Chapter 4: Nutrient Source Control Programs in the Southern Everglades

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SUMMARY

This chapter provides an update on the South Florida Water Management District (SFWMD or District) source control programs for phosphorus in stormwater runoff in basins tributary to the Everglades Protection Area (EPA) as directed by the Everglades Forever Act (EFA, Section 373.4592, Florida Statutes [F.S.]). Source controls are the foundation for cost-effective water quality improvement strategies that integrate with local, state, and federal stormwater programs and construction projects.

The tributary basins and their locations relative to the EPA are depicted in **Figure 4-1**. Among these basins, the Everglades Agricultural Area (EAA) and C-139 basins have historically discharged the greatest portion of the total phosphorus (TP) load to the EPA. As such, they are subject to Everglades Works of the District (WOD) permits, issued by SFWMD, that include best management practices (BMPs) and monitoring requirements that vary slightly between the EAA and C-139 basins. Other basins that discharge to the EPA are not subject to WOD permits but are required to implement BMPs and conduct monitoring through cooperative agreements and the state regulatory program through SFWMD-issued Environmental Resource permits (ERPs). All basins have performance metrics or goals to assess the effectiveness of their source control strategies. The metrics may be TP load or concentration-based, as needed, to meet the water quality restoration objectives of the EFA. In general, over the long term the TP reduction efforts have been successful within the basins that discharge into the EPA; however, consistent application of the program is required to maintain progress. Additionally, the District continues to identify optimization opportunities.

A source control program update for Water Year 2021 (WY2021; May 1, 2020–April 30, 2021) is provided below. A summary of the measured TP in runoff from the EAA, C-139, and other tributary basins for WY2021 is provided in **Table 4-1**.

EAA BASIN

As mandated by statute, the measure of effectiveness of BMP implementation for the EAA Basin is for permittees to collectively maintain TP load levels in stormwater runoff 25% below the levels that existed prior to the WOD permit program adoption in 1992. In WY2021, the EAA Basin discharged 168 metric tons (t) of TP, which represents a 59% reduction in TP load when compared to pre-program discharges (409 t). The SFWMD BMP program has prevented approximately 4,282 t of TP from entering the Everglades for the WY1996–WY2021 period. With the WY2021 results, the 26-year average annual TP load reduction for the program is 57%. EAA Basin runoff is directed to the Everglades Stormwater Treatment Areas (STAs) for further nutrient reduction before discharging to the EPA.

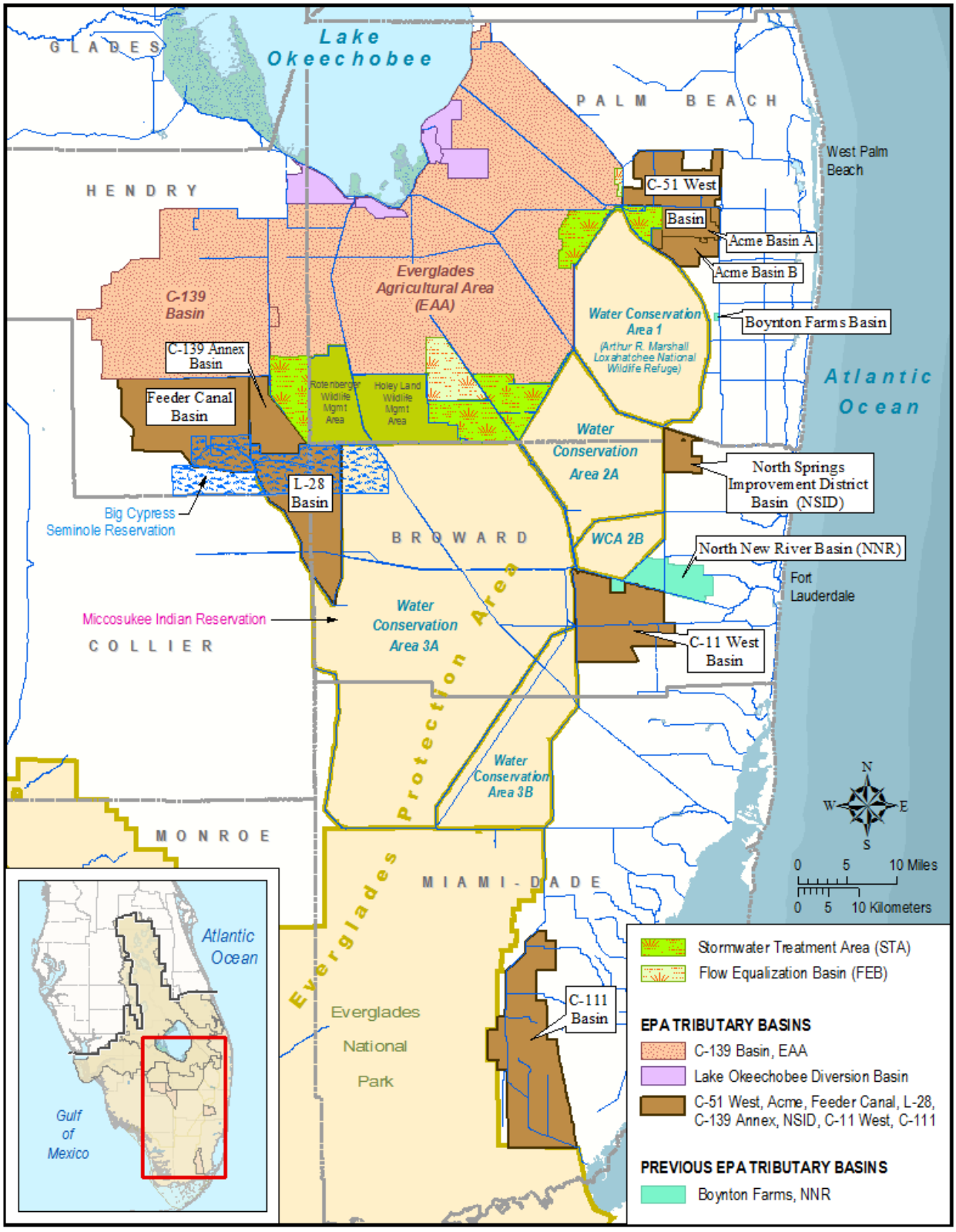

Figure 4-1. The EPA source control program tributary basins. (Notes: Watershed areas are based on the most recent hydrologic boundaries and may differ from areas shown in previous reports.)

Table 4-1. Summary of WY2021 TP in runoff from tributary basins.

Basin[a]	Receiving Water Body	Performance Metrics[b]	WY2021 TP Load (metric tons)[c]	WY2021 TP FWMC (µg/L)[c]	Area (acres)[c,d]	WY2021 TP Unit Area Load (pounds per acre)[c]
Everglades Agricultural Area (EAA)[e]	STAs and Lake Okeechobee	Maintain 25% TP Load Reduction (306 t)[f]	168	116	473,776	0.78
C-139	STA 5/6 and EAA	Maintain Historic TP Load Levels (37 t)[f]	46	266	168,450	0.60
C-51 West (incl. Acme Improvement District)[g]	STA-1E, C-51 East Basin, and WCA-1[h]	157 (µg/L)	30	131	51,080	NA[g]
L-28[i]	WCA-3A[h]	72 (µg/L)	18	78	71,790	0.56
Feeder Canal	WCA-3A[h]	50 (µg/L)	16	139	68,883	0.51
C-11 West[g]	WCA-3A[h]	17-28 (µg/L)[j]	9	25	45,728	NA[g]
C-111[g]	ENP[h]	11 (µg/L)	4	7	72,902	NA[g]
North Springs Improvement District (NSID)[g]	WCA-2A[h]	109 kg[k]	0.01	5	9,022	NA[g]

Cell shading indicates the relative magnitude of each value. When reviewing these data, note that TP levels in runoff are influenced by many site-specific factors such as land uses, regional water management features, soils, historic uses of the land, source control activities, and rainfall variability.

a. North New River and Boynton Farms historically flowed to the EPA but have since diverted flows away from these areas and are no longer monitored.

b. Performance metrics for phosphorus levels identified in the table are for each basin's discharges.

c. Water year data (annual computed values) are in the following units: 1 microgram per liter (µg/L) ≈1 part per billion (ppb); 1 metric ton (t) = 1,000 kilograms (kg); 1 pound per acre ~ 1.121 kilograms per hectare. Note: FWMC – Flow-Weighted Mean Concentration.

d. Area based on most recent hydrologic boundaries. However, if the basin acreage changed during the water year (e.g., lands previously generating runoff were converted to Everglades Stormwater Treatment Areas (STAs), the average basin acreage during the water year was used.

e. TP concentration in basin runoff is calculated by subtracting flows and loads that pass through the EAA from Lake Okeechobee to the Everglades STAs and are not the same as TP concentrations measured in permittee discharges.

f. Compared to a pre-BMP baseline period.

g. TP in C-51 West, C-11 West, C-111, and NSID discharges to the Atlantic Ocean are not included.

h. WCA – Water Conservation Area and ENP – Everglades National Park.

i. The *Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals* (Long-Term Plan; Burns & McDonnell 2003) contains a predicted TP FWMCs of 72 µg/L in inflows to future regional projects.

j. The Long-Term Plan contains predicted TP FWMCs for the C-11 West Basin based on the completion status of regional projects: 17 µg/L prior to completion of the Critical Project; 22 µg/L after completion of the Critical Project and diversion to the Western C-11 Impoundment; and 28 µg/L after completion of the North Lake Belt Storage Project.

k. The Surface Water Management permit issued to NSID stipulates that total TP loading to WCA-2A may not exceed 109 kilograms per year (kg/yr) in any given water year, or a moving five-year cumulative TP load of 145 kg in three or more consecutive years.

C-139 BASIN

The C-139 Basin permittees are mandated to implement BMPs to collectively maintain TP loads in stormwater runoff at or below levels that existed prior to the WOD permit program adoption in 2002. In the initial years of program implementation, the C-139 Basin did not consistently meet the TP load requirements from year to year. Based on lessons learned, adjustments were made to the program in 2010 including additional permittee requirements. WY2021 was the twelfth consecutive water year that the C-139 Basin maintained the required phosphorus levels. It should be noted that the C-139 Basin discharged 46 t of TP in WY2021, which is more than the pre-program target discharges (37 t) but below the limit load (94 t). Should this occur in the next two consecutive water years, then the C-139 Basin will be determined out of compliance. C-139 Basin runoff is also directed to the STAs for further nutrient reduction before discharging to the EPA.

OTHER TRIBUTARY BASINS

Six other basins are tributary to the EPA directly (L-28, C-11 West, Feeder Canal, C-111, and North Springs Improvement District [NSID]) or indirectly (C-51 West, including Acme Improvement District). Performance of these basins with respect to their performance metrics is summarized within **Table 4-1**. As depicted in **Table 4-1**, four of the other tributary basins met their respective performance metrics. The Feeder Canal and L-28 basins exceeded their performance metrics.

Phosphorus concentration and/or discharge targets for these basins are established in statutes, applicable SFWMD-issued permits, cooperative agreements, and regional water quality improvement plans, or as described in the federal Everglades Settlement Agreement (Settlement Agreement dated July 26, 1991, Case Number 88 1886-CIV-MORENO, United States District Court for the Southern District of Florida, as modified by the Omnibus Order entered in the case on April 27, 2001).

INTRODUCTION

As part of an extensive ecosystem restoration plan that combines source control activities with large-scale regional treatment projects, the 1994 EFA (Section 373.4592, F.S.) directs SFWMD to implement regulatory and cooperative source control programs for areas tributary to the EPA. Phosphorus is the primary nutrient of concern as the EPA is a phosphorus-limited system. The SFWMD WOD BMP program was adopted under Chapter 40E-63, Florida Administrative Code (F.A.C.), as the primary source control activity for the EAA and the C-139 basins, which were historically the greatest contributors of TP loads to the EPA. The EAA and C-139 basins were originally referred to as the Everglades Construction Project (ECP) basins because they discharged into the constructed Everglades STAs for treatment prior to discharging into the EPA. In contrast, other tributary basins that discharged relatively lower TP loads to the EPA, sometimes referred to as the Non-Everglades Construction Project (Non-ECP) or Everglades Stormwater Program (ESP) basins, were permitted to discharge directly to the EPA without passing through regional treatment projects, if water quality improvement strategies and BMPs were implemented. Note that for some of these basins, the *Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals* (Long-Term Plan; Burns & McDonell 2003) called for diversion of flows away from the EPA and/or to treatment areas.

BMPs, as defined by the EFA, are the most effective and practicable on-site means for improving water quality in discharges by balancing water quality improvements and economic and technological considerations, including agricultural productivity. BMPs are based on research, field testing, and expert review. Effectiveness of BMP implementation is measured through monitoring networks and assessment methods. While BMPs have proved to be effective, they have a maximum achievable water quality benefit dependent on site-specific conditions, thus regional construction projects are typically needed to achieve the much lower phosphorus levels that are required to meet ecosystem water quality needs. This treatment train approach to ecosystem restoration is shown in **Figure 4-2**. The Everglades STAs, regional construction projects in the Southern Everglades, were designed with consideration to the EFA-mandated TP load reduction requirement from these basins. Performance of these STAs and their ability to meet water quality standards in the Everglades is dependent on land users' effective implementation of BMPs and other sources controls to achieve TP load requirements in their discharges that flow into the STAs.

Figure 4-2. The treatment train process from source controls to ecosystem restoration.

The primary objective of the SFWMD WOD BMP program is to achieve specific TP loads in basin discharges. These TP loads are verified by monitoring at representative locations. The program is based on SFWMD WOD permits issued to all landowners or operators (referred to as permittees) located within the boundary of the EAA and C-139 basins. These WOD permits require implementation of comprehensive BMP plans to control phosphorus discharged to the District's regional stormwater system. Comprehensive BMP plans address both input of phosphorus and off-site transport by including practices implemented in three categories: nutrient management, particulate matter and sediment control, and water management.

In addition to the EAA and C-139 basins, other tributary basins historically discharged approximately 13% of the TP load to the EPA. These other tributary basins are the C-11 West, C-111, Feeder Canal, L-28, NSID, Acme Improvement District (Acme)/C-51 West, North New River (NNR), and Boynton Farms basins. SFWMD structures associated with these basins are regulated by a permit[1] issued by the Florida Department of Environmental Protection (FDEP) in accordance with the EFA's mandate that the SFWMD apply for a permit to operate and maintain structures that discharge into, within, or from the EPA and are not included in the ECP. This FDEP permit requires the implementation of water quality improvement plans (WQIPs) to reduce TP loads prior to discharging into the EPA (see Appendix 4-3 of this volume for more information). WQIPs combine source controls, and integration with or reliance on local and federal projects. WQIPs were refined and supplemented with the activities and projects described in the Long-Term Plan (Burns & McDonnell 2003), the *Restoration Strategies Regional Water Quality Plan* (SFWMD 2012), and their amendments, as subsequently adopted by the EFA.

Continued implementation of the regulatory WOD BMP programs in the EAA and C-139 basins and WQIPs in the other tributary basins are necessary for SFWMD to (1) achieve the TP criterion in the EPA (established in Rule 62-302.540, F.A.C.); and (2) fulfill its obligations under the EFA, the FDEP permit, and the federal Everglades Settlement Agreement, which established concentration limits and load reduction criteria for TP discharged into the EPA.

[1] FDEP Permit: Non-Everglades Construction Project Permit Number 0237803 (Original Permit Number 06,502590709) issued to SFWMD. See *2022 South Florida Environmental Report* (SFER) – *Volume III*, Appendix 3-2 for the annual permit report.

SOURCE CONTROL PROGRAMS IN THE EAA AND C-139 BASINS

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BACKGROUND

For the EAA and C-139 basins, the EFA mandates the SFWMD WOD BMP program to achieve specified TP loads by controlling phosphorus at the source. This source control strategy relies on the implementation of BMPs and an annual basin compliance assessment utilizing methods adopted under Chapter 40E-63, F.A.C., to measure effectiveness.

The annual basin compliance assessment determines whether the EAA Basin TP loads in runoff are, at a minimum, 25% less than the TP loads for the historical pre-BMP baseline period. When developing the program, this reduction requirement was determined to be practicable and consistently achievable by the EAA Basin over the long-term within the framework of implementing BMPs under a regulatory program. For the C-139 Basin, as TP loads were increasing, the objective was to revert to TP loads at or below the historic loads measured during its baseline period, as defined in the EFA. If the annual basin compliance assessment determines that TP load requirements are not met, permittees in areas contributing the greatest phosphorus load will be required to revise their BMP plans or implement other improvements.

SOURCE CONTROL STRATEGY FOR EAA AND C-139 BASINS

The source control program is based on WOD permits issued by SFWMD pursuant to Chapter 40E-63, F.A.C. These permits require implementation of a BMP plan for all land uses on properties that discharge to WOD. A BMP plan is comprised of individual BMPs that are selected based on the specific land use and operation for the permitted area. To obtain SFWMD approval, the proposed BMP plan must be comprehensive in addressing drivers of TP load (concentrations, transport mechanisms, and flow volume of discharges), including BMPs from three main categories: nutrient management, particulate matter and sediment controls, and water management.

Table 4-2 provides a summary of the most implemented BMP plans in the EAA and C-139 basins meeting the comprehensive BMP plan requirement. **Table 4-3** provides a description of the BMPs listed in **Table 4-2**. Ongoing investigation to improve the selection, design criteria, and implementation of BMPs occurs through different mechanisms specific to each basin. More information on comprehensive BMP plans and BMP plan examples are available in the *2009 South Florida Environmental Report* (SFER) – *Volume I*, Appendix 4-1 (Gomez and Bedregal 2009).

Land use is a dominant factor impacting TP loads in runoff. The EAA and C-139 basins include predominantly agricultural land uses (**Table 4-4**). The C-139 Basin has 69% of its total acres (ac) in pasture (primarily low density cattle operations), so pasture management BMPs, including those that minimize concentrated cattle congregation areas, are common in the C-139 Basin BMP plans. Alternatively, a BMP plan for row crops is typically used in the EAA Basin where sugarcane is grown on 95% of the land. A common farming practice is to rotate other crops with sugarcane, so the crops in **Table 4-4** may vary from year to year. However, when comparing the most recent land use data (2014–2015) and SFWMD's latest field observations, no substantial differences were observed.

Table 4-2. Typical BMP plans.

BMP Category	BMP Plan for Row Crops	BMP Plan for Pasture
Nutrient Management BMPs	✓ Nutrient Application Control ✓ Nutrient Spill Prevention ✓ Soil Testing	✓ No Nutrients Applied
Particulate Matter & Sediment Control BMPs	✓ Canal Cleaning ✓ Land Leveling ✓ Sediment Sumps ✓ Vegetative Filter Strips	✓ Low Cattle Density ✓ Restricted Placement of Feeders ✓ Restricted Placement of Cowpens
Water Management BMPs	✓ Detain 1.0 inch of rainfall prior to off-site discharge	✓ Maintain the unimproved drainage system to allow for detention of rainfall in soils and low-lying areas

Table 4-3. Descriptions of common BMPs.

BMP	BMP Description
Nutrient Application Control	Utilize uniform and controlled application methods with a minimum 4-foot setback from canals and no overlapping application.
Nutrient Spill Prevention	Follow formal practices and protocols for handling and placement of nutrients, storage and disposal of nutrient containers, and nutrient transfer.
Soil Testing	Control phosphorus inputs considering the soil and crop type and follow standard recommendations for application rates or recommendations based on the analysis of optimum economic crop response to added phosphorus.
Particulate Matter & Sediment Controls	Prevent or minimize the transport of phosphorus off-site with sediments and particulate matter by controlling erosion and sediment transport.
Water Management BMP	Manage control structures to minimize and delay off-site discharges by storing stormwater on-site via canals, soils, or impoundments. For example, the runoff following the first rain event of a new season may contain several months of nutrient build-up commonly known as the first flush.
Pasture Management	Manage cattle operations to reduce nutrients in runoff by preventing congregation of cattle near waterways, providing sufficient watering sources to draw cattle away from drainage canals, and maintaining a low density of cattle on-site to allow for sustainable forage growth to minimize erosion.

Table 4-4. Latest land use distribution data (2014–2015) for the EAA and C-139 basins.

Land Use [a]	EAA	C-139
Citrus	0%	7%
Institutional, Urban, & Industrial	2%	5%
Other Agriculture	< 1%	6%
Pasture	2%	69%
Rock Mining	< 1%	0%
Row Crops	< 1%	5%
Sugarcane	95%	8%
Water	< 1%	< 1%

a. The 2014–2015 SFWMD land use is the most recent data set available.

In the EAA Basin, the initial BMP plan design and implementation was based on the *Procedural Guide for the Development of Farm-Level Best Management Practice Plans for Phosphorus Control in the EAA, Version 1.1*, developed by scientists at the University of Florida's Institute of Food and Agricultural Sciences (IFAS) (Bottcher et al. 1997). Ongoing research to improve BMP effectiveness is implemented in the EAA under the Everglades Agricultural Area – Everglades Protection District (EAAEPD) Master Research Permit, as indicated in this chapter. For additional information on BMP development, see Appendix 4-1 of this volume.

