APPENDIX C
COMBINED OPERATIONS PLAN ADAPTIVE MANAGEMENT AND MONITORING PLAN

C.1 INTRODUCTION TO APPENDIX C

C.2 ADAPTIVE MANAGEMENT

C.3 ECOLOGICAL MONITORING PLAN

C.4 WATER QUALITY AND HYDROLOGY MONITORING PLAN

C.5 WATER QUALITY AND HYDROLOGY MONITORING PLAN SOUTH OF S-331

C.6 WATER QUALITY AND HYDROLOGY MONITORING PLAN FOR 8.5 SMA FLOOD MITIGATION

C.7 CULTURAL RESOURCES MONITORING PLAN

This page intentionally left blank

Table of Contents

C.1 Introduction to Appendix C: Adaptive Management and Monitoring plans for COP . 1

C.1.1 COP Objectives, Constraints and Planning Considerations 1

C.1.2 Definitions of Adaptive Management and Types of Monitoring 4

C.1.3 Structure of the COP Adaptive Management and Monitoring Plan 5

C.2 COP Adaptive Management 8

C.2.1 How the COP AMMP was developed: Identification, Screening and Prioritization of COP Uncertainties 8

C.2.2 Ecological Adaptive Management Uncertainties 15

C.2.3 Hydrological Adaptive Management Uncertainties 66

C.2.4 Water Quality / Hydrological Adaptive Management Uncertainties 98

C.2.5 Uncertainties screened out of the COP AAMP 112

C.2.6 COP Adaptive Management and Monitoring Plan Implementation 116

C.3 Ecological Monitoring Plan 151

C.3.1 Ecological Performance Measure Monitoring and USFWS Biological Opinion Monitoring 151

C.3.2 Baseline for Ecological Monitoring 152

C.3.3 Management Options 152

C.3.4 Ecological Monitoring Plan Additional Cost Estimate and Links to Existing Monitoring Programs 170

C.4 Water Quality and Hydrology Monitoring Plan 184

C.4.1 Summary 184

C.4.2 Glossary/Acronyms 186

C.4.3 Introduction 190

C.4.4 Project Description 191

C.4.5 Primary Objectives of Water Quality and Hydrology Monitoring Plan 193

C.4.6 Active Mandates and Permits 194

C.4.7 Monitoring Components 194

C.4.8 Duration 211

C.4.9 Monitoring/Sampling Locations and Naming Convention 211

C.4.10 Project Reporting 219

C.4.11 Administration and Implementation of the Monitoring Plan 227

C.4.12 Cost Estimates 229

C.4.13 Data Quality Objectives for Water Quality Data 229

C.4.14 Monitoring Data Elements/Indicators 229

C.4.15 Procedures and Methods 229

C.4.16 Data Collection 230

C.4.17 Documentation 232

C.4.18 Quality Assurance and Quality Control 232
C.4.19 Data Analysis and Records Management 232
C.4.20 Adaptive Management Considerations 232
C.5 Water Quality and Hydrology Monitoring Plan South of S-331 233
C.5.1 Introduction 233
C.5.2 Project Description 233
C.5.3 Primary Objectives of Water Quality and Hydrology Monitoring Plan South of S-331 234
C.5.4 Monitoring Components 235
C.5.5 Duration 243
C.5.6 New Monitoring/Sampling Locations and Naming Convention 243
C.5.7 Project Reporting 244
C.5.8 Administration and Implementation of the Monitoring Plan 246
C.6 Water Quality and Hydrology Monitoring Plan for 8.5 SMA Flood Mitigation 248
C.6.1 Purpose 248
C.6.2 History and Background 249
C.6.3 Assessment Methodology 251
C.6.4 Data Requirements for the COP Water Quality and Hydrology Monitoring Plan 261
C.6.5 Periodic Updates to 8.5 SMA Assessment Methodology 261
C.7 Cultural Resources Monitoring Plan 263
C.8 References 266

List of Tables

Table C.2-1. Prioritization scenarios for identified uncertainties. Uncertainties ranked as Tier 3 were not developed further in the COP AMMP. 10
Table C.2-2. COP Adaptive Management Uncertainties identified during July 2019 workshop. Note the uncertainty ID numbers below refer to the ID numbers assigned to each uncertainty during the workshop, and therefore may not appear sequential since those that did not pass screening are no longer included. 11
Table C.2-3. COP AM Uncertainty ID#1 and #21 (Flows, salinity, and peat collapse) management option matrix. 20
Table C.2-4. COP AM Uncertainty ID#8 (Tree Islands) management options matrix. 28
Table C.2-5. COP AM Uncertainty ID#20 (WCA 3B Vegetation) management options matrix. 30
Table C.2-6. Field components, study sites, ecological parameters, frequency and mode associated with data collection. 33
Table C.2-7. COP AM Uncertainty ID#2 (S-197 / Manatee Bay Discharges) management option matrix. 35
Table C.2-8. COP AM Uncertainty ID#9 (Hydrologic Transmissivity) management options matrix. ... 39

Table C.2-9. COP AM Uncertainty ID#11a (Pennsuco wetlands) management options matrix. 41
Table C.2-10. COP AM Uncertainty #23 (Soil oxidation and peat fires) management option matrix. 44
Table C.2-11. COP AM Uncertainty ID #18 (Wading Birds in Alligator Alley North Colony) management option matrix. 53
Table C.2-12. COP AM Uncertainty ID#24 (salinity, water flow, algal blooms in Whitewater and Florida Bays) management options matrix. 60
Table C.2-13. COP AM Uncertainty ID#25 (Wading Birds) management option matrix.....65
Table C.2-14. COP AM Uncertainty ID#6 (Seepage) management options matrix.....70
Table C.2-15. COP AM Uncertainty ID #10 (NESRS and TS) management option matrix. 74
Table C.2-16. COP AM Uncertainty ID#12a (Tamiami Trail Flow Formula-General) management options matrix. 80
Table C.2-17. COP AM Uncertainty ID #12b (Tamiami Trail Flow Formula and Drought) management option matrix. 86
Table C.2-18. COP AM Uncertainty ID #5b (FDOT Constraint on Tamiami Trail) management option matrix. 91
Table C.2-19. COP AM Uncertainty ID#7 (Saltwater intrusion) management options matrix.....96
Table C.2-20. COP AM Uncertainty ID#16A (Water Quality in Taylor Slough) management option matrix. 101
Table C.2-21. COP AM Uncertainty ID#16b (Water Quality in NESRS) management option matrix. 108
Table C.2-22. Uncertainties screened out of the COP AMMP. 113
Table C.2-23. Adaptive management actions identified as requiring further NEPA or no further NEPA review. The table provides a link between adaptive management uncertainties, and their corresponding actions, and whether additional NEPA permitting and review would be required. 117
Table C.2-24. Management options included in the COP Adaptive Management Plan and implementing group. 128
Table C.2-25. Linking adaptive management uncertainties, compliance, and performance monitoring evaluation and response to most relevant institutional groups. “X”= will typically be discussed in this group. “--” = typically will not be discussed in this group (but still could be). 129
Table C.2-26. Estimated proposed new COP monitoring costs and proposed costs for optional adaptive management actions. TBD=To Be Determined. 133
Table C.2-27. Adaptive management uncertainties linked to existing monitoring programs and estimated new costs.....136
Table C.3-1. Ecological performance measures. 153
Table C.3-2. Estimated monitoring required for USFWS Biological Opinion. 164
Table C.3-3. Ecological Performance Measure (PM) and estimated USFWS Biological Opinion (BO) linked to existing monitoring.....171
Table C.4-1. Gages and sensors for surface water hydrologic monitoring during COP. 195
Table C.4-2. Hydrologic characteristics measured in existing monitoring wells. 205
Table C.4-3. Proposed surface water quality monitoring for G-3273/S-356 Increment 2 test. 216
Table C.4-4. Agency roles and responsibilities for each activity. 228
Table C.5-1. Gages and sensors for surface water hydrologic monitoring during the COP located south of S-331.....235
Table C.5-2. Existing active and inactive monitor wells with real-time groundwater level data in the southern L-31N and C-111 basins. 237
Table C.5-3. Agency roles and responsibilities for each activity for monitoring south of the S-331 structure. 247

Table C.6-1. Preliminary recession rate targets for short duration rainfall events. 254
Table C.6-2. Additional 8.5 SMA monitoring and data collection requirements. Table shows real-time monitoring information required for 8.5 SMA Flood Mitigation Assessment. Data is expected to be used to assess conditions weekly with more frequent reporting in response to significant rainfall events (>2.5 inches). 262
Table C.7-1. Tree islands monitored during the COP.....264

List of Figures

Figure C.2-1. Inflows from S-197 structure on C-111 canal into Manatee Bay, southern Biscayne Bay. 32
Figure C.2-2. Federally listed threatened and endangered species with the potential to occur within the COP action area (Provided by USFWS 2018). Yellow triangles note active Wood Stork colonies within the study area. 47
Figure C.2-3. Current and historic wading bird colony locations, with the Alley North and 6th Bridge colonies labeled. Red five pointed stars represent historic colony locations. Blue seven pointed stars represent current colony locations. Black dots represent smaller wading bird colony locations. 48
Figure C.2-4. Location of plug in L38W Canal, scheduled for spring 2020.....50
Figure C.2-5. Monthly count of low water closure days in WCA 3 as simulated in COP Alt Q, with years when TTFF drought conditions test would be implemented indicated by heavy black outline. Design test implementable only in 1973-1974, 1989-1990, and 1990-1991. 83
Figure C.2-6. Normalized duration curves of depths at specific gages in WCA 3. a) Gage WCA 3_3B_71 (top), b) WCA 3_3A_28 (middle), and c) WCA 3_3A-NE (lower). Curves for WCA_3_3-69 and WCA 3-3 gages are similar but not shown. 84
Figure C.2-7. Locations of four transects of transducers along Tamiami Trail between S-333 and S-356. The transducers are used to monitor moisture levels in soils beneath the road, a good indicator of to monitor road condition. 89
Figure C.2-8. Map of Hydrology Stations grouped by region in Everglades National Park and nearby vicinity. 134
Figure C.4-1. Existing surface water stage and flow monitoring locations at structures in WCA 3A/3B. 198
Figure C.4-2. Existing surface water stage and flow monitoring locations at structures along the northern and eastern boundary of ENP. 199
Figure C.4-3. Existing surface water stage monitoring at marsh locations in WCA 3A and WCA 3B. Monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total

suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis.....200
Figure C.4-4. Existing surface water stage monitoring at marsh locations in ENP. Monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis.....201
Figure C.4-5. Existing surface water flow velocity monitoring along L-29 and L-31N with ADVMS. ..202
Figure C.4-6. Existing groundwater monitoring wells in the project area. Left, base map showing all well locations. Right, four inset maps: 1) instrumented monitoring wells along L30 and WCA 3B (Tree Island wells); 2) Approximately 1 mile south of Tamiami Trail, along L-31N between ENP and the L-31N Canal; 3) East of L30 proximal to the Miami-Dade Water and Sewer Department Northwest Well Field; 4) Approximately 4 miles south of Tamiami Trail, along L-31N between ENP and the L-31N canal. 204
Figure C.4-7. Bar diagrams showing selected groundwater quality data at different depths from Biscayne Aquifer monitoring well clusters L-31NN and L-31NS. 210
Figure C.4-8. Cross-section locations in the L-29 canal tailwater of the S-356 pump station. 212
Figure C.4-9. Transect locations for piezometer installation along the Tamiami Trail. 213
Figure C.4-10. Surface water quality monitoring station locations along Tamiami Trail.....215
Figure C.5-1. Selected real-time groundwater monitoring stations and structures in southern L-31N basin. 240
Figure C.5-2. Selected real-time groundwater monitoring stations and structures in the northern C-111 basin. 240
Figure C.5-3. Selected real-time groundwater monitoring stations and structures in the central C-111 basin. 241
Figure C.5-4. Selected real-time groundwater monitoring stations and structures in the southern C-111 basin. 241
Figure C.5-5. Locations for the new monitoring stations in the C-111 Detention Areas.....242
Figure C.6-1. Terminology for 8.5 SMA flood mitigation assessment. 253
Figure C.6-2. Preliminary recession rate targets for rainfall events with duration of 1 to 3 days.....255
Figure C.6-3. Preliminary recession rate targets for rainfall events with duration of 4 to 7 days.....255
Figure C.6-4. Preliminary hydroperiod target limits for accumulated rainfall totals over 15 days, 30 days, and 60 days. 257
Figure C.6-5. Historical data used to identify preliminary hydroperiod target limits for accumulated wet season rainfall totals.....259
Figure C.6-6. Preliminary hydroperiod target limits for accumulated wet season rainfall totals. 259
Figure C.6-7. Historical data used to identify preliminary hydroperiod target limits for accumulated dry season rainfall totals.....260
Figure C.6-8. Preliminary hydroperiod target limits for accumulated dry season rainfall totals. 260

List of Acronyms

ADaPT	Automated Data Processing Tool Software
ADVM	Acoustic Doppler Velocity Meter
AM	Adaptive Management
AMMP	Adaptive Management and Monitoring Plan
BAMM	Baseline and Modification modeling
BO	USFWS Biological Opinion
BWRF	Biweekly if Recorded Flow
C&SF	Central and Southern Florida
CDOM	Chromophoric (Colored) Dissolved Organic Matter
CEPP	Central Everglades Planning Project
CERP	Comprehensive Everglades Restoration Plan
Cfs	Cubic feet per second
Chl	Chlorophyll
COP	Combined Operations Plan
CSSS	Cape Sable Seaside Sparrow
DO	Dissolved Oxygen
DOI	Department of the Interior
DQO	Data Quality Objectives
EA	Environmental Assessment
EB	Equipment Blank
ECB	Existing Condition Baseline
EDEN	Everglades Depth Estimation Network
EIS	Environmental Impact Statement
EM	Engineering Manual
ENP	Everglades National Park
ERTP	Everglades Restoration Transition Plan
FB	Field Blank
FCEB	Field Cleaned Equipment Blank
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEB	Flow Equalization Basin
FL Bay	Florida Bay
FWM	Flow Weighted Mean
HSI	Habitat Suitability Index
LECSA	Lower East Coast Service Area
LRR	Limited Revaluation Report
LTL	Long Term Limit
MAP	RECOVER Monitoring and Assessment Plan
MOM	Management Options Matrix
MWD	Modified Water Deliveries Project
MWD GDM	Modified Water Deliveries General Design Memorandum
NEPA	National Environmental Policy Act
NESRS	Northeast Shark River Slough
NGVD	National Geodetic Vertical Datum
NPS	National Park Service

P.L.	Public Law
PDT	Project Development Team
PDT+	Project Delivery Team, Plus
PIR	Project Implementation Report
PLMP	Project-Level Monitoring Plan
PM	Performance Measure or Constraint
QA	Quality Assurance
QAOT	Quality Assurance Oversight Team
QASR	Quality Assurance System Requirements
QC	Quality Control
RACU	Remote Acquisition and Command Unit
RECOVER	CERP Restoration, Coordination & Verification Program
RS	Replicate Samples
SDCS	South Dade Conveyance System
SET	Soil or Surface Elevation Table
SFCN	NPS South Florida / Caribbean Network
SFWMD	South Florida Water Management District
SMA	Square Mile Area
SRF	Systematic Reconnaissance Flights
SRS	Shark River Slough
TBD	To Be Determined
TP	Total Phosphorous
TS	Taylor Slough
UNC	Uncertainty
USACE	U. S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey
UTS	Upper Taylor Slough
WADEM	Wading Bird Distribution Evaluation Model
WBS	Work Breakdown Structure
WCA	Water Conservation Area
WCP	Water Control Plan
WRDA	Water Resources Development Act
WRF	Weekly if Recorded Flow

C.1 Introduction to Appendix C: Adaptive Management and Monitoring plans for COP

The planning process for the Combined Operational Plan (COP) was based on knowledge of the greater Everglades; understanding of the problems and opportunities; and the evaluation of alternatives and estimation of the potential project performance. However, while the COP Water Control Plan and Environmental Impact Statement (EIS) are based on a wealth of knowledge, some uncertainty inevitably exists in such a complex system. Such uncertainties include: fine-tuning the computer models used to accurately predict performance and meet constraints under real world conditions; determining how to use available water to the best advantage while maintaining flood control; and anticipating how to adapt the COP to changes in both the environment (e.g., sea level rise) and due to human activities (e.g., additional operational structures implemented through CEPP). The primary objective of the COP Adaptive Management and Monitoring Plan (COP AMMP) is to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on achieving project success. A successful COP will protect existing resources, as well as address uncertainties related to project performance that can be addressed with efficiently structured hypothesis testing strategies. The COP adaptive management process is a tool to help address such remaining uncertainties. The COP AMMP meets the requirements of the U.S. Army Corps of Engineers (USACE) Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) – Monitoring Ecosystem Restoration (USACE 2009).

C.1.1 COP Objectives, Constraints and Planning Considerations

Monitoring and adaptive management in this plan must be tied to projects goals and objectives or linked to compliance with regulations or agreements and clearly linked to management decision-making. Below are the goals, objectives, constraints, and planning considerations including in the development of the COP AMMP.

Goal of the Combined Operation Plan: The purpose of the COP is to define water management operations for the Water Conservation Area (WCA 3A) and WCA 3B outlets, structures in the L-31N and C-111 basins constructed as part of the Central and Southern Florida (C&SF) Project and the recently constructed components of the Modified Water Deliveries (MWD) and C-111 South Dade Projects.

Objectives of the COP include:

1. Improve water deliveries (timing, location, volume) into ENP and take steps to restore natural hydrologic conditions in ENP given current C&SF infrastructure and features expected to be completed by the time of implementation, to the extent practicable by
    a. Changing schedule of water deliveries so that it fluctuates in consonance with local meteorological conditions, including providing for long term and annual variation in ecosystem conditions in the Everglades (Timing) (P.L. 101-229, Section 101b)
    b. Restoring NESRS as a functioning component of the Everglades hydrologic system (Location) (P.L. 101-229, Section 101b)
    c. Adjusting the magnitude of water discharged to ENP to minimize effects of too much or too little water (Volume) (1992 MWD GDM, Section 44)
2. Maximize progress toward restoring historic hydrologic conditions in the Taylor Slough, Rocky Glades, & eastern Panhandle of ENP.
3. Protect the intrinsic ecological values associated with WCA 3A and ENP.

4. Minimize the damaging freshwater flows to Manatee Bay/Barnes Sound through the S197 structure and increase flows through Taylor Slough and coastal creeks (1994 C-111 GRR, Section 5.2)
5. Include consideration of cultural values and tribal interests & concerns within WCA 3A and ENP.

Constraints: Additional constraints considered during AMMP development include:

1. Maintain the authorized purposes of the C&SF project of flood damage reduction, regional water supply for agricultural and urban areas, prevention of saltwater intrusion, preservation of ENP, water supply to ENP, preservation of fish and wildlife resources, recreation, navigation and ecosystem restoration.
2. The Flood Control Act of 1962 (PL 87-874) authorized project works in South Dade County, in accordance with the recommendations of the Secretary of the Army and the Chief of Engineers in Senate Document Numbered 138, Eighty-seventh Congress, in the interests to provide flood control for the developed lands east of the L-31N and C-111 Levees and to provide water control to prevent over-drainage in the area, prevent saltwater intrusion, and provide facilities to convey water to ENP.
3. The Flood Control Act of 1968 (PL 90-483) Authorized the SDCS project, including modifications to the existing C&SF project in accordance with Senate Document Numbered 101, Ninetieth Congress, and in accordance with House Document Numbered 369, Ninetieth Congress, in the interest of improved conservation and distribution of available water and extended flood protection.
4. The Everglades National Park Protection and Expansion Act of 1989 (PL 101-229) authorized the acquisition of 107,600 acres and authorized the Secretary of the Army in consultation with the Secretary of the Interior to construct modifications to the C&SF project "to improve water deliveries into the park and shall, to the extent practicable, take steps to restore the natural hydrological conditions within the park." The modifications were to be based on the 1984 Experimental Program and a GDM prepared by the USACE, Jacksonville District entitled "Modified Water Deliveries to Everglades National Park".
5. Maintain the mitigation for project induced flood damages in the East Everglades, including the 8.5 SMA, the Osceola Indian Camp, and the Tiger Tail Indian Camp, consistent with the recommended plan identified in the 1992 MWD GDM.
6. Maintain the level of flood reduction associated with the 1994 C-111 GRR: flood damage reduction project recommended plan.
7. ERTP WCA 3A Regulation Schedule, as identified in the 2012 Water Control Plan for the Water Conservation Areas, Everglades National Park (ENP), and the ENP-South Dade Conveyance System (pending results of the Baseline and Modification Modeling [BAMM]). Maintain Zone A of the WCA 3A Regulation Schedule to not exceed the 1960 WCA 3A 9.5 to 10.5 feet, NGVD Regulation Schedule, as specified within the ERTP Interim Water Management Criteria for WCA-3A Zone A and measured by the 3-gauge average (Sites 63, 64, and 65). (Source: USACE Draft 2011 ERTP EIS, Appendix A-5: Analysis of Standard project Flood, WCA 3A). Additional USACE guidance resultant from the USACE WCA Regional Flood Routing Analysis Study (BAMM) will also be incorporated into the planning constraints if relevant new information from this analysis is available prior to completion of the COP.

8. L-29 canal maximum stage (8.5 feet, NGVD) (2008 MWD Tamiami Trail LRR). Based on coordination between the USACE, the FDOT, and other state agencies conducted for the LRR, while the target stage for the L-29 canal is 8.5 feet, NGVD it is understood that the average October wet season elevation is expected to be approximately 7.89 feet, NGVD based on multiple years (36-year simulated period-of-record). Since this elevation is an average, during some individual years the average October elevation may exceed the 7.89 feet, NGVD stage and other years it would be below 7.89 feet, NGVD. The average elevation will be dependent on the meteorological conditions of that year. However, when considering multiple years, the October average should be at or below 7.9 feet, NGVD. (Source: 2008 TTM LRR). The LRR additionally specifies operational scenarios during which all inflow structures to the L-29 canal will be closed and all inflows terminated, allowing the canal to naturally recede (the complete excerpt from the 2008 LRR, Section 6.1.3)
9. 2008 Tamiami Trail Modifications Relocation Agreement (FDOT/USA), which set forth operational constraints for the L-29 canal reach between S-333 and S-334 for inclusion in future operational planning studies as minimum protective standards necessary to ensure the safety and stability of the roadway subbase infrastructure along this segment of Tamiami Trail (U.S. Highway 41).
10. Maintain the purposes of the 2000 GRR for the 8.5 SMA. The periodic flooding of landowners east of the 8.5 SMA perimeter levee, before and after MWD project implementation, will remain unchanged from conditions in existence prior to implementation of the MWD project. Flood mitigation, not flood protection, should be provided by the Preferred Plan and future operational planning studies.
11. 2016 Canal 111 South Dade Final LRR. This LRR describes past and proposed refinements and design changes associated with all construction of the C-111 South Dade project, comparing each design change to the features authorized in the 1994 GRR (USACE 1994). This LRR describes refinements and design changes associated with all construction of the C-111 South Dade project, comparing each design change to the features authorized in the 1994 General Reevaluation Report (USACE 1994). The LRR consolidates and documents previously approved post PACRs and their associated NEPA documents, encompassing numerous design changes were needed on the C-111 South Dade project during construction from 1996 through 2018.

Planning Considerations: COP planning considerations taken into account are listed below.

1. Burial Resources Agreement
2. Avoid or minimize adverse effects to cultural resources. Explore opportunities to develop monitoring protocols for “at risk” cultural resources
3. Water Quality Standards (CEPP language - Section 6.3.2 Paragraphs 1-4)
4. Maintain multi-species objectives (2012 WCP) and comply with requirements of the applicable BO from USFWS to include the July 2016 ERTP BO and the CERP C-111SC Western Project
5. Consider compatibility with future restoration actions including CEPP. Reasonably connect the planning under this project authority to other near-term changes that are likely to be implemented in the system in the next few years using an Adaptive Management framework.
6. Explore opportunities for enhancing the recovery of federally and state listed species under the Endangered Species Act, the USACE’s authorities for MWD and C-111 projects and operational considerations.

7. Explore opportunities to enhance flood control and mitigation.

U.S. Fish and Wildlife Service (USFWS) Biological Opinion: The COP AMMP contains the monitoring and associated costs required under the USFWS Biological Opinion (BO) and other agency permits that are needed to protect and conserve natural resources.

Coordination with CERP Restoration, Coordination, and Verification (RECOVER) Monitoring and Assessment Plan (MAP), CEPP, and other programs: The COP AMMP is and will continue to be closely coordinated with the CERP RECOVER MAP and draws strongly from monitoring identified for the Central Everglades Planning Project (CEPP) Adaptive Management and Monitoring Plans as this CERP project occurs in the same action area as COP. Although COP is legally defined as a pre-CERP project, the spatial footprint and objectives overlap strongly. Thus, this effort took advantage of work done in the CERP-RECOVER MAP and CEPP to use already developed conceptual models, high priority uncertainties identified by CEPP, and existing monitoring where they were consistent with the needs, objectives, and scope of COP. Local adaptations of existing monitoring are suggested if necessary. This allows the COP AMMP to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and ensure cost-effectiveness.

This is the first time an adaptive management process is being considered for C&SF operations in south Florida related to the MWD and C-111 South Dade projects. While it is recognized that the USACE is the ultimate decision authority for the operations the C&SF water management infrastructure, one of the goals of the COP AMMP is to broaden the awareness and understanding of operational strategies/constraints to include land management agencies and stakeholder groups. The adaptive management process in the COP does not seek to take control over water management out of the hands of system operators, instead it seeks to inform their decisions with expertise on wildlife, biogeochemistry, and ecology. Establishing feedback between hydrologic system operators and these other groups, documenting the record of how feedback is acted upon, and summarizing these actions in periodic reports is how the COP AMMP hopes to increase awareness of challenges present in the system and to use this awareness to systematically improve ecological outcomes in the future. Enhanced awareness could be applied to future project designs, the schedule of implementation of future projects, or the design of future operational plans.

The COP AMMP will only be able to address uncertainties that occur as a result of naturally varying climate during the period in which the COP is the governing operational strategy. Because the natural system exhibits high interannual variability in rainfall, the project team has tried to integrate monitoring for the COP into our long term system-level monitoring in as much as possible. Many uncertainties with system performance can be enhanced through the implementation of CERP projects, and that is the primary driver of system enhancements moving forward. Continuing to implement CERP projects and integrate these projects into system operations is among the most important tactic for addressing the uncertainties associated with the COP.

C.1.2 Definitions of Adaptive Management and Types of Monitoring

The definition of adaptive management for the COP AMMP is as follows:

> *Adaptive Management – A scientific process for continually improving management policies and practices by learning from their outcomes; Adaptive Management links science to decision making to improve restoration performance, efficiency, and probability of success. In the context of Everglades*

restoration, adaptive management is a structured approach for addressing uncertainties by testing for best project designs and operations to achieve restoration goals and objectives, linking science to decision making, and adjusting implementation, as necessary, to improve the probability of restoration success and avoid constraints. The COP AMMP will also inform water managers on decisions that require updates to the COP Water Control Plan.

The COP AMMP involves several types of monitoring:

- *Uncertainty Monitoring* – Also called adaptive management monitoring (or a targeted study) to provide resolution to a question faced during planning or implementation regarding the best actions to take to achieve desired goals and objectives within constraints.
- *Performance Monitoring* – Performance monitoring is used to determine if the project is meeting its goals and objectives.
- *Compliance / Constraint Monitoring* – Compliance and constraint monitoring is used to determine whether the project is meeting its requirements and constraints under applicable laws and agreements.

Some overlap exists between performance monitoring and uncertainty monitoring, especially in the ecological arena as there is uncertainty whether "getting the water right" is sufficient to restore other natural resources such as wading birds across the landscape. In this document monitoring of wading birds across the landscape is addressed as an adaptive management uncertainty.

C.1.3 Structure of the COP Adaptive Management and Monitoring Plan

The COP AMMP is an appendix to the COP EIS document and contains seven sections organized by major topic category, followed by references:

C.1 Introduction;

C.2 COP Adaptive Management

C.3 Ecological Monitoring Plan

C.4 Water Quality and Hydrology Monitoring Plan

C.5 Water Quality and Hydrology Monitoring Plan South of S-331

C.6 Water Quality and Hydrology Monitoring Plan for 8.5 SMA Flood Mitigation

C.7 Cultural Resources Monitoring Plan

Where possible, COP monitoring described here relies on existing monitoring resources including physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies. Therefore, the monitoring requirements described and budgeted in the COP adaptive management and monitoring plan are limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address COP-specific questions. The COP adaptive management and monitoring plan relies on other monitoring in order to keep its monitoring costs to a minimum and assumes these other monitoring efforts will continue at least for the period required by COP.

Section C.2: Adaptive Management – the COP Adaptive Management section (Section C.2), provides the strategies to address prioritized project uncertainties that will be faced as COP progresses toward achieving goals and objectives while remaining within constraints. Each strategy follows a scientific approach that identifies the questions to be answered, methodology, triggers and/or thresholds to inform progress and support decisions regarding the need to adjust COP to improve performance, and recommendations for management options.

The types of management options included in the COP Adaptive Management Plan can be described as the following:

- *Inform Operational Decisions*– results inform changes to operations within the flexibility already allowed for within the Water Control Plan.
- *National Environmental Policy Act (NEPA) Covered COP Adaptive Management Contingency Options* - if observed conditions in the system indicate a need to implement contingency options described within the adaptive management strategies or management options matrix (MOM), several of the more limited contingency options that are described in sufficient detail (and do not require construction modifications) are implementable under the authority of this document.
- *Actions requiring additional NEPA permitting and review* – Actions requiring additional construction or otherwise not covered with sufficient specificity in the EIS will require additional environmental review and public comment and potentially additional modeling or analyses.
- *Informing CEPP or Other Project Implementation* - results may inform CEPP or other agencies regarding the next phase of CEPP project sequencing or other advisable actions that are beyond the scope of COP, such as construction of additional seepage barriers.

Management Options Matrices (MOMs) are provided as a quick reference to the adaptive management options and to link monitoring, triggers and thresholds, and the management options. The descriptions and summary matrices are intended to inform decision-makers, COP partner agencies, and the public on potential actions to improve restoration performance. ***Implementation of adaptive management options is not automatic; the options are suggestions that capture current understanding of potential future issues and solutions. A few AM options, as identified in Table C.2-23 are currently defined within the COP Water Control Plan and are supported in the environmental effects analysis contained in the EIS.***

The monitoring identified in this plan is considered part of the adaptive management strategies in accordance with WRDA 2007 and its subsequent implementation guidance. The monitoring is specific to uncertainties raised during COP planning which require refined data to address, and which will inform feasible options to adjust COP as identified in the COP Adaptive Management and Monitoring Plan (COP AMMP). Per USACE planning guidance ER-1105-2-100, Planning Guidance Notebook. Appendix E, Civil Works Programs, the intent of focusing on the uncertainties is to address questions and reduce the uncertainties. For COP in particular, the purpose is to ensure that water in south Florida is distributed optimally to meet the requirements for flood control, a reliable water supply, and effective environmental restoration.

Section C.2.6 describes the processes and institutional structures through which adaptive management will be implemented. These processes include feedback from Adaptive Management Uncertainties, the Ecological Monitoring Plan, and the Water Quality and Hydrology Monitoring Plans, which for simplicity are presented together in this section.

Part C.3: Ecological Monitoring Plan – The primary purpose of the COP Ecological Monitoring Plan is to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on COP's achievement of its project objectives, i.e. its achievement of success. This monitoring will be leveraged as much as possible to contribute to COP adaptive management. However, given the scope and scale of COP, the ecological monitoring and the monitoring identified in the COP adaptive management uncertainties are not one-and-the-same as that identified in the COP Ecological Monitoring Plan because the ecological monitoring plan focuses on COP's success at meeting project objectives (per WRDA 2007 guidance) while the monitoring specified in the adaptive management plan focuses on addressing project uncertainties (per WRDA 2007 and subsequent guidance) that may be more specific in their location and/or scale than the overall project objectives. Also, the adaptive management uncertainties focus on project adjustments that could be made relatively easily within WCP flexibility to improve project performance and/or ecological outcomes, and the monitoring described in the corresponding section of the AMMP will inform such adjustments. Whereas monitoring for overall project success for a project as large as COP may not provide the level of detail needed to answer the specific adaptive management questions to inform location-specific adjustments. In summary, since the project objectives and the uncertainties are not redundant then neither is the monitoring, but the plans have been designed to work together and inform each other as much as possible and it is encouraged that any future refinements of these plans include continual improvements of the streamlining between plans.

The ecological performance measures identified for COP are derived from the modeling performance measures used during Increment 1 and Increment 2 alternative comparisons.

The ecological monitoring plan also contains the monitoring mandated under the USFWS BO and other agency permits required to protect and conserve natural resources.

Part C.4: Water Quality and Hydrology Monitoring Plan – This plan identifies the necessary water quality, hydrologic monitoring needed to operate COP project structures and evaluate compliance with State and Federal regulations. The monitoring plan is directly derived from the COP Increment 2 monitoring plan.

Part C.5: Water Quality and Hydrology Plan South of S-331 – Identifies the necessary water quality, hydrologic monitoring needed to operate COP project structures and evaluate compliance with State and Federal regulations in the area south of S-331. The monitoring plan is directly derived from the COP Increment 2 monitoring plan.

Part C.6: Water Quality and Hydrology Plan South for 8.5 SMA Flood Mitigation – Identifies the necessary water quality, hydrologic monitoring needed to operate COP project structures and evaluate compliance with State and Federal regulations in the 8.5 SMA. The monitoring plan is directly derived from the COP Increment 2 monitoring plan.

Part C.7: Cultural Resources Monitoring Plan – The plan contains the necessary monitoring to better understand the response of archaeological deposits to changes in water elevation for future operational plans.

C.2 COP Adaptive Management

C.2.1 How the COP AMMP was developed: Identification, Screening and Prioritization of COP Uncertainties

The COP AMMP was developed through a workshop in July 2019 during which adaptive management uncertainties were identified and prioritized and workshop attendees were broken into three sub-teams to detail the strategies of the adaptive management uncertainties and to develop plans for performance monitoring and monitoring for compliance and other constraints.

A large list of possible uncertainties was developed prior to the workshop. The initial list was screened using the following criteria:

1. Must be directly related to COP goals, objectives, or 'constraints'.
2. Must be at project-scale. Although COP is large, it is not system-wide scale.
3. Must have adaptive management options, i.e., ability to be addressed during implementation, improved by adjusting COP. In some cases, additional ability to address the uncertainty with a future increment of restoration can be noted as a "future opportunity", but this feature is not sufficient in itself to pass this COP AM criteria.
4. Must be an uncertainty. Don't include items that are already known.
5. The uncertainty needs at least one attribute that is measurable that will provide information to resolve the uncertainty, i.e. the attribute must be a trait able to change in the timeframe of the adaptive management plan, and one that is distinct from the 'background noise' of natural variability. Long-term (multi-decadal) changes need a faster responding surrogate-measure for the adaptive management plan.
6. Some items may remain on the uncertainties list to "Keep them in view". Some examples a) observing effects of flow in NESRS on peat dynamics, which is important but hard to link to management options; b) remaining watchful of the potential for COP to cause hydrologic changes in the Pennsuco wetlands east of the project area. Due to the need to keep these important topics in view, they are kept on the uncertainties list due solely to this criterion.

The workshop attendees reviewed the initial list of potential COP adaptive management uncertainties, added additional uncertainties, and then proceeded to rank each uncertainty according to level of "Risk", "Knowledge" and "Relevance to Adaptive Management" using the criteria defined below.

Risk: What is the risk (high, medium, low) of not meeting COP restoration goals if this uncertainty is not addressed?

- Low risk means that even if the uncertainty isn't addressed, it doesn't pose much risk to achieving COP goals and objectives.
- Medium risk means that if the uncertainty isn't addressed it may or may not affect achievement of a goal/objective.
- High risk means that without addressing this uncertainty, there is a high risk to achieve COP goals and objectives.

Knowledge: What is the level of (high, medium, low) understanding of this uncertainty (i.e., how much is known about this uncertainty)?

- Low understanding means little is known about the question/issue or how to address it;
- Medium understanding means some information is known in some geographical areas, but not all;
- High understanding means a lot is known about addressing this question in multiple geographical areas.

Relevance to Adaptive Management for COP: What is the level of confidence (high, medium, low) that anything could be done to address the uncertainty? The team's preliminary identification of management options helped to determine this.

- Low confidence means that even if this uncertainty is addressed, COP or operations will not be able to be modified given the results of COP implementation.
- Medium confidence means if this question is addressed, a connection to future CERP project implementation is established/documented but future adjustments to the COP may or may not be limited, especially if indicator response is longer than 10 years and is more relevant to RECOVER system-wide monitoring.
- High confidence means if this question is addressed, COP design, implementation, and/or operations can be modified to improve restoration results.

Each uncertainty was assigned a Tier 1, 2, or 3 designation based on the rankings identified for each of the above criteria (Risk, Knowledge, and Relevance) using the scenarios in **Table C.2-1**. The workshop attendees discussed the rankings and finalized them. Those with a Tier 3 ranking were not carried forward into the COP AMMP. Note: the uncertainty ID numbers below refer to the ID numbers assigned to each uncertainty during adaptive management screening, and therefore may not appear sequential since those that did not pass screening are no longer included. The ID numbers were maintained for organizational purposes. The identification, screening, and prioritization process resulted in a final prioritized list of uncertainties. In some cases, during the filling out of the adaptive management uncertainty template, an uncertainty was split into two uncertainties either at the workshop or subsequently to assist clarity. In such cases the uncertainties are labeled with the workshop number followed by an "a" or "b". In the case of uncertainties #1 and #21 identified in the workshop, subsequently those filling in the uncertainty template determined there was a high degree of redundancy and chose to combine them. The final prioritized list appears in **Table C.2-2**. This list was used to develop strategies, management options, and costs for the COP AMMP.

Table C.2-1. Prioritization scenarios for identified uncertainties. Uncertainties ranked as Tier 3 were not developed further in the COP AMMP.

Scenario	Risk	Knowledge	Relevance	Tier
1	High	Low	High	1
2	Med	Low	High	1
3	High	Low	Med	1
4	High	Med	High	1
5	High	Med	Med	2
6	Med	Med	High	2
7	High	High	High	2
8	High	High	Med	2
9	Med	High	High	2
10	Med	Low	Med	2
11	Med	Med	Med	2
12	High	Low	Low	2
13	High	Med	Low	3
14	Low	High	High	3
15	High	High	Low	3
16	Med	Low	Low	3
17	Low	Med	High	3
18	Low	Med	Low	3
19	Med	Med	Low	3
20	Low	Med	Med	3
21	Med	High	Med	3
22	Med	High	Low	3
23	Low	High	Med	3
24	Low	High	Low	3
25	Low	Low	High	3
26	Low	Low	Low	3
27	Low	Low	Med	3

Table C.2-2. COP Adaptive Management Uncertainties identified during July 2019 workshop. Note the uncertainty ID numbers below refer to the ID numbers assigned to each uncertainty during the workshop, and therefore may not appear sequential since those that did not pass screening are no longer included.

COP ID#	COP AM Uncertainty	Final Tier Group	Breakout Group
1 / 21	Flows, Salinity and Peat Collapse: Will predicted COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? How do changes in salinity influence nutrient availability and what are the ecological consequences?	1	Ecology
8	Tree Islands: Can COP create hydrology favorable for tree island elevation requirements?	1	Ecology
20	WCA 3B Vegetation: Are COP operations likely to decrease hydroperiods and water depths in WCA 3B and cause the expansion of sawgrass in the remnant ridge and slough area?	1	Ecology
2	S-197 / Manatee Bay Discharges: How can the quantity, timing, duration, distribution and quality of discharges into Manatee Bay and overland flow into northeast Florida Bay be managed to promote restoration, sustain seagrass habitat, and avoid harmful algal blooms?	2	Ecology
9	Hydrologic Transmissivity: Can vegetation management south of Tamiami Trail be used to increase flow and manage flow direction from the Tamiami Trail Canal?	2	Ecology
11a	Pennsuco Wetlands: Will COP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 in areas such as the Pennsuco Wetlands?	2	Ecology
23	Soil Oxidation and Peat Fires: Are inundation and hydroperiod sufficient to reduce current high rates of soil oxidation and peat fires?	2	Ecology
18	Wading Birds in Alligator North Colony: Will changes in hydrology under COP negatively influence the Alligator Alley North Colony in WCA 3A?	1 or 2	Ecology
24	Water flow, salinity and algal blooms in Whitewater Bay, Florida Bay, and southwest coast estuaries. What are the water quality impacts and ecological benefits of changing patterns of freshwater flow into estuarine waters of the southern Everglades?	1 or 2	Ecology
25	Wading Birds: How much will hydrologic restoration result in potential changes in wading bird foraging conditions and nesting under COP?	1 or 2	Ecology
6	Seepage: Do COP operations, while leveraging existing seepage management infrastructure, sufficiently support project objectives and constraints?	1	Hydrology/ Modelers
10	NESRS & TS: Will increased flows to northeastern Shark River Slough and toward the southeastern Everglades (Taylor Slough and lower C-111 basin) yield natural distribution of waters and moderate recession rates? Are flows towards Taylor Slough sufficient to alter the anticipated flows or stages (recession rates)?)	1	Hydrology/ Modelers

COP ID#	COP AM Uncertainty	Final Tier Group	Breakout Group
12a	Tamiami Trail Flow Formula – General: Based on consideration of the existing water budget used to formulate COP, is there an opportunity to improve the Tamiami Trail Flow formula such that desired ecological targets are more universally achieved?	1	Hydrology/ Modelers
12b	Tamiami Trail Flow Formula and Drought: Based on consideration of the upstream water availability is there an opportunity to deliver water to NESRS in a specific manner such that the delivery enhances freshwater flows to Florida Bay by delivering more water during the dry season without harming the ecological condition of WCA 3?	1	Hydrology/ Modelers
5b	FDOT constraint on Tamiami Trail: Can L-29 canal elevations be raised to 8.5 feet NGVD for more than 90 days per water year without adversely impacting safety and stability of the Tamiami Trail roadway between S-333 and S-334? Following completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project, to what extent, if any, does the 8.5 SMA flood mitigation requirement limit the ability to operate the L-29 Canal up to 8.5 feet NGVD beyond the 90-day restriction assumed in-place through at least the 2020 wet season?	2	Hydrology/ Modelers
7	Saltwater intrusion: What are the effects of sea-level rise on COP operations, resulting salinity patterns in Florida Bay, water supply risks associated with saltwater intrusion, and ability to meet flood protection constraints?	2	Hydrology/ Modelers
16a	Water Quality in Taylor Slough - Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?	2	Water Quality / Hydrology
16b	Water Quality in NESRS - Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?	2	Water Quality / Hydrology

Adaptive management strategies for each uncertainty are provided in **C.2.2** (**Ecological Adaptive Management Uncertainties**), **Section C.2.3** (**Hydrological Adaptive Management Uncertainties**) and **C.2.4** (**Water Quality / Hydrological Adaptive Management Uncertainties**). This section provides 1-5 page strategy descriptions for each uncertainty and summary tables of suggested management options matrices to improve restoration performance, as illustrated in the example below.

C.2.1.1 Example AM Strategy Template

AM Uncertainty and ID#. The uncertainty is a question faced during planning or implementation regarding the best restoration actions to achieve desired goals and objectives within constraints, which cannot be fully answered with available data or modeling. Uncertainties were screened and prioritized to determine which to include in the AM Plan.

COP Objective or Constraint: Uncertainties needed to relate to project objectives or constraints, among other criteria, to be included in the AM Plan. This rule helped to focus the scope of the AM Plan.

Region(s): Area of project footprint to which the uncertainty and strategy pertain.

Associated Features: Structures or measures to which the uncertainty and strategy pertain.

Driver or Uncertainty Type: Unlike most AM Plans, not all project AM uncertainties and strategies are ecological. Types such as Engineering and Operations are identified.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Why the uncertainty needs to be addressed in the project.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: A scientific approach begins with a well-informed, pointed, detailed statement that will be tested. For the purposes of the project's AM Plan the statement can be referred to as an expectation or hypothesis. Approaching uncertainties scientifically is efficient because it is targeted; a properly identified hypothesis statement is the most important step to lead to effective, efficient methodology to address an uncertainty. It leads to proper identification of what to measure, how, how often, how to analyze, etc.

More Information on attributes to be measured:

- What is expected to be learned by measuring this attribute, i.e., how will the project benefit from knowledge gained about this attribute?
- What is the time frame in which changes to this attribute are expected to be measurable?
- Is this attribute complimented by other monitoring programs within and/or outside of the project? If so, provide reference to other monitoring. Note the monitoring paid for by others in the project AM budget spreadsheet.
- When during the project's life cycle should this monitoring begin and end?

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the project AM Plan varies in the level of methodology detail provided; in

several cases the details will be formed during the project's detailed design phase. In ALL cases, methodology will be reviewed, updated and adjusted if needed by agency subject experts, before initiation, to best meet the intent of the AM Plan.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Triggers or thresholds are a point, range, or limit that signifies when restoration performance is veering away from expectations and is trending toward an unintended outcome. Triggers/thresholds should be described per attribute to be monitored because each should result in an outcome that informs management decisions.

Management options that may be chosen based on test results: Management Options are provided in case a performance trigger or threshold is crossed, which would indicate that the project performance needs to be adjusted. The Management Options are suggested paths forward and adjustments that can be made to keep the project progressing toward objectives and within constraints. The Management Options are summarized in tables after each region's strategies.

C.2.2 Ecological Adaptive Management Uncertainties

C.2.2.1 COP AM Uncertainty #1 and #21 (Flows, salinity, and peat collapse): Will predicted COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? How do changes in salinity influence nutrient availability and what are the ecological consequences?

There are two closely related uncertainties relevant to the COP objective for the restoration of flow patterns, surface water depths, and hydroperiods downstream of control structures to reduce saltwater intrusion, soil subsidence, and nutrient release. Addressing this uncertainty about water level and salinity influences on saltwater intrusion will support maintenance of associated coastal wetland vegetation, soil stability, and nutrient availability/retention. Specifically:

COP Uncertainty ID #1: Will predicted COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release?

COP Uncertainty ID #21: How does changes in salinity influence nutrient availability and what are the ecological consequences?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 2, 3

Region(s): COP Uncertainties #1 and #21 are focused on the biogeochemical effects of sea level change/saltwater intrusion into the southern coastal wetlands (lower portions of Shark River and Taylor Sloughs) adjacent to Florida Bay and the Lower Southwest Coast, its potential mitigation by increased flows across Tamiami Trail, and its impact on soil stability and nutrient release to the estuaries. Unmitigated sea level change has the potential to impact Shark River and Taylor Sloughs miles inland of the current southern coastline.

Associated Features:

- The L-30, L-31N, C-111, LECSA 2 & 3 SFWMD Canal System canals;
- The S-12 Structures, S-356, G-211, divide and coastal water management structures of LECSA 2 & 3 SFWMD Canal System

Driver or uncertainty type: Hydrology, Ecology

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Benefits to COP will optimize restoration by understanding current conditions and rates of change for specific attributes and determining if they are changing as CERP projects are implemented. At the core of this uncertainty is that longer hydroperiods and lower salinities in the southern Everglades marsh and adjacent estuaries from restored flows will mitigate saltwater intrusion and protect coastal wetland vegetation and soil stability in this region. Sea level rise and saltwater intrusion as well as extended dry down can lead to increased porewater salinity and is of great concern in the southern coastal wetlands as it has the potential to negatively impact restoration success. Increased salinities in the southern coastal wetlands and their subsequent effect on the mangrove and sawgrass coastal vegetation communities are being documented. In addition, increased salinities in the coastal wetlands also have the potential to negatively impact the soil elevation, amplifying the effects of sea level change. Elevated salinity has been found to reduce gross ecosystem productivity and belowground root growth of sawgrass and extended dry down or drought stimulates organic matter

mineralization and CO_2 loss from the marsh, which culminates in peat collapse. In areas where peat collapse is prevalent, former marsh habitat can transition to open water.

However, uncertainties remain if flows delivered by COP to the southern coastal wetlands: 1) are sufficient to maintain or reverse the current spatial extent of surficial saltwater intrusion and associated mangrove-"white zone" "(an area with a low biomass of plants upstream of the coastal mangroves, this area only occurs near the Atlantic coast where nutrient concentrations in soils are exceptionally low) expansion; 2) will influence plant growth and soil decomposition processes to increase rates of soil accretion, elevation increase, and minimize nutrient and material releases caused by peat collapse, mitigating the effects of sea level rise; and 3) can minimize the inland extent of the groundwater salt wedge resulting in a decreased rate of internal phosphorus release to surface water and subsequent transport to the estuaries, decreasing the probability of an algal bloom event, especially on eastern Florida Bay where nitrogen levels are relatively high.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Hydrologic patterns, sediment characteristics, and ecological attributes are selected to better understand the effects of COP hydrologic modifications to the volume of freshwater delivery south of Tamiami Trail and saltwater intrusion on the biogeochemistry, soil accretion, and coastal wetland vegetation dynamics within the southern coastal wetlands. The southern coastal wetlands include lower portions of Shark River and Taylor Sloughs adjacent to Florida Bay and the Lower Southwest Coast. The attributes were selected based on existing knowledge of 1) surface/groundwater hydrology in Shark River and Taylor Sloughs and adjacent estuaries; 2) biogeochemical processes and nutrients in sediment and water; 3) soil accretion dynamics and mechanisms in marsh communities that lead to peat collapse in Shark River and Taylor Sloughs; and 4) mangrove-white zone movement and changes to vegetation coverage. Many of the attributes listed are currently monitored in this region by other agencies or USACE projects and may provide, in part, input to the testing of the hypotheses associated with this uncertainty. Costs for the additional monitoring have been included in the Table C.2-3. The timeframe in which the attributes listed below will be able to measure changes as a function of the project range from a minimum of yearly (water level and salinity) to a maximum of 5 years (soil nutrients, mangrove-white zone and other vegetation changes, soil elevation). Estimated timeframes to begin perceiving changes are listed following each attribute in parentheses along with complementary monitoring programs that measure the attribute:

1. *Hydrology (1-5 years) Uncertainty #1: What is the hydroperiod and frequency of elevated salinity in NESRS and ENP? What are the discharge rates into southern estuaries? What is the change in soil elevation, accretion, and depth?*
    - Water level: Increased, more sustained, and improved timing of freshwater flows are expected to increase hydroperiods and improve wetland inundation to prevent extended periods of dry down in the brackish marsh. The prevention of dry down is expected to decrease vulnerability of marsh elevation by preventing root loss and decomposition which are primary contributors to peat collapse.
    - Salinity: Restoration of freshwater flows is expected to prevent the surface/ground saltwater wedge from encroaching landward as well as prevent or limit frequency of elevated salinity (~20 psu) occurrence in brackish marsh, which decreases plant productivity and facilitates root loss, preventing marsh elevation from "keeping pace" with sea level rise.
2. *Biogeochemistry (5 years)-Uncertainties #1/#21: What is the size/extent of the P pool in soils and what are effects of groundwater salt wedge on P release?*

- Soil and plant nutrients: With the prevention or lowered frequency and duration of elevated salinity events, porewater C and nutrients will remain consistent and contribute to plant and soil productivity that helps maintain peat elevation. Stabilization and the stoppage or slowing of salt wedge encroachment will limit phosphorus release to surface waters.
- Porewater nutrients: Restoration will limit increase of SO_4 in brackish marsh porewater that will help reduce loss of organic matter that helps to maintain peat elevation.

3. *Soil elevation/Peat accretion (10-15 years)-Uncertainty #1: What is the change in soil elevation, accretion, and depth?*
   - As a result of longer hydroperiods and limited dry down, vegetation productivity is expected to increase and contribute to sediment and peat accretion rates that exceed subsidence rates and prevent peat loss and transition of marsh habitat to open water.
4. *Mangrove white Zone movement and marsh vegetation changes (15-20 years)-Uncertainty #1: What is the rate of mangrove-white zone expansion inland and vegetation distribution along the surface/groundwater wedge?*
   - With restoration, no change or a decrease in the rate of mangrove-white zone expansion will occur.
   - Hydrological restoration of Taylor Slough improves the southeastern Everglades marsh community with increased *Eleocharis* density, a species coinciding with fresher salinities and longer hydroperiods.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Monitoring is needed concurrent with implementation of COP to better understand the interaction of surface water and groundwater conductivity on hydrology, biogeochemistry, soil decomposition processes, and vegetation changes in the southern coastal wetlands. Monitoring includes hydrological and biogeochemical sampling and monitoring, soil elevation measurements, and the determination of historical mangrove-white zone movement and vegetation mapping and monitoring.

Hydrological and Biogeochemical Monitoring: A program of surface water quality monitoring operated by multiple agencies (ENP, USGS, and SFWMD) exists across ENP. Continuous conductivity/salinity and water depth in brackish and freshwater marsh will be accessed monthly at established stations (NMP and NP62, respectively; ENP), to which additionally selected stations in areas of concern may be added as necessary. Currently, discharge into the southern estuaries is monitored based on stage measurements at coastal water management structures in Biscayne Bay and Manatee Bay and a USGS network of measuring flow velocity at the mouths of creeks and rivers in Everglades National Park. Monitoring of discharge from the C-111 Canal into Manatee Bay via its terminal structure, S-197, is central to COP, as minimizing damaging discharges from C-111 is a COP (and C-111 South Dade Project) objective. COP is expected to improve flows to coastal wetlands and estuaries, mostly via Taylor and Shark River Sloughs and thus has a reliance on USGS creek and river flow monitoring and a small set of upstream flow monitoring stations (Upper Taylor River and Taylor Slough Bridge) stations. In addition to the supply of freshwater from the watershed, coastal wetlands are influenced by the extent and magnitude of the P pool and effects of the groundwater salt wedge on P release to surface waters in the southern coastal wetlands needs to be determined to identify any change in the rate and extent of P mobilization resulting from implementation of COP. Quarterly soil phosphorus, surface and groundwater conductivity, and below ground resistivity will be determined in the areas of concern (e.g. Model Lands to Lostman's River). It may be necessary to determine sources of freshwater (i.e., precipitation, runoff, groundwater) following

implementation of COP at specific locations. In this case, freshwater inputs would be determined using 18O and 2H stable isotopes following Price et al. (2012). See also Price et al. (2006) and Dessu et al. (2018).

Elevation: Annual soil elevation and depth monitoring in the areas of concern are needed to document any change in the soil elevation resulting from the increase in deliveries past Tamiami Trail. Elevation will be measured throughout the coastal area over time using Trimble GPS referenced to benchmarked Surface Elevation Tables (SETs) sites already established and monitored for the last 15 years by the SFWMD along the southern coast, in addition to two relatively new established locations, one each in brackish and freshwater marsh sites (near Nine Mile Pond and Pay-Hay-Okee, respectively, in ENP). Soil depth will be determined by probing (depth to bedrock) at SET locations, adjacent to vegetation transects (see vegetation changes, below), and selected locations where it was examined previously (e.g., Hohner and Dreschel 2015). Increased spatial intensity of soil accumulation measurements may be desirable, or alternatively, an effective method for estimating elevation change in unmeasured locations may be needed.

Mangrove-white zone movement and vegetation changes: The current rate and extent of mangrove-white zone expansion and surface/groundwater intrusion into the southern coastal wetlands is not known. Analyses of historic and current databases and/or aerial photos to determine the current rate and extent of mangrove and "white zone" expansion and surface/groundwater intrusion are necessary to set the baseline condition for COP. Vegetation transects that are monitored in the ENP panhandle as part of the SFWMD C-111 restoration plan will continue to be monitored annually and integrated with new landscape-scale aerial vegetation mapping every 3-5 years. Changes in vegetation, including transition of marsh to open water, will be spatially compared with existing porewater and groundwater conductivity and resistivity data to document any changes to the vegetation distribution and the location of the surface/ground saltwater wedge.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: The triggers and baseline thresholds for the implementation of adaptive management measures for the region are listed below. If a trigger is detected, this will necessitate the implementation of first, a scientific peer-review of the data to determine the relationship between the trigger metric, COP implementation, and the environmental drivers and second, the implementation of one or more specific adaptive management measures to improve the environmental situation. These AM triggers listed below are based on the best professional judgment of scientists familiar with the region, actual environmental monitoring data, modeled scenario data, and scientific research. However, every 2-3 years an adaptive management data review will be conducted (possibly managed by RECOVER) to see if specific thresholds to those listed below may be added or refined as new research and data are analyzed and incorporated by the PDT.

Triggers:

- Alteration of current spatial distribution of soil and vegetation nutrient pools relative to current conditions
- Increase in the rate of mangrove expansion in the white zone
- Increase in soil loss and/or elevation reduction
- Change in spatial extent of wetland surface water or groundwater salinity relative to two similar rainfall years from the period of record

Baseline Thresholds:

- Movement of spatial nutrient front or increase in nutrient rate of release from soils as observed along soil and/or vegetation transect
- White zone expansion rate exceeds Ross rate (3 km/50 yr. west of US1, 1km/50 yr. east of US1) and mangrove zone expansion rate exceeds current rate of expansion
- Increase in rate of coastal soil loss over the existing rate
- Magnitude of wetland surface or groundwater salinity exceeds equivalent rainfall conditions for the past 2 years from the period of record
- Inland movement of the saltwater wedge from current location

Additional Proposed Specific Thresholds:

- Salinities in brackish marsh ≥ 20 psu for ≥ 2 consecutive months in a calendar year, for 2 consecutive years.
- Median daily water level 0cm or below ground >2 months in brackish water marsh (Nine Mile Pond station; ENP)
- Decrease in below ground resistivity (i.e., increase in conductivity) from the prior 2 years of the period of record
- Any accelerated loss of elevation and accretion rates compared to previous measurements at established SET locations.
- Evidence of peat collapse along vegetation transects (e.g., exposed Cladium culms)
- Decreased sawgrass density or transition of vegetated marsh habitat to open water in 3 to 5-year aerial vegetation mapping and surface vegetation analyses.
- Retraction or decreasing density of *Eleocharis* (spike rush) in freshwater marsh and Taylor Slough

Management options that may be chosen based on test results: Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate. Reference **Table C.2-3**.

- Spatial redistribution of water into less sensitive areas
- Reduce discharges (e.g., S-12A, S-12B, S-12C, S-12D) and shift more water to the NESRS
- Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries
- Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast

Table C.2-3. COP AM Uncertainty ID#1 and #21 (Flows, salinity, and peat collapse) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
These two closely related uncertainties were combined. COP UNCERTAINTY ID #1 - Flows, salinity & peat collapse: Will COP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? COP UNCERTAINTY ID #21 - Water level, water quality and ecological consequences: How does changes in salinity influence nutrient availability and what are the ecological consequences?	Inundation Duration and Salinity in Coastal Marsh	Water level and salinity measured continuously at permanent installed hydro gages NMP and NP62, others as identified	1-5 years	NESRS, Taylor Slough	Salinities in brackish marsh ≥ 20 psu ≥2 consecutive months in a calendar year, for 2 consecutive years; Median daily water level 0 cm or below ground >2 months in brackish water marsh (Nine Mile Pond station; ENP)	Existing	• Spatial redistribution of water into less sensitive areas • Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries • Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast to evaluate options for dealing with changing sea levels. • Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Discharge and salinity from Taylor Slough	Discharge (flow rate) and salinity measured continuously at permanent installed Hydro gage NP-TSB (northern Taylor Slough), ENPTR (Taylor River) and TaylorS3 (downstream near Florida Bay)	1-5 years	ENP(TS)	Is there a change in flow relative to two similar rainfall years from the period of record?	existing	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Soil P pool relation to groundwater salt wedge	Soil, surface water, and groundwater P; Surface and groundwater conductivity; Groundwater resistivity monitored with quarterly samples in "areas of concern (e.g., Model Lands, Lostman's River)"	5 years	NESRS, ENP(TS), ENP(SC)	Is there a change in soil P from the prior 2 years of the period of record? Does this coincide with areas with elevated surface/ groundwater conductivity and belowground resistivity?	$100,000	Same as above
Same as above	Soil elevation and depth change	Soil elevation and depth at SETs established along the southern coast, NMP station in brackish marsh	3-5 years	ENP(TS), ENP(SC), Florida Bay	Is there an increase in soil loss or a reduction in elevation?	Existing	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Mangrove-white zone movement and marsh vegetation changes	Mangrove-white zone movement; marsh vegetation composition and density; Open-water area in marsh at mangrove-white zone at Everglades-Florida Bay transition zone; monitored with 5 year aerial vegetation mapping surveys and annual vegetation transect surveys	3-5 years	ENP, ENP(TS), ENP(NESRS), ENP(SC), Florida Bay	Is there an increase in rate of mangrove-white zone expansion? Is vegetated marsh habitat transitioning to open water?	$80,000	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Source of freshwater (Tentative/if necessary)	Normalized isotopic compositions (stable isotopes (18O and 2H)) in surface water and rainfall grab samples at "areas of concern (e.g., Model Lands, Lostman's River)".	5 years	NESRS, ENP(TS), ENP(SC)	This is not a trigger or a threshold. It is a hydrologic evaluation measure to assist in the selection of an adaptive management option, if necessary.	Cost range depending on scale of investigatio n is between $50,000 and $100,000	Same as above

C.2.2.2 COP AM Uncertainty #8 (Tree Islands). Can COP create favorable hydrologic conditions to sustain individual islands and increase soil elevation on tree islands?

COP Objective or Constraint: COP Objectives 3 and 5.

Region(s): WCA 3A, WCA 3B, ENP-SRS

Associated COP Features: S-333, S-356, Tamiami Trail, S-12D, and S-12C (outflow of WCA 3/inflow to Shark River Slough portion of ENP, as well as S-11 A-C, S-8, and S-140 (inflows into WCA 3).

Driver or uncertainty type: Hydro-ecological

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? The COP adaptive management monitoring plan will set the stage for closely related CEPP AM activities. Monitoring and targeted ecological studies conducted in CEPP should help to unravel the mechanisms of tree island restoration and sustainability in order to a) manage hydrological parameters (i.e., depth, hydroperiod, flow) downstream of major operational structures and b) promote ecological processes such as, peat accumulation and soil accretion rates, vegetation diversity, seedling recruitment and tree growth rates. Sustainability of the ridge/slough landscape is dependent upon the ability of the regional system to redistribute sediments, decrease peat oxidation rates, prevent peat fires, produce microtopography and create the diversity of habitats needed by all plant and animal communities. According to the ecological theory of Dynamic Equilibrium, the creation of historic water depths and hydroperiods will help to restore historic tree island peat depths and plant diversity.

COP initiates landscape scale changes in Northeast Shark River Slough driven by increasing hydroperiods and up to 1.5 ft. increase in water depths (driven by 1.5 ft. increase in stage constraint on Tamiami Trail, from 7.0 to 8.5 ft. NGVD29). CEPP is expected to increase stages another 1.2 ft. (driven by a 1.2 ft. increase in stage constraint on Tamiami Trail, from 8.5 to 9.7 ft. NAVD). These landscape scale changes are underway in NESRS (since incremental testing elevated the stage constraint at Tamiami Trail to 7.5 ft. beginning October 2015). A maximum stage of 8.5 ft. was reached first in January 2016 as part of an emergency operational deviation. Vegetation monitoring in NESRS provides the basis for initial detection of subtle changes in tree island boundaries, maximum tree size, and functional composition. Initial insights will be used to help inform longer term, more comprehensive monitoring through CEPP.

COP drives water levels in WCA 3 closer to the range of hydrologic conditions estimated to occur in the pre-drainage system (Park and Brown 2013). A higher proportion of mapped tree islands in WCA 3 should experience inundation less than 10% of the time (over a 5-10 year time horizon). As a result of COP fewer tree islands with hardwood hammock species will be inundated for long periods in WCA 3.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Changes to tree island size, forest structure, species composition, and boundary characteristics will provide a low cost/high frequency landscape scale perspective on shifts in vegetation in both tree islands and marshes across the landscape. Testing these hypotheses will inform how to determine longer-term monitoring strategies in CEPP. We expect tree island vegetation density to increase (independent of hurricane effects – which will selectively impact large trees), edges to sharpen (i.e. become more regular and defined), structural complexity to increase in 5-10 year periods following rehydration.

For COP we will be monitoring water depths for 371 mapped tree islands that were used to support the performance indicator that was evaluated to support the design of COP operations. Additional information about tree island change over time may be collected in RECOVER monitoring, and establishment/development of new tree islands will be monitored through landscape-scale vegetation mapping.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- The performance of COP is evaluated in terms of ecological benefits. Documenting the expected benefits to tree islands will help inform subsequent hydrological restoration efforts in WCA 3A, WCA 3B, and ENP under CERP. By reducing perceived risks associated with restoration actions, resource managers may choose to expedite additional large scale restoration actions.

What is the time frame in which changes to this attribute are expected to be measurable?

- 10 year increments

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Yes, monitoring is complemented by RECOVER tree island monitoring, RECOVER hydrologic monitoring, and proposed CEPP monitoring in addition to the vegetation mapping conducted by COP.

When during COP's life cycle should this monitoring begin and end?

- Monitoring was initiated in 2010 – prior to operation of the Tamiami Trail 1-mile bridge. Vegetation mapping is scheduled to occur every 2-3 years through FY2024.
- Attributes: Tree Island Attributes (Peat Accretion, Soil Nutrients, Community Structure, GW flows)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Vegetation mapping consists of accumulating imagery from Worldview 2/3 satellites. Each satellite is tasked to collect 2-3 cloud free images during each dry and wet season. Composite maps are accumulated and classified using an algorithm based process. Ground truthing of maps is conducted using a combination of 6 permanent star transect systems and the use of flights to sample closely related vegetation groups, using a data driven approach for maximizing mapping accuracy. These maps spatially aggregate 2 meter pixels to accumulate reasonably homogeneous patches of vegetation across the landscape, producing classified objects that are 12-100 m^2. Summary statistics on cumulative vegetation change and class-specific vegetation change are reported. Two of these vegetation mapping reports have already been developed and filed (see Gann et al. 2015, 2019)

Triggers/thresholds that indicate good COP performance or need for adaptive management action: We've confirmed that no observable ecological degradation has occurred as a result of initial COP actions. Specific thresholds for vegetation change will be developed as part of the CEPP effort, as sufficient information to inform these thresholds does not yet exist.

An existing threshold of avoiding more than 60 days of inundation of high elevation tree islands in two consecutive years or 120 days of inundation in any single year. It is desirable to add water depth criteria

to these duration thresholds in the future, as it is clear that for many species, the depth of inundation is a clear stressor that amplifies the effect of long durations on inundation.

Management options that may be chosen based on test results: Feedback to resource managers for COP will be provided as an outcome of an annual meeting and in regular reports every 1-2 years developed by NPS staff, shared with partner agencies, and submitted by USACE as part of permit compliance reporting.

Feedback to regional water managers could include informing operational decisions such as timing of water deliveries, pulsing of water deliveries, managing FEB/STA water to either enhance or reduce tree island hydroperiods, or routing water through an area slightly differently than originally specified. Suggested adaptive management options for tree islands downstream of COP water control structures listed below are not in any particular order and can be implemented simultaneously, as appropriate. Some options that would need additional authorization to improve restoration beyond COP are presented in the management options matrix.

- Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded Landscape Assessment (LILA) Everglades ecological experiments.
- Increase operational flexibility to maximize flow velocities in the key areas including: 1) hydrological pulsing, 2) Vegetation clearing or management.
- Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP.
- Adjust operations along the northern boundary of WCA 3A by redistributing water into the S-8.

Table C.2-4. COP AM Uncertainty ID#8 (Tree Islands) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #8 Tree Islands.	Tree island size; Structural complexity; Species composition; Boundary shifts	Mapping every 2-3 years of change in • Tree island boundaries and area • Maximum tree height/island, • Functional vegetation composition (e.g., presence of short hydroperiod, late succession hardwood hammock species) • Locations of additional new or missing tree islands	5-10 years	WCA 3A, WCA 3B, ENP-SRS	• Change in tree island number, size, and boundary firmness that indicates ecological degradation of tree islands is occurring and where. • Occurrence of more than 60 days of inundation of high elevation tree islands in two consecutive years or 120 days of inundation in any single year. • Specific thresholds for vegetation change will be developed as part of the CEPP effort.	Existing monitoring	• Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded Landscape Assessment (LILA) Everglades ecological experiments. • Increase operational flexibility to maximize flow velocities in the key areas including: 1) hydrological pulsing, 2) Vegetation clearing or management. • Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP. • Adjust operations along the northern boundary of WCA 3AWCA 3A by redistributing water into the S-8.

C.2.2.3 COP AM Uncertainty #20 (WCA 3B Vegetation): Are COP operations likely to decrease hydroperiods and water depths in WCA 3B and cause expansion of sawgrass in the remnant ridge and slough area?

COP Objective or Constraint: This uncertainty is related to the COP constraint of maintaining C&SF project purposes (Constraint 1).

Region(s): WCA 3B

Associated Features: S-151, S-152

Driver or uncertainty type: Hydrology/Operations, Ecological

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Are COP operations likely to decrease hydroperiods and water depths in WCA 3B and cause the expansion of sawgrass in the remnant ridge and slough area?

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: It is expected that drier conditions in WCA 3B will cause the remnant sloughs to transition to sparse sawgrass communities within a 5-year period, but it is uncertain how much the projected conditions will actually affect slough transitions. Specific attributes to be measured are local water depths in remnant slough area from EDEN water surfaces and % change in slough coverage within the remnant ridge and slough area from aerial/satellite imagery on an annual basis. A ridge and slough multistate transition model will be used to predict the most vulnerable sloughs/areas and how they might change over time. Monitoring of % change in slough coverage will validate model predictions and provide data to increase model efficiency and for future water management options.

Changes in slough coverage may or may not happen within the 2-3 year time frame of COP, but the effects from decreased water levels during COP is expected to be reflected in vegetation changes within 5 years of implementation. Monitoring should end 5-8 years after the project.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Sloughs will be delineated from aerial photography or satellite imagery every year and the multistate transition model will be run for each year. The results will be compared and used to provide feedback to water management in case the option of providing more water to WCA 3B is available and the model/results from slough delineation determine it would have a positive impact on WCA 3B sloughs.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Signs of significant slough loss from remote sensing or results from the multistate model could provide a trigger for more water to be allowed into WCA 3B.

Management options that may be chosen based on test results: More water could be provided to WCA 3B through S-152. This water would reach the southwestern side of WCA 3B that has the most remnant sloughs.

This uncertainty is further summarized in **Table C.2-5**.

Table C.2-5. COP AM Uncertainty ID#20 (WCA 3B Vegetation) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #20 - WCA 3B Vegetation	Slough percent coverage (filling in of the sloughs); multistate transition probabilities for slough to ridge	WCA 3B sloughs mapped every year using remote sensing and compared with multi-state transition model run; EDEN gages and surfaces within WCA 3B	5-8 years	Within remnant ridge and slough section of WCA 3B (southwest)	Signs of significant slough loss from remote sensing or results from the multistate model could provide a trigger for more water to be allowed into WCA 3B.	Existing	Input of water from S-152

C.2.2.4 COP AM Uncertainty #2 (S-197 / Manatee Bay Discharges): How can the quantity, timing, distribution, duration, and quality of discharges into Manatee Bay and overland flow into northeast Florida Bay be managed to promote restoration, sustain seagrass habitat, and avoid harmful algal blooms?

COP Objective or Constraint: COP Objectives 1a, 1c, 2, 4

Region(s): Manatee Bay / Barnes Sound, ENP (Taylor Slough), Northeastern Florida Bay

Associated Features: S-197, S-18C, C-111, C-111 Spreader Canal Western Project structures, L-31N and L-31W detention areas and associated structures.

Driver or uncertainty type: Hydro-ecological

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? A central COP goal is to improve freshwater inflow regimes into NESRS and Taylor Slough, while maintaining levels of flood control for adjacent developed lands (U.S. Army Corps of Engineers, 2017). This goal now is expected to be achieved, with completion of critical infrastructure construction and modifications by the C-111 Spreader Canal Western Project (SCWP), the MWD and C-111 South Dade projects and implementation of these features via COP. S-197 is the terminal structure of the C-111 Canal, discharging into Manatee-Barnes Sound in the southernmost portion of the Biscayne Bay system. The structure is used to alleviate the flood risk to private lands along the eastern border of ENP and South Dade County (**Figure C.2-1**). S-197 water discharges freshwater to Manatee Bay. During large rainfall event or in anticipation of such events, discharge pulses can be large and have the potential to cause downstream ecological harm via the stress of rapid salinity change, water column stratification and dissolved oxygen depletion, and nutrient enrichment that can stimulate damaging algal blooms. In contrast, water flows diffusely to northeast Florida Bay overland via Taylor Slough and the ENP panhandle, with conveyance via numerous coastal creeks near the Florida Bay shoreline.

COP is expected to benefit northeastern Florida Bay as a consequence of improved and more natural flows through Taylor Slough. Operation of seepage management features of the C-111SD Project and C-111SCW project are expected to decrease seepage losses from Taylor Slough into the C-111 Canal, decreasing the need for discharges via S-197. Benefits are expected with COP establishing an increased proportion of flow through Taylor Slough and decreasing proportion of flow via C-111 and through S-197. Thus, key uncertainties of COP implementation are the amount and distribution of flow into northeast Florida Bay along with S-197 discharges, benefits derived from this change in distribution, and any negative water quality impacts in downstream estuarine waters. Addressing these uncertainties will contribute to COP adaptive management, optimizing the effectiveness of the South Dade Conveyance System to benefit Florida Bay, reducing risks of potential harm to Manatee Bay and Barnes Sound, while still meeting the needs of south Florida hydrological operations to provide flood control and a reliable water supply.

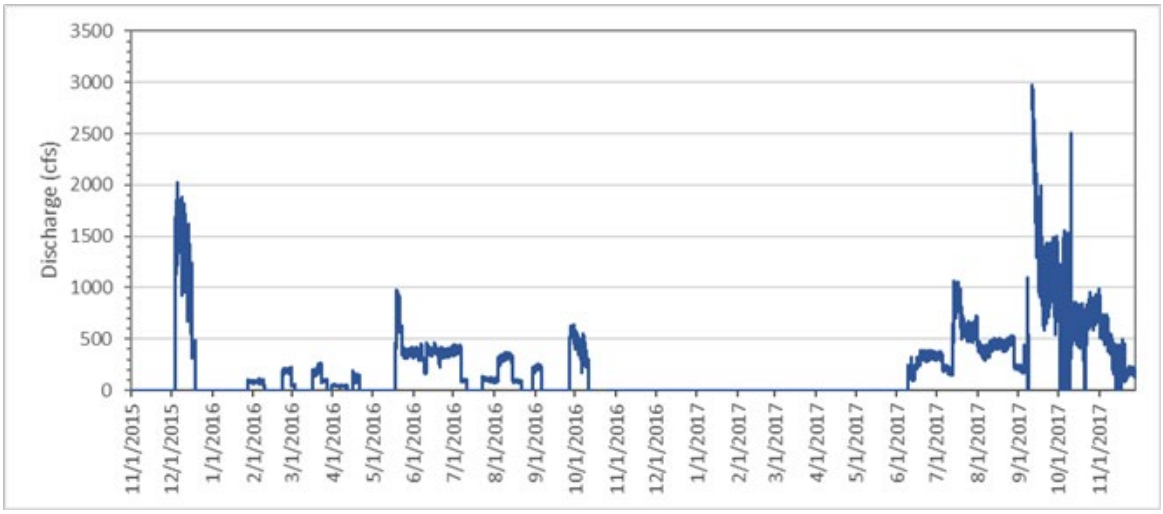


Figure C.2-1. Inflows from S-197 structure on C-111 canal into Manatee Bay, southern Biscayne Bay.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: COP is expected to benefit northeastern Florida Bay by increasing the relative distribution of water, along with the absolute quantity of water flowing overland to the bay. Concurrently, COP is expected to decrease the proportion of water discharged through S-197 into Manatee Bay, and especially decrease large water pulses to this bay. These hydrologic changes are expected to decrease salinity in northeastern Florida Bay and minimize rapid salinity changes in Manatee Bay, improve ecological conditions in Florida Bay in a manner similar to that described in Uncertainty #24, and minimize ecological harm in Manatee Bay.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Methodologies and data sources for assessing responses to changing freshwater flow, salinity, seagrass habitat, and water quality (specifically algal blooms, as estimated from chlorophyll *a* measurements) are described in Uncertainty #24 of this appendix and summarized in Table C.2-6 below. Measurements specific to assessing S-197 discharge effects include both routine (fixed frequency) monitoring and episodic monitoring that will be done in association with large discharge events (800 cfs or more for one week through S-197) and/or the detection of algal blooms. The timing of event-based sampling may be determined by the timing of large discharge events, detected biological events (such as algal blooms) or the combination of such events. The duration of event sampling will be sufficient to determine whether a problem persists or has diminished, see **Triggers/thresholds that indicate good COP performance or need for adaptive management action**. Triggers and thresholds that indicate good COP performance for Florida Bay are described in Uncertainty #24. Triggers spurring adaptive management action include phytoplankton blooms or excessive nutrients, also described in Uncertainty #24, or large S-197 discharges that rapidly decrease Manatee Bay salinity and/or cause stratification events with DO depletion (hypoxia or anoxia) in this bay's bottom waters. This likely requires sustained discharges exceeding 800 cfs for at least one week and are more likely if such discharges are a time of high water temperature and high bay salinity. Event-driven assessment will be necessary in order to establish robust numerical thresholds for discharge rates and durations. These events may include large discharge events, detected biological events (such as algal blooms) or the combination of such events. The duration of events sampling will be determined whether a problem persists or diminished.

Table C.2-6.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. Triggers and thresholds that indicate good COP performance for Florida Bay are described in Uncertainty #24. Triggers spurring adaptive management action include phytoplankton blooms or excessive nutrients, also described in Uncertainty #24, or large S-197 discharges that rapidly decrease Manatee Bay salinity and/or cause stratification events with DO depletion (hypoxia or anoxia) in this bay's bottom waters. This likely requires sustained discharges exceeding 800 cfs for at least one week and are more likely if such discharges are a time of high water temperature and high bay salinity. Event-driven assessment will be necessary in order to establish robust numerical thresholds for discharge rates and durations. These events may include large discharge events, detected biological events (such as algal blooms) or the combination of such events. The duration of events sampling will be determined whether a problem persists or diminished.

Table C.2-6. Field components, study sites, ecological parameters, frequency and mode associated with data collection.

Component	Sites	Parameters	Frequency
C-111 and creek flow	S-18C, S-197, Manatee Bay Creek , West Highway Creek, Trout Creek	Temperature, salinity, flow velocity	Continuous from C-111 stage gauges; 20 minute from USGS creek flow velocity meters
Salinity and Water Quality (fixed sites)	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove; S-197, S-18C	Salinity, temperature, pH, dissolved oxygen (DO), turbidity, nutrients, chlorophyll a (Chl a)	NPS MMN hourly salinity, temperature; SFWMD monthly and event-driven DO, pH, turbidity, Chl a, nutrients (with vertical profiles during events)
Salinity and Water Quality (Dataflow mapping)	Manatee Bay, Barnes Sound, Long Sound	Salinity, temperature, DO, Chl a, pH, CDOM, turbidity, phycoerythrin/phycocyanin	Quarterly and event-driven
Seagrass habitat, light	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Seagrass cover, species, light attenuation	4 times per year

Management options that may be chosen based on test results: Recommendations to benefit northeast Florida Bay and minimize harm from pulse discharges into Manatee Bay are:

1. Avoid discharges through S-197 in order to maintain sufficient flows in Taylor Slough and into northeastern Florida Bay and avoid eastward seepage of water from Taylor Slough.
2. If discharges through S-197 are unavoidable and when not otherwise constrained by safety and flood control requirements,
    a. Minimize discharge rates and durations, especially over 800 cfs and over a week duration. Several smaller releases (e.g., < 500 cfs) are preferred over large, pulsed releases.
    b. Avoid two or more discharge events within six months that are magnitude 800 cfs or more for a week duration.

See Uncertainty #24 for more details regarding metrics and management options to benefit Florida Bay and **Table C.2-7** for Manatee Bay options, relevant to Manatee Bay, Barnes Sound and northeastern Florida Bay.

Table C.2-7. COP AM Uncertainty ID#2 (S-197 / Manatee Bay Discharges) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Esti-mated Additional Annual Cost	Management Action Options Suggestions
UNC #2 – (S-197 / Manatee Bay Discharges)	C-111, S-197, and adjacent or downstream creek discharge	Discharge estimates (daily, monthly, and annual) from flow velocity or rating curve, with tracking of proportion of total discharge from S-197 and specified creeks.	For the duration of COP imple-mentation (estimated 5 years)	S-18C, S-197, Manatee Bay Creek, West Highway Creek, Trout Creek	For S-197, discharges into Manatee Bay that: • cause rapid salinity changes sufficient to cause a faunal or seagrass mortality event; • water column stratification with development of hypoxic or anoxic bottom waters; • chlorophyll *a* concentrations with red stoplight indicator or exceeding Numerical Nutrient Criteria thresholds	Existing	Operate the SDCS in ways less likely to damage the ecosystem: • Avoid discharges through S-197, distributing sufficient flows in Taylor Slough to northeastern Florida Bay and minimize eastward seepage of water from Taylor Slough. • If discharges through S-197 are unavoidable and when not otherwise constrained by safety and flood control requirements, ○ Minimize discharge rates and durations, especially over 800 cfs and over a week duration. Several smaller releases (e.g., < 500 cfs) are preferred over large, pulsed releases. ○ Avoid two or more discharge events within six months that are magnitude 800 cfs or more for a week duration

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Esti-mated Additional Annual Cost	Management Action Options Suggestions
Same as above	Continuous salinity and temperature monitoring	Daily average: temperature, conductivity, salinity	Same as above	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Trout Cove	Same as above	Existing	Same as above
Same as above	Salinity, temperature, and water quality	Regular & Event driven sampling, with grab samples, vertical profiles and surface mapping: temperature, salinity, pH, DO, Chl *a*, turbidity, light, CDOM, inorganic and organic nutrients	Same as above	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Same as above	Existing plus $10,000 / year for event-driven sampling	Same as above
Same as above	Seagrass habitat	Seagrass cover and species composition	Same as above	Random sites in Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Same as above	Existing plus $10,000 / year for seasonal sampling	Same as above

C.2.2.5 COP AM Uncertainty #9 (Hydrologic Transmissivity): Can vegetation management south of Tamiami Trail be used to increase flow and manage flow direction from the Tamiami Trail Canal?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c.

Region(s). ENP – Immediately south of water control structures (S-12s) and both existing and new culvert sets along the entire Tamiami Trail.

Associated Features: Vegetation "halos" immediately south of water control structures and culverts along Tamiami Trail.

Driver or uncertainty type: Hydrology and Vegetation

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Whether the vegetation halos at the culvert sets through the Tamiami Trail act as a barrier to water flow.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each. In order to restore North East Shark River Slough as a functioning component of the Everglades ecosystem, barriers to water flow downstream of Tamiami Trail must be removed. It is uncertain as to whether the vegetation downstream of the culverts and structures impedes southward water flow into Shark River Slough.

More Information on attributes to be measured: Flow velocity through the culvert sets. This work is on-going through the USGS and ENP. These data will be compared to historical data from when the L-29 was constrained at 7.5' NGVD.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Work is currently on-going to determine the hydrologic effects of dredging and removing vegetation south of S-12B. This is a five-year study with the objectives of:

1) Environmental quality: how does dredging and vegetation removal affect P transport into downstream wetlands?
2) Water residence times: are downstream water velocities increased by expanding tailwater pond area?
3) Project conditions: how is the discharge capacity of the structure affected?

Annual reports will be provided.

Additionally, analyses performed for the EVER Pilot Spreader Swale Project (ENP 2008) indicated that field observations at several culvert sets, including the far eastern culvert 59, show that although there is a significant tree canopy, there are ample channels between the trees to allow water to flow through to the undisturbed marsh areas downstream.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. Is the difference in stage north and south of the Tamiami Trail structures consistent with expectations during modeling (of performance) or is additional management of vegetation required to facilitate water flow?

The difference in stage at canal to 10,000 feet downstream is greater than expected or takes longer to achieve expected stages downstream than expected when compared with historical datasets.

Management options that may be chosen based on test results.

- Conduct a dye study to determine where water flow is being impeded.
- Managing agency conducts controlled fire to remove impeding vegetation.

Suggested adaptive management options listed below in **Table C.2-8.**

Table C.2-8. COP AM Uncertainty ID#9 (Hydrologic Transmissivity) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #9 – Hydrologic Transmissivity	Flow velocity at Tamiami Trail	Flow velocity through culverts; Difference in stage drop north to south of Tamiami trail versus expectations compared with historical datasets.	Near real time	ENP - Vegetation "halos" immediately south of water control structures and culverts along Tamiami Trail.	Difference in stage at canal to 10 km downstream is greater than expected or takes longer to achieve expected stages downstream than expected compared with historical datasets	No new monitoring will be required to address this uncertainty. Current on-going gages will be used to monitor this uncertainty.	• Conduct a dye study to determine where water flow is being impeded. • Managing agency conducts controlled fire to remove impeding vegetation.

C.2.2.6 COP AM Uncertainty #11a (Pennsuco wetlands). Will COP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 in areas such as the Pennsuco wetlands?

COP Objective or Constraint: This uncertainty is related to the COP constraint of maintaining C&SF project purposes (Constraint 1).

Region(s) and Associated Features: This uncertainty relates to the Pennsucco wetlands. Pennsuco is located between the Dade-Broward Levee, Krome Avenue, and Tamiami Trail (U.S. 41) and covers approximately 13,000 acres.

Driver or uncertainty type: Hydrology

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? The Pennsuco Wetlands provide groundwater recharge to the Northwest Wellfield public water supply for Miami-Dade County. Implementation of COP needs to sufficiently maintain the current levels of surface and groundwater in the Pennsuco Wetlands to where there is no change in the ecological conditions of this area. Under COP, the operations of S-335 and the L-30N canal will change from the existing water control plan which may influence seepage to the east in Pennsuco.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: The implementation of the COP will be analyzed to test for any potential adverse effects on the hydrology of the Pennsuco wetlands. ALTQ indicated the possibility of increased dry conditions in Pennsuco, but our hypothesis is that drier conditions are unlikely to occur as operations are implemented.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Near real-time analyses of operational changes of the S-356 pump, S-151, S-337 and S-335 and their potential effect on surface and ground water flows and the ecosystems east of the L-30 is needed to evaluate the ecological conditions of the Pennsuco Wetlands. Focus of the analyses are on the distribution, magnitude, and timing of surface and groundwater flows and stage elevation at water management structures and select wetland stage gages (e.g., G-975, G-3818, G-1488).

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums. Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Management options that may be chosen based on test results: Feedback to COP management will include providing information that can inform project decisions such as timing of water deliveries, the pulsing of water deliveries, or routing water through an area slightly differently than originally specified but within the approved COP study area to maintain hydroperiods and water depths in the Pennsuco wetlands. The goal is to keep water level variability in the Pennsuco wetlands consistent with pre-COP conditions, with the option to provide additional water from WCA 3B when the risk of going below these water level thresholds is expected. Monitoring and adaptive management actions are summarized below in **Table C.2-9**.

Table C.2-9. COP AM Uncertainty ID#11a (Pennsuco wetlands) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #11 – Pennsuco Wetlands	Hydroperiod; Water Depth	• Hydroperiod (Surface and Ground water) observed across a water year as measured at an identified set of gages in the study area. • Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. • Depth and duration of dry season below ground across a year, as measured at an identified set of gages in the study area.	2-3 Years	Pennsuco wetlands	Deviation from historic conditions	No new monitoring will be required to address this uncertainty. Current on-going EDEN gages (G-975, G-3818, and G- 1488) will be used to monitor this uncertainty.	Modify and/or adjust operations to include additional flows through S-151 to reduce potential negative effects on areas of decreased hydroperiod and water depths

C.2.2.7 COP AM Uncertainty ID #23 (Soil oxidation and peat fires): Are inundation and hydroperiod sufficient to reduce current high rates of soil oxidation and peat fires?

COP Objective or Constraint: Objectives 1a, 1b, 1c, 3.

Region (s) and Associated Features: While this uncertainty relates to all regions of COP, it is most specific to northeast WCA 3A and WCA 3B, where modeled performance indicated the potential for increased risk of soil oxidation and in ENP within NESRS and Taylor Slough where the potential for improved water depths and hydroperiods under COP may result in peat accumulation.

Driver or uncertainty type: Hydro-ecological

What is expected to be learned by addressing this uncertainty, i.e. how will COP benefit from addressing this uncertainty? Fire is a component of almost every type of terrestrial habitat in Florida and is a primary ecological driver in many of those habitats. If water levels decrease far enough below ground to dry out the surface of organic soils, peat or muck fires, can occur. Suppressing fires during extremely dry conditions is essential for protecting organic soils. Major canal and levee systems cause areas to be more vulnerable to drought and intense peat fires which can be ecologically damaging. COP simulations suggest that the frequency of soil consuming fire events should decrease compared to pre-COP operations. Reduced frequency of soil consuming fires should decrease the potential of a shift in community composition from the ridge-slough-tree island landscape that is the historical (and target) condition to flattened/disturbed sawgrass plain that becomes dominant when the landscape is under hydrated.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: A performance measure was used to evaluate the risk of soil oxidation across WCA-3 and ENP during plan formulation efforts for COP. Cumulative drought intensity is the sum of the daily depth of stage below ground (negative ponded depth) across the modeled period of record. Cumulative drought intensity was evaluated at indicator regions located in WCA 3 and ENP. Model results from COP were observed to decrease drought intensity at locations in NESRS and in Taylor Slough relative to the existing condition baseline (ECB19RR); however model results were also observed to increase drought intensity at locations in WCA 3A and WCA 3B relative to ECB19RR.

Expectations: Decreased frequencies and durations of dry outs leading to decreased rates of organic soil loss through oxidation and/or peat fires in portions of NESRS and Taylor Slough where improvements in cumulative drought intensity were observed. The expectation under COP is to maintain rates of organic soil loss and/or peat fires in portions of the study area where cumulative drought intensity was observed to increase, which includes portions of northern WCA 3A including indicator regions 190, 114, 115, 116, 118, the southeast portion of WCA 3B represented by indicator region 128, and the distal portions of Taylor slough represented by indicator regions 133S, 144N and 144S.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) for reporting: The cumulative intensity of dry down will be calculated each year and compared to expectations set for years with similar rainfall levels and antecedent conditions in Alternative Q+.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums.

Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Management options that may be chosen based on test results: Muck fire events are broadly accepted as negative. Feedback to COP management will include providing information that can inform project decisions such as timing of water deliveries, the pulsing of water deliveries, or routing water through an area slightly differently than originally specified but within the approved COP study area to improve hydroperiods and water depths. The goal is to determine whether such management actions would significantly improve cumulative drought intensity. Suggested adaptive management options listed below in **Table C.2-10** are not in any particular order and can be implemented simultaneously, as appropriate.

Table C.2-10. COP AM Uncertainty #23 (Soil oxidation and peat fires) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #23 - Soil oxidation and peat fires	Hydroperiod; Water Depth; Soil Oxidation; Peat Accretion; Fire Frequency	• Hydroperiod (Surface and Ground water) observed across a water year as measured at an identified set of gages in the study area. • Depth Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. • Depth and duration of dry season below ground water levels across a year, as measured at an identified set of gages in the study area. • Soil moisture content • Peat accretion • Fire mapping • Soil decomposition	3 Years	• Areas directly west of the Miami Canal and north of WCA 3B and northern WCA 3B are of particular concern due to observed model results • Areas within NESRS and Taylor Slough in ENP are most likely to be affected; however, monitoring within all of WCA 3 and ENP should be conducted	• Statistically significant decrease in soil moisture content • Organic soil content decrease • Sediment elevation decrease in ridges and tree islands • Statistically significant increase in frequency of peat soil consuming fires.	No new monitoring will be required to address this uncertainty.	• Modify and/or adjust operations to include (1) additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects on areas of decreased hydroperiod and water depths; (2) alteration in flows to NESRS through S-333N/S-333; (3) adjustment in flows at S-335 • Prioritize backfilling of Miami canal to reduce dry out of northern WCA-3

C.2.2.8 COP AM Uncertainty ID#18 (Wading Birds in Alligator Alley North Colony): Will changes in hydrology under COP negatively influence the Alligator Alley North Colony in WCA 3A?

COP Objective: COP Objective 3.

Region(s) and Associated Features: This uncertainty is specific to northeast WCA 3A, where the Alligator Alley North Colony (the colony) is currently located (see **Figure C.2-2** and **Figure C.2-3**). This colony is the largest in the Everglades and one of the largest wading bird colonies in the world. The ecological significance of this colony can be considerable when conditions are conducive both at the local island level and at the regional scale within a foraging flight of this island. In 2018 this one colony contained nearly 60,000 nesting pairs which is more than the CERP goal for the entirety of the Everglades system (Cook 2018).

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Addressing this uncertainty will test whether COP operations can be targeted toward preserving an important natural resource on a flexible case-by-case basis that may vary among years. Northern WCA 3A is expected to experience increased dryness under COP operations and addressing this uncertainty will protect the Alley North and other important colonies in WCA 3A that may be negatively impacted by increasing dryness during a critical period. This uncertainty should be addressed even if overall wading bird numbers show a positive response to COP operations in order to benefit the project's overall goal of protecting the ecological values of the WCA.

Expectations or hypotheses to be tested and attribute(s) that will be measured to test each: One hydrologic factor that influences the initiation and success of wading bird nesting at the Alley North colony is the presence of water above the soil surface at the island location. The presence of standing water protects nesting birds in two ways: (1) it prevents access to the colony by terrestrial predators (i.e. raccoon) and similarly (2) standing water increases the presence of alligators which are also a deterrent to predators. The hypothesis is that water levels expected under COP operations may dry the area around the Alley North or other important colonies during the critical nesting period causing nesting failure due to increased predator access at a critical time, but temporarily altering operations to improve conditions adjacent to the colony can avoid negative impacts due to COP operation. Extending the time that surface water is present at the colony site by as little as a few days could have significant ecological benefit in terms of nesting success.

Another factor that influences the success and initiation of wading bird nesting at the colony is regional foraging conditions. Below average depths in WCA 3A leading up to the wading bird nesting season (i.e. low stage) will also limit nest initiation and success. Higher than average recession rates also limit foraging later in the nesting season as this causes water depths go below ground before nestlings become mobile enough to avoid predation.

The specific attributes and expectations for this area includes maintaining: appropriate hydroperiods for wading bird nesting adjacent to the colony; appropriate recession rates for wading bird foraging adjacent to the colony; and appropriate water depths adjacent to the colony.

The Wading Bird Distribution Evaluation Model (WADEM) was utilized during plan formulation efforts for COP to identify potential improvements for wading birds within the study area as a result of COP implementation. From 1985-2012, Systematic Reconnaissance Flights (SRF) have been used to document

the abundance, flock composition, and spatiotemporal distribution of foraging wading birds across the Greater Everglades system. To develop WADEM (Beerens 2014 and Beerens et al. 2015), SRF occurrence data for great egrets, white ibis, and wood storks, are paired with daily hydrological variables calculated from water depths generated by the Everglades Depth Estimation Network (EDEN). Output from this type of model, averaged over the landscape, serves as a surrogate measure of the abundance of high-quality foraging patches. WADEM was developed to predict how Great Egrets, White Ibis and Wood Stork distributions respond to prey resources linked to hydrologic variables. Results from the model have been used to determine locations where hydrologic restoration improves the capacity of the habitat to produce prey densities suitable for wading bird foraging success.

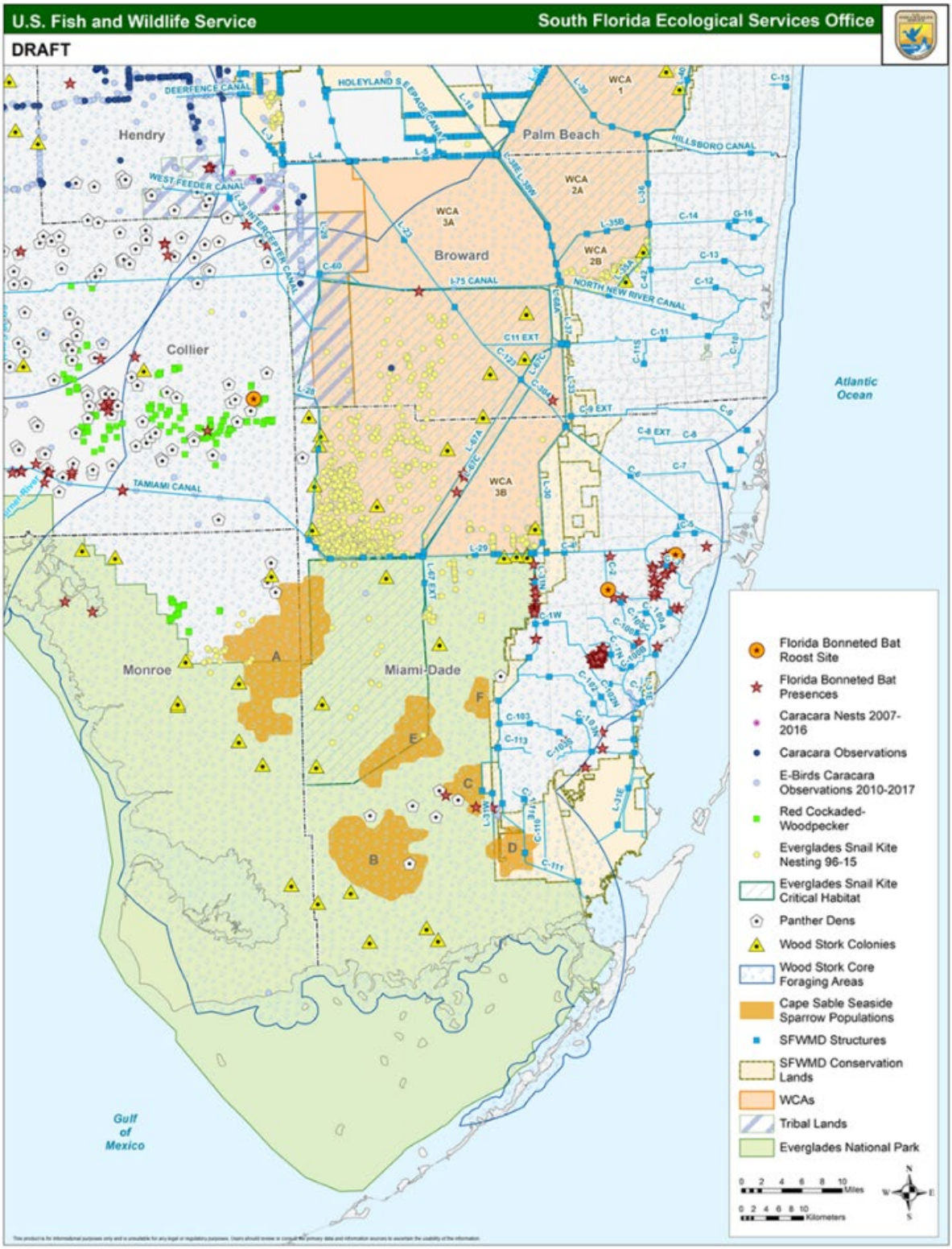


Figure C.2-2. Federally listed threatened and endangered species with the potential to occur within the COP action area (Provided by USFWS 2018). Yellow triangles note active Wood Stork colonies within the study area.

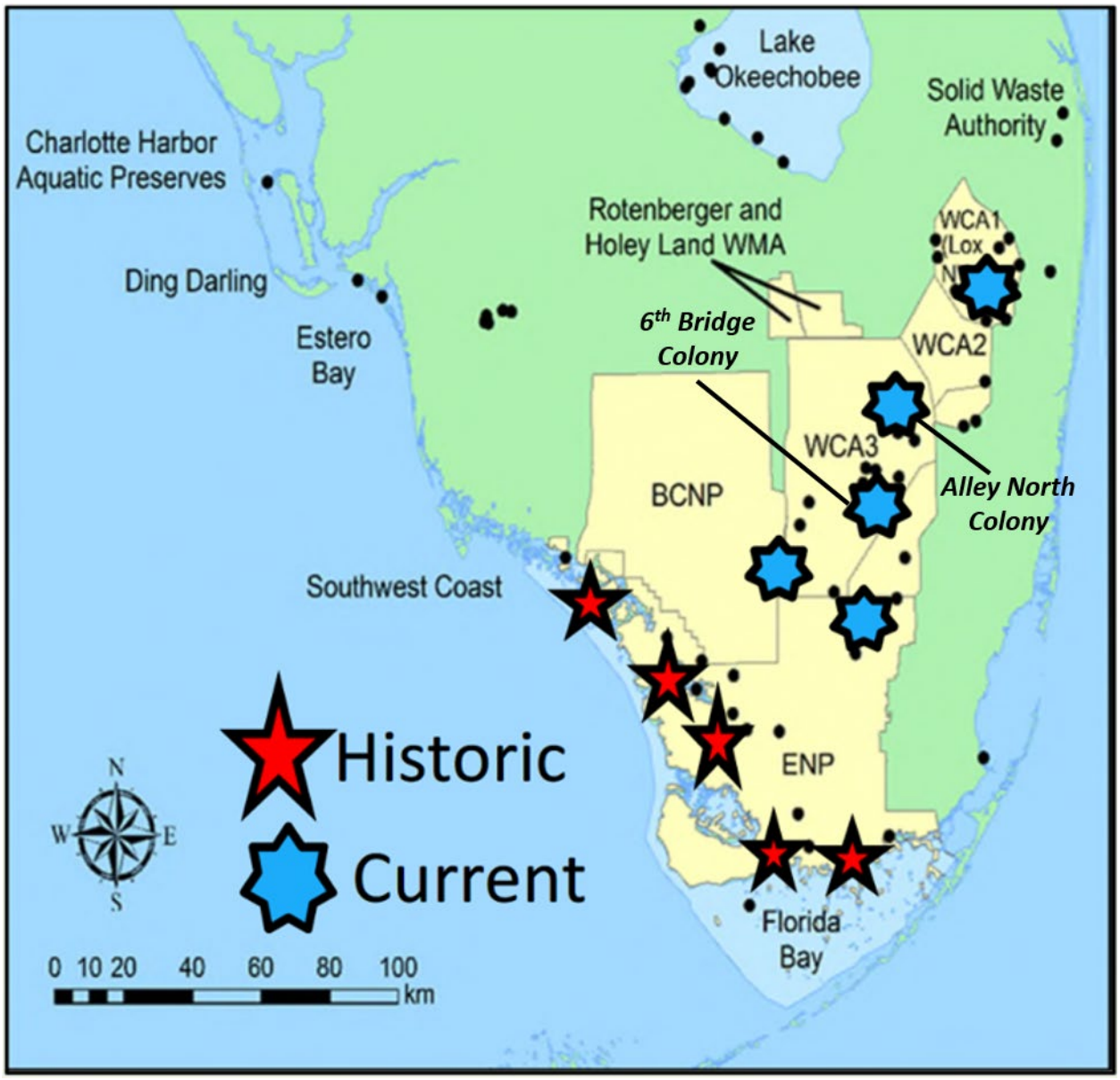


Figure C.2-3. Current and historic wading bird colony locations, with the Alley North and 6th Bridge colonies labeled. Red five pointed stars represent historic colony locations. Blue seven pointed stars represent current colony locations. Black dots represent smaller wading bird colony locations.

Specific attributes and expectations for these areas include:

Foraging Conditions and Nesting Success: Hydrologic change within WCA 3A that diminishes water depth and hydroperiod will decrease both prey density and the length of time that standing water is present around Alley North. This will be reflected by a decrease in the number of wading birds found foraging in those areas and a decrease in nesting success. The highly variable set of hydrologic parameters necessary to create suitable foraging conditions cannot be done solely through operational flows. The proper depths for the initiation of nesting and foraging related to nesting can only be established by the seasonally dependent regional climate driven precipitation. In some years the hydrology of the region surrounding the Alley North colony cannot support wading bird foraging conditions or nest initiation and no level of AM assisted water management could or should change that, this is natural variability. However, when suitable conditions are present prior to the historical initiation of the wading bird nesting season at the Alley North colony, it is expected that AM assisted water management may be able to accomplish three important functions.

1. Extend the hydroperiod in the marsh surrounding and upstream of Alley North (Foraging conditions).
2. Slow the recession rate in the marsh and at the Alley North Island (Foraging conditions).
3. Provide standing surface water around the Alley North Island that serves to protect the nests from mammalian predators (Nesting Success).

Pre-project monitoring and historical data will establish baselines for determining what suitable hydrologic conditions are necessary for wading bird nesting at Alley North. It is expected that a hydrologic as well as wildlife behavior trigger would be developed. This trigger would indicate that AM assisted water management has the potential to be efficacious.

The expectation under COP is to maintain and/or increase the total number of pairs of nesting birds in mainland colonies within ENP as determined by pre-project monitoring. It is reasonable to assume that given the model output of the alternatives, COP will have a deleterious impact on the foraging conditions and the nesting success of the Alley North colony. As COP isn't bringing in additional water volumes into WCA 3A only a change in the infrastructure would make significant difference in the hydrologic conditions near the colony. In a parallel effort to COP the SFWMD is undergoing the installation of a single canal plug in the L-38W (**Figure C.2-4**) and initial modeling with this feature (not modeled in COP) in place suggests improvement in at least extending the hydroperiod and slowing the recession rates in the marsh upstream of the colony. The installation of the plug as well as nine surface water wells in the vicinity of the plug and island are planned.

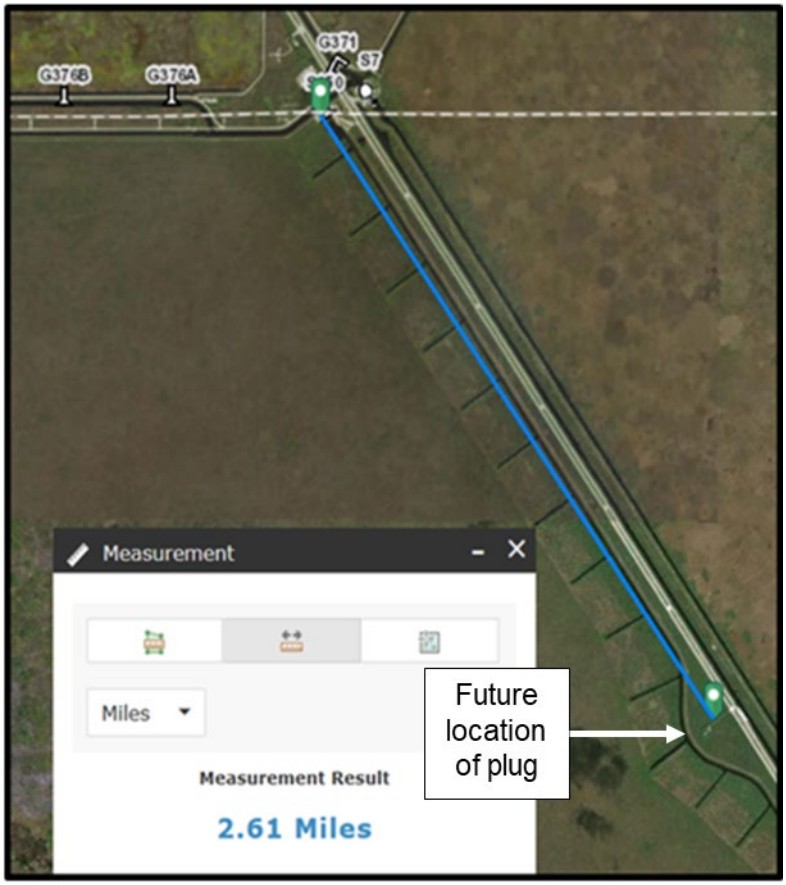


Figure C.2-4. Location of plug in L38W Canal, scheduled for spring 2020.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A comparative historical analysis will be required to test COPs potential to have a negative impact on wading bird foraging and nesting success at the Alley North Colony. In this approach, the before period is defined by measurements made annually 10 years prior to the initiation of COP operations that will affect the study area, and the after is the period 10 years following implementation. RECOVER's MAP and wading bird monitoring by the partner agencies will be utilized as appropriate to document historical wading bird foraging and nesting at the Alley North Colony and the surrounding marsh. That information will then be linked to the hydrologic conditions that led to suitable foraging and ultimately nest production at the Alley North Colony. As noted above the USGS's EDEN system and WADEM model as well as the SFWMD's wading bird (HSI) habitat suitability index based on SFWDAT can be used to determine the historical suitability of the hydrologic conditions for foraging. This analysis should provide baseline information for the expected number of wading birds utilizing the colony island given a set of hydrologic conditions, as well as information for the determination of a trigger for AM assisted water management. A preliminary analysis linking stage at gauge 63 to nesting effort at the colony strongly suggests that if a stage of approximately 9.4 feet NGVD29 or greater on March 15 is not met, nesting will be minimal to non-existent. This means a stage of approximately 11.5 on October 1st, with a recession rate averaging 0.09 feet per week (currently recommended rate creating optimal foraging conditions is 0.05 to 0.12 feet per week), would provide the hydrology needed for wading birds to nest successfully at the colony.

As the conditions for wading birds will change given the institution of COP as well as the installation of the plug, it will be necessary to collect information from the sonde network installed as part of the SFWMD's L-38W plug. This network will provide the resolution required to determine the impact of these changes to this critical area for sustaining healthy populations of wading birds in the Everglades during transitionary periods between larger restoration efforts. The current scarcity of gauge's located within the northwestern section of WCA 3A and the need for better information on the flux between the L-38W canal and the marsh upstream and surrounding the Alley North colony makes the support of this new monitoring effort critical to determining whether or not COP will have a negative impact on the Alley North colony. The data will be collected from the sondes on a monthly basis. Post processing and storage of the data will take place within the SFWMD's Applied Sciences Division. The sondes will be maintained bi-annually or if a problem is detected. The information gathered will be used to assess current conditions as well as validate an ongoing SFWMD modeling effort undertaken to better understand and predict the hydrology associated with discharges into WCA 3A North and the impact of the plug.

Existing and ongoing monitoring conducted/funded by the partner agencies will be leveraged as much as possible to contribute to adaptive management under COP and to avoid duplication of monitoring efforts.

Water depths before the breeding season and recession rates during the breeding season will be monitored. Current gages under EDEN and related EDEN applications will be utilized to understand how hydrologic parameters (e.g. hydroperiod, water depth and recession rates) near and adjacent to Alley North are being influenced by current COP operations, and to inform decisions about how to alter COP operations within the current breeding season to avoid decreased nesting success and colony abandonment due to COP operations.

Triggers/thresholds that indicate good COP performance or need for adaptive management action (plus how results will be reported): Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads and the general public through appropriate forums. Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Water depths and forecast conditions will be discussed during periodic multispecies operations calls hosted by USFWS, recommendations for operations will be made during these meetings and forwarded along to system operators. These meetings generally occur weekly during the wading bird nesting season, and no less than quarterly otherwise. A meeting prior to October 1 will be conducted in order to analyze hydrologic conditions in order to determine if initiating AM management actions would be prudent. A recommendation will be put forth from that analysis and provided to water managers.

Management options that may be chosen based on monitoring results: Feedback to COP management will be done in real time during Periodic Scientist Calls and weekly multispecies calls during the wading bird nesting season to determine whether operations need to be altered in the short-term. Management options include changes to the timing of water deliveries or routing water through an area slightly differently than originally specified to improve hydroperiods, water depths, and recession rates adjacent to wading bird colonies of concern in WCA 3A. Suggested adaptive management options listed below in **Table C.2-11** are not in any particular order and can be implemented simultaneously, as appropriate. Some potential adaptive management assisted water management options/strategies include:

- Allow water from WCA-2A to back flow through the S-7 structure into the L3/L4 canal, to then be discharged through the S-150 into northwestern WCA 3A. This may mean deploying temporary

pumps in order to be protective of stages in STA ¾ and ensure an effective volume of water is being moved into the S-150 (the nearest upstream water control structure to the Alley North Colony).

- Restrict outflow from WCA 3A
- Reprioritize the movement of water through the S-150 structure (vs. S-11s, S-140s, S-8, G-404)
- Install an additional plug

Table C.2-11. COP AM Uncertainty ID #18 (Wading Birds in Alligator Alley North Colony) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #18 – Wading Birds in Alligator Alley North Colony	Wading bird presence, Foraging conditions, Nest initiation	Nesting numbers, Nesting success, Water depth/stage, Recession rate	2 to 4 weeks	WCA 3A – Alligator Alley North colony and surrounding marsh.	Depth triggers at gauge 63. Evaluation of foraging conditions, nesting effort, previous years foraging conditions.	9 X surface water wells and sondes (Existing). EDEN gages and SFWMD wading bird surveys are part of on-going monitoring. Additional costs = $50,000 / year.	• Modify and/or adjust operations to include (1) additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; (2) reduction in flows to NESRS through S-333N/S-333; (3) adjustment in flows at S-335 • Allow water from WCA-2A to back flow through the S-7 structure into the L3/L4 canal, to then be discharged through the S-150 into northwestern WCA 3A. This may mean deploying temporary pumps in order to be protective of stages in STA ¾ and ensure an effective volume of water is being moved into the S-s150 (the nearest upstream water control structure to the Alley North Colony). • Reprioritize the movement of water through the S-150 structure (vs. S-11s, S-140s, S-8, and G-404). • Install an additional plug

C.2.2.9 COP AM Uncertainty ID #24 (Water flow, salinity, and algal blooms in Whitewater Bay, Florida Bay, and southwest coast estuaries): What are the water quality impacts and ecological benefits of changing patterns of freshwater flow into estuarine waters of the southern Everglades?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 2, 3

Region(s): Southern estuaries and near-shore southwest coastal waters, including Florida Bay, Whitewater Bay, Shark River and other southwest riverine estuaries influenced by COP, as far north as Lostman's River.

Associated Features: Tamiami Trail and ENP eastern boundary structures, including: S-333; S-12s, S-356 and L-31N seepage barrier; L-31N structures and adjacent detention areas, C-111 structures and C-111SCW features.

Driver or Uncertainty Type: Hydrology, water quality, ecology

What is expected to be learned by addressing this uncertainty, i.e., how will the project benefit from addressing this uncertainty? Implementation of the MWD, C-111 South Dade, and C-111 Spreader Canal Western Projects via COP is a foundational step toward restoring estuaries that depend on freshwater flow from Shark River Slough and Taylor Slough, including Florida Bay, Whitewater Bay, Shark River and other southwest riverine estuaries, likely as far north as Broad River. Based on model output used to evaluate COP alternatives, we expect COP will create more natural patterns of flow (especially distribution and timing, but also increased water quantity as a consequence of decreased seepage losses), resulting in more natural salinity patterns and associated restoration of estuarine ecological structure and function (especially seagrass habitat and associated fish populations). We also expect that water quality will be unaffected by COP implementation. However, there is a high degree of uncertainty regarding these expectations, as our expectations hinge on complex hydrologic models of the upstream watershed, statistical models to estimate salinity change, and various models that estimate ecological relationships with salinity. Estimates from such a chain of models within a large, complex, and dynamic watershed-estuarine ecosystem inevitably have high uncertainty. Uncertainty regarding estuarine responses is also a consequence of estuaries being strongly influenced by unmanaged coastal and ocean forces. Accelerating sea-level rise and climate change further increase this uncertainty. Better understanding of how the primary watershed driver of estuarine ecosystem change, freshwater flow, affects salinity, water quality, habitats and fauna will help COP and future restoration projects maximize benefits in these ecosystems.

Major categories of uncertainty to be addressed to promote COP success are:

1. Flow to the estuaries. How will patterns of flow distribution, timing, and quantity change with COP? Estuarine benefits from COP depend on improvement on flows from the Everglades watershed. Florida Bay restoration requires more water delivery toward the central bay. Monitoring of creek and river discharges to estuarine waters will inform future operational adaptations under COP and plans for CEPP, as well as improve hydrologic models that simulate coastal boundary conditions.

2. Salinity. How will salinity patterns be influenced by COP and will areas of critical concern have lower, more natural salinity? Will salinity be moderated in areas with a history of prolonged periods of extreme hypersalinity, especially north-central Florida Bay? Salinity monitoring and tracking the relationship of flow and salinity will inform operational adaptations under COP and plans for CEPP, as well as improve understanding and projections of how changing water management can influence estuarine conditions.
3. Algal blooms. The effects of changing patterns of freshwater inflow on estuarine nutrient availability and phytoplankton productivity are highly uncertain. Coastal phytoplankton (algal) blooms are a major concern, as they can negatively impact seagrass habitat and fauna. Increased freshwater flows to Florida Bay with the COP may concurrently increase delivery of nitrogen (N) compounds to northeastern Florida Bay, which predominately is a phosphorus limited region. Uncertainty regarding N delivery to the bay is associated both with variability of the N content of upstream waters (e.g., in WCA 3A and upstream canals) and increased N processing in Taylor Slough, as the COP shifts flow pathways away from the C-111 Canal toward Taylor Slough. Coastal water quality monitoring, including nutrient (P and N) and chlorophyll *a* measurements, along with assessment of potential upstream (watershed) nutrient sources, is essential to understand how restoration can best be achieved without compromising water quality, including algal bloom propagation. Other uncertainties in this Appendix (#16a, #16b, #23, #1/21) pertain to assessing upstream nutrient sources, including canal inputs, mobility of legacy nutrient enrichment, and nutrient release from soil oxidation or subsidence or fire. Also, the state of seagrass beds and their productivity, which is part of this estuarine uncertainty, has a strong interaction with algal bloom potential; healthy seagrass beds sequester nutrients and lessen bloom risk, while seagrass die-off releases nutrients and increase bloom risk.
4. Ecological benefits. How will changing patterns of freshwater flow and salinity improve seagrass bed habitat and fish populations, including economically important recreational fisheries? Monitoring of these critical ecological components, combined with information on flow, salinity, and water quality, will enable understanding of overall estuarine ecosystem responses to COP and inform operational adaptations under COP and plans for CEPP to maximize ecological benefits.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: For each of the above categories of estuarine uncertainty, expectations and measurements to assess those expectations are as follows.

1. Flow to the estuaries. COP is expected to increase freshwater flow down Shark River Slough and Taylor Slough, with most of this increase occurring during the dry season. The uncertainty of realized flow delivery to the estuaries will be addressed with calculation of water discharge from the existing USGS network of flow velocity gauges in creeks flowing into Florida Bay and rivers flowing into Whitewater Bay and the Gulf of Mexico.

2. Salinity. With increased flow, especially during the wet season and early dry season, salinity in estuarine and coastal nearshore waters is expected to decrease with COP. In particular, dry season salinity maxima are expected to decrease. The uncertainty of COP's influence on salinity, in terms of magnitude, seasonality, and spatial distribution will be addressed via salinity monitored by the ENP Marine Monitoring Network. Additional spatial mapping may be conducted by SFWMD's shipboard Dataflow surveys.

3. Algal blooms. The initiation and duration of algal (phytoplankton) blooms with COP is dependent upon many factors, but often is controlled by nutrient availability. This availability is in turn influenced by several factors, including storm disturbance, nutrient content of freshwater flow from the Everglades, and the demand and uptake of nutrients by seagrass and benthic algae in the estuaries (i.e., competitors for available nutrients). We hypothesