To better focus management efforts, measure the effectiveness of individual or collective projects.

To achieve these objectives, the monitoring strategy focuses on the following parameters:

- | | |
|---------------------------------|--------------------------------|
| • Alkalinity | • Nitrogen – Total Kjeldahl |
| • Ammonia as Nitrogen | • Nitrogen – Total |
| • BOD | • Orthophosphate as Phosphorus |
| • Carbon – Organic | • pH |
| • Carbon – Total | • Phosphorus – Total |
| • Chlorophyll <i>a</i> | • Specific Conductance |
| • Color | • Salinity |
| • DO | • Temperature, Water |
| • DO Saturation | • Total Suspended Solids |
| • Flow | • Turbidity |
| • Nitrate + Nitrite as Nitrogen | |

The stakeholders responsible for monitoring continue to sample their sites and uploaded the data to the Watershed Information Network (WIN) database.

2.3.2 Water Quality Evaluation

To help track implementation progress for the Caloosahatchee River and Watershed BMAP, a water quality evaluation was completed using data available as of May 31, 2022. Trend analyses were conducted as part of the 2017 5-Year Review and updated for this 2022 5-Year Review to track changes in nutrient concentrations in tributaries and in the impaired Caloosahatchee Estuary WBIDs. The results from the water quality trend analyses for Caloosahatchee River Watershed basins are described below. **Appendix A** describes the methods used to retrieve, process, and analyze the data.

2.3.2.1 Data Management and Processing

Data were collated from the previous 5-year trend analysis and new data retrieved from the WIN database. The analysis was conducted using five water years (WYs) of data from before BMAP adoption and ten WYs of data from after BMAP adoption, for a period of record (POR) extending from May 1, 2008, through April 30, 2022. The evaluation used data from the Tier 1 and Tier 2 BMAP monitoring stations. Concentrations, rather than nutrient loads, are analyzed as few locations have adequate flow data to calculate loads for a trend analysis. The TN analysis is comprised of 4,583 records, and the TP analysis is comprised of 5,076 records, an increase of 2,392 records and 3,471 records, respectively, from the previous 5-year trend analysis. Available data were used to calculate TN from its constituents (described in **Appendix A**), as necessary, where TN was not reported. Monthly medians were calculated for TN and TP where multiple, non-duplicated samples were reported in a month. The analysis used the Seasonal Kendall test, which is robust in respect to missing data; therefore, a 50% cut-off was used to select basins with adequate data for the trend analysis. The requirement for five years of continuous data was maintained from the 2017 5-Year Review to ensure a robust analysis, which limited which basins had sufficient data. However, increased monitoring is underway in the Roberts, Okalochochee Branch, Goodno, S4, and Nine Mile basins, and a trend analysis should be achievable in the next few years.

2.3.2.2 Statistical Analyses

Autocorrelation was tested using the '*acf*' function in R v.4.0.4 on monthly median values. Serial correlation was typically only found within the Tidal Caloosahatchee Subwatershed stations for TN and TP concentrations and was more frequently seen for TP samples (see **Table A-2** in **Appendix A**). Trends were analyzed using the U.S. Geological Survey (USGS) Seasonal Kendall formula, provided as a Window's executable program (Helsel et al. 2006). For basins with multiple stations, trends were also analyzed by station if the station followed the data requirements. Nineteen stations met the requirements, and results can be found in **Appendix A**.

2.3.2.3 Seasonal Kendall Trend Results for Basins

Of the 27 basins in the Caloosahatchee River Watershed, 9 basins do not have enough monitoring data to see trends for TN (**Table 11**) or TP (**Table 12**). These basins are within the East and West Caloosahatchee subwatersheds and show a combination of large data gaps and only 1–2 years of monitoring data.

Only one basin, Billy Creek/Manuel Branch, showed a significant decreasing trend in TN and TP concentrations. Orange, Bedman/Dog, and Cypress Creek basins showed a significant increasing trend for TN (**Table 11, Figure 6**), and Orange Basin showed a significant increasing trend for TP (**Table 12, Figure 7**).

Table 11. Results of the Seasonal Kendall test for TN

Note: Cells highlighted in grey and marked with a – indicate insufficient data. See **Appendix A** for details on data sufficiency requirements.

Subwatershed	Basin	Tau	Kendall S	Slope	p-value	Trend
East	C19	-	-	-	-	-
East	Lake Hicpochee	-	-	-	-	-
East	Long Hammock	-	-	-	-	-
East	Nine Mile	-	-	-	-	-
East	S4	-	-	-	-	-
East	Turkey Creek	-	-	-	-	-
East	York	-	-	-	-	-
Tidal	Billy Creek/Manuel Branch	-0.298	-322	-0.031	0.0349	Significant Decreasing Trend
Tidal	Daughtry	-0.172	-186	-0.018	0.1462	No Significant Trend
Tidal	Hancock/Yellow Fever	-0.023	-22	-0.002	0.8422	No Significant Trend
Tidal	Orange	0.449	123	0.039	<0.0001	Significant Increasing Trend
Tidal	Owl/Trout	-0.163	-165	-0.018	0.2381	No Significant Trend
Tidal	Popash/Stroud	-0.209	-225	-0.023	0.1357	No Significant Trend
Tidal	Powell	-0.177	-189	-0.018	0.1511	No Significant Trend
Tidal	Telegraph	0.139	82	0.014	0.0499	No Significant Trend
Tidal	Tidal Northwest	0.091	89	0.008	0.1339	No Significant Trend
Tidal	Tidal Southwest	0.069	70	0.007	0.2527	No Significant Trend
West	Bedman/ Dog	0.0243	73	0.029	0.0057	Significant Increasing Trend
West	Bee Branch/Pollywog	-0.161	-5	-0.021	0.5322	No Significant Trend
West	Cypress Creek	0.249	75	0.063	0.0045	Significant Increasing Trend
West	Deadmans/Cypress Branch	-	-	-	-	-
West	Goodno	-	-	-	-	-
West	Jacks Branch	-	-	-	-	-
West	Okalochoochee Branch	-	-	-	-	-
West	Olga/Hickney	0.12	36	0.014	0.1789	No Significant Trend
West	Roberts	-	-	-	-	-
West	Townsend	-	-	-	-	-

Table 12. Results of the Seasonal Kendall test for TP

Note: Cells highlighted in grey and marked with a – indicate insufficient data. See **Appendix A** for details on data sufficiency requirements.

Subwatershed	Basin	Tau	Kendall S	Slope	p-value	Trend
East	C19	-	-	-	-	-
East	Lake Hicpochee	-	-	-	-	-
East	Long Hammock	-	-	-	-	-
East	Nine Mile	-	-	-	-	-
East	S4	0.319	51	0.006	0.0677	No Significant Trend
East	Turkey Creek	-	-	-	-	-
East	York	-	-	-	-	-

Subwatershed	Basin	Tau	Kendall S	Slope	p-value	Trend
Tidal	Billy Creek/Manuel Branch	-0.267	-292	-0.008	0.014	Significant Decreasing Trend
Tidal	Daughtry	0.006	7	0.000	0.9586	No Significant Trend
Tidal	Hancock/Yellow Fever	0.135	13	0.002	0.1051	No Significant Trend
Tidal	Orange	0.432	180	0.003	0.0216	Significant Increasing Trend
Tidal	Owl/Trout	0.047	48	0.000	0.4382	No Significant Trend
Tidal	Popash/Stroud	-0.059	-60	-0.001	0.5623	No Significant Trend
Tidal	Powell	-0.147	-155	-0.003	0.2015	No Significant Trend
Tidal	Telegraph	0.15	96	0.001	0.172	No Significant Trend
Tidal	Tidal Northwest	0.129	13	0.000	0.3076	No Significant Trend
Tidal	Tidal Southwest	0.117	122	0.001	0.2512	No Significant Trend
West	Bedman/Dog	0.121	43	0.001	0.1498	No Significant Trend
West	Bee Branch/Pollywog	0.032	1	0.001	1	No Significant Trend
West	Cypress Creek	0.108	43	0.001	0.1824	No Significant Trend
West	Deadmans/Cypress Branch	-	-	-	-	-
West	Goodno	-	-	-	-	-
West	Jacks Branch	-	-	-	-	-
West	Okalocoochee Branch	-	-	-	-	-
West	Olga/Hickney	0.07	28	0.001	0.3905	No Significant Trend
West	Roberts	-	-	-	-	-
West	Townsend	-	-	-	-	-

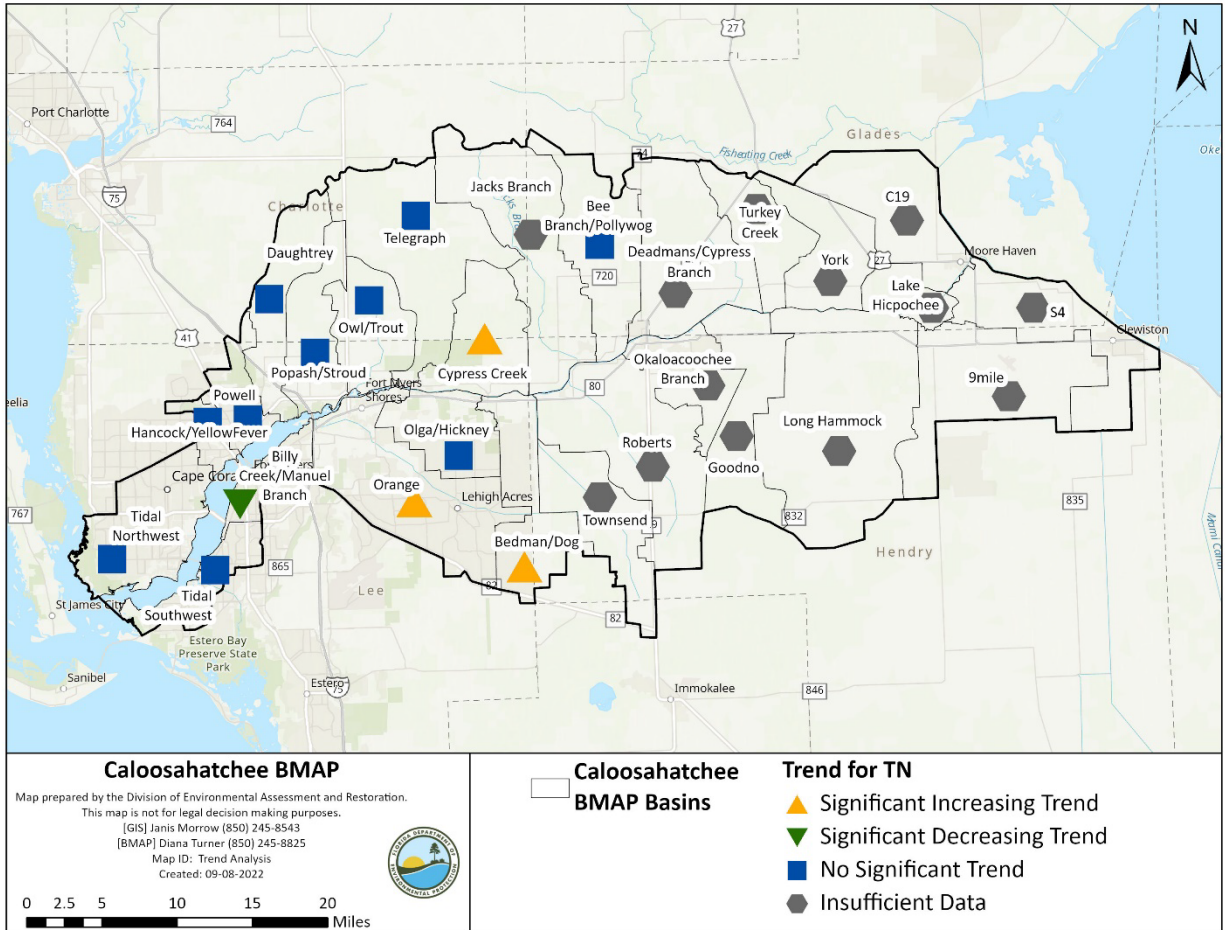


Figure 6. Map of Seasonal Kendall test for TN

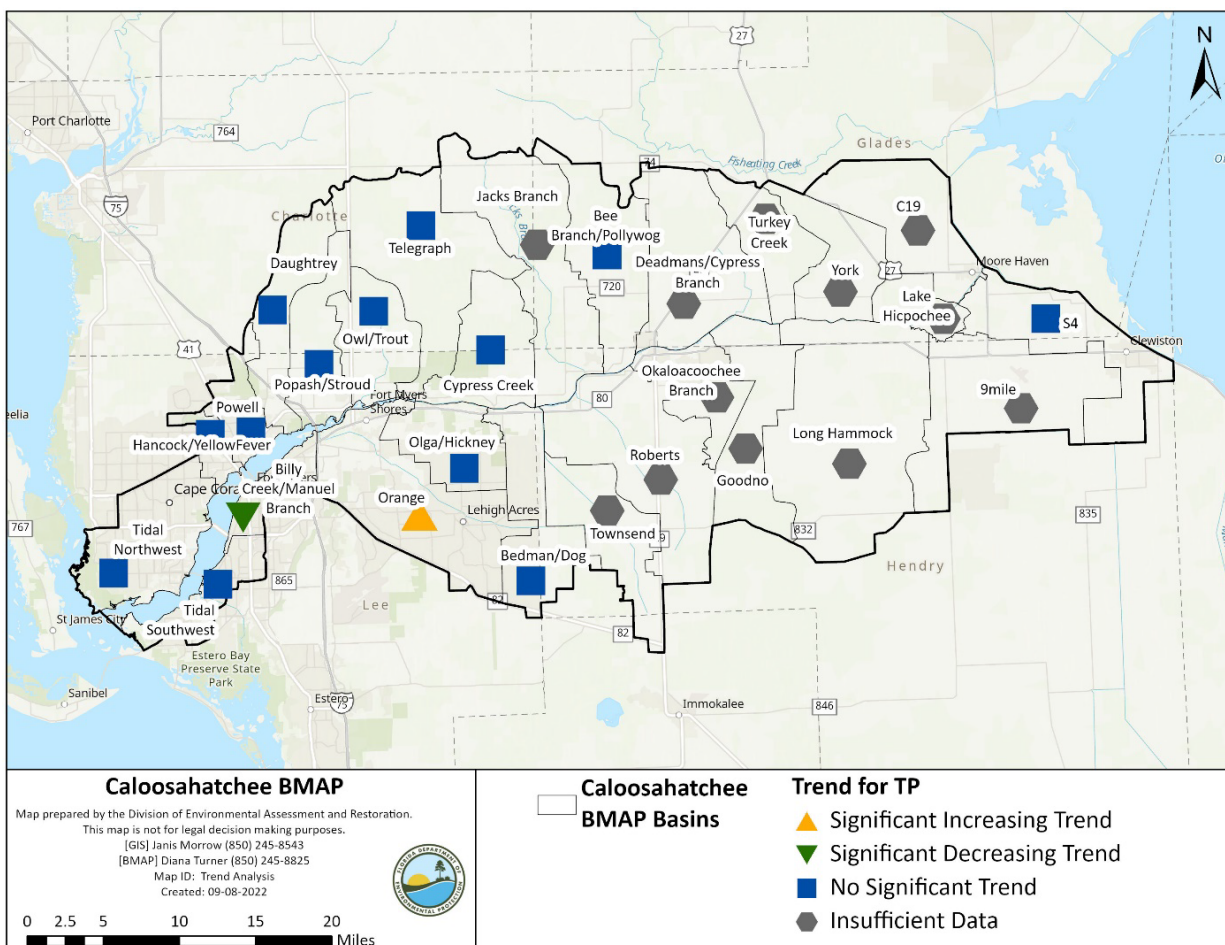


Figure 7. Map of Seasonal Kendall test for TP

2.4 TRA Approach

To better prioritize and focus resources to achieve restoration most efficiently in the Caloosahatchee River Watershed, DEP developed the TRA approach, which is described in full in the 2020 BMAP document (DEP 2020). This approach uses measured data collected throughout the watershed to evaluate TN and TP concentrations in each of the subwatersheds and associated basins. In conjunction with concentration, the approach looks at flows, past trends, and unit area loading targets across the watershed to prioritize where resources are most needed. Priorities were set with 1 as the highest priority, 2 the next highest priority, and 3 a priority as resources allow. The TRA allows for DEP and stakeholders to prioritize water quality restoration projects based on areas that show the greatest need from monitoring data. **Table 13** provides the TRA evaluation results based on data from WY2017 through WY2021.

Table 13. TRA evaluation results for Caloosahatchee River Watershed basins

Note: The numbers highlighted in green and marked with an * have moved down in priority since the BMAP update. The numbers highlighted in orange and marked with an ** increased in priority since the BMAP update.

*Denotes basins which are missing information due to lacking monitoring, rather than basins recently added to monitoring

Subwatershed	Basin	Station	TN Priority	TP Priority
East	Nine Mile	G3SD0088	Insufficient Data	Insufficient Data
East	C-19	C19	Insufficient Data	Insufficient Data
East	Lake Hicpochee	N/A	Insufficient Data	Insufficient Data
East	Long Hammock	N/A	Insufficient Data	Insufficient Data
East	S-4	S235	Insufficient Data	Insufficient Data
East	Turkey Creek	N/A	Insufficient Data ⁺	Insufficient Data ⁺
East	York	N/A	Insufficient Data	Insufficient Data
Tidal	Billy Creek/Manuel Branch	CFMFSP/ CFMMANUEL	2	2*
Tidal	Daughtry	20-9GR	3	3
Tidal	Hancock/Yellow Fever	16-3GR	2	2
Tidal	Orange	G3SD0128	Insufficient Data	Insufficient Data
Tidal	Owl/Trout	27-6GR/27O-GR20	3	3
Tidal	Popash/Stroud	23-5GR/24-7GR	2	3
Tidal	Powell	POWLGR20	3	2
Tidal	Telegraph	G3SD0129	Insufficient Data	Insufficient Data
Tidal	Tidal Northwest	300/400/470/540/ 590/600	2	Insufficient Data
Tidal	Tidal Southwest	WHISGR18	2	2
West	Bedman/Dog	37-4GR	2**	3
West	Bee Branch/Pollywog	G3SD0085	Insufficient Data	Insufficient Data
West	Cypress Creek	CYPRESSGR/ FICHTERSGR/ SPANISHGR	1	3
West	Deadmans/Cypress Branch	N/A	Insufficient Data ⁺	Insufficient Data ⁺
West	Goodno	CRFW06/CRFW07	Insufficient Data	Insufficient Data
West	Jacks Branch	CRFW23	Insufficient Data	Insufficient Data
West	Okalocoochee Branch	CRFW09	Insufficient Data	Insufficient Data
West	Olga/Hickey	38-3GR	2	3
West	Roberts	G3SD0146	Insufficient Data	Insufficient Data
West	Townsend	WQ SITE 15	2	Insufficient Data

For TN, most basins with sufficient data to assign a priority level are above the benchmark TN concentration of 1.54 milligrams per liter (mg/L), but not more than twice that level (priority 2). Cypress Creek is the only basin with a TN concentration greater than 3.08 mg/L (priority 1). Bedman/Dog basin has moved up from priority 3 to priority 2. For TP, no basin is more than twice the benchmark concentration of 0.12 mg/L, and Billy Creek/Manuel Branch basin showed improved TP concentrations and has moved down to priority 2.

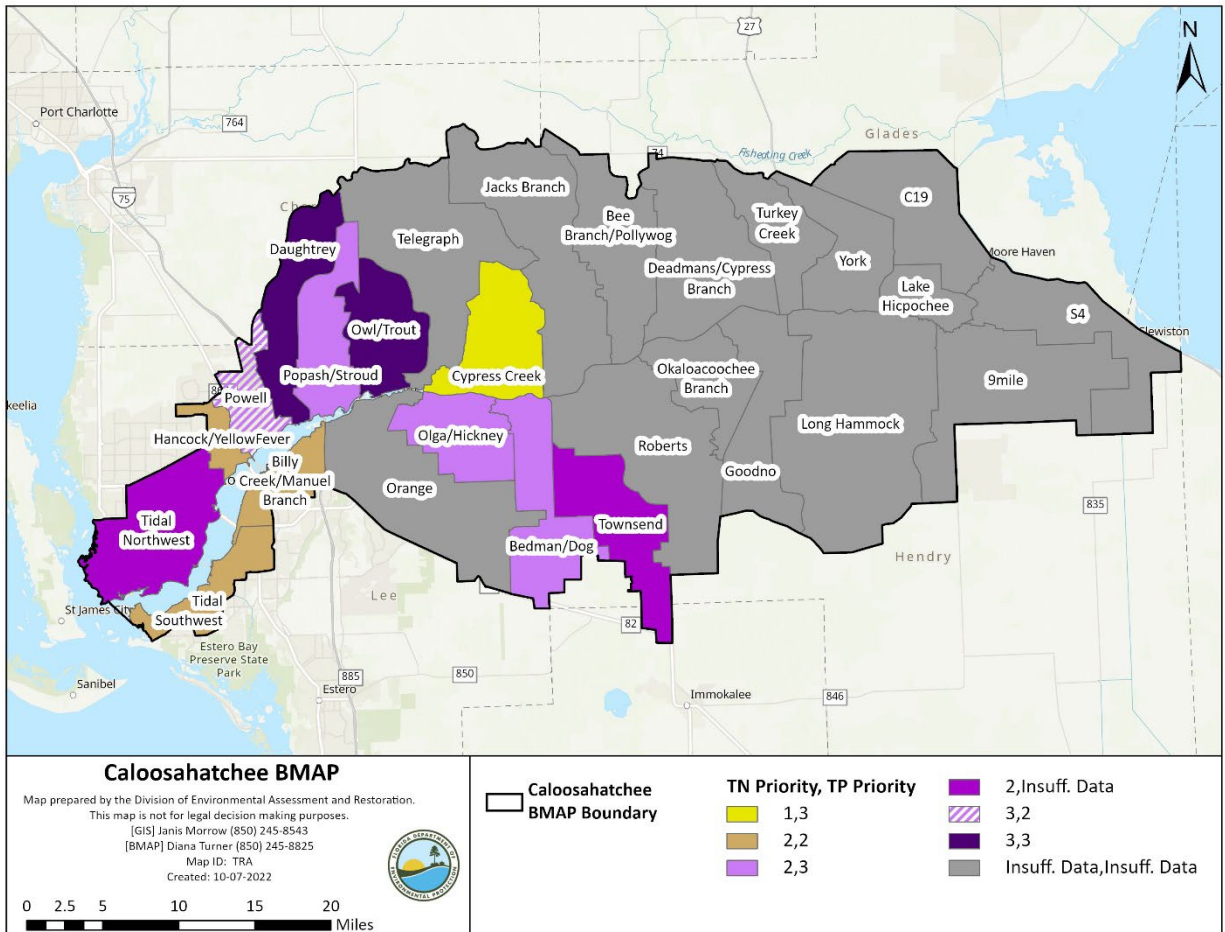


Figure 8. TRA designations for the Caloosahatchee River Watershed basins

Basins that have had significant investment in projects but still do not show changes in water quality may require further investigation into more appropriate project types to support reductions in nutrient pollution in the Caloosahatchee.

Basins with insufficient data to determine a priority level typically have monitoring, but the data do not cover the entire 5-year period. These basins have newer stations that were added in 2018 or 2020 in response to recommendations from the previous water quality trend evaluation and BMAP update, and priority levels will be assigned as more data are collected. Two basins do not have a representative water quality monitoring site: Turkey Creek and Deadmans/Cypress Branch. The Coordinating Agencies are working to identify representative monitoring locations in these basins (see **Section 3.2** for more information).

Chapter 3. Recommendations

The BMAP implements phased TN and TP reductions according to section 403.067(7)(a)1., F.S. The purpose of this 2022 5-Year Review is to evaluate implementation activities that have taken place during the first and second 5-year phases. The recommendations included here are for future implementation activities that may be incorporated into a revised BMAP and adopted by Secretarial Order.

The first and second BMAP phases included significant restoration efforts by stakeholders, and the implementation process will continue to help meet the TMDLs. The projects and other activities, collected through stakeholder participation, are estimated to achieve TN reductions to the estuary of 727,315 lbs/yr (or 80%) by the end of the 10-year phase, a significant portion of those reductions coming from the tidal basins. Projects to reduce TN and TP in the tributaries shows a range of progress within a basin depending on starting loads but, overall, only 1% of required TN reductions and 0.8% of required TP reductions have been attained for the tributaries. Further details on BMAP projects can be found in the online STAR (DEP 2021).

Recommendations for consideration in the next BMAP update are summarized in the sections below.

3.1 Milestones

As part of the 2017 5-Year Review, milestones with percent reduction goals were established as follows:

- 5-year milestone (Years 1 to 5): 50%
- 10-year milestone (Years 6 to 10): 75%
- 15-year milestone (Years 11 to 15): 95%
- 20-year milestone (Years 16 to 20): 100%

Current projects associated with the Caloosahatchee River Watershed have resulted in 727,315 lbs/yr of reductions in TN in the estuary, bringing the BMAP to the 80% reduction set by the 10-year milestone. Approximately 57% of the reductions come from agricultural BMP enrollment, 28% come from stormwater treatment projects and education efforts, 10% come from wastewater treatment projects (which are predominantly OSTDS phase out projects), and 5% come from land use changes. However, recent loading calculations (Taylor et al. 2022) show the 5-year average TN load to be 5,166,700 lbs/yr, an increase of 1,207,239 lbs/yr from the original BMAP starting load (3,959,461 lbs/yr), nearly a 77% increase in the required reductions for the Caloosahatchee River Watershed. As monitoring data are collected, that information can be incorporated into the required reductions for the Caloosahatchee River and Estuary BMAP as it is updated.

Considering the increased loading shown by monitoring data, and the recent increase in the size of the Caloosahatchee River and Estuary BMAP, it is unlikely that currently underway and planned projects will be enough to meet the 20-year milestone for the Caloosahatchee River Watershed. The two newest subwatersheds predominantly include agricultural land use, and 71% of the TN loading, based on calculations in the BMAP, comes from agricultural sources. To reduce TN, as well as TP tracked by the tributary TMDLs, large regional-scale projects will be necessary along with additional measures such as cost-share and innovative technologies, in addition to ongoing agricultural BMP enrollment in the East and West Caloosahatchee subwatersheds. Past studies by SFWMD have found that the Caloosahatchee River water is chemically unique compared to other areas in the state; therefore, time to implement pilot projects on any treatment technologies new to this watershed will be required. In contrast, the long-standing pollutant criteria implemented for the Tidal Caloosahatchee Subwatershed have led to significant progress towards TN reductions by stakeholders.

Due to water quality trend results, credits for projects such as fertilizer ordinances and education efforts may need to be reevaluated in future BMAP updates, particularly with respect to enforcement of fertilizer ordinances.

DEP continues to work with the coordinating agencies and other stakeholders to identify needed projects and prioritize projects based on results from the TRA and trend analysis. DEP will incorporate updated measured loading data into the required reductions and the current milestones during the next BMAP update.

3.2 Water Quality Monitoring

Recommendations for improving monitoring in the Caloosahatchee River Watershed made in the previous 5-Year Review and 2020 BMAP update have generally been implemented, with regular samples occurring at three of the newest SFWMD sites (32272/CRFW06, 32273/CRFW07, and 32275/CRFW09), and three of the newest DEP sites (G3SD0085, G3SD0088, and G3SD0146). This additional monitoring is providing critical data to better understand the Caloosahatchee River Watershed basins. The monitoring stations included in the BMAP network should continue to be sampled at the frequency and for the parameters noted in the BMAP update.

Several stations have had infrequent samples including G3SD0087 (Lake Hicpochee), WQ SITE 15 (Townsend), 32289/CRFW23 (Jacks Branch), 32271/CRFW05 (Long Hammock), and 32296/CRFW30 (York). Very few samples were lost from these sites due to quality assurance/quality control removal, so more information is needed as to why samples are not being collected at least monthly. Potential issues may include changes in flow, access, or scheduling problems. DEP is working with stakeholders to ensure that sufficient data may be collected at these locations to help track trends and identify areas for projects.

Representative sampling sites are needed for Deadmans/Cypress Branch and Turkey Creek basins. The desired representative station for Deadmans is 53174, but this is station was a one-time location for the DEP Watershed Monitoring Section. The DEP South Regional Operation Center also took one sample at site G3SD0178, which is close to the preferred location. SFWMD

is reviewing potential locations in these basins to evaluate access and will provide DEP with estimates of the resources needed to collect additional samples.

3.3 Compliance

The attainment of the estuary TN TMDL will be calculated based on a 5-year rolling average using information from SFWMD's South Florida Environmental Report. Attainment of the S-4 Basin, C-19 Canal, Lake Hicpochee, Long Hammock Creek, and Townsend Canal TN and TP TMDLs will be calculated based on a 5-year rolling average load, also using information from SFWMD's South Florida Environmental Report. Using a 5-year rolling average for the Caloosahatchee River and Estuary BMAP applies a consistent compliance approach to the three Northern Everglades BMAPs, which also include Lake Okeechobee and St. Lucie River and Estuary. A 7-year rolling average for the impaired tributaries will also be monitored to be consistent with how those TMDLs were developed.

Compliance for the BMAP is recommended to be based on the allowable loads calculated in the BMAP update, rather than a percent reduction, as loading estimates are likely to change over time with changes in land use and project implementation. The allowable loads in the BMAP were calculated by applying the percent reduction from the estuary TMDL and each tributary TMDL to the BMAP modeled starting loading in each area to determine the required TN and TP load reductions. The required load reduction was subtracted from the modeled TN and TP starting loads to determine the allowable loading for the estuary and tributaries. This allowable load is recommended to be set as the compliance load. For the estuary TMDLs, the assumption is that achieving the TN and TP loading would also achieve the BOD TMDL requirements.

Compliance loads would be as follows:

- Caloosahatchee estuary — 3,048,783 lbs/yr of TN.
- C-19 Canal — 31,327 lbs/yr of TN and 1,579 lbs/yr of TP.
- Lake Hicpochee — of 24,929 lbs/yr of TN and 1,348 lbs/yr of TP.
- Long Hammock — of 253,673 lbs/yr of TN and 16,295 lbs/yr of TP.
- S-4 — 111,935 lbs/yr of TN and 7,555 lbs/yr of TP.
- Townsend Canal — 160,314 lbs/yr of TN and 14,300 lbs/yr of TP.

Recent loading calculations for the Caloosahatchee River Watershed (Taylor et al. 2022) have shown the 5-year average TN load to be 5,166,700 lbs/yr, an increase of 1,207,239 lbs/yr from the original starting load (3,959,461 lbs/yr). DEP will take the most updated loading calculations into account and update allocations as needed with the next BMAP update.

3.4 Wastewater and OSTDS Plans

Subparagraph 403.067(7)(a)9, F.S., states that in BMAP watersheds with at least 20% of the nutrient loading from WWTF or OSTDS, local governments must develop a plan to address any necessary construction, expansion, or upgrades to address these sources. The plans are to be developed with cooperation from DEP, water management districts, and adjacent stakeholders. The plan must name responsible parties and include permitted capacity, average nutrient load, a projected timeline for improvements, and a projected cost for improvements. These plans must be incorporated into the revised BMAP no later than July 1, 2025. DEP has begun to provide information and resources to local governments to help them in preparing these plans.

DEP recommends including a new OSTDS requirement in the next BMAP update that prohibits new conventional systems on lots of one acre or less within the BMAP area unless certain other requirements are met. DEP will work with stakeholders on refining OSTDS requirements in BMAP areas.

3.5 Environmental Justice

EPA began collecting information on potentially disproportionate environmental impacts on "populations identified by race, national origin, or income" (Executive Order 12898) in 1994 and has developed several mapping tools in that time. Starting in 2010, EPA developed the EJScreen tool to provide data relating to Environmental Justice (EJ) concerns to the public. This tool was released in 2015 and is updated each year as data become available.

EJScreen compares demographic data from census blocks, including percent people of color, percent low income, percent linguistic isolation, and others. These values can then be compared to environmental indicators including community proximity to wastewater discharge or hazardous waste facilities. More information on all the indices provided by EPA can be found on their website. To further understand where communities in the Caloosahatchee River Watershed could be better served, data from the EJScreen at the state level (e.g., percentiles are calculated between state census blocks) was compared to where BMAP projects have been developed to highlight any gaps that may exist and how they relate to EJ.

Currently, relationships between BMAP projects and vulnerable communities are difficult to define as information on cost, acres treated, and/or pollution reduction is missing from many completed and ongoing projects. Without these data, it is difficult to estimate any trends in project efficacy or effort within possible EJ communities. However, the State of Florida under the Rural Economic Development Initiative (section 288.0656) considers funding and other resources needed by rural and economically distressed areas. DEP will continue to evaluate opportunities to incorporate EJ into BMAP processes.

Chapter 4. References

- Florida Department of Agriculture and Consumer Services (FDACS). 2022. *Status of Implementation of Agricultural Nonpoint Source Best Management Practices*. Tallahassee, FL: Office of Agricultural Water Policy. FDACS-P-01924 Rev. 07/22.
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- Florida Department of Environmental Protection (DEP). 2009. TMDL report. *Nutrient TMDL for the Caloosahatchee Estuary*. Tallahassee, FL: Division of Water Resource Management, Bureau of Watershed Management.
- Florida Department of Environmental Protection (DEP). 2019. TMDL report. *Dissolved Oxygen TMDLs for the S-4 Basin, C-19 Canal, Lake Hicpochee, Long Hammock Creek, and Townsend Canal (WBIDs 3246, 3237E, 3237C, 3237B, and 3235L)*. Tallahassee, FL: Division of Environmental Assessment and Restoration.
- Florida Department of Environmental Protection (DEP). 2020. *Caloosahatchee River and Estuary Basin Management Action Plan*. Tallahassee, FL: Division of Environmental Assessment and Restoration.
- Florida Department of Environmental Protection (DEP). 2021. *2021 Statewide Annual Report on Total Maximum Daily Loads, Basin Management Action Plans, Minimum Flows or Minimum Water Levels, and Recovery or Prevention Strategies*. Tallahassee, FL: Division of Environmental Assessment and Restoration.
- Helsel, D.R., D.K. Mueller, and J.R. Slack. 2006. *Computer program for the Kendall family of trend tests*. U.S. Geological Survey Scientific Investigations Report 2005–5275.
- Taylor, D., M. Parker, and J. Bobsein. 2022. Chapter 8D: Caloosahatchee River Watershed Protection Plan Annual Progress Report. In: *Final 2022 South Florida Environmental Report – Volume I*, South Florida Water Management District, West Palm Beach, FL.

Appendices

Appendix A. Water Quality Data Processing and Analysis Methods

For this 2022 5-Year Review, trend analyses were conducted on available data from Tier 1 and Tier 2 stations in the Caloosahatchee River and Estuary BMAP network from an overall POR of May 1, 2008, to April 30, 2022 (five years before BMAP adoption through the first ten years of BMAP implementation). WIN data for nutrient concentrations were processed using the methods described below, and only data that meet quality control objectives were used in the analyses. Nonparametric statistical techniques were used to identify monotonic trend analyses in a statistically rigorous way with the Seasonal Kendall trend test. Data are not required to conform to a particular distribution for nonparametric analyses. Nonparametric tests are also robust against outliers and large data gaps. **Section 2.3** in the main report summarizes the analyses and results; additional details on the methods are provided below.

Data Download

- Stations used for each basin to collect TN and TP data from WIN and the 2017 5-Year Review are summarized in **Table A-1**.

Table A-1. List of stations selected for processing

Subwatershed	Basin	WIN Station (Other Name)
East Caloosahatchee	C19	17971 (S47D)
East Caloosahatchee	Lake Hicpochee	G3SD0087
East Caloosahatchee	Long Hammock	32271 (CRFW05)
East Caloosahatchee	Nine Mile	G3SD0088
East Caloosahatchee	S4	17545 (S235)
East Caloosahatchee	Turkey Creek	N/A
East Caloosahatchee	York	32296 (CRFW30)
Tidal Caloosahatchee	Billy Creek/Manuel Branch	BILLGR20; CFMFSP; CFMMANUEL
Tidal Caloosahatchee	Daughtry	20-9GR; CALUSA0054FTM; GATRGR91
Tidal Caloosahatchee	Hancock/Yellow Fever	16-3GR; CALUSA0025FTM; G3SD0130
Tidal Caloosahatchee	Orange	40-18GR; 40-32GR; G3SD0128
Tidal Caloosahatchee	Owl/Trout	27-6GR; 27O-GR20
Tidal Caloosahatchee	Popash/Stroud	22-7GR; 23-27GR; 23-5GR; 24-19GR; 24-7GR; 25GR20
Tidal Caloosahatchee	Powell	18-6GR; POWLGR20; POWLGR81
Tidal Caloosahatchee	Telegraph	29-8GR; CALUSA0024FTM; G3SD0129
Tidal Caloosahatchee	Tidal Northwest	300; 400; 470; 540; 590; 600
Tidal Caloosahatchee	Tidal Southwest	DEEPGR10; WHISGR18; WHISGR50
West Caloosahatchee	Bedman/Dog	37-4GR
West Caloosahatchee	Bee Branch Pollywog	G3SD0085
West Caloosahatchee	Cypress Creek	CYPRESSGR; FICHTERSGR; SPANISHGR
West Caloosahatchee	Deadmans Cypress Branch	53174; 53183
West Caloosahatchee	Goodno	32272 (CRFW06); 32273 (CRFW07)
West Caloosahatchee	Jacks Branch	32289 (CRFW23)
West Caloosahatchee	Okalocoochee Branch	32275 (CRFW09)
West Caloosahatchee	Olga/Hickney	38-3GR
West Caloosahatchee	Roberts	G3SD0146
West Caloosahatchee	Townsend	WQ SITE 15

- Station concentration data were retrieved from WIN for the designated POR of May 1, 2008, through April 30, 2022, for Tier 1 and 2 basin stations.

Data Processing (in order of operation)

- Nutrient Characteristic Selection:
 - TP: Phosphorus.
 - TN: TN or Total Kjeldahl Nitrogen + (Nitrate + Nitrite), whichever was available.
- Sample Depth:
 - Samples were not filtered by sample depth as only surface water samples were used in this analysis.
- Data Qualifiers:
 - Data with result qualifiers of "A," "F," "G," "H," "K," "L," "N," "O," "T," "V," "Y," or "?" were not used in the analysis, as per Table 1, Data Qualifier Codes, in Rule 62-160.700, F.A.C., Quality Assurance.
 - Data with a result qualifier of "I" were only used if a corresponding minimum detection level (MDL) was listed:
 - Data with qualifier of "I" with corresponding comment "*Present<QL" were not used in the analysis.
 - Data with a result qualifier of "U" were reviewed:
 - If not already present, a result qualifier of "U" was assigned to any data with a result value of "*Non-Detect."
 - Data with a result value of "*Not Reported" were deleted unless they also had a value qualifier of "U."
 - Data with a result value or qualifier that indicated values were below the MDL were reviewed within the dataset's POR. If it was determined that the analytical methods were changed during the POR resulting in differences in the MDL, the highest MDL value was used as the uniform MDL for the entire POR.
 - Data with a result qualifier of "U" were processed in accordance with subsection 62-303.320(12), F.A.C., Aquatic Life-Based Water Quality Criteria Assessment. Results reported by a laboratory with the "U" data qualifier code were assessed as half the reported result or half the criterion (whichever was lower).
- Basin Data:
 - Station data were combined by basin (parameters kept separate) for processing and analysis.
 - Additional analyses were run on stations with more than 50% data coverage and 5 continuous years of data.

- Temporal Processing:
 - Monthly time series: If multiple data points existed within a month, the monthly median was calculated for each month.
- Processing for Statistical Tests:
 - Data were processed according to the needs of each statistical test and formatted for use in the R statistical program or USGS Fortran executable.
 - Sampling Frequency:
 - Monthly data series were used for analysis.
 - Missing data entries were removed.
 - Data Gap Filling:
 - If a series did not have at least 5 years of continuous data, it was not used for trend analysis.

Statistical Analyses

- Trend Analysis:
 - Autocorrelation Function:
 - Autocorrelation was conducted to evaluate seasonal patterns and/or serial correlation (monthly seasons).
 - Autocorrelation was conducted on monthly, non-gap-filled series to determine seasonality.
 - For purposes of Seasonal Kendall analysis, statistically significant correlation on the 12-month lag was considered representative of serial correlation.
 - Seasonal Kendall Tau Test:
 - Statistical Test Description: A nonparametric statistical test that does not require data to conform to a specific distribution and is not sensitive to outliers or data gaps:
 - Identifies monotonic trends in the datasets.
 - Yields statistical significance value and direction of trend (increasing or decreasing).
 - Accounts for seasonal data patterns (using months as seasons).
 - Use in Trend Analysis:
 - Serial correlation was identified with autocorrelations prior to trend analysis.
 - USGS Fortran code for Seasonal Kendall Tau Test was used to produce tau, p-value, adjusted p-value, and Sen slope.
 - Raw P-value used for series with no serial correlation detected.
 - Adjusted p-value used if serial correlation was identified.

Table A-2. Summary of POR and data availability for basins

Basin	TN Serial Correlation	TN Number of Samples	TN Percent Complete	TN WY Range	TP Serial Correlation	TP Number of Samples	TP Percent Complete	TP WY Range
C19	N/A	34	N/A	2016–2017, 2021–2022	N/A	15	42%	2021–2022
Lake Hicpochee	N/A	9	N/A	2018, 2021–2022	N/A	9	N/A	2018, 2021–2022
Long Hammock	N/A	14	39%	2020–2022	N/A	14	39%	2020–2022
Nine Mile	N/A	29	60%	2019–2022	N/A	29	60%	2019–2022
S4	N/A	23	96%	2021–2022	Yes	68	57%	2013–2022
Turkey Creek	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
York	N/A	9	25%	2021–2022	N/A	9	25%	2021–2022
Billy Creek/Manuel Branch	Yes	167	99%	2009–2022	Yes	168	100%	2009–2022
Daughtry	Yes	167	99%	2009–2022	Yes	168	100%	2009–2022
Hancock/Yellow Fever	Yes	158	94%	2009–2022	Yes	158	94%	2009–2022
Orange	No	87	91%	2015–2022	Yes	106	98%	2014–2022
Owl/Trout	Yes	162	96%	2009–2022	No	163	97%	2009–2022
Popash/Stroud	Yes	167	99%	2009–2022	Yes	162	96%	2009–2022
Powell	Yes	166	99%	2009–2022	Yes	167	99%	2009–2022
Telegraph	No	125	87%	2011–2022	Yes	130	90%	2011–2022
Tidal Northwest	No	159	95%	2009–2022	No	55	92%	2018–2022
Tidal Southwest	No	162	96%	2009–2022	Yes	164	98%	2009–2022
Bedman/Dog	No	91	95%	2015–2022	No	98	91%	2014–2022
Bee Branch/Pollywog	No	31	52%	2018–2022	No	31	52%	2018–2022
Cypress Creek	No	91	95%	2015–2022	No	104	96%	2014–2022
Deadmans/Cypress Branch	N/A	2	N/A	2018	N/A	2	N/A	2018
Goodno	N/A	27	75%	2020–2022	N/A	28	78%	2020–2022
Jack's Branch	N/A	12	50%	2021–2022	N/A	12	50%	2021–2022
Okalochoochee Branch	N/A	24	67%	2020–2022	N/A	25	69%	2020–2022
Olga/ Hickney	No	91	95%	2015–2022	No	104	96%	2014–2022

Basin	TN Serial Correlation	TN Number of Samples	TN Percent Complete	TN WY Range	TP Serial Correlation	TP Number of Samples	TP Percent Complete	TP WY Range
Roberts	N/A	12	100%	2022	N/A	20	56%	2020–2022
Townsend	N/A	27	28%	2015–2021	N/A	18	30%	2018–2022

Table A-3. Summary statistics for nutrient concentrations by basin

Note: All values in mg/L.

Basin	TN Average	TN Standard Deviation	TN Minimum	TN Maximum	TP Average	TP Standard Deviation	TP Minimum	TP Maximum
C19	1.934	0.770	1.090	5.870	0.218	0.183	0.082	0.818
Lake Hicpochee	2.226	1.344	1.230	7.810	0.227	0.261	0.052	1.300
Long Hammock	1.302	0.222	1.080	1.950	0.127	0.064	0.054	0.247
Nine Mile	1.639	0.484	1.000	3.284	0.130	0.081	0.050	0.350
S4	1.808	0.464	1.140	3.120	0.147	0.186	0.011	2.392
Turkey Creek	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
York	1.648	0.392	0.926	2.090	0.145	0.031	0.081	0.184
Billy Creek/Manuel Branch	0.972	0.361	0.448	3.020	0.237	0.118	0.037	0.820
Daughtry	0.918	0.414	0.138	2.128	0.095	0.092	0.009	0.640
Hancock/Yellow Fever	1.005	0.250	0.520	1.920	0.159	0.051	0.037	0.360
Orange	0.695	0.278	0.351	2.420	0.038	0.029	0.006	0.210
Owl/Trout	1.003	0.457	0.193	2.678	0.069	0.039	0.013	0.370
Popash/Stroud	1.128	0.368	0.228	2.605	0.114	0.103	0.007	1.000
Powell	0.906	0.342	0.170	2.240	0.179	0.144	0.006	1.300
Telegraph	1.121	0.304	0.560	2.345	0.077	0.043	0.017	0.280
Tidal Northwest	0.645	0.524	0.000	13.000	0.114	0.106	0.010	1.000
Tidal Southwest	1.053	0.391	0.330	3.210	0.110	0.059	0.031	0.520
Bedman/Dog	0.796	0.294	0.283	1.764	0.020	0.014	0.003	0.087
Bee Branch/Pollywog	1.396	0.609	0.687	3.630	0.142	0.081	0.055	0.380
Cypress Creek	1.687	1.511	0.085	7.261	0.059	0.047	0.008	0.300
Deadmans/Cypress Branch	1.277	0.316	1.053	1.500	0.100	0.028	0.080	0.120

Basin	TN Average	TN Standard Deviation	TN Minimum	TN Maximum	TP Average	TP Standard Deviation	TP Minimum	TP Maximum
Goodno	1.289	0.289	0.938	2.240	0.110	0.095	0.033	0.438
Jacks Branch	1.197	0.256	0.798	1.880	0.131	0.068	0.035	0.270
Okalocoochee Branch	1.127	0.186	0.704	1.610	0.075	0.042	0.039	0.264
Olga/Hickney	0.662	0.225	0.220	1.268	0.047	0.031	0.006	0.190
Roberts	1.229	0.199	0.999	1.574	0.094	0.046	0.046	0.270
Townsend	0.619	0.683	0.000	3.920	0.057	0.025	0.010	0.100

Table A-4. Trend analysis results by station for TN

Basin	Station	TN Serial Correlation	TN Tau	TN Kendall S	TN Slope	TN p-value	TN Trend
Daughtry	20-9GR	Yes	-0.208	-222	-0.021	0.0893	No Significant Trend
Billy Creek/ Manuel Branch	CFMFSP	No	-0.197	-24	-0.038	0.1148	No Significant Trend
Billy Creek/ Manuel Branch	CFMMANUEL	No	-0.186	-121	-0.011	0.0065	Significant Decreasing Trend
Cypress Creek	CYPRESSGR	No	0.159	47	0.078	0.074	No Significant Trend
Cypress Creek	FICHTERSGR	Yes	0.156	46	0.024	0.0864	No Significant Trend
Cypress Creek	SPANISHGR	No	0.333	75	0.077	0.0007	Significant Increasing Trend
Hancock/Yellow Fever	16-3GR	Yes	-0.043	-40	-0.004	0.7446	No Significant Trend
Owl/Trout	27-6GR	Yes	-0.139	-141	-0.013	0.2224	No Significant Trend
Owl/Trout	27O-GR20	Yes	-0.126	-117	-0.019	0.3818	No Significant Trend
Popash/Stroud	23-5GR	Yes	-0.209	-220	-0.026	0.1044	No Significant Trend
Popash/Stroud	24-7GR	Yes	-0.136	-145	-0.014	0.301	No Significant Trend
Powell	POWLGR20	Yes	-0.154	-160	-0.018	0.1674	No Significant Trend
Tidal Northwest	300	No	-0.164	-139	-0.014	0.0087	Significant Decreasing Trend
Tidal Northwest	400	No	0.167	154	0.016	0.0066	Significant Increasing Trend
Tidal Northwest	470	No	-0.088	-82	-0.010	0.1526	No Significant Trend
Tidal Northwest	540	No	0.259	236	0.025	0	Significant Increasing Trend
Tidal Northwest	590	No	-0.174	-154	-0.014	0.0046	Significant Decreasing Trend
Tidal Northwest	600	No	0.287	251	0.029	0	Significant Increasing Trend
Tidal Southwest	WHISGR18	No	-0.027	-4	-0.008	0.8548	No Significant Trend
9Mile	G3SD0088	—	—	—	—	—	—
Bedman/Dog	37-4GR	—	—	—	—	—	—
Bee Branch/Pollywog	G3SD0085	—	—	—	—	—	—

Basin	Station	TN Serial Correlation	TN Tau	TN Kendall S	TN Slope	TN p-value	TN Trend
Billy Creek/ Manuel Branch	BILLGR20	—	—	—	—	—	—
C-19	17971	—	—	—	—	—	—
Daughtry	CALUSA0054FTM	—	—	—	—	—	—
Daughtry	GATRGR91	—	—	—	—	—	—
Deadmans/Cypress Branch	53174	—	—	—	—	—	—
Deadmans/Cypress Branch	53183	—	—	—	—	—	—
Goodno	32272	—	—	—	—	—	—
Goodno	32273	—	—	—	—	—	—
Hancock/Yellow Fever	CALUSA0025FTM	—	—	—	—	—	—
Hancock/Yellow Fever	G3SD0130	—	—	—	—	—	—
Jacks Branch	32289	—	—	—	—	—	—
Lake Hicpochee	G3SD0087	—	—	—	—	—	—
Long Hammock	32271	—	—	—	—	—	—
Okalocoochee Basin	32275	—	—	—	—	—	—
Olga/Hickney	38-3GR	—	—	—	—	—	—
Orange	40-18GR	—	—	—	—	—	—
Orange	40-32GR	—	—	—	—	—	—
Orange	G3SD0128	—	—	—	—	—	—
Popash/Stroud	22-7GR	—	—	—	—	—	—
Popash/Stroud	23-27GR	—	—	—	—	—	—
Popash/Stroud	24-19GR	—	—	—	—	—	—
Popash/Stroud	25-GR20	—	—	—	—	—	—
Powell	18-6GR	—	—	—	—	—	—
Powell	POWLGR81	—	—	—	—	—	—
Roberts	G3SD0146	—	—	—	—	—	—
S4	17545	—	—	—	—	—	—
Telegraph	29-8GR	—	—	—	—	—	—
Telegraph	CALUSA0024FTM	—	—	—	—	—	—
Telegraph	G3SD0129	—	—	—	—	—	—
Tidal Southwest	DEEPGR10	—	—	—	—	—	—
Tidal Southwest	WHISGR50	—	—	—	—	—	—
Townsend	WQ SITE 15	—	—	—	—	—	—
York	32296	—	—	—	—	—	—

Table A-5. Trend analysis results by station for TP

Basin	Station	TP Serial Correlation	TP Tau	TP Kendall S	TP Slope	TP p-value	TP Trend
Daughtry	20-9GR	Yes	0.065	70	0.001	0.5008	No Significant Trend
Billy Creek/ Manuel Branch	CFMFSP	No	-0.175	-17	-0.013	0.1987	No Significant Trend
Billy Creek/ Manuel Branch	CFMMANUEL	No	-0.127	-19	-0.002	0.2742	No Significant Trend
Cypress Creek	CYPRESSGR	No	0.087	34	0.001	0.2887	No Significant Trend
Cypress Creek	FICHTERSGR	Yes	0.087	64	0.002	0.3927	No Significant Trend
Cypress Creek	SPANISHGR	No	0.178	54	0.001	0.0454	Significant Increasing Trend
Hancock/Yellow Fever	16-3GR	Yes	0.131	125	0.002	0.1952	No Significant Trend
Owl/Trout	27-6GR	No	0.019	20	0.000	0.7535	No Significant Trend
Owl/Trout	27O-GR20	No	0.032	30	0.000	0.6076	No Significant Trend
Popash/Stroud	23-5GR	Yes	-0.083	-89	-0.002	0.3551	No Significant Trend
Popash/Stroud	24-7GR	No	0.023	25	0.000	0.7694	No Significant Trend
Powell	POWLGR20	Yes	0.086	91	0.002	0.3823	No Significant Trend
Tidal Northwest	300	No	0.333	21	0.002	0.0155	Significant Increasing Trend
Tidal Northwest	400	No	0.183	19	0.003	0.1491	No Significant Trend
Tidal Northwest	470	No	0.106	11	0.000	0.4019	No Significant Trend
Tidal Northwest	540	No	0.072	6	0.000	0.6304	No Significant Trend
Tidal Northwest	590	No	0.059	5	0.000	0.7016	No Significant Trend
Tidal Northwest	600	No	0.034	3	0.000	0.849	No Significant Trend
Tidal Southwest	WHISGR18	No	-0.118	-18	0.004	0.2997	No Significant Trend
9Mile	G3SD0088	—	—	—	—	—	—
Bedman/Dog	37-4GR	—	—	—	—	—	—
Bee Branch/Pollywog	G3SD0085	—	—	—	—	—	—
Billy Creek/ Manuel Branch	BILLGR20	—	—	—	—	—	—
C-19	17971	—	—	—	—	—	—
Daughtry	CALUSA0054FTM	—	—	—	—	—	—
Daughtry	GATRGR91	—	—	—	—	—	—
Deadmans/Cypress Branch	53174	—	—	—	—	—	—
Deadmans/Cypress Branch	53183	—	—	—	—	—	—
Goodno	32272	—	—	—	—	—	—
Goodno	32273	—	—	—	—	—	—
Hancock/Yellow Fever	CALUSA0025FTM	—	—	—	—	—	—
Hancock/Yellow Fever	G3SD0130	—	—	—	—	—	—

Basin	Station	TP Serial Correlation	TP Tau	TP Kendall S	TP Slope	TP p-value	TP Trend
Jacks Branch	32289	—	—	—	—	—	—
Lake Hicpochee	G3SD0087	—	—	—	—	—	—
Long Hammock	32271	—	—	—	—	—	—
Okaloocoochee Basin	32275	—	—	—	—	—	—
Olga/Hickney	38-3GR	—	—	—	—	—	—
Orange	40-18GR	—	—	—	—	—	—
Orange	40-32GR	—	—	—	—	—	—
Orange	G3SD0128	—	—	—	—	—	—
Popash/Stroud	22-7GR	—	—	—	—	—	—
Popash/Stroud	23-27GR	—	—	—	—	—	—
Popash/Stroud	24-19GR	—	—	—	—	—	—
Popash/Stroud	25-GR20	—	—	—	—	—	—
Powell	18-6GR	—	—	—	—	—	—
Powell	POWLGR81	—	—	—	—	—	—
Roberts	G3SD0146	—	—	—	—	—	—
S4	17545	—	—	—	—	—	—
Telegraph	29-8GR	—	—	—	—	—	—
Telegraph	CALUSA0024FTM	—	—	—	—	—	—
Telegraph	G3SD0129	—	—	—	—	—	—
Tidal Southwest	DEEPGR10	—	—	—	—	—	—
Tidal Southwest	WHISGR50	—	—	—	—	—	—
Townsend	WQ SITE 15	—	—	—	—	—	—
York	32296	—	—	—	—	—	—

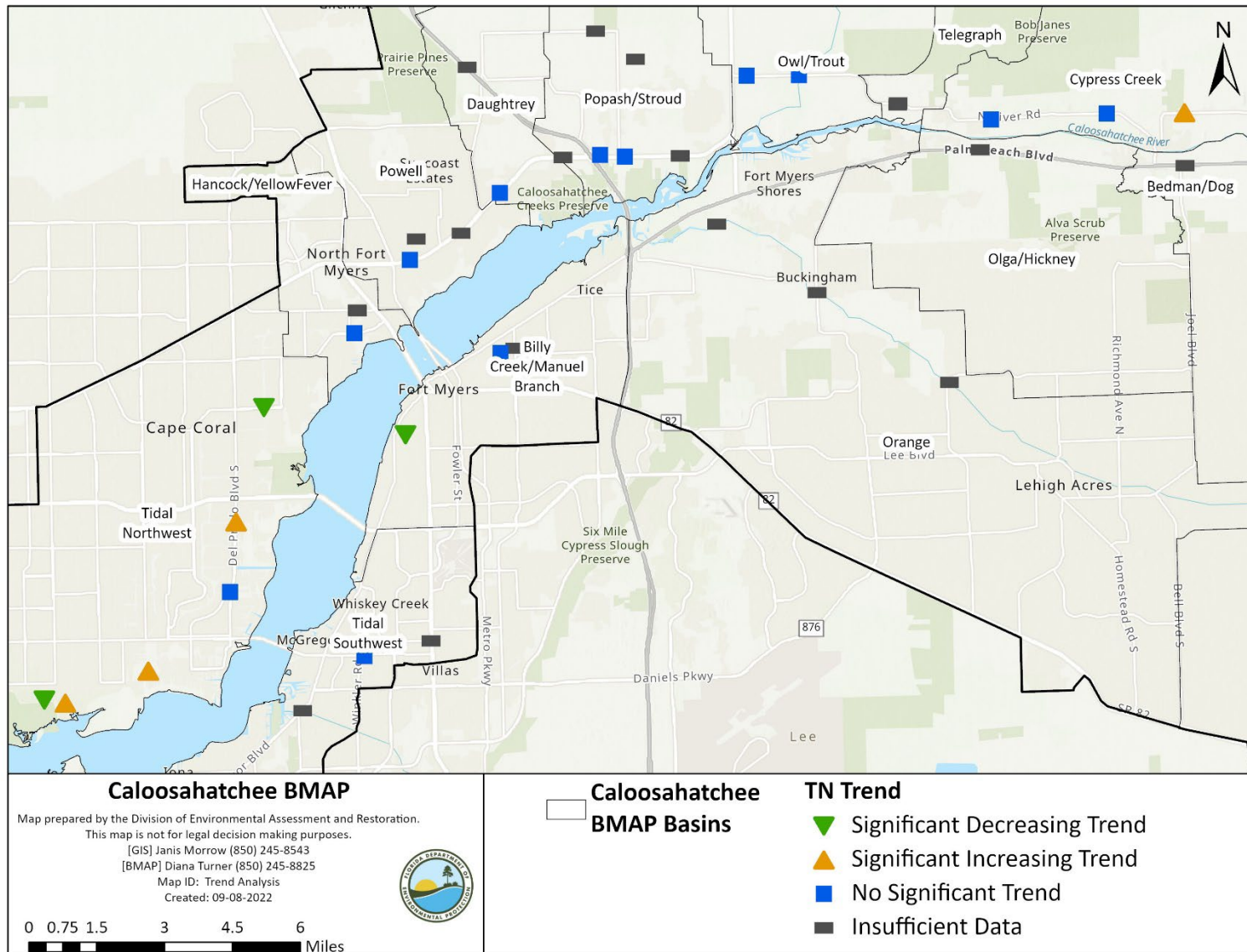


Figure A-1. Map of Seasonal Kendall test for TN by station

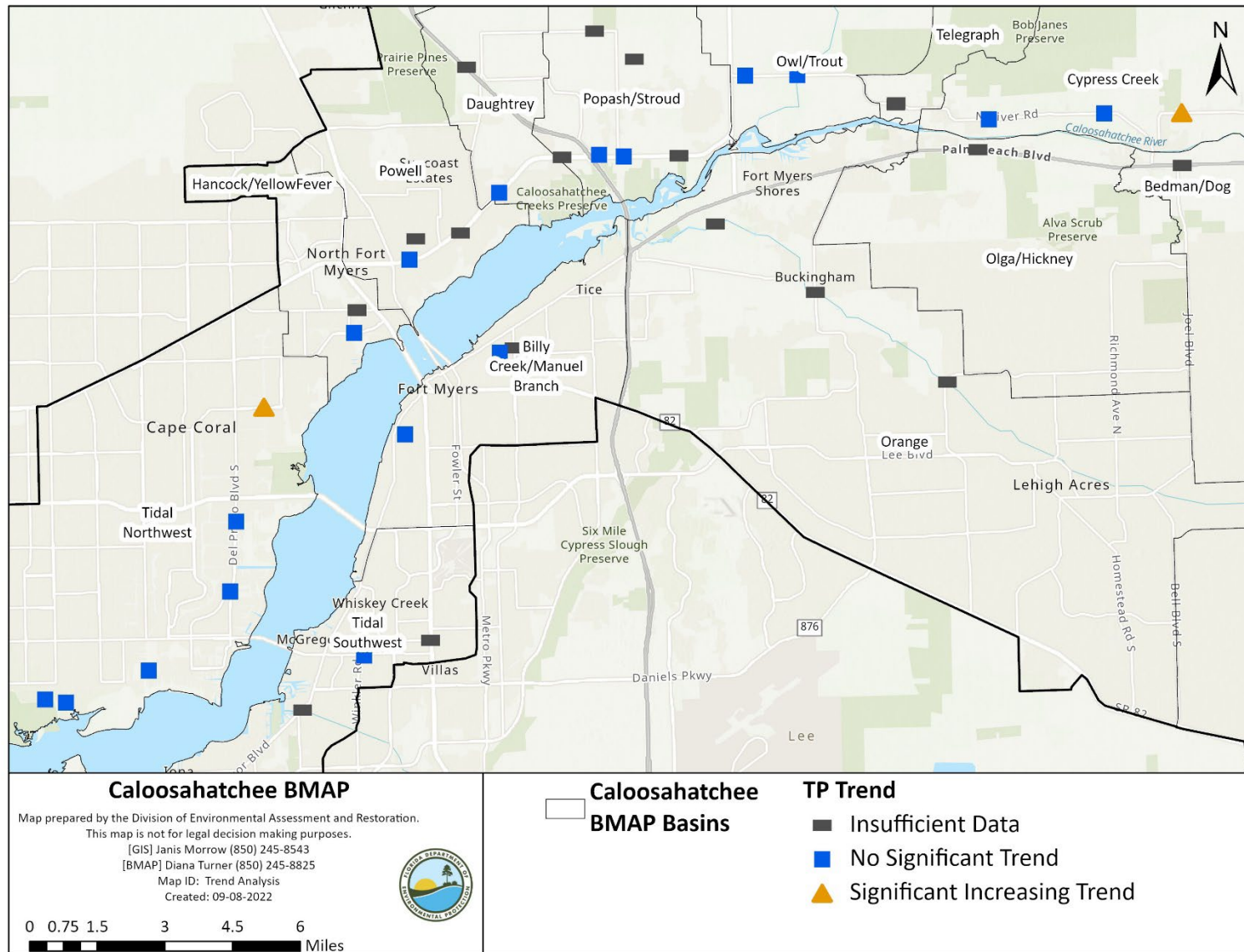


Figure A-2. Map of Seasonal Kendall test for TP by station