In the C-139 Basin, the source control program was patterned after the successes in the EAA Basin with input from C-139 Basin landowners and other stakeholders. At the time of the adoption of the C-139 Basin rule in 2002, Chapter 40E-63, F.A.C., Part IV, mandated that BMP implementation requirements would incrementally increase if the performance measure was not complied with ultimately warranting rule amendment. As the C-139 Basin was unable to maintain phosphorus loads at or below historic levels from WY2003 through WY2006, Chapter 40E-63, F.A.C., directed the program be amended to ensure that the EFA-mandated TP levels could be met. In 2010, the rule was amended and required the implementation of comprehensive BMP plans, which included all defined categories of BMPs (nutrient management, sediment controls, and water management; see Appendix 4-2 of this volume) to control dominant drivers affecting TP load, TP concentrations, transport mechanisms, and flow volume of off-site discharges.

BMP PERFORMANCE MEASUREMENT

A unique element of the WOD BMP program is an annual compliance assessment to determine if the basin has collectively achieved TP load requirements. The method compares the current year's TP load in basin runoff with BMP program implemented against the baseline period TP load prior to the BMP program's implementation. The baseline period TP load is calculated using a multiple linear regression equation of TP load as a function of the annual rainfall and the monthly distribution of rainfall to account for the current year's rainfall conditions. Factoring in hydrologic variability when comparing the current year and the baseline period is essential to determine BMP performance because annual rainfall intensity and monthly rainfall distribution can influence TP load in stormwater runoff. For the EAA Basin, TP loads (with BMPs implemented) must be maintained at levels that are, at a minimum, 25% less than baseline period levels (WY1980–WY1988), while for the C-139 Basin, the TP levels must be no greater than the baseline period levels (WY1980–WY1988).

To measure the TP load in runoff from the EAA and C-139 basins each year, SFWMD monitors flow volume and TP concentration at each basin boundary structure and follows the methods described in Appendix A3 and Appendix B2 of Chapter 40E-63, F.A.C. These methods determine the TP target and limit loads, which are adjusted annually based on the monthly distribution of annual basin rainfall. Each water year, the measured TP load in basin runoff is compared against the estimated baseline period target (providing a 50% theoretical confidence level) and limit loads (providing for a 90% theoretical confidence level). The basin is determined to be out of compliance if the target load is exceeded for three consecutive years (providing for an overall confidence level of 87.5%) or if the limit load is exceeded in a single year.

If a basin is determined to be out of compliance collectively, a secondary compliance method representing the individual permittee's proportional share of TP load is implemented as described by rule. In the EAA Basin, permittees are required to collect water quality and quantity data at off-site discharge structures (permit-level) in compliance with approved discharge monitoring plans and report data to SFWMD monthly. Permit-level water year data summaries are reported by SFWMD annually in the SFER (see Appendix 4-1 of this volume). The EAA Basin has complied with basin-level TP load requirements every year since the program's inception, so the secondary compliance method has not been used. The secondary means of compliance for the C-139 Basin relies on a SFWMD monitoring network for collecting data at a subbasin level. Subbasins are subregional hydrologic units made up of multiple permit basins that are often not distinct hydrologic areas because of runoff mixing among permit basins. Additional

information on the SFWMD subbasin monitoring network and WY2021 data for the C-139 Basin are provided in Appendix 4-2 of this volume.

This year's results are provided in the *EAA Basin WY2021 Results* and *C-139 Basin WY2021 Results* subsections below. The water quality and quantity data collection sources and methods used are adopted under Chapter 40E-63, F.A.C. The specific procedures for determining EAA and C-139 basins' compliance, basin-level and subbasin-level data collection efforts, and permit-level discharge monitoring results are outlined in Appendices 4-1 and 4-2 of this volume.

BMP PROGRAM OPTIMIZATION AND BENEFITS

Based on measured results, the WOD BMP program has been verified as effective at reducing phosphorus at the source through BMP implementation and discharge monitoring plans approved under SFWMD-issued WOD permits. The results have also provided data that verify the cost-effectiveness of implementing the source control program as the foundation for achieving initial phosphorus reductions in discharges prior to entering regional TP load reduction projects. The WOD program prevented a cumulative total of 4,282 t of TP load in EAA Basin runoff from entering the regional system/projects since the first compliance determination in 1996. Greater reductions at the source result in less TP load discharging to the stormwater system, directly affecting regional treatment capacity and associated costs. Maintaining BMP effectiveness and consistent long-term compliance with the EFA requirements is highly dependent on BMP site verifications, which allow SFWMD to discuss water quality trends, current research findings, alternative BMP strategies, and tailored optimization of current BMP practices with individual permittees. Additionally, optimizing effectiveness of BMP implementation is dependent on adaptive management and continued research.

As part of the source control program optimization efforts, the *Restoration Strategies Regional Water Quality Plan* (SFWMD 2012) directed SFWMD to build upon the success of the existing WOD BMP program by focusing on subregional areas and projects, primarily downstream of where BMPs are implemented, with the greatest potential to further reduce TP loads to the Everglades STAs. The S-5A subbasin was selected as a priority subbasin within the EAA Basin based on the inflow TP concentrations, the water quality of permit-level discharges within the S-5A subbasin (**Figure 4-3**), potential effect on inflows to the STAs, and potential positive impact to the Arthur R. Marshall Loxahatchee National Wildlife Refuge. Conceptual projects are being evaluated with stakeholder input to determine their feasibility to implement and their potential water quality benefits. As future projects are deemed feasible, contracts for project design and implementation will be initiated.

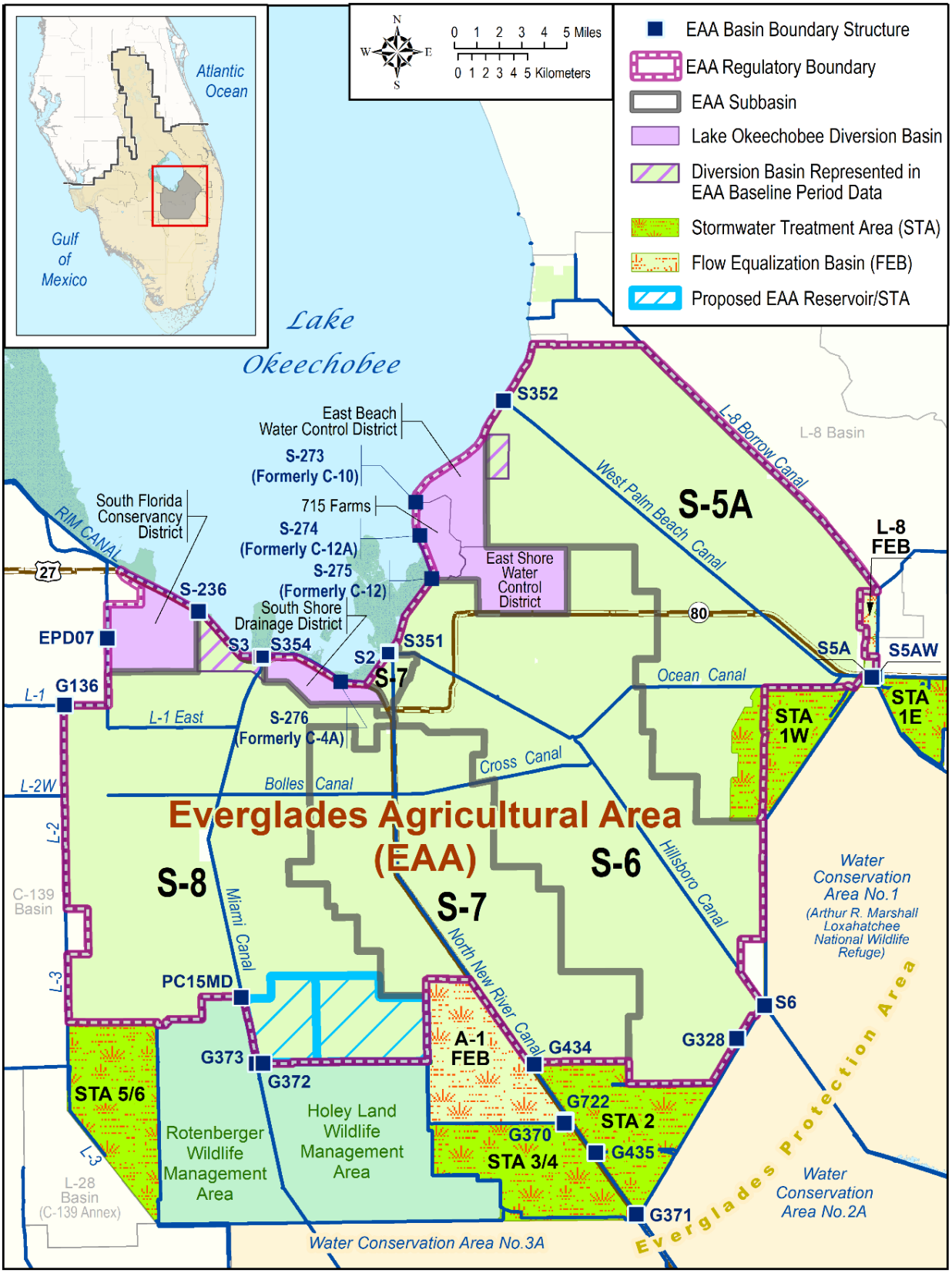


Figure 4-3. WY2021 EAA Basin map of boundaries structures.
(Note: STA 1W – STA-1 West and STA 1E – STA-1 East.)

EAA BASIN UPDATE

The primary focus in the EAA Basin for WY2021 was ensuring that permittees met all individual WOD permit reporting requirements and are accurately measuring TP load in off-site discharges. At the end of WY2021, permitted areas within the EAA and the Lake Okeechobee diversion basins included 178 hydrologic drainage basins drained by 243 permittee-operated water control structures. The remaining EAA Basin acreage consists of residential areas less than 40 ac or commercial areas less than 5 ac under a General Permit. SFWMD continued to provide BMP training for permittees and growers, which included updates on BMP implementation requirements. In addition, the process for reviewing permittee water quality data was expanded to further ensure proper sample collection methods and data collection procedures and accurate reporting of data and to ensure consistency with permit conditions.

In response to SFWMD's analyses of EAA farms' phosphorus contributions in the Restoration Strategies flow paths (see Chapter 5A of this volume for flow paths) during WY2020, EAAEPD has initiated a voluntary consultation program encompassing 11 operators within five of the six permit basins led by University of Florida's IFAS. The program consists of the following:

- Consultations with participating farms regarding their BMP programs, and review of documentation describing their implementation of particulate matter and sediment controls.
- Recommendations from IFAS concerning selection and implementation of BMPs, with a focus on optimizing the implementation or effectiveness of the farmer's current 25-point BMP plan.
- Implementation of IFAS recommendations in selected farm units for a period of three years (or via an alternative schedule if necessary). IFAS will conduct a review to summarize the outcome of implementing the recommendations.
- A final report upon collection and review of data during implementation (July 2025)

Due to contract management and COVID-19, initiation of this project was delayed. Therefore, farmers opted to combine tasks and the report titled *Report of IFAS Extension Services for Selected Basins in the EAA* dated October 12, 2021, was submitted to SFWMD. The EAAEPD has confirmed that implementation of the recommendations is underway.

In addition to the above-described BMP program implementation review efforts, SFWMD conducted 39 field sampling quality assurance audits. These audits are conducted to confirm that water quality monitoring programs are implemented in accordance with WOD permit requirements and the relevant requirements in the *Florida Department of Environmental Protection Standard Operating Procedures for Field Activities* (DEP-SOP-001/01; FDEP 2017). Field sampling quality assurance audit efforts will continue in WY2022.

Research on BMP effectiveness is conducted by IFAS via the EAAEPD Master Research permit, pursuant to the EFA and Chapter 40E-63, F.A.C., Part III, which requires a comprehensive program of research, testing, and implementation of BMPs to address all water quality standards within the EAA and EPA. Updates to IFAS BMP technical references are available at https://ifas.ufl.edu. Searching this site for "EAA BMP" provides documents on topics such as design criteria for construction, operation of BMPs, and farm management applicable to the EAA Basin. Permit renewal activities, including submittal of a scope of work for new research for the 2020–2025 period occurred in WY2021. The scope of work must meet the provisions of Section 373.4592(4)(f)2., F.S., such as field testing BMPs, consistent with an approved water quality monitoring program in a sufficient number of representative sites in the EAA to reflect soil and crop types and other factors that influence BMP design and effectiveness, and other criteria specified in subsections 40E-63.310(1)-(6), F.S. A public workshop to present and discuss the scope of work was conducted on July 31, 2020, and SFWMD took final action on the permit on September 15, 2020. The approved scope includes evaluating the differences in BMP performance as it relates to phosphorus concentration and loads associated with soil chemistry and historical land uses. Particularly, verifying the

hypothesis that phosphorus in runoff is higher with certain prior land uses; deeper soils; soils with properties that do not promote high phosphorus retention (e.g., lands with low iron, aluminum, or calcium content; or high magnesium to calcium ratios), with the ultimate goal of identifying the most effective BMPs on farms with such conditions (refer to Appendix 4-1 of this volume for additional information on the Master Research permit).

EAA Basin WY2021 Results

The performance measure compliance evaluation for the EAA Basin, as defined by Chapter 40E-63, F.A.C., is presented below. In WY2021, the measured TP load in runoff from the EAA Basin was below the target load and the limit load and, therefore, the basin complied with the performance measure. In WY2021, the measured TP load in runoff from the EAA Basin was 59% less than the baseline period. This is a greater reduction than the 25% required by the EFA, so the EAA Basin met the EFA TP load requirement for WY2021. **Table 4-5** provides a summary of the EAA Basin WY2021 TP loads for the performance measures. Representative monitoring locations for determining WY2021 compliance with the TP load reduction requirement are shown in **Figures 4-3** and **4-4**.

To estimate the EAA Basin monthly runoff TP load for WY2021, the EAA Basin monthly inflow, pass-through[2], and outflow loads were calculated based on data collected at the boundary structures. Monthly TP loads for WY2021 shown in **Figure 4-5** depict the comparison between monthly pass-through (green bars; includes flows from Lake Okeechobee and the A-1 Flow Equalization Basin [FEB]), other inflows (blue bars; inflows from the C-139 Basin), and outflow (red line; total of all sources including EAA Basin runoff). The measured TP load in runoff from the EAA Basin is the difference between the outflow (red line) and the sum of TP load in the other inflows and pass-through flows (blue and green bars). As shown in **Figure 4-5**, most of the outflows are due to the rainfall generated runoff during the wet season months (May–October); the measured TP load in runoff during the wet season months accounted for 64% of the total outflow discharged during WY2021. November discharges during the dry season months (November–April) were associated with high November rainfall. The highest monthly discharge in June was associated with above-normal historical rainfall in May and June for WY2021. The detailed monthly rainfall information is discussed in the next subsection below (**Figure 4-6**).

The EAA Basin calculated TP flow-weighted mean concentration (FWMC) is affected by the TP concentrations from Lake Okeechobee inflow, A-1 FEB inflow, and C-139 Basin inflow. **Table 4-6** presents a summary of the inflow TP concentrations to each subbasin from Lake Okeechobee, A-1 FEB inflow, and C-139 Basin and the outflow TP concentration from each subbasin for WY2021. The annual TP FWMCs at the Lake Okeechobee inflows (S-351, S-352, and S-354) to the EAA subbasins (ranged from 129 to 223 micrograms per liter [µg/L]) were greater than their respective subbasin outflow annual TP FWMCs (ranged from 74 to 193 µg/L) in WY2021. In contrast, inflows from the A-1 FEB and the C-139 Basin were lower than their respective EAA subbasin outflows.

This section also includes the results of the annual diversion evaluation to determine if the Lake Okeechobee diversion basins (see locations in **Figure 4-4**) met the goal of diverting to the Everglades STAs 80% of the average annual volume of flow volume and phosphorus load historically discharged to Lake Okeechobee. Each diversion basin diverted over 90% of its flows and loads toward the STAs meeting the diversion goal in WY2021.

[2] Pass-through is defined to be that quantity of water that is released from Lake Okeechobee to the Everglades Water Conservation Areas (WCAs), the Lower East Coast, and the West Palm Beach Canal. The release could be regulatory release for flood control, water supply, or to maintain canal and WCA stages.

Table 4-5. WY2021 EAA Basin TP compliance evaluation results.

	TP Load
Baseline period estimated TP load (adjusted for WY2021 rainfall and monthly distribution) [a]	409 t
Target TP load (baseline period estimated TP load reduced by 25%) [b]	306 t
Limit TP load (upper 90th percentile confidence level for target load)	445 t
WY2021 measured TP load in runoff from the EAA Basin with BMP plans	168 t
WY2021 TP load reduction [c]	59%

a. The baseline period of record is October 1978–September 1988 in accordance with EFA requirements. Under Chapter 40E-63, F.A.C., compliance is based on entire water year periods (May 1–April 30) that fall within the October 1978–September 1988 range, that is, WY1980–WY1988 (May 1, 1979–April 30, 1988).

b. The target TP load used for compliance is the estimated baseline period TP load adjusted for WY2021 rainfall and monthly distribution with a 25% reduction.

c. TP load reduction is the difference between WY2021 TP load based on measured data and baseline period estimated TP load.

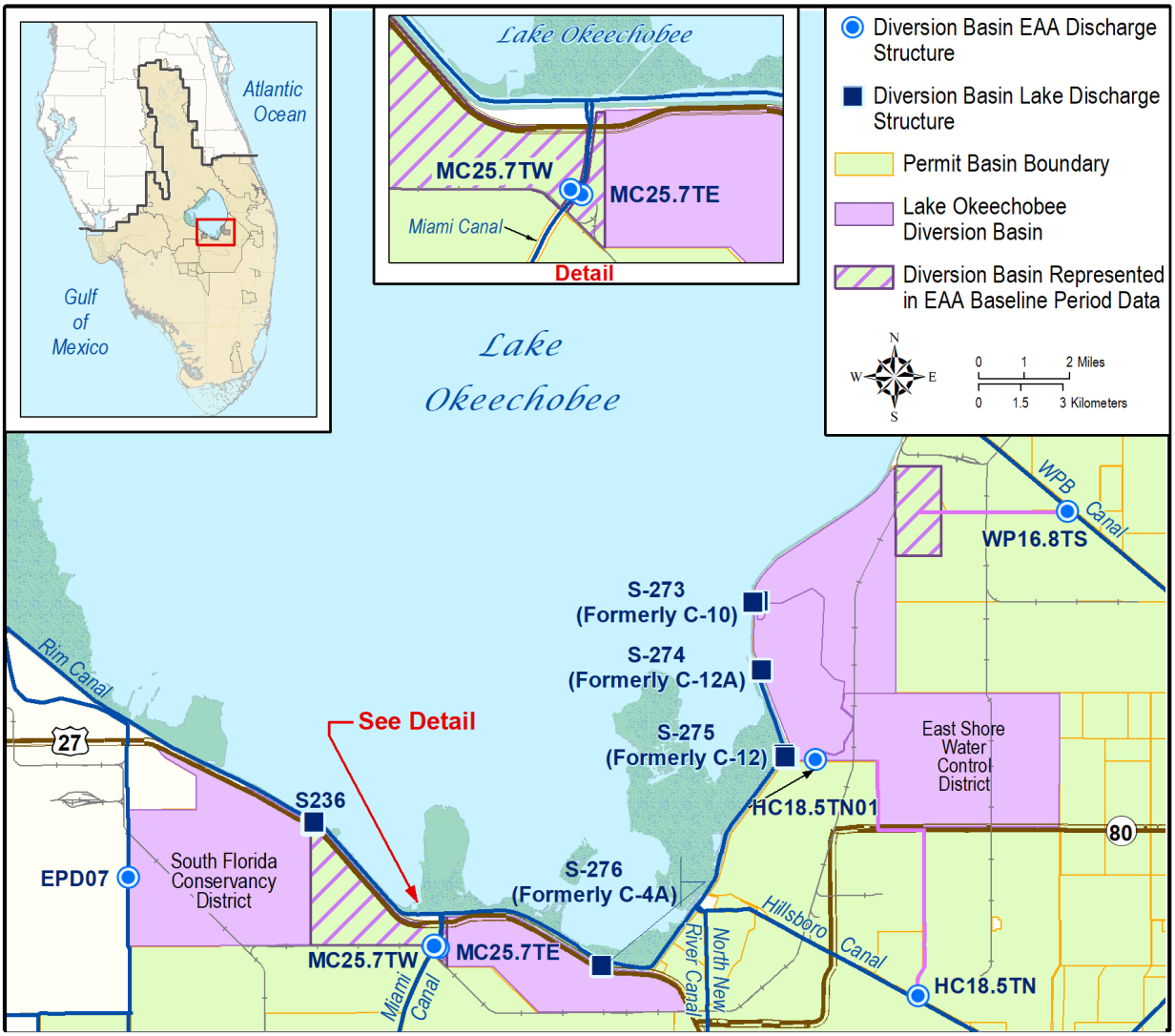
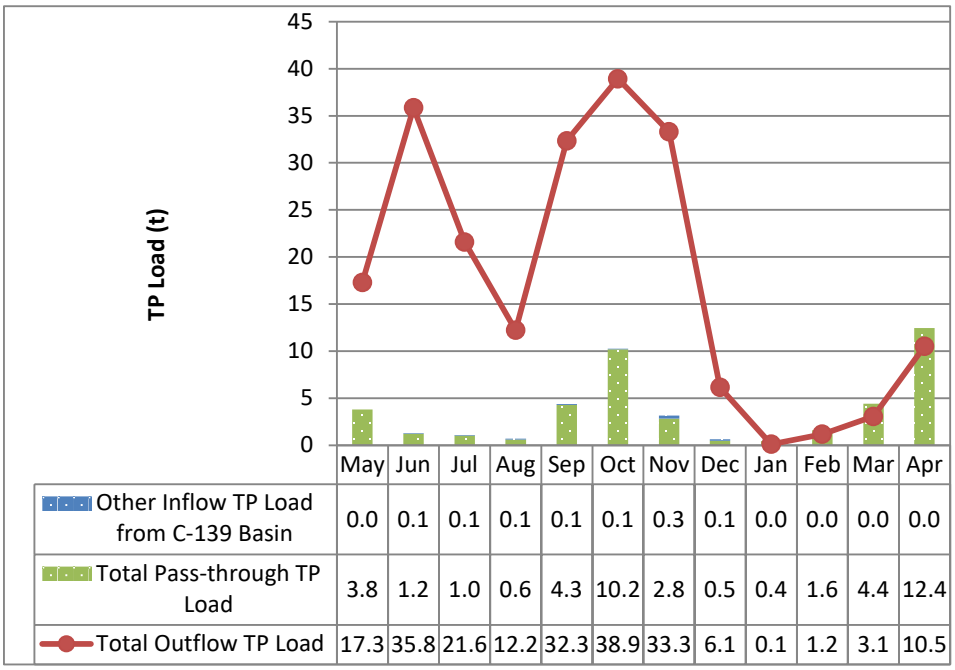


Figure 4-4. Lake Okeechobee diversion basin boundaries and their discharge structures to Lake Okeechobee and within the EAA Basin.



	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Other Inflow TP Load from C-139 Basin	0.0	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.0	0.0	0.0	0.0
Total Pass-through TP Load	3.8	1.2	1.0	0.6	4.3	10.2	2.8	0.5	0.4	1.6	4.4	12.4
Total Outflow TP Load	17.3	35.8	21.6	12.2	32.3	38.9	33.3	6.1	0.1	1.2	3.1	10.5

Figure 4-5. WY2021 monthly EAA Basin inflow and outflow loads.

Table 4-6. TP FWMC at the EAA Basin Inflow and outflow structures by subbasin (**Figure 4-3**) for WY2021.

EAA Subbasin	TP FWMC (µg/L)			
	Lake Okeechobee Inflow to EAA	A-1 FEB Inflow to EAA	C-139 Basin Inflow to EAA	Total Outflow from EAA [a]
S-5A (West Palm Beach Canal)	223			193
S-2/S-6 (Hillsboro Canal)	163			105
S-2/S-7 (NNR Canal)	163	17		74
S-3/S-8 (Miami Canal)	129		68	88

a. Includes outflows from EAA Basin boundary structures to Everglades STAs, A-1 FEB, and Lake Okeechobee.

EAA Basin WY2021 Discussion

Water quality compliance assessments began in WY1996 and the EAA Basin has complied each year since. A summary of the EAA Basin data for all water years since 1980 is provided in **Table 4-7**, including the water year TP load in runoff from the EAA Basin and the baseline period TP load in runoff based on calculation methods that account for differences in rainfall between the water year and the baseline period.

As described in the previous section, TP load can enter the EAA Basin at inflow boundary structures via discharges from external sources. External sources include but are not limited to discharges from the adjacent C-139 Basin, as well as releases from Lake Okeechobee to meet water supply demands downstream of the EAA Basin outflow boundaries. These releases from Lake Okeechobee are known as "pass-through" under the calculation methods. Thus, flow and loads leaving the EAA Basin at its outflow boundary structures are the combination of EAA Basin runoff and inflows from other sources. These pass-through TP loads and other inflow TP loads are also presented in **Table 4-7**, as they must be deducted from total EAA basin outflows to determine annual EAA Basin runoff. Likewise, the TP FWMC for the collective EAA Basin runoff presented in **Table 4-7** is derived from the calculated EAA basin runoff TP load and volume using SFWMD data collected at the boundary structures. These assessment methods are described in Chapter 40E-63, F.A.C., Appendix A3.

Table 4-7. WY1980–WY2021 EAA Basin TP measurements and calculations.

Water Year	Annual Rainfall (inches) [a]	Water Year Measured Runoff TP Load [b,c] (t) [a]	Baseline Period Estimated Runoff TP Load [d] (t) [a]	Percent TP Load Reduction [e]	Pass-Through TP Load [b] (t) [a]	Other Inflow TP Load [b] (t) [a]	Calculated TP FWMC [e,c] (µg/L) [a]	Calculated Permittee TP FWMC [f] (µg/L) [a]	Baseline Period and BMP Status Timeline [g]
1980	54	167			4	1	117		Baseline Period / Pre-BMP Period
1981	35	85			6	0	126		
1982	47	234			4	0	243		
1983	64	473			1	39	195		
1984	50	188			24	6	155		
1985	40	229			23	1	225		
1986	51	197			5	1	151		
1987	52	291			1	2	183		
1988	43	140			14	4	161		
1989	40	183			18	9	197		Partial BMPs
1990	40	121			33	1	177		
1991	50	180			2	2	207		
1992	48	106			12	1	94		
1993	62	318			100	5	157		
1994	51	132			3	3	112		
1995	67	268			37	27	116		
1996	57	162	503	68%	61	26	98	143	Everglades Rule BMPs (Full BMP Implementation)
1997	52	122	240	49%	22	7	100	138	
1998	56	161	244	34%	25	6	102	111	
1999	43	128	249	49%	60	6	123	179	
2000	58	193	425	55%	46	24	119	174	
2001	37	52	195	73%	19	5	64	158	
2002	49	101	227	55%	3	21	77	125	
2003	46	81	125	35%	86	42	66	104	
2004	47	82	229	64%	17	31	69	111	
2005	51	182	444	59%	50	47	124	154	
2006	50	153	270	44%	29	38	119	146	
2007	37	150	182	18%	15	12	166	160	
2008	47	94	167	44%	1	9	123	130	
2009	44	129	407	68%	15	22	119	136	
2010	62	169	288	41%	3	32	127	134	
2011	42	45	219	79%	9	12	71	105	
2012	44	63	217	71%	12	11	93	103	
2013	54	154	263	41%	9	20	141	127	
2014	53	105	285	63%	32	21	94	92	
2015	44	39	185	79%	107	13	47	105	
2016	51	151	206	27%	50	25	142	150	
2017	45	66	218	70%	57	11	81	147	
2018	68	298	869	66%	55	43	182	190	
2019	51	136	243	44%	125	3	119	162	
2020	48	73	229	68%	41	1	86	156	
2021	61	168	409	59%	43	1	116	138	

a. 1 t = 10^3 kilogram; 1 inch = 2.54 centimeters; and 1 microgram per liter (µg/L) ≈ 1 part per billion (ppb).

b. Measured runoff TP load is the TP load in runoff attributed to the EAA Basin (farms, cities, and industries) based on monitoring of EAA Basin inflows and outflows and methods established in Chapter 40E-63, F.A.C. Pass-through TP load is the TP load attributed to Lake Okeechobee and the A-1 FEB, which is defined as waters from outside the EAA passing through the EAA Basin tracked on a daily basis. Other inflow TP load is the TP load input from the C-139 Basin. The calculation assumed that 100% of the other inflow TP load is discharged from the EAA Basin.

c. This table represents total TP load and FWMC in EAA Basin landowner runoff discharged to the north (Lake Okeechobee) and south (e.g., STAs). Appendix 3A-5 of this volume represents the TP load and FWMC in EAA Basin discharges only to the south.

d. Estimated TP load represents the baseline period load adjusted for the rainfall variability compared to the current water year.

e. Percent TP load reduction values represent the difference between the water year measured runoff TP load and the estimated baseline period (pre-BMP period) runoff TP load.

f. Calculated TP FWMC is calculated based on the EAA Basin-level measured runoff TP load and total EAA Basin-level outflow TP load for the water year. Permittee TP FWMC represents TP measured in permittee discharges to EAA Basin canals.

g. Complete implementation of BMPs was required prior to WY1996, which was the first water year assessed for performance measure compliance for the EAA Basin. The BMP implementation phase occurred from WY1992 to WY1995.

Conversely, the permittee TP FWMC in runoff is measured by direct analysis of individual permittee discharges. It should be noted that discharges from permittees into EAA Basin canals comingle and can be subject to recycling, adsorption, and evaporation, such that the total EAA Basin runoff TP load computed from the EAA Basin boundary structures is 55% of the permittee aggregated TP load for the period from WY1996 to WY2021. However, the permittee aggregated TP FWMC and load generally increase or decrease from year to year in sync with EAA Basin-level data.

The EAA Basin data summary is provided in **Table 4-8** for the baseline period, BMP program period, and WY2021. This table compares annual rainfall, measured runoff TP load, baseline period estimated runoff load, percent TP reduction, pass-through and other inflow TP loads, and TP FWMC including the average, median, minimum, and maximum for each. As shown in **Tables 4-7** and **4-8**, the EAA Basin average runoff TP load (168 t) and TP FWMC (116µg/L) during WY2021 were lower than the average runoff TP load (223 t) and TP FWMC (173 µg/L) for the baseline period, which indicates the EAA BMP program is effective in achieving the EFA mandated TP levels.

Table 4-8. EAA Basin data summary comparing the baseline period, BMP program period, and WY2021.

	Rainfall (inches)	Water Year Measured Runoff TP Load (t)	Baseline Period Estimated Runoff TP Load (t)	Percent TP Load Reduction	Pass-Through TP Load (t)	Other Inflow TP Load (t)	Calculated TP FWMC (µg/L)	Permittee TP FWMC (µg/L)
Baseline Period (WY1980–WY1988)								
Average	48	223	-	-	9	6	173	-
Median	50	197	-	-	5	1	161	-
Minimum	35	85	-	-	1	0	117	-
Maximum	64	473	-	-	24	39	243	-
BMP Program Period (WY1996–WY2021)								
Average	50	125	290	55%	38	19	106	140
Median	50	129	242	57%	31	17	109	142
Minimum	37	39	125	18%	1	1	47	96
Maximum	68	298	869	79%	125	47	182	190
WY2021								
	61	168	409	59%	43	1	116	138

The EAA Basin monthly rainfall for the historical period WY1980–WY2020 is compared to the rainfall observed in WY2021 (**Figure 4-6**) to demonstrate the effect of the monthly rainfall on the estimated rainfall generated runoff TP load. As shown in **Figure 4-6**, the box in the middle of the box plots represents the lower 25th percentile and upper 75th percentile of the historical rainfall, and the dividing line in the box represents the 50th percentile of the historical rainfall. The red plus sign represents the historical monthly average rainfall and the green circle represents the monthly rainfall for WY2021. In general, the monthly rainfall data varies from month to month for WY2021, and the seasonal rainfall shows a pattern of wetter wet season (May–October) in comparison with the historical period of rainfall. For WY2021, five out of six wet season months (except in August) featured rainfall (green circle) higher than the historical average rainfall (red plus sign). May, July, and October had above 75th percentile of historical rainfall. The wetter wet season rainfall resulted in the higher rainfall generated runoff in June, September, and October (**Figure 4-5**) for WY2021. Runoff discharges in November during the dry season were also associated with above 75th percentile historical November rainfall (**Figures 4-5** and **4-6**).

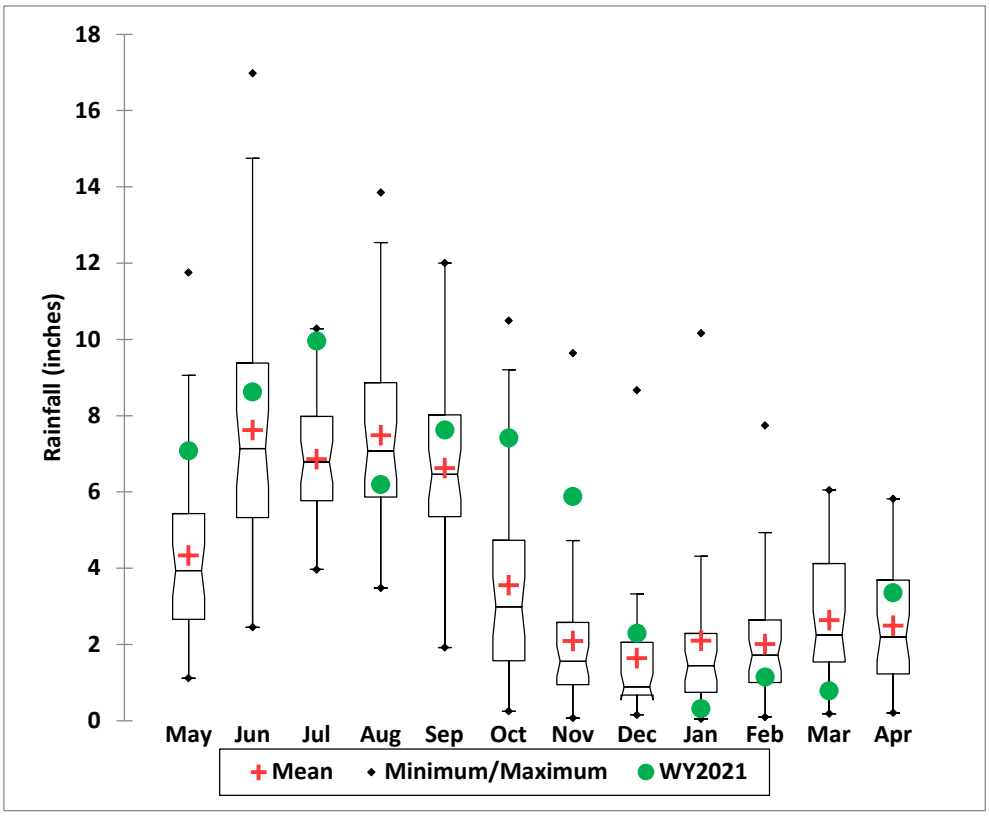


Figure 4-6. WY2021 measured EAA Basin monthly rainfall compared to the WY1980–WY2020 historical period.

The EAA compliance methodology accounts for variations in hydrologic conditions between the baseline period and the current water year. For reference, the baseline period data on which the model TP load equation is based includes a range of annual rainfall levels and monthly distributions. The model TP load equation (found in Chapter 40E-63, F.A.C., Appendix A3, or by the following link https://www.sfwmd.gov/sites/default/files/documents/40e_63_everglades_prog.pdf) is based on annual rainfall (total amount) as the first predictor, and monthly rainfall distribution (rainfall variability) as a second predictor. In general, the higher annual rainfall generates higher runoff TP load. **Figure 4-7** depicts the EAA Basin measured runoff TP load and annual rainfall for each water year since the start of the baseline period.

The EAA Basin water year compliance assessment results are presented in **Figure 4-8** beginning with the first water year, WY1996, the EAA Basin was assessed for compliance. **Figure 4-8** presents the assessment that takes place annually by which the TP load discharged from the EAA Basin is compared against a target and a limit. The EAA Basin percent TP load reduction trend was also updated as presented in **Figure 4-9**. The red line shows the five-year trend of percent load reduction. The diamond (♦) symbols represent the annual TP load reduction percentage. An upward trend in the red line in **Figure 4-9** denotes a reduction in loads; that is, an increase in the TP load reductions. Also, as shown in **Figure 4-9**, there is variability in the annual TP load reduction levels, with a 26-year overall average reduction of 57%.

Detailed information on the procedures SFWMD followed to determine whether the EAA Basin met the compliance requirement of the TP loads in runoff is presented in Appendix 4-1 of this volume. This includes the data collection sources and methods applied in WY2021. The appendix also includes supplemental information for the EAA Basin at basin and permit levels, including permit-level monitoring data.

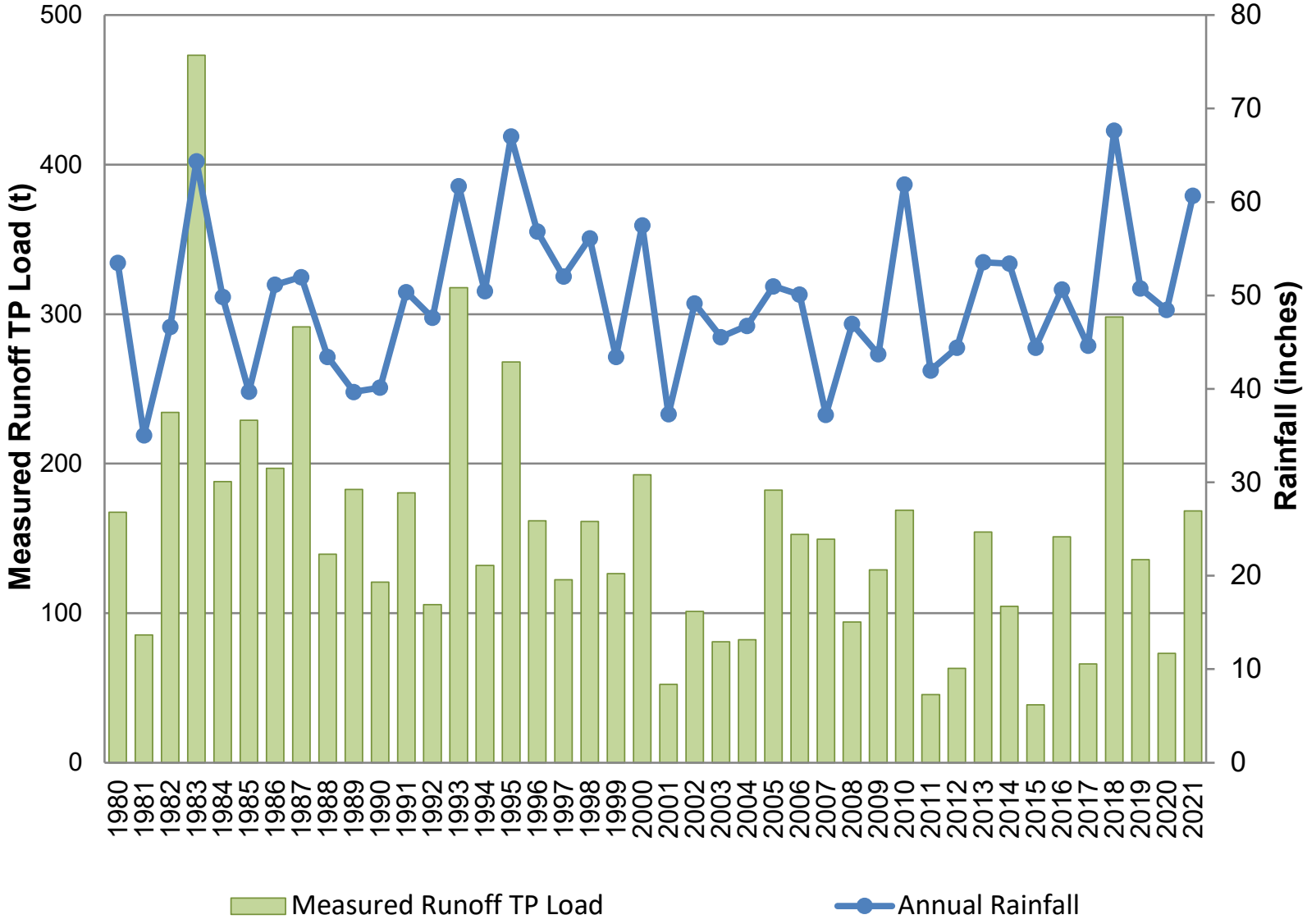


Figure 4-7. WY1980–WY2021 EAA Basin measured runoff TP load and annual rainfall.

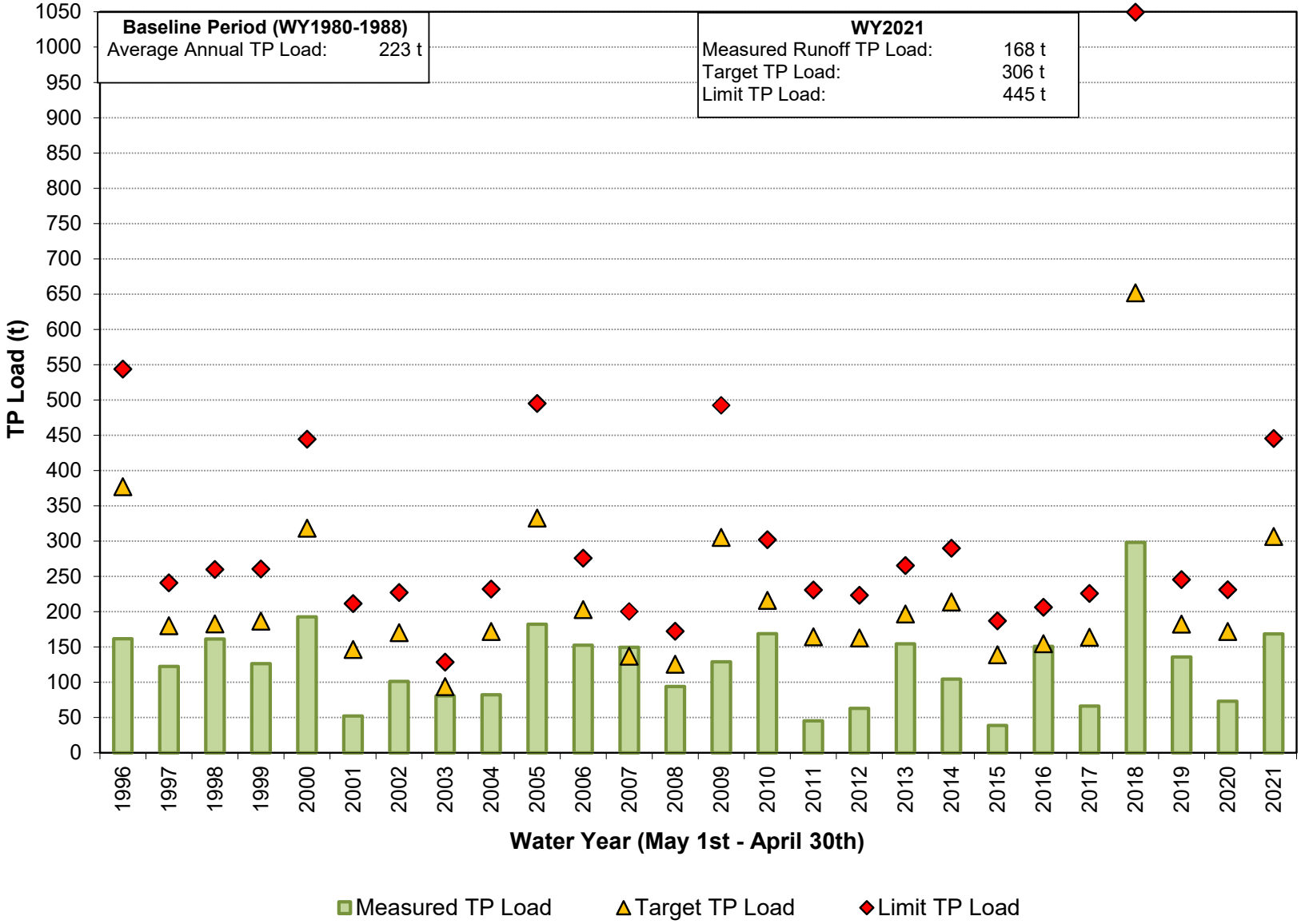


Figure 4-8. EAA Basin TP load data summary by water year.

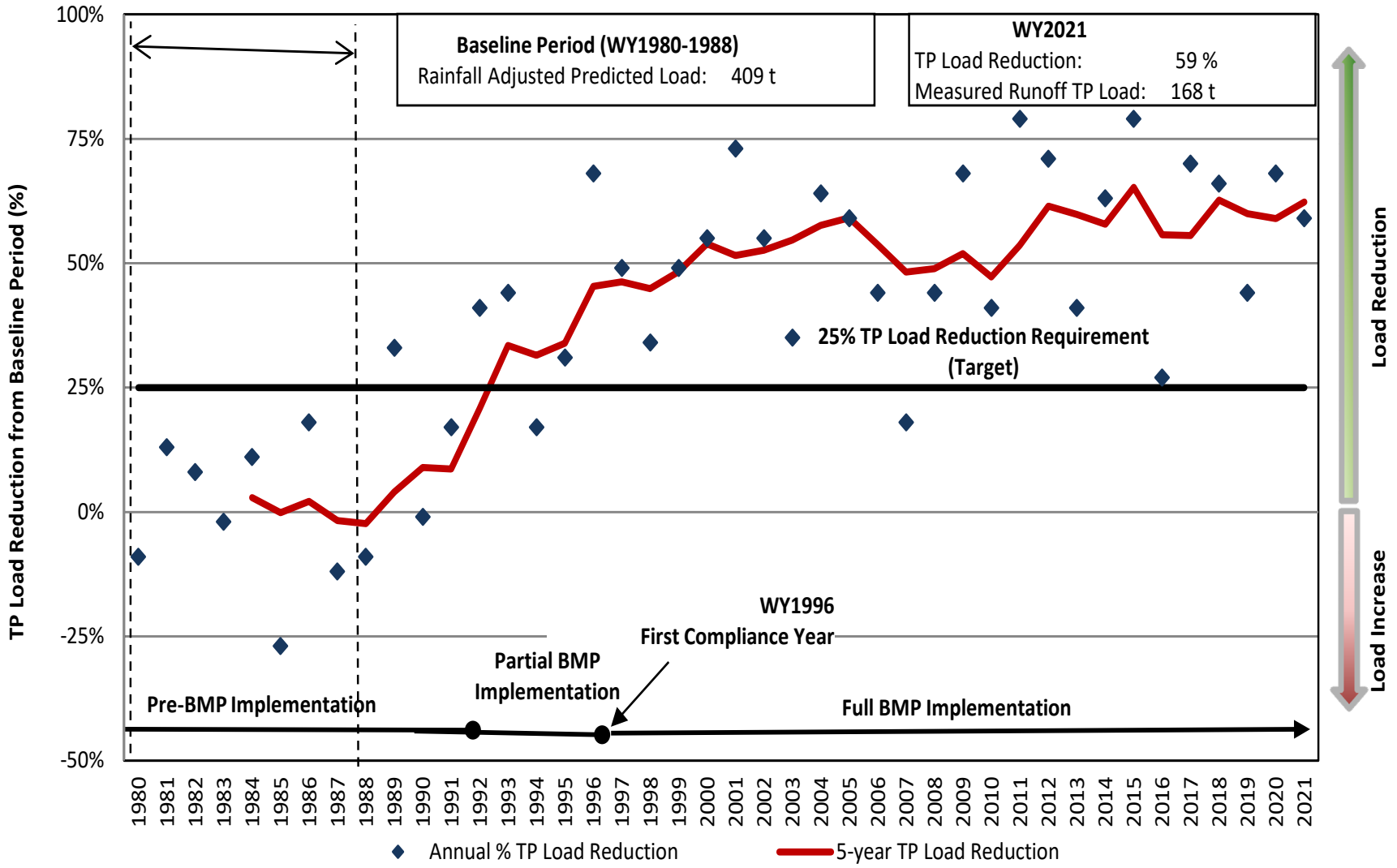


Figure 4-9. WY1980–WY2021 EAA Basin percent TP load reduction from baseline period.

C-139 BASIN UPDATE

In addition to focusing on ensuring that permittees met all permit reporting requirements, permits in the C-139 Basin were renewed in WY2021. At the end of WY2021, a total of 57 basins within the C-139 Basin were permitted under Noticed General permits. The remaining acreage is associated with parcels with no discharge or less than 40 ac qualifying for No Notice General permits. SFWMD continued to provide BMP training to update permittees on BMP implementation and on-site field verification requirements and basin compliance results. SFWMD collected water quality samples to calculate phosphorus loading from all basin boundary structures used for the basin-level compliance assessment and for tracking trends at the subbasin-level and upstream synoptic level. In WY2021, SFWMD continued collecting data at its C-139 Basin upstream synoptic monitoring sites (also known as the C139B project). The goal of this project is to further understand upstream drivers of TP load contributions to the C-139 Basin, improve program effectiveness, and assist with focused remedial action if water quality goals are not met for the C-139 Basin. Data collected to date are presented in Appendix 4-2 of this volume. A map of the C-139 Basin boundary monitoring sites in WY2021 is shown in **Figure 4-10**.

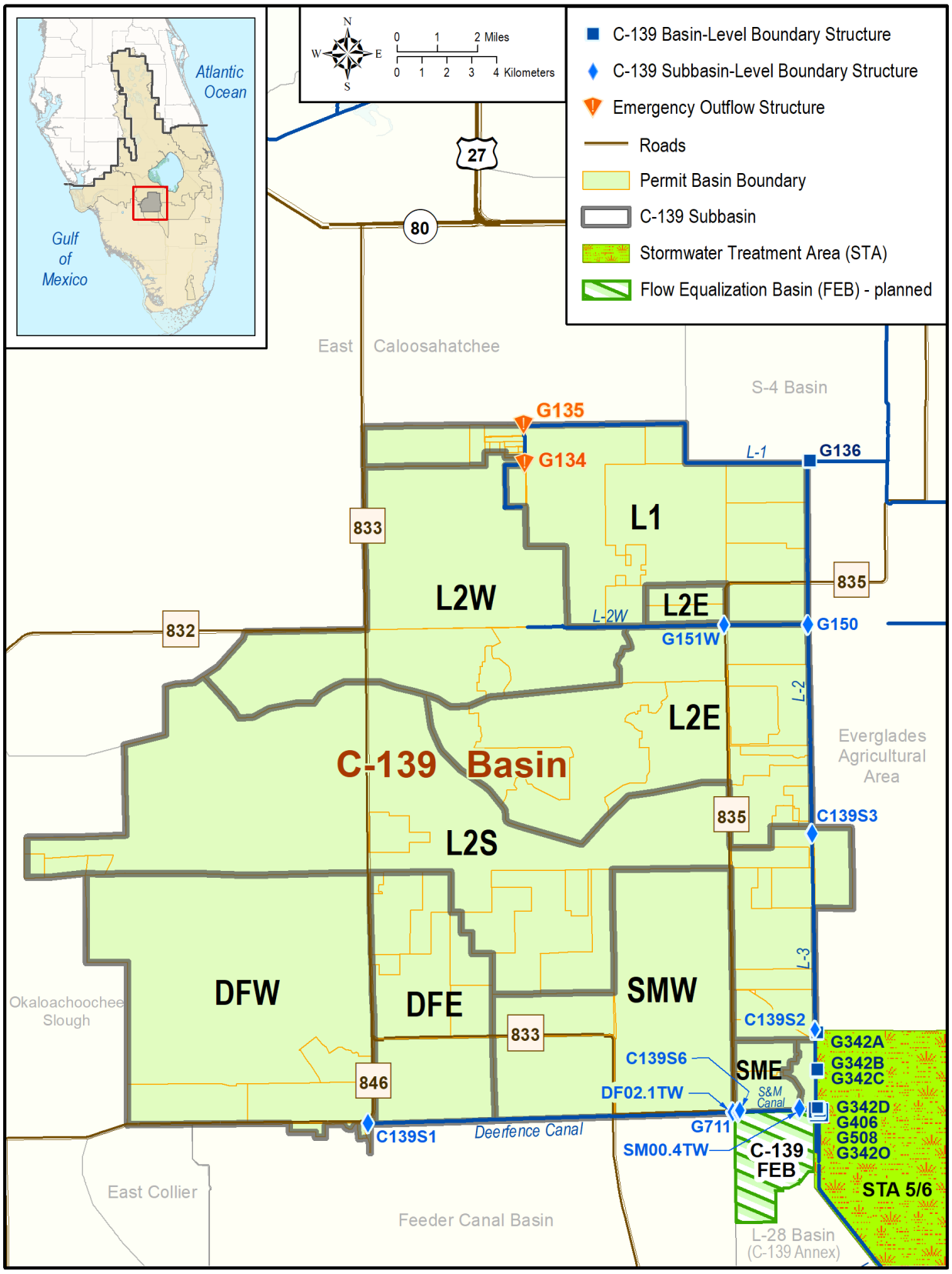


Figure 4-10. WY2021 C-139 Basin boundary and compliance sites.

C-139 Basin WY2021 Results

The performance measure compliance evaluation for the C-139 Basin, as defined by Chapter 40E-63, F.A.C., is presented below. The C-139 Basin is required to maintain historic TP levels. Noncompliance with the performance measure occurs when the target load is exceeded for three consecutive years or the limit load is exceeded in a single year. **Table 4-9** provides a summary of the C-139 Basin WY2021 TP loads for the performance measures. Although the measured TP load in runoff from the C-139 Basin (46 t) was above the target load (37 t) in WY2021, it was below the limit load (94 t); therefore, the basin met the performance measure TP levels for WY2021. Should the basin exceed the target load the next two consecutive years or the limit load in any one year, then the basin as a whole will be deemed out of compliance with the water quality requirements of Chapter 40E-63, F.A.C. Actions are currently underway to ensure compliance with the target in future water years.

Table 4-9. WY2021 C-139 Basin TP compliance evaluation results.

	TP Load (t)
Target TP load (adjusted for WY2021 rainfall and monthly distribution) [a,b]	37
Limit TP load (upper 90th percentile confidence level for target load)	94
WY2021 measured TP load in runoff from the C-139 Basin with BMP plans	46

a. The baseline period of record is October 1978–September 1988 in accordance with EFA requirements. Under Chapter 40E-63, F.A.C., compliance is based on whole water year periods (May 1–April 30) that fall within the October 1978–September 1988 range, that is, WY1980–WY1988 (May 1, 1979–April 30, 1988). In 2010, Chapter 40E-63, F.A.C., was amended, at which point a calibration period of WY2000–WY2009 was incorporated into the model to improve the model's future representation of the C-139 Basin TP load.

b. The target TP load used for compliance is the estimated baseline period TP load adjusted for WY2021 rainfall and monthly distribution.

In the event the C-139 Basin is determined to exceed required TP levels, Chapter 40E-63.401(3), F.A.C., describes a secondary compliance methodology that relies on the SFWMD subbasin monitoring network[3] to determine the permittees' proportional share of TP load based upon the acres within their hydrologic drainage area relative to the total C-139 Basin acreage. In cases where the C-139 Basin performance measure is not met, SFWMD will institute corrective actions per Chapter 40E-63.444(1)(q), F.A.C., in subbasins where the proportional share is exceeded.

C-139 Basin WY2021 Discussion

The water quality compliance assessment in the C-139 Basin began in WY2003. **Table 4-10** presents the measured TP load in runoff from the C-139 Basin, along with rainfall, flow, and the annual target and limit loads, for each water year since the start of the baseline period. More detailed information such as the historical activities leading up to these observed reductions and subbasin TP loads is presented in Appendix 4-2 of this volume.

[3] Chapter 40E-63, F.A.C., also provides a SFWMD-independent option by allowing permittees to implement a permit-level discharge monitoring plan to demonstrate their proportional share of TP load for the secondary compliance methodology. To date, none of the C-139 Basin permittees have elected to monitor.

Table 4-10. WY1980–WY2021 C-139 Basin TP measurements and calculations

Water Year	Annual Rainfall (inches) [a]	Water Year Measured Runoff TP Load [b] (t)	Baseline Period Estimated Runoff TP Load [c] (t)	Limit TP Load (t)	Calculated TP FWMC [d] (µg/L) [a]	Annual Flow (10^3 ac-ft) [a]	Baseline Period and BMP Status Timeline [e]	
1980	56	37	42	76	173	172	Baseline Period	Pre-BMP Implementation
1981	31	4	4	7	69	51		
1982	39	6	9	16	120	44		
1983	72	154	115	222	363	345		
1984	47	41	20	36	215	156		
1985	47	15	20	35	195	63		
1986	47	18	19	34	129	110		
1987	60	38	55	101	208	149		
1988	48	29	22	38	252	94		
1989	41	15	11	20	163	73		
1990	40	6	10	18	102	46		
1991	48	5	21	37	93	45		
1992	51	13	28	50	104	100		
1993	56	27	39	71	162	137		
1994	52	23	30	54	134	137		
1995	60	65	54	98	194	272		
1996	60	48	55	101	164	236		
1997	56	46	40	72	226	165		
1998	57	36	43	77	170	170		
1999	51	36	30	53	212	136		
2000	54	52	36	65	210	202		
2001	36	17	6	12	245	57		
2002	54	66	36	64	267	200		
2003	55	76	39	70	276	224	40E-63e	Increasing BMP Implementation [f,g]
2004	49	69	25	45	274	204		
2005	50	41	27	48	197	168		
2006	55	107	35	62	260	333		
2007	36	29	7	13	305	77		
2008	42	5	12	22	113	39		
2009	43	52	14	25	256	165		
2010	60	43	54	98	171	202		
2011	41	20	13	31	154	106		Comprehensive BMP Plans [f]
2012	45	15	32	74	159	78	40E-63e	
2013	50	10	22	55	116	73		
2014	47	28	17	41	181	127		
2015	50	27	30	69	206	107		
2016	53	43	33	80	215	164		
2017	45	26	30	69	150	137		
2018	69	90	283	887	221	330		
2019	59	30	47	118	153	161		
2020	57	36	71	172	217	133		
2021	54	46	37	94	266	140		

a. 1 inch = 2.54 centimeters; 10^3 ac-ft = thousands of acre-feet; 1 acre-foot = 1,233.5 cubic meters; and 1 µg/L ≈ 1 part per billion (ppb).

b. TP values attributable only to the C-139 Basin.

c. Target (estimated) TP load represents the baseline period load adjusted for the rainfall variability compared to the current water year. For WY1980–WY2010, Rule 40E-63, F.A.C., January 2002, and for WY2011–current, Amended Rule 40E-63, F.A.C., November 2010.

d. Calculated TP FWMC is calculated based on the measured runoff TP load and the C-139 Basin outflow.

e. C-139 Basin compliance assessment under Chapter 40E-63, F.A.C. WY2003 first compliance assessment year as adopted in January 2002. WY2012 first compliance assessment year as amended in November 2010.

f. Please refer to Appendix 4-2 Table 1 of this volume for a summary of the C-139 Basin BMP implementation timeline.

g. Referred to as Pre-Comprehensive BMP Program Period in **Table 4-11**.

The C-139 Basin data summary is provided in **Table 4-11** for the baseline period, calibration period, BMP program period, and historical period of record comparing annual rainfall, TP load in runoff, target (baseline period estimated load) and limit loads, TP FWMC, and flow, including the average, median, minimum, and maximum for each parameter. As shown in **Tables 4-10** and **4-11**, in WY2021, the C-139 Basin average runoff TP load (46 t) and TP FWMC (266 µg/L) during WY2021 were greater than the average runoff TP load (38 t) and TP FWMC (235 µg/L) for the baseline period. The average TP load during the baseline period (WY1980–WY1988) compared to WY2021 increased from 38 to 46 t. Contributing factors causing this increase will be discussed below and in Appendix 4-2.

Table 4-11. C-139 Basin data summary comparing the baseline period, BMP program period, and WY2021

	Rainfall (inches)	Water Year Measured Runoff TP Load (t)	Baseline Period Estimated Runoff TP Load (t)	Limit TP Load (t)	Calculated TP FWMC (µg/L)	Annual Flow (10^3 acre-feet)
Baseline Period (WY1980–WY1988)						
Average	50	38	-	-	235	132
Median	47	29	-	-	195	110
Minimum	31	4	-	-	69	44
Maximum	72	154	-	-	363	345
Comprehensive BMP Program Period (WY2011–WY2021)						
Average	50	38	37	82	192	146
Median	50	30	30	55	194	137
Minimum	31	4	4	7	69	39
Maximum	72	154	283	887	363	345
WY2021						
	54	46	37	94	266	140

The C-139 Basin monthly rainfall for the historical period WY1980–WY2020 is compared to the rainfall observed in WY2021 (**Figure 4-11**) to demonstrate the effect of the monthly rainfall on the estimated rainfall generated runoff TP load. **Figure 4-12** depicts the C-139 Basin annual rainfall and TP load measured in discharges from the basin for each water year since the start of the baseline period. **Figure 4-13** compares the C-139 Basin monthly rainfall and measured TP load in runoff between the WY1980–WY2020 historical period (**Figure 4-13, left panel**) and the WY2021 period (**Figure 4-13, right panel**).

As discussed above in the *EAA Basin Update* subsection of this chapter, the model TP load equation for the C-139 Basin (found in Appendix B2 of Chapter 40E-63, F.A.C., or by the following link: https://www.sfwmd.gov/sites/default/files/documents/40e_63_everglades_prog.pdf) was developed to account for variations in hydrologic conditions between the baseline period (pre-BMP Program) and the current water year (with the BMP Program), and is based on annual rainfall (total amount) as the first predictor and monthly rainfall distribution (rainfall variability) as a second predictor. Like the EAA Basin method, increasing total annual rainfall or rainfall variability increases the estimated TP load calculated by the model for the baseline period.

The WY2021 estimated TP load (target TP load) representing historic levels was 37 t and the C-139 Basin measured TP load in runoff for WY2021 was 46 t, which is above target TP historic levels. Because the measured TP load was above total target TP load historic levels, monthly TP loads are important to highlight in WY2021. Higher than average rainfall and thus measured loads in the dry season (November and December specifically) were documented in WY2021 (**Figure 4-13**). In fact, the rainfall in November of WY2021 (9.0 inches) was the highest on record since WY1987 (8.8 inches). Consequently, in WY2021, 69% of the measured TP load in runoff occurred in the dry season (historically, only 13% occurred in the dry season).

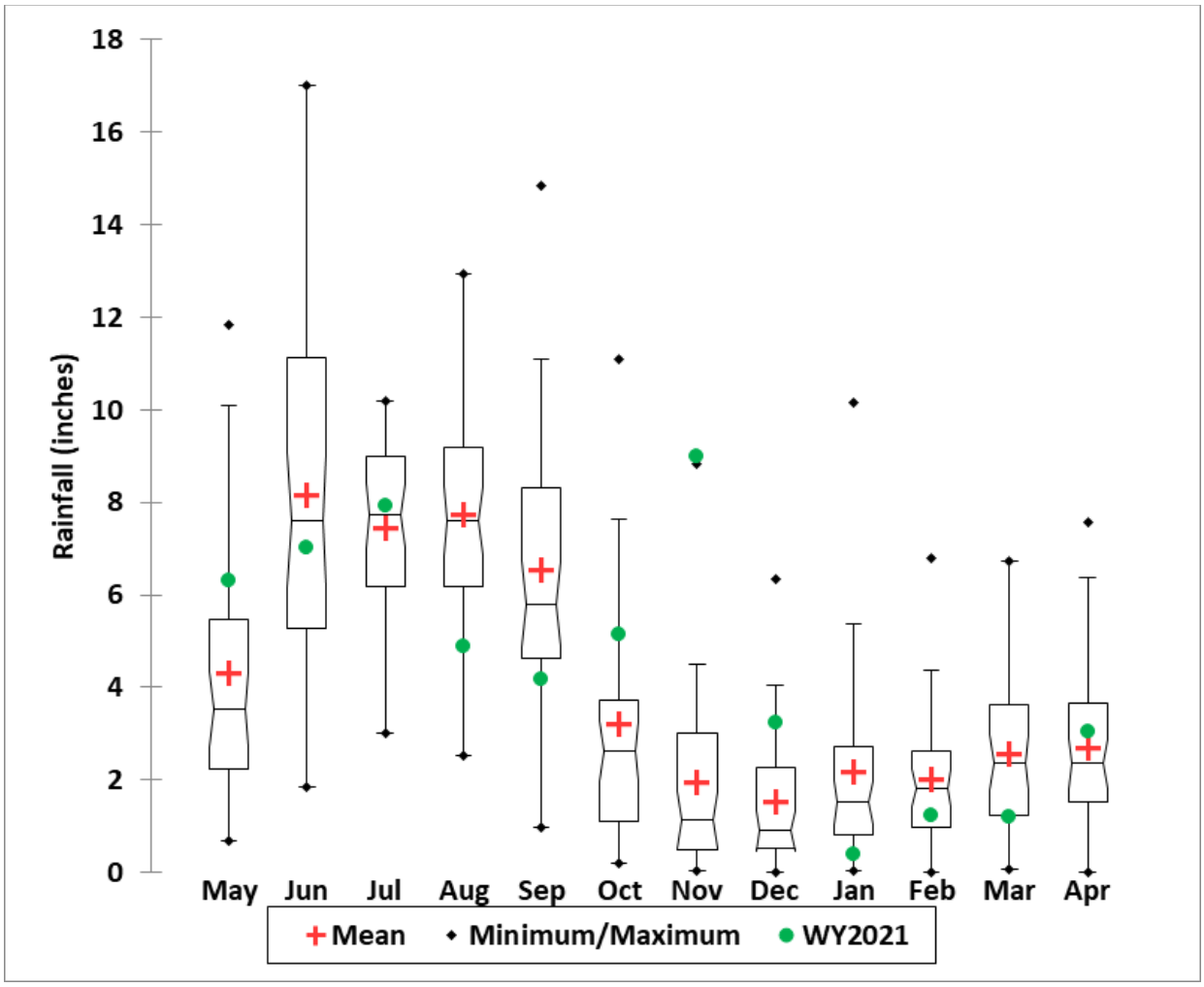


Figure 4-11. WY2021 measured C-139 Basin monthly rainfall compared to the WY1980–WY2020 historical period.

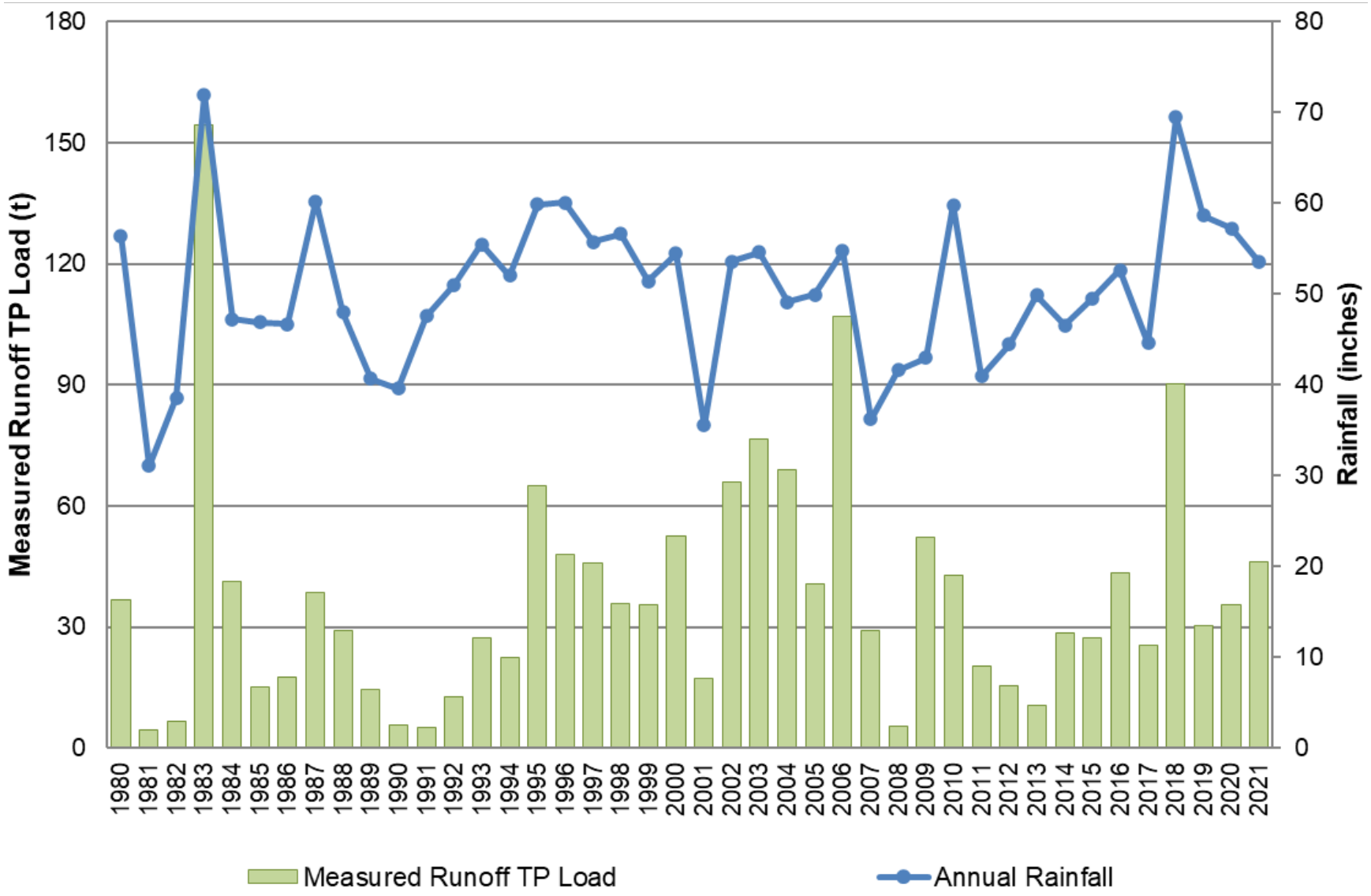


Figure 4-12. WY1980–WY2021 C-139 Basin measured runoff TP load and annual rainfall.

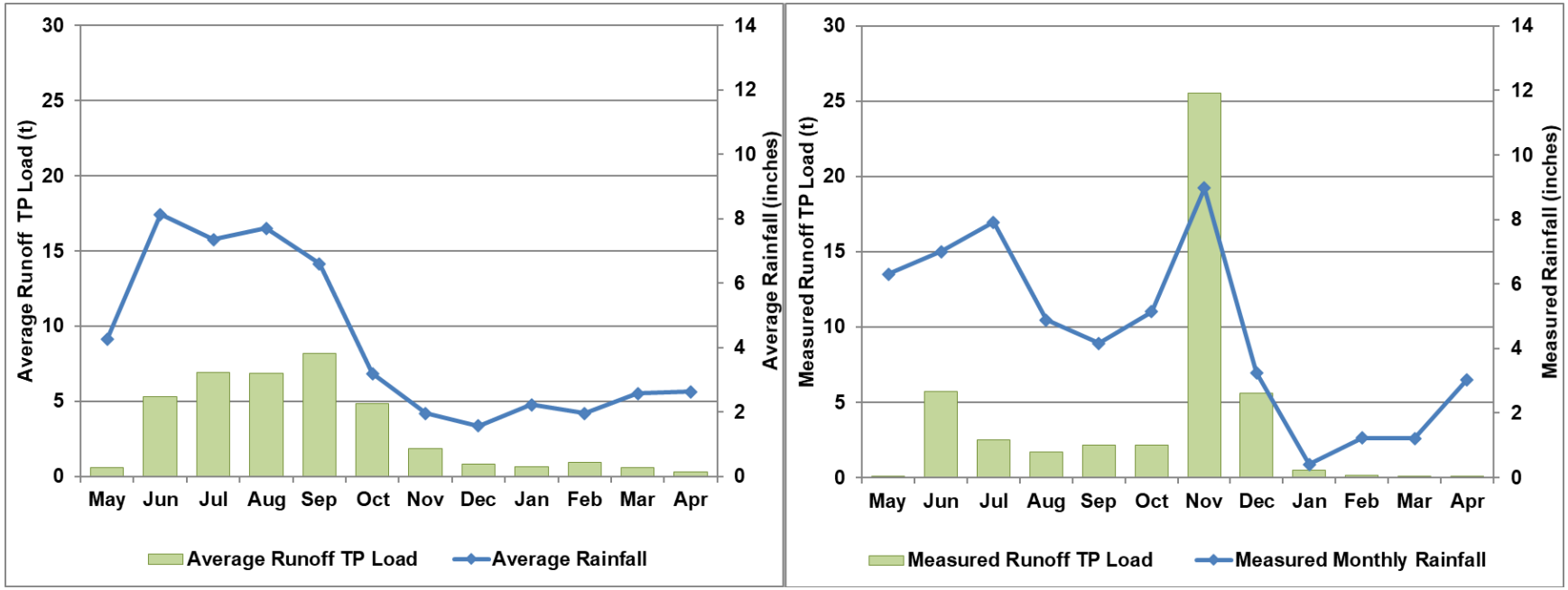
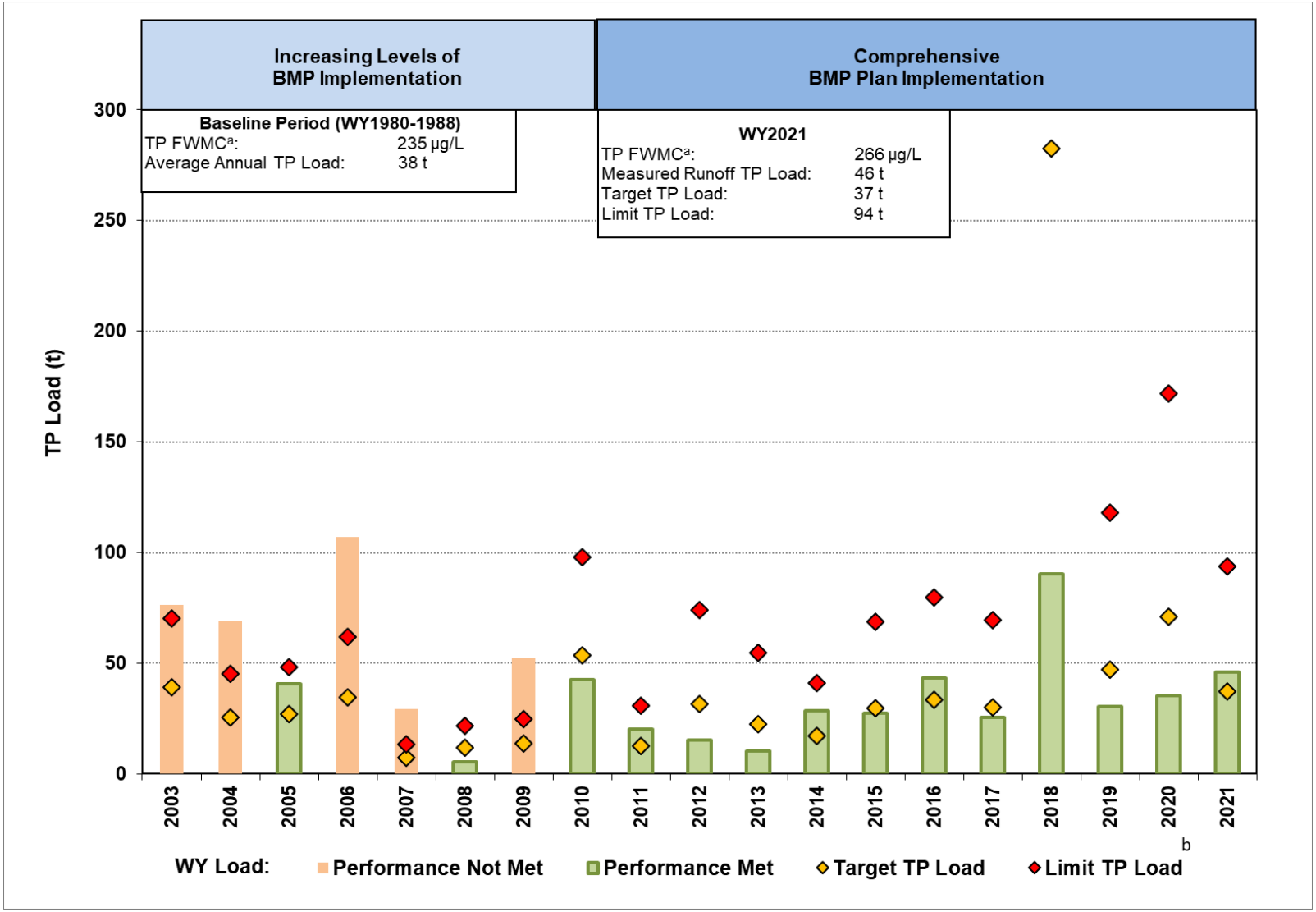


Figure 4-13. Comparison of C-139 Basin monthly rainfall and runoff TP load for WY1980–WY2020 (left) and WY2021 (right).

Localized rainfall can vary substantially over the large C-139 Basin area so basin-specific methods were developed for calculating basin rainfall totals. See discussion below regarding how variations in hydrologic conditions are accounted for in the compliance assessment. Historical data indicates the C-139 BMP program is effective in achieving the EFA mandated TP levels (note that the C-139 Basin was not consistently meeting the required TP levels prior to the rule amendments of 2010).

The C-139 Basin annual assessments of the WOD BMP program are presented in **Figure 4-14**, and historical TP FWMCs with the five-year rolling averages are presented in **Figure 4-15**. When reviewing these results, note that target and limit loads from WY2003 to WY2010 are based on methods adopted under Chapter 40E-63, F.A.C., in January 2002, and were expressed as a function of annual rainfall observed during the WY1980–WY1988 baseline period to account for hydrologic variability. Based on multiple metrics, including a lower standard error and the ability to explain a higher percentage of the variance in the TP load data, it was determined that the relationship between rainfall and load improved when it is based on both the monthly distribution of rainfall and total annual rainfall. Therefore, the targets and limits derived and adopted under the November 2010 Chapter 40E-63, F.A.C., amendment are based on a multiple linear regression equation of the annual C-139 Basin TP load as a function of the annual rainfall and the monthly distribution of rainfall to account for hydrologic variability. The November 2010 amendment also included refining the load compliance methodology to account for regional system changes; for example, the completion of STA-5, and hydrologic conditions that occurred during the calibration period (WY2000–WY2009). The model TP load equation for the C-139 Basin can be found in Appendix B2 of Chapter 40E-63, F.A.C., or by clicking on the following link: https://www.sfwmd.gov/sites/default/files/documents/40e_63_everglades_prog.pdf. The data collection sources and detailed methods to determine whether the C-139 Basin met the requirement to maintain historic TP loads in runoff are presented in Appendix 4-2 of this volume.



a. TP FWMC calculated based on the measured TP load and the C-139 Basin outflow.
b. WY2018 limit TP load off-scale.

Figure 4-14. C-139 Basin TP load data summary by water year.

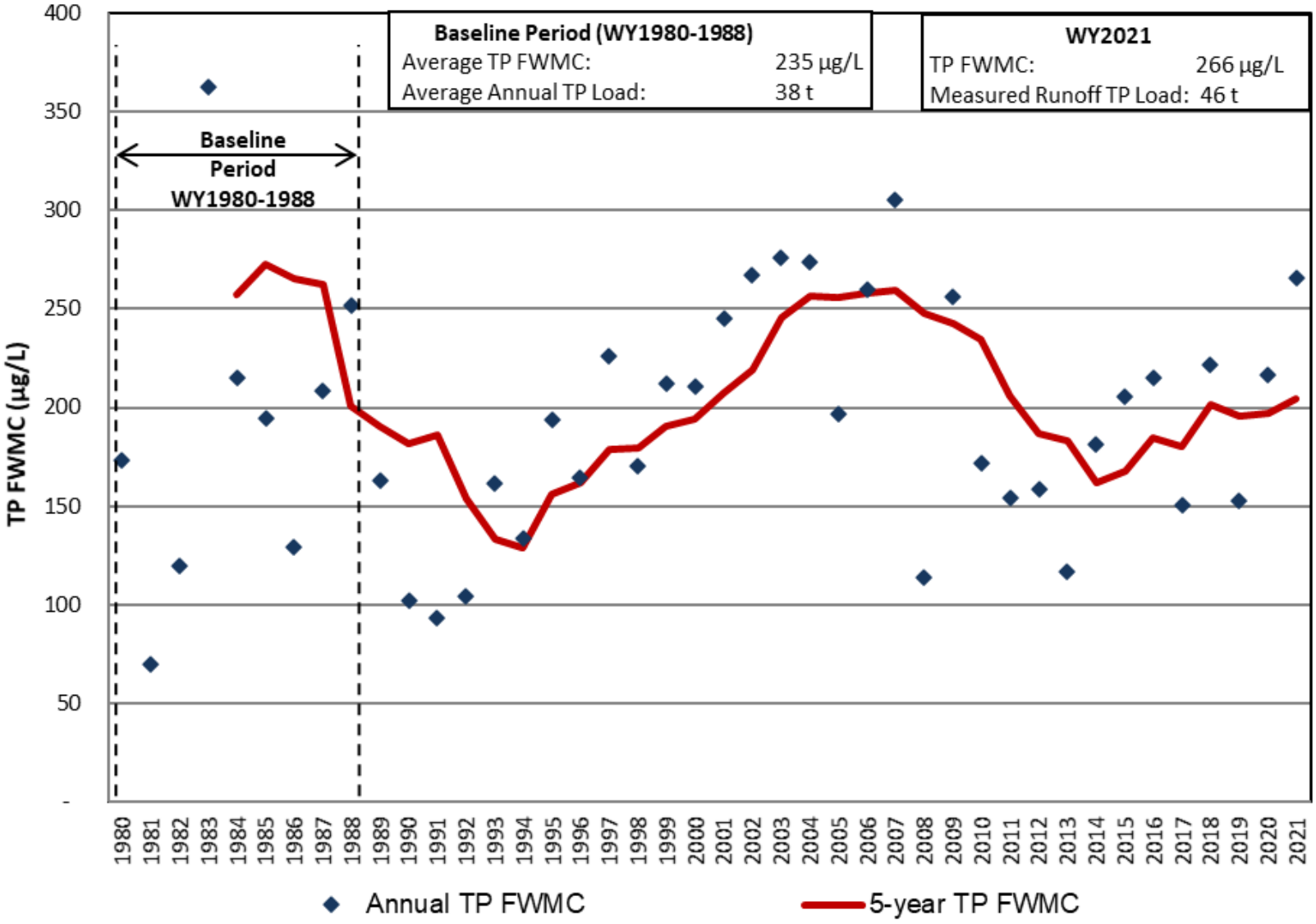


Figure 4-15. WY1980–WY2021 C-139 Basin annual TP FWMC and five-year rolling averages.

SOURCE CONTROL PROGRAMS IN THE OTHER TRIBUTARY BASINS

Steve Sarley, Youchao Wang, and Aubrey Frye

Contributors: Pamela Wade, Carmela Bedregal, and Olena Leskova

BACKGROUND

Because of their relatively small TP load contributions discharged directly into the EPA, other tributary basins, historically referred to as the Non-Everglades Construction Project (Non-ECP) or Everglades Stormwater Program (ESP) basins, were not included within the Chapter 40E-63, F.A.C., regulatory BMP program. Instead, each of these basins were required to implement basin-specific water quality improvement plans (WQIPs) and monitoring programs designed to assess progress towards achieving water quality goals. The basins include the C-11 West, C-111, Feeder Canal, L-28, Acme Improvement District (serving the Village of Wellington, and Acme Basins A and B), North Springs Improvement District (NSID), Boynton Farms, and North New River (NNR). These are shown in **Figure 4-16**.

Currently, only five of the original basins continue to discharge directly to the EPA: C-11 West, C-111, Feeder Canal, L-28, and NSID. Boynton Farms and NNR basins have diverted discharges away from the EPA and are no longer monitored for water quality in discharges to the EPA. Discharges to the EPA, i.e., Water Conversation Area (WCA) 1, from Acme were diverted in 2007 to combine with discharges from the C-51 West Basin, and Acme Basin A and Acme Basin B became subbasins of the C-51 West Basin. However, Acme Basin B can discharge directly to WCA-1 through structure Acme 2, during emergency conditions.

To address TP in discharges pursuant to the EFA, an FDEP permit was issued to SFWMD to implement WQIPs describing activities within these basins (see Appendix 4-3 for more information). WQIPs were developed through a public process that considered basin-specific conditions and stakeholder input, and included a combination of source controls using BMPs, diversion strategies, integration of local projects, capital improvement projects and water quality monitoring to track progress. The WQIPs were included in the October 27, 2003, Long-Term Plan and its subsequent revisions, and were ultimately incorporated into enforceable FDEP-issued permits, SFWMD-issued Environmental Resource permits (ERPs), and/or local cooperative agreements. The WQIPs for each basin are listed in Appendix 4-3 of this volume.

The Long-Term Plan included interim TP FWMCs for the C-11 West, Feeder Canal, L-28, Acme, NNR, and NSID basins pending completion of the Comprehensive Everglades Restoration Plan (CERP) and other regional projects designed to divert discharges away from the EPA. The C-111 Basin and Boynton Farms basins were not included in the Long-Term Plan, as strategies for these basins were to be addressed by other SFWMD and/or federal programs. The basin-specific TP performance goals are established in formal agreements and the interim TP FWMCs are documented in the Long-Term Plan and are listed for each basin in the next section. For more detailed information, see Appendix 4-3 of this volume.

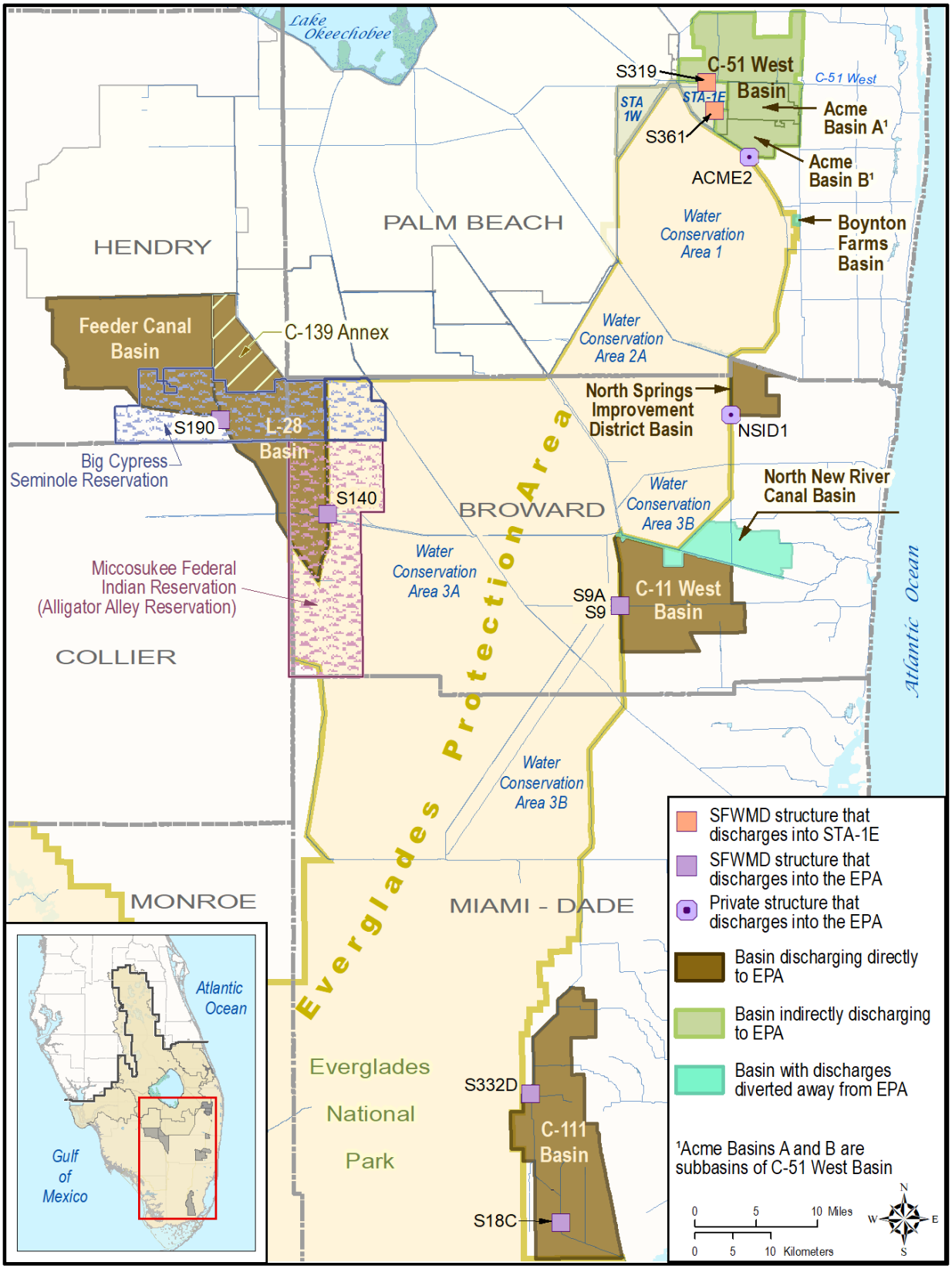


Figure 4-16. Other basins tributary to the EPA and associated structures. (Note: STA-1E – STA 1 East.)

WATER QUALITY RESULTS SUMMARIES

The TP FWMC for each tributary basin by water year is presented in **Table 4-12** beginning in 1998 when the FDEP permit was issued requiring WQIPs and water quality monitoring[4]. The distribution of TP loads from the basins is presented in **Figure 4-17** for WY1998–WY2021. The total rainfall recorded in WY2021 for each tributary basin ranged from 63 to 76 inches, which was above the 23-year historical average rainfall of 52 inches. As a result of high rainfall during WY2021, a total TP load of 48 t was discharged directly to the EPA from these basin structures, including 9 t from the C-11 West Basin, 4 t from the C-111 Basin, 16 t from the Feeder Canal Basin, and 18 t from the L-28 Basin. WY2021 levels are on the relatively high end of the TP load levels historically discharged to the EPA, which ranged from 11 t in WY2011 to 55 t in WY2018. With the TP load of 30 t from C-51 West Basin, the WY2021 total TP load from the other tributary basins is the highest TP load since WY1998. Appendix 4-3 of this volume provides additional information on TP FWMCs and loads discharged to the EPA from these basins, data submitted in association with SFWMD-issued ERPs, and agreements mandating upstream monitoring. Appendix 3-2 of Volume III provides the annual report satisfying requirements of the FDEP permit.

Table 4-12. WY1998–WY2021 TP FWMC for other basins tributary to the EPA. [a]

Water Year	TP FWMC (µg/L)							
	C-11 West	NNR [b]	NSID [b]	Feeder Canal	L-28	C-111	Acme [b,c]	C-51 West [d]
1998	17		33	80	36	9	94	
1999	19		18	76	55	9	161	
2000	30		27	110	70	8	144	
2001	23	13	16	161	144	9	94	
2002	19	16	16	88	48	6	122	
2003	17			87	62	7	100	
2004	16	16		99	42	8	89	
2005	16		20	97	42	8	171	
2006	18			155	50	13	97	
2007	15			215	47	6	129	
2008	16			101	36	7		100
2009	15			137	40	7		129
2010	18			73	55	7		221
2011	13			45	39	11		82
2012	15			41	48	8		83
2013	14		26	97	50	8	139	216
2014	13			76	47	6		180
2015	13			108	74	5		29
2016	16			114	64	7		108
2017	15		6	97	45	9		118
2018	30		71	123	69	9		217
2019	18		29	53	64	7		227
2020	13			78	54	6		87
2021	25		5[e]	139	78	7		131

a. Historically, flow data has not been available for the Boynton Farms Basin. However, since December 2011, there have been no structures that discharge from the basin to the EPA.

b. The structures serving the NNR, NSID, and Acme basins that discharge to the EPA are only sampled when they discharge to the EPA. Years with blanks represent years with no discharge to the EPA.

c. Acme TP FWMC represents Acme Basin discharges to WCA-1 only. Structures Acme 1 and Acme 2 that discharged to WCA-1, ceased operation in WY2007, because of the diversion of Acme Basin B flows away from WCA-1. The Acme 1 structure was removed shortly after. The Acme 2 structure can flow to the WCA-1 under emergency conditions; for example, the Acme 2 structure flowed into the WCA-1 during Tropical Storm Isaac (August 28–31, 2012).

d. Values represent C-51 West discharges to STA-1 East only. As discussed in footnote c, Acme Basin B flows were diverted away from WCA-1 upon the completion of the Acme Basin B CERP project in WY2007.

e. TP values for NSID is below minimum detection limit (MDL) (MDL= 0.00930 mg/L). Therefore, we use half of the MDL as the TP value and round to 5 ppb.

[4] The Boynton Farms Basin is not included in **Table 4-12** and **Figure 4-17**, as flow data was not collected from this basin prior to its diversion in 2011.

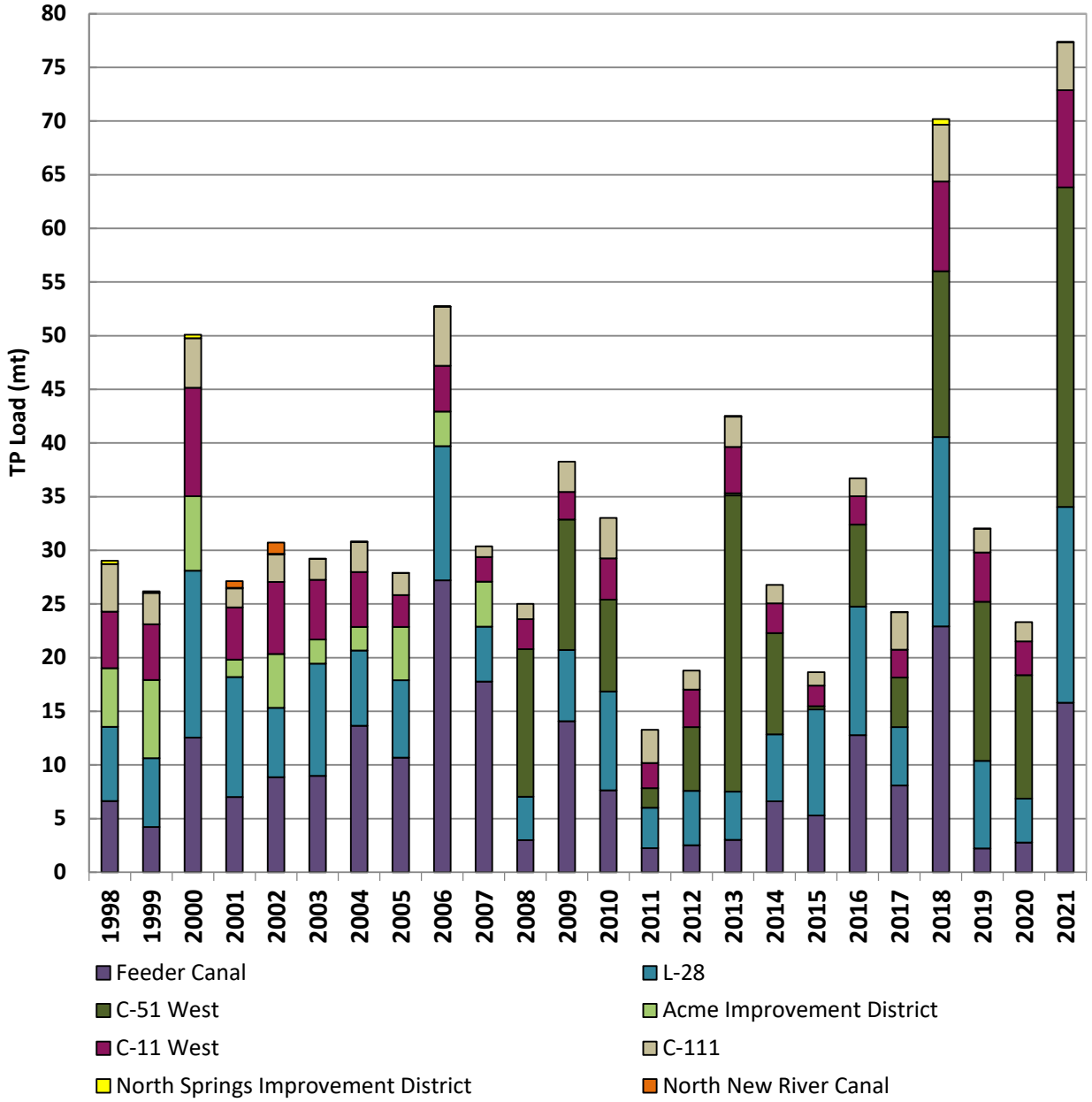


Figure 4-17. Tributary basin TP load for WY1998–WY2021.
(Note: Acme Improvement District, which consists of Acme Basin A and Acme Basin B, became subbasins of C-51 West and are included with C-51 West Basin TP loads beginning in WY2008. Prior to WY2008, Acme Improvement District TP loads were sent directly to WCA-1.)

SOURCE CONTROL STRATEGY FOR OTHER TRIBUTARY BASINS

WQIPs for these tributary basins include a combination of source controls and integration with local and federal projects. SFWMD works cooperatively with local governments, the Seminole Tribe of Florida, the Miccosukee Tribe of Indians of Florida, and state and federal agencies to ensure essential components of the WQIPs are implemented and maintained. Strategy updates reflect the revised schedules of associated CERP projects as changes occur. Water quality monitoring programs implemented through SFWMD-issued permits and cooperative agreements play a key role in tracking the progress and adjusting strategies as needed. Verification of strategy implementation will remain a priority. In WY2021, source control activities in these basins continued as summarized below. Refer to Appendix 4-3 of this volume for a brief discussion on these basins as well as historical information including a chronology of basin strategies and WQIP components for each basin.

C-11 West Basin

The C-11 West Basin (**Figure 4-18**) encompasses approximately 43,000 ac in south-central Broward County west of Fort Lauderdale, and includes portions of Weston, Sunrise, Cooper City, Pembroke Pines, Davie, Southwest Ranches, and unincorporated areas. Urban areas currently encompass approximately 70% of the basin, with agricultural and nursery land uses comprising the remainder. Four primary canals are located within this basin: C-11 West, C-11 South, L-37 Borrow, and a portion of the L-33 Borrow. Discharge from the C-11 West Canal flows into the L-33 Canal within proximity to the S-9 and S-9A structures, which direct flow into WCA-3A. A divide structure, S-381, is located approximately 1.5 miles east of S-9/S-9A along the C-11 West Canal serving to reduce inflow of drainage from the basin into the L-33 Canal. Surface water management operations within the C-11 West Basin are conducted by three drainage districts: Indian Trace Development District (ITDD), South Broward Drainage District (SBDD), and Central Broward Water Control District (CBWCD).

Elements of the WQIPs in the C-11 West Basin include water quality monitoring and structural and operational BMPs. Each of the drainage districts were responsible for executing the provisions of the WQIPs via cooperative agreements established with SFWMD in the early 2000s. Certain WQIPs monitoring requirements were later incorporated into ERPs issued to SBDD and ITDD. Water quality reports submitted in compliance with ERP requirements for areas within these drainage districts are reviewed by SFWMD and provide tracking of WQIP effectiveness. The water quality data for SBDD and ITDD are summarized in Appendix 4-3 of this volume. ERP-specific monitoring requirements for entities within the C-11 West Basin (permits 06-01400-S and 06-00709-S) are available on the SFWMD website via the e-Permitting portal (https://www.sfwmd.gov/doing-business-with-us/permits).

In addition to WQIPs, efforts are underway to design and construct the Broward County Water Preservation Areas (BCWPA) CERP Project, which consists of two aboveground impoundments (C-11 and C-9) and an approximate 0.05-mile-wide wetland buffer strip running along the eastern borders of WCA-3. These components are designed to reduce seepage from WCA-3 to the C-11 and C-9 basins; maintain existing levels of service for flood protection; increase the spatial extent of wetlands; improve hydroperiods and hydropatterns in WCA-3; and provide recreational opportunities. The United States Army Corps of Engineers (USACE) awarded a design contract to an architectural engineering consulting firm (Stantec/Tetra Tech) in September 2020 to complete the preliminary, intermediate, final, and corrected final design for the C-11 Impoundment feature. Design is anticipated to be completed by March 2022. The seepage modeling contract for this feature is ongoing and anticipated to be completed by September 2021. SFWMD is continuing to work on utility relocations necessary for this project. For additional information, see the USACE's website at http://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Broward-County-Water-Preserve-Areas/.

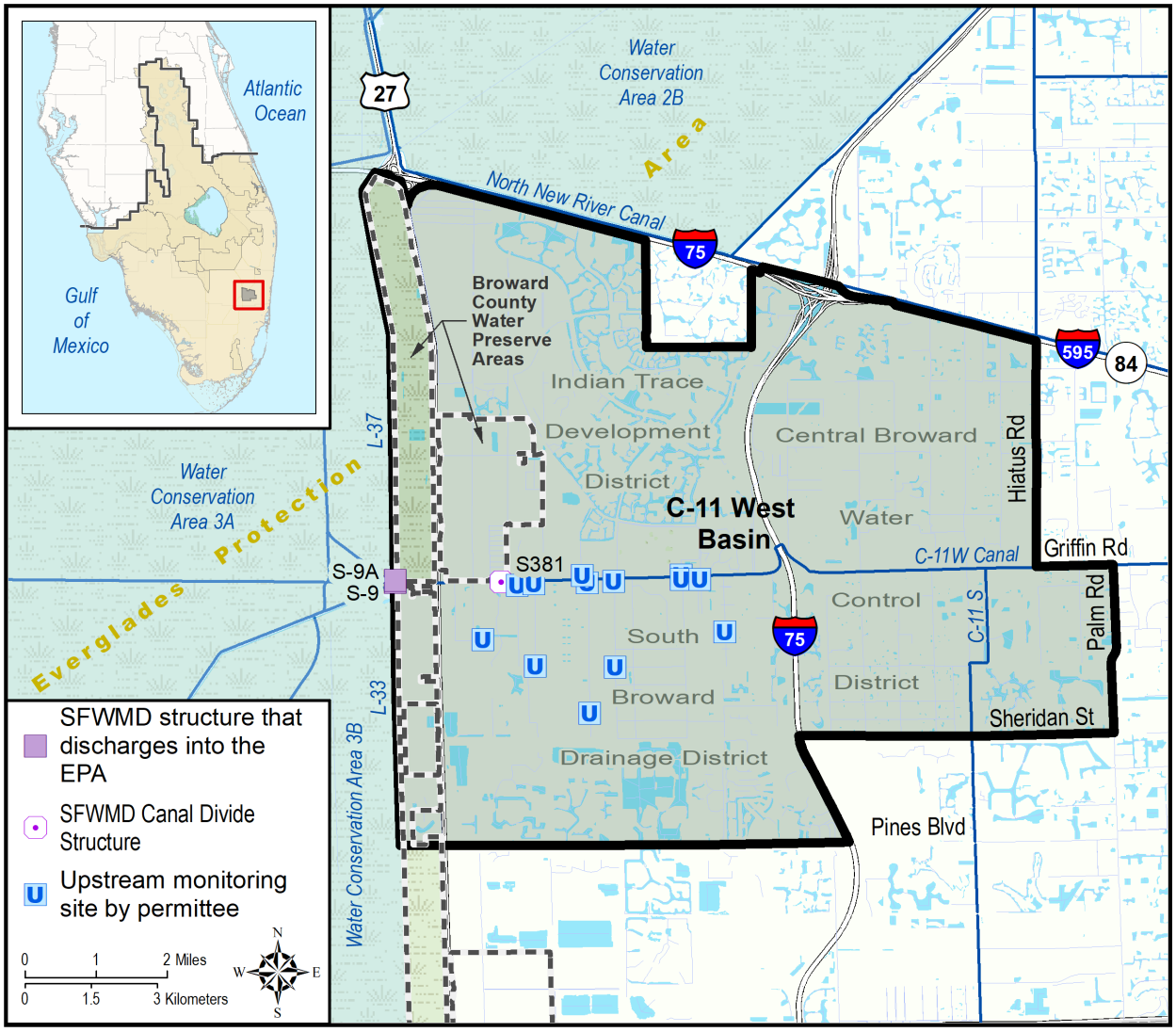


Figure 4-18. C-11 West Basin.

Table 4-12 and **Figure 4-17** above summarize the annual TP FWMC and load based on water quality data collected at S-9 and S-9A for WY1998–WY2021. In comparison to C-11 West Basin TP FWMC goals of 17 to 28 µg/L (Burns & McDonnell 2003), TP FWMC at S-9 and S-9A have ranged from 13 µg/L in WY2011, WY2014, WY2015, and WY2020, to 30 µg/L in WY2018. Refer to Appendix 4-3 of this volume for additional water quality monitoring data summaries and upstream monitoring data summaries for the C-11 West Basin.

C-111 Basin

The C-111 Basin (**Figure 4-19**) encompasses approximately 64,000 ac in the southern portion of Miami-Dade County adjacent to Everglades National Park (ENP), and is composed primarily of agricultural lands, along with some urban portions of Florida City and Homestead. Five operational canals (C-111, C-111E, C-113, L-31N Borrow, and L-31W Borrow) in the basin (1) provide drainage and flood control protection for the C-111 Basin; (2) provide water supply to the C-111, C-102, and C-103 canals; (3) provide water supply to ENP, specifically Taylor Slough via structure S-332D, and the eastern panhandle of ENP

via overbank flow between structures S-18C and S-197; and (4) maintain groundwater near the lower reach of the C-111 Canal at levels adequate to prevent saltwater intrusion.

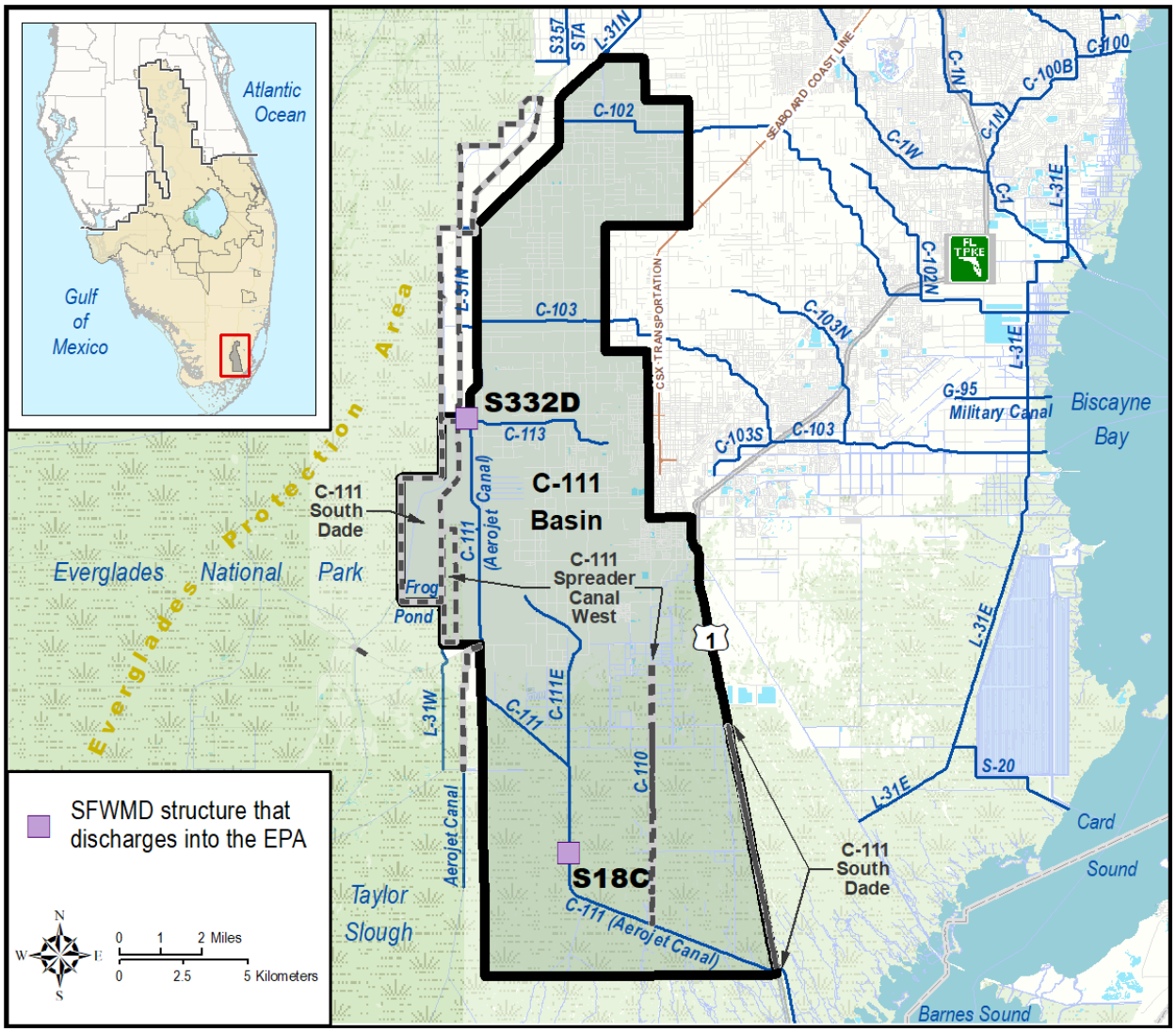


Figure 4-19. C-111 Basin.

The C-111 Basin is included in the FDEP permit but is not addressed in the Long-Term Plan since strategies for this basin are addressed by other SFWMD and federal programs. Current WQIP strategies include water quality monitoring and implementation of the C-111 South Dade and C-111 Spreader Canal Western projects.

The C-111 South Dade Project is designed to restore natural hydrologic conditions in Taylor Slough and the eastern panhandle of ENP while maintaining the existing level of flood protection for agricultural lands in South Dade County. Efforts associated with the project are divided into nine contracts to construct and modify water management features within the C-111 Basin. The C-111 South Dade Project works in concert with the infrastructure constructed as part of the Modified Water Deliveries to ENP project to create a hydraulic ridge that will help prevent groundwater from seeping out of ENP. As of WY2020, USACE and SFWMD have completed all features in the nine contracts.

In January 2020, USACE and SFWMD completed the *Canal 111 (C-111) South Dade Project Replacement of Interim Pump Stations S-332B and S-332C Draft Integrated General Re-Evaluation Report and Environmental Assessment* (USACE and SFWMD 2020) for public review, per the South Dade Project Cooperation Agreement between the two agencies. This recommended plan includes construction of two permanent, hardened pump stations (allowing for a 50-year design life; these will replace temporary pump structures S-332B and S-332C, which are reaching their failure points), an intake canal, concrete lined discharge channels, demolition of the temporary pump stations, and revisiting the cost share for South Dade Project features' operation, maintenance, repair, replacement, and rehabilitation. Once the Assistant Secretary of the Army approves the report, the United States Congress will consider authorization. If authorized, design and construction of the pump stations will be cost-shared equally by USACE and SFWMD. Additional information regarding the project, component contracts, and the draft report may be found at https://www.saj.usace.army.mil/C111SouthDade and in Appendix 4-3 of this volume.

The C-111 Spreader Canal Western Project aims to create a six-mile hydraulic ridge adjacent to ENP, helping to improve water quantity, timing, and distribution in the southern Everglades and Model Lands (wetland areas adjacent to the C-111 Canal that form a contiguous habitat corridor with ENP), downstream estuaries, and Florida Bay via Taylor Slough. Additional information regarding the C-111 Spreader Canal Western Project may be found in Volume III, Appendix 2-4, and Appendix 4-3 of this volume and at https://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/C-111-Spreader-Canal-Western/.

Table 4-12 and **Figure 4-17** above summarize the annual TP FWMC and load for S-332D to Taylor Slough and S-18C to ENP for WY1998–WY2021. Over the past ten water years, TP FWMCs for discharges to ENP have ranged from 5 µg/L in WY2015 to 9 µg/L in WY2018 for the C-111 Basin. Refer to Volume I, Appendix 4-3 and Volume III, Appendix 2-4 for water quality monitoring data summaries for the C-111 Basin. The TP FWMC in WY2021 was 7 µg/L, which is below the long-term goal of 11 µg/L established via the Settlement Agreement. TP concentration results reported as part of the federal Everglades Settlement Agreement for the C-111 Basin, which established long-term TP limits for inflows to Shark River Slough, Taylor Slough, and Coastal Basins, are available at www.sfwmd.gov/techpubs, under Settlement Agreement and Companion Reports.

Feeder Canal Basin

The Feeder Canal Basin (**Figure 4-20**), located in Hendry County, is largely agricultural and encompasses approximately 68,883 ac. The canals and structures within this basin provide flood protection and drainage within three subbasins and convey excess runoff to WCA-3A. The two major canals associated with the Feeder Canal Basin are the North Feeder and West Feeder canals, which merge and discharge through the S-190 structure into the L-28 Interceptor Canal with eventual discharge into WCA-3A.

The North Feeder Subbasin, consisting of approximately 23,150 ac, was under the operation of three landowners in WY2020: ST McDaniel Ranch, LLC, Garcia Farms, and Florida Power & Light (FPL) with discharges controlled downstream by the PC-17A[5] structure.

The West Feeder Subbasin is approximately 31,900 ac with 30 private property owners. This subbasin is served by the Lard Can and Wingate Mill secondary canals that discharge to the West Feeder Canal, the subbasin's primary drainage canal with discharges controlled downstream by the WWEIR structure. Land use in the West Feeder Subbasin is primarily agricultural, pasture, and native or undeveloped lands. The southernmost subbasin, a section of the Big Cypress Seminole Reservation, encompasses approximately 13,850 ac.

[5] In 2010, the G-108 water control structure was removed. This structure became unnecessary once construction of the upstream structure W-D1AB was completed in May 2007, resulting in most of the flows from McDaniel Ranch go through structure PC-17A.

The following WQIPs for the Feeder Canal Basin rely on source controls through BMPs described in SFWMD-issued ERPs, integration with CERP, and other local construction projects described below.

The 1996 landowner's agreement between McDaniel Ranch and the Seminole Tribe of Florida was executed to address water quality. This agreement required the development of a master plan including BMPs and a water quality monitoring plan for sampling at PC-17A, G-108, and upstream sampling sites, and enumerated the "target level" for TP concentration in discharges from the North Feeder Canal Subbasin at 50 µg/L. Since the ownership of some parcels within the original McDaniel Ranch has changed since the 1996 landowner agreement was finalized, the agreement requirements were also incorporated into new ERPs issued by SFWMD to the new landowners. BMP implementation and water quality monitoring is verified periodically during on-site inspections.

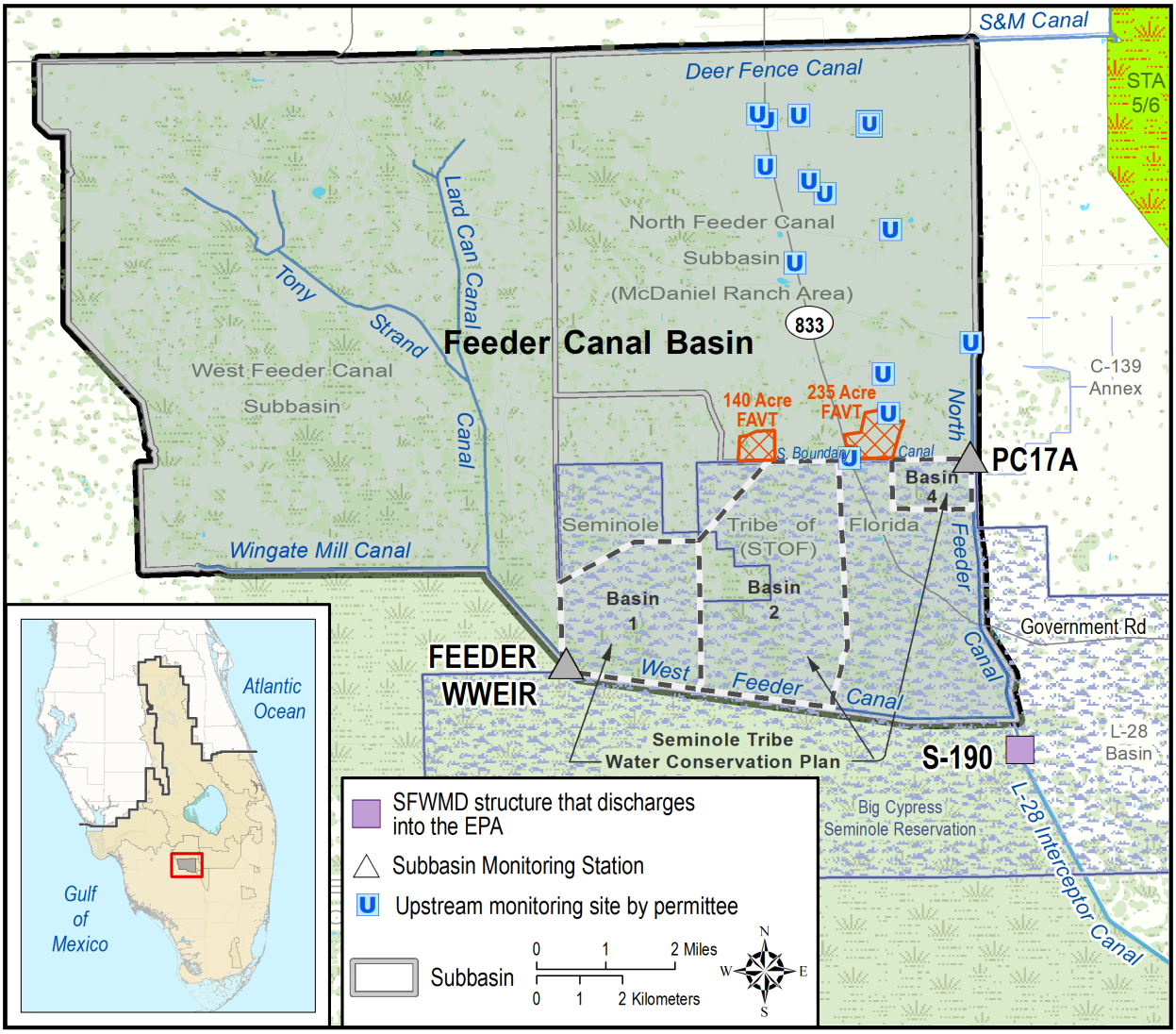


Figure 4-20. Feeder Canal Basin and subbasins. (Note: FAVT – floating aquatic vegetation tilling.)

Additional BMP projects developed to supplement existing BMP requirements include a floating aquatic vegetation tilling (FAVT) project sponsored by the Florida Department of Agriculture and Consumer Services (FDACS) in the North Feeder Canal Subbasin. The FAVT water quality treatment concept consists of a minor aboveground impoundment within a fallow farm field. Surface water from the

North Feeder Subbasin will be routed through the FAVT impoundment where water quality improvement and flow attenuation occur using floating plant roots (Water & Soil Solutions, LLC 2020), which result in a net reduction in TP and total nitrogen (TN) concentration, prior to discharging treated surface water back into the system. Water quality improvement and flow attenuation is verified periodically through on-site inspection activities and review of water quality data. The biomass is then incorporated directly into the soil via tilling during the dry season. The 140-ac project, referred to as the North Feeder Canal FAVT, was initialized in 2016. This FAVT facility removes approximately 76% of the inflow TP load on an annual basis. From July 1, 2019, to June 30, 2020, a total of 2,488 million gallons was treated removing 0.9 t of TP. Another FAVT project, referred to as the L28i FAVT, also in the North Feeder Canal Subbasin covering 245 ac, was initialized in 2019, with pre-initialization activities commencing during WY2020, that included filling and grow-in phases. Expected annual load reductions from the L28i FAVT facility will be determined after optimization is completed. From July 1, 2019, to June 30, 2020, a total of 1,404 million gallons was treated removing 0.9 t of TP; however, this period represents no outflows, as the system was filling; therefore, all the TP observed in inflows was removed/retained.

The Long-Term Plan called for completion of the Big Cypress/L-28 Interceptor Modification, which has evolved into the federal-state planning study now known as the Western Everglades Restoration Project (WERP). WERP is a CERP study currently in the planning stages. The goal of WERP is to restore freshwater flow paths, flow volumes and timing, seasonal hydroperiods, and historic distributions of sheetflow in the western Everglades, including Big Cypress National Preserve, WCA-3, the Big Cypress Seminole Reservation, and the Miccosukee Tribe of Indians of Florida's Alligator Alley Reservation; reestablish ecological connectivity in the western Everglades; and reduce wildfires associated with altered hydrology; all while maintaining flood protection and ensuring applicable water quality standards are met. SFWMD is the non-federal sponsor of the study and is actively engaged in all aspects of planning. Project planning began in 2016; however, USACE suspended work on the project from July 2019 to March 2020 due to issues that the team could not resolve within the existing schedule, including cost-effectiveness of the preferred alternative, stakeholder acceptability and risks with the siting of the STAs, and the potential need to acquire many privately-owned parcels of land within and adjacent to Big Cypress National Preserve. SFWMD continues to meet regularly with USACE and project stakeholders to develop and refine a recommended plan and evaluate it based on costs, benefits, environmental effects, and effects on existing levels of flood protection. In January 2021, USACE suspended work on the WERP study due to budget constraints. Additional budget and time to complete the study was requested by the USACE team. Once approved, work will resume with the goal of completing the study in time for approval by Congress as part of the Water Resources Development Act (WRDA) 2024. For more information, see http://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Western-Everglades-Restoration-Project/.

Another critical CERP restoration project, the Seminole Tribe Water Conservation Plan, was authorized in WRDA 1996. The project will rehydrate wetlands and improve water quality and water storage capacity on the Big Cypress Seminole Reservation, Big Cypress National Preserve, and EPA. The project accommodates the Seminole Tribe of Florida's water entitlement, supports sustainable agriculture, and contributes to the restoration of the western Everglades ecosystem basin. All facilities constructed under this project have been transferred to the Seminole Tribe. For more information regarding the project, see http://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/BCSIR/. See Appendix 4-3 of this volume for greater detail on these WQIPs, and a chronology of basin strategies and WQIP components.

Table 4-12 and **Figure 4-17** above summarize the annual TP FWMC and load for the Feeder Canal Basin (S-190) for WY1998–WY2021. Over the past 10 water years, TP FWMCs at S-190 have ranged from 41 µg/L in WY2012 to 139 µg/L in WY2021. The TP FWMC in WY2021 is above the 50 µg/L referenced by the landowners' agreement and the Long-Term Plan. Follow-up activities such as BMP site verifications and upstream water quality monitoring data reviews are ongoing. For the North Feeder Canal Subbasin,

annual memoranda are posted to the SFWMD ePermitting ERP file, summarizing the status of the 1996 landowner agreement. Refer to Appendix 4-3 of this volume for water quality monitoring data summaries for each tier of monitoring within the Feeder Canal Basin, including the North Feeder Canal Subbasin (PC-17A) and the West Feeder Canal Subbasin (WWEIR), and upstream sampling sites within the North Feeder Canal Subbasin.

L-28 Basin

The L-28 Basin (**Figure 4-21**), located in portions of Broward, Hendry, and Collier counties, is predominately agricultural and encompasses approximately 71,790 ac. Landowners within the basin are SFWMD (C-139 Annex), the Big Cypress Seminole Reservation, the Miccosukee Indian Reservation, and Big Cypress National Preserve, which is managed by the National Park Service. The predominant land use in the L-28 Basin consists of wetlands, improved and unimproved pasture, citrus, and sugarcane. The C-139 Annex makes up approximately 25% of the L-28 Basin and is served by the USSO structure that discharges into the L-28 Borrow Canal. The surface water management systems within the L-28 Basin provide drainage, flood protection, and water supply to WCA-3A, conveying excess runoff to the L-28 Borrow Canal, extending approximately 10 miles along the eastern border of the basin, and discharging through the S-140 structures to WCA-3A.

L-28 Basin WQIPs rely on source controls through SFWMD-issued ERPs, integration with CERP, and other local construction projects as described below.

Source controls through BMP implementation are required for the citrus operation on land currently leased by the Southern Garden Groves Corporation within the C-139 Annex. In WY2021, SFWMD reviewed submission of the BMP annual report for the area and assured compliance with the SFWMD-issued ERP. The lease for the Southern Garden Groves Corporation citrus agriculture in the C-139 Annex will end upon notification of termination from SFWMD or notice from the lessee that the lease is no longer desired.

The C-139 Annex/Sam Jones Abiaki Prairie Restoration Project is designed to restore approximately 7,500 ac of the C-139 Annex to wetland habitat consistent with the historical Everglades hydrologic conditions to the greatest extent possible. Activities include removing farm beds and furrows, filling internal ditches, planting, and seeding with appropriate native species, and exotic and nuisance species control. The 3,000-acre Phase 1 portion of the project is complete. Construction of the remainder of the site, including a seepage management system along the southern boundary (Phase 2), began in December 2020.

The C-139 Flow Equalization Basin (FEB), a Restoration Strategies project, is intended to attenuate peak stormwater flows and temporarily store stormwater runoff from the C-139 Basin. It is anticipated that this will improve water quality treatment performance of STA-5/6. The new FEB will be within the northern portion of the C-139 Annex. SFWMD design components, including an inflow pump, berms, groundwork, and seepage canals, began in October 2018. Project completion is expected by 2023.

The Seminole Tribe Water Conservation Plan and the Miccosukee Tribe Water Management Plan are two additional projects described in the Long-Term Plan. The Long-Term Plan recommended the accelerated completion of these projects by 2010; however, to date, federal funding for these projects has not been authorized.

Table 4-12 and **Figure 4-17** above summarize the annual TP FWMC and load for S-140 for WY1998–WY2021. TP FWMC at S-140 is 78 µg/L for WY2021, which is above the interim predicted TP FWMC of 72 µg/L referenced in the Long-Term Plan[6]. Refer to Appendix 4-3 of this volume for water quality

[6] The long-time data set for the L-28 Basin indicates a TP concentration of 39 µg/L representing native and agricultural areas, while discharges from agricultural areas-only at 72 µg/L and being those needed to be treated in regional STAs.

monitoring data summaries for each tier of monitoring within the L-28 Basin, including the C-139 Annex Subbasin (USSO). Appendix 4-3 also provides greater detail on the WQIPs and a chronology of basin strategies and WQIP components.

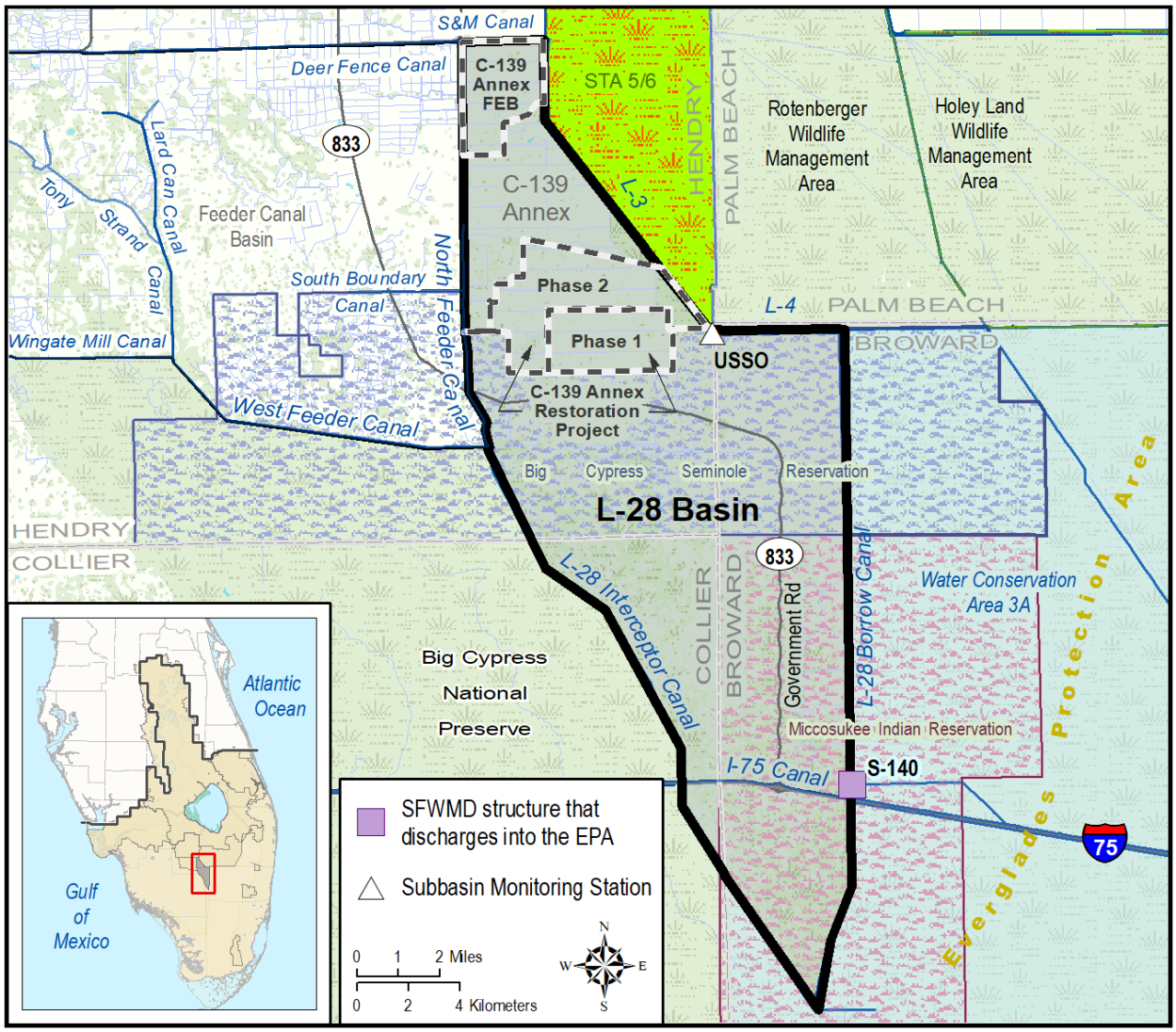


Figure 4-21. L-28 Basin.

North Springs Improvement District

The NSID Basin encompasses approximately 9,000 ac in northern Broward County along the eastern border of WCA-2A south of Lox Road and includes northern portions of the City of Coral Springs and western and northern portions of the City of Parkland (**Figure 4-22**). The NSID Basin is primarily composed of residential properties, with agricultural and mining operations located in portions of the northernmost 2,000 ac. Excess flows within NSID currently discharge via three pump structures: NSID1, NSID2, and NSID3. NSID1 is equipped to discharge to the L-36 North and South canals, and to WCA-2A. NSID2 discharges only to the L-36 North Canal. NSID3, which was completed in June 2019, is located on the northern border of NSID and discharges into the Hillsboro Canal. Except for any NSID1 discharges to WCA-2A, all flows from NSID ultimately discharge to downstream receiving bodies outside of the EPA. NSID is authorized to discharge to WCA-2A through NSID1 when the L-36 North, L-36 South, C-14, and

Hillsboro canals cannot accept additional flows, as described within an ERP and a 2009 memorandum of understanding among the NSID, SFWMD, and Coral Springs Improvement District.

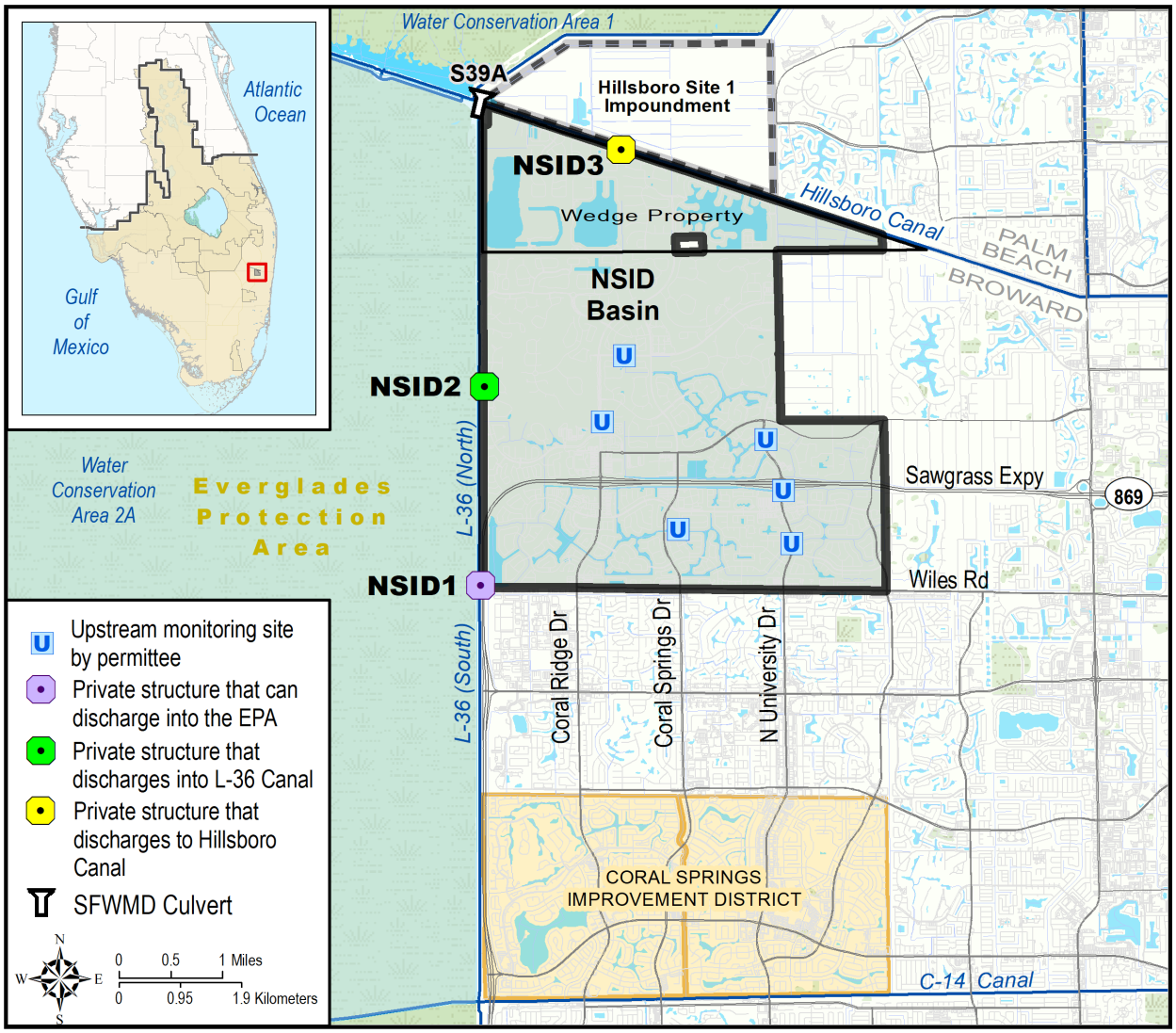


Figure 4-22. NSID Basin.

Current WQIP strategies within NSID include water quality monitoring and implementation of a BMP plan as defined by NSID's SFWMD-issued Surface Water Management permit. The permit mandates NSID to collect daily water quality samples at structure NSID1 during discharges into WCA-2A, and at NSID1, NSID2, and multiple "upstream" locations within the NSID Basin in response to storm events. The BMP plan requires NSID to conduct an ongoing public outreach program that includes guidance on limiting fertilizer use; ensuring that proposed development and redevelopment within the basin complies with or exceeds SFWMD Surface Water Management requirements (BMPs for water retention and detention, as well as erosion and sediment control BMPs, e.g., slope stabilization and turbidity controls); and diverting stormwater from the NSID West Basin to the NSID East Basin under specified permit criteria to limit discharges to the EPA. NSID is also required to demonstrate maintenance of a five-year recertification program, which requires that all entities issued Surface Water Management permit by NSID verify compliance with operation requirements. This verification process must be certified by a Florida registered

engineer. Additional conditions of NSID's permit include compliance criteria for TP loads discharged to WCA-2A, requirements for NSID to submit an annual BMP report detailing all activities conducted in the previous year in accordance with the permitted monitoring and BMP plans, and verification of adherence to the 2009 memorandum of understanding.

In WY2021, NSID's BMP implementation was verified by SFWMD's review of the NSID BMP annual report. SFWMD will continue to ensure basin-level compliance is consistent with the NSID memorandum of understanding requirements through review of submitted pump logs, BMP annual reports, and the performance of BMP site verification visits.

The Long-Term Plan for the NSID basin called for the implementation of source controls and the diversion of discharges from WCA-2A to the Hillsboro Site 1 Impoundment/Fran Reich Preserve CERP project and other downstream receiving bodies. Phase I of the project is complete and transferred to SFWMD; Phase II requires additional Congressional authorization. A fact sheet about this project can be downloaded at https://usace.contentdm.oclc.org/digital/api/collection/p16021coll11/id/2583/download. Refer to Appendix 4-3 of this volume for greater detail on these WQIPs, monitoring efforts, the memorandum of understanding, and a chronology of basin strategies and WQIP components.

Table 4-12 and **Figure 4-17** above summarize the annual TP FWMC and load for NSID1 for the WY1998–WY2021 period. Three discharges were reported by NSID into WCA-2A in WY2021. Refer to Appendix 4-3 of this volume for water quality monitoring data summaries for each tier of monitoring within the NSID Basin.

C51-West and L8 Basins

The C-51 West Basin is approximately 50,000 ac and is bisected by the east-west orientation of the C-51 Canal (**Figure 4-23**). The C-51 West Basin receives inflows from the L-8 Basin through structure S-5AE, and discharges to the east through the S-155A control structure, and to STA-1 East (STA-1E) through control structures S-319 and S-361. A portion of the discharges from the C-51 West Basin to STA-1E will be redirected to the L-8 FEB for flow attenuation as part of the *Restoration Strategies Water Quality Plan* (SFWMD 2012).

Areas south of the C-51 Canal, making up approximately 45% of the C-51 West Basin, include Acme Basin A (primarily residential) and Acme Basin B (primarily equestrian and agricultural), and the Pine Tree Water Control District (PTWCD). PTWCD encompasses approximately 3,800 ac west of Flying Cow Road and south of Southern Boulevard. The area includes agricultural, residential (Rustic Ranches, approximately 825 ac), and undeveloped land. Portions of the original PTWCD were acquired by SFWMD for the construction of STA-1E. Stormwater runoff from Rustic Ranches is directed to a seepage canal constructed as part of STA-1E via control structure S-361. The remaining PTWCD and Acme Basin A and Acme Basin B discharges to the C-51 West Canal and can enter STA-1E through structure S-319.

Areas north of the C-51 Canal include Indian Trails Improvement District, Loxahatchee Groves Water Control District, Seminole Improvement District, Northern Palm Beach County Improvement District, and the Village of Royal Palm Beach. The area land use includes agriculture, residential, recreational, and undeveloped land.

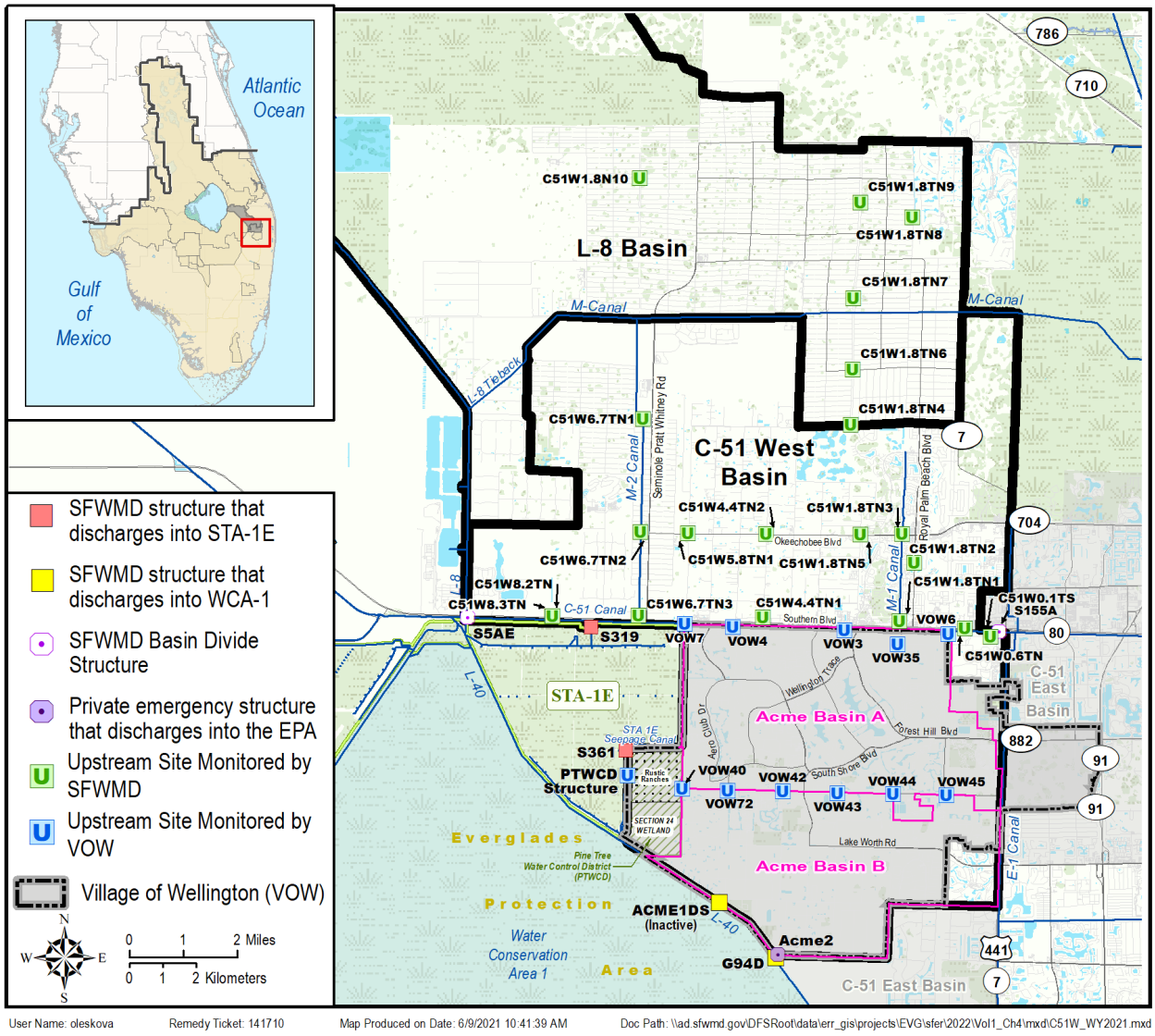


Figure 4-23. C-51 West Basin. (Note: The Village of Wellington (VOW) municipal boundary shown is only meant to display the VOW hydrology that is within the C-51 West Basin. STA-1E is also within the VOW municipal boundary, however it is not within the C-51 West Basin.)

Acme Improvement District

Acme Improvement District (Acme), the water control district serving the Village of Wellington (VOW), is made up of two subbasins, Acme Basin A and Acme Basin B, and encompasses approximately 19,000 ac. Acme Basin A and Acme Basin B historically discharged via two structures, known as Acme 1 and Acme 2, to the L-40 Canal within WCA-1, prior to the Acme Basin B diversion project. Runoff from Acme 1 and Acme 2 flowed through the downstream culvert structures, ACME1DS and G-94D (referenced in the FDEP permit), respectively, into the L-40 Canal.

In 2007, the completion of the Acme Basin B CERP project enabled operational modifications for the diversion of stormwater runoff from Acme Basin B to Acme Basin A for ultimate discharge to the C-51 Canal. These operational changes also made possible the removal of the Acme 1 structure. The Acme 2 structure remains operational but is currently only operated as a discharge structure under emergency flood

conditions to discharge directly to WCA-1. Since the completion of the Acme Basin B CERP project, Acme Basin A and Acme Basin B have been designated as subbasins of the C-51 West Basin.

The WQIPs for Acme rely on source controls through the implementation of BMPs through SFWMD issued ERPs, and the completed Acme Basin B CERP project, which provided the diversion of stormwater runoff from WCA-1 to the C-51 Canal to improve water quality entering WCA-1. In addition, TP reductions from the C-51 West Basin rely on the *Restoration Strategies Regional Water Quality Plan* (SFWMD 2012). Updates on these projects/programs are described below.

Throughout Acme, mandatory BMP implementation was enacted by a VOW BMP ordinance and a livestock waste storage and disposal ordinance included in the VOW ERP Permit 50-00548-S and the PTWCD ERP Permit 50-00458-S. An upstream water quality monitoring program is also required pursuant to the SFWMD-issued ERPs (see **Figure 4-23** for the permittee upstream monitoring site locations). In WY2020, SFWMD reviewed the submitted Acme surface water quality report, pump log records, and upstream water quality monitoring reports. Discharges from PTWCD are currently being monitored as described in their ERP.

The water quality monitoring program for Acme consists of monitoring for TP concentration at the Acme 2 structure, and the Acme and PTWCD upstream monitoring sites identified in **Figure 4-23**. **Table 4-12** and **Figure 4-17** summarize the annual TP FWMC and load for Acme discharges into WCA-1 for WY1998–WY2021. Refer to Appendix 4-3 of this volume for additional water quality data summaries for Acme and the upstream monitoring, greater detail on the WQIPs, and a chronology of basin strategies. For reference, the Acme TP concentration goal is included in the C-51 West Basin goal, as the Acme Basin A and Acme Basin B are subbasins of the C-51 West Basin.

C51WL8 Project

The C-51 West and L-8 Basins are in the "Eastern Flow Path" (see Chapter 5A of this Volume for more information on flow paths) and generally have higher phosphorus levels in STA inflows. However, limited water quality data exists for the northern areas within the C-51 West basin and L-8 basin. The L-8 Canal, which drains the L-8 Basin, discharges to the C-51W Canal east of STA1-E. More than half of the area is comprised of the J.W. Corbett Wildlife Management Area and the Dupuis Reserve, while the remaining area is under the jurisdiction of Indian Trail Improvement District. The area north of the C-51W Canal (approximately 41.5 square miles) discharges to the C-51W Canal via various culverts and gated structures maintained by local stakeholders.

In WY2020, an expanded upstream water quality monitoring network (C51WL8 Project) was approved for the areas north of the C-51 Canal in the C-51 West and L-8 Basins (see SFWMD upstream monitoring site locations in **Figure 4-23**). In WY2021, site selection was finalized for 21 of the 22 originally approved sites. The twenty-second site was dropped due to lack of access. Sampling stations were chosen based on their upstream or discharge location relative to the C-51 West or L-8 canals, and their location relative to activities associated with stormwater discharges and/or proximity to septic tank sewage systems. Water quality samples are collected when flow is observed, biweekly, via grab samples. The following parameters are analyzed: ammonium (NH_4), nitrate + nitrite (NO_X), ortho-phosphorus (OPO_4), surfactants, TN, TP, and total suspended solids. In addition, the following in-situ measurements are collected: dissolved oxygen, pH, temperature, and specific conductance. Monitoring stations came online as access was attained, starting in November 2019. This monitoring project will identify areas of water quality concern so that effective activities may be considered to facilitate nutrient reductions at STA-1E and STA-1 West (STA-1W) inflows.

As described above, the basis for reducing TP levels in discharges from the C-51 West Basin is through implementation of the *Restoration Strategies Water Quality Plan.* The modeled average annual TP concentrations (and loads) from the C-51 West Basin to the STA-1 complex and L-8 FEB, and from Rustic Ranches (via S-361) to STA-1E, are 163 µg/L (28.2 t) and 73 µg/L (0.9 t), respectively, with a combined

TP concentration of 157 µg/L (**Table 4-13**; SFWMD 2012). A comparison between the modeled values and those in WY2021 is presented in **Table 4-13**.

Table 4-13. C-51 West Basin WY2021 data.

STA-1E Inflow	TP FWMC Goal (µg/L)	WY2021 TP FWMC (µg/L)	TP Load Goal (t)	WY2021 TP Load (t)
C-51 West Basin including Acme & PTWCD (S-319)	163	135	28.2	29.4
C-51 West Basin including Rustic Ranches (S-361)	73	46	0.9	0.4
Total	**157**	**131**	**29.1**	**29.8**

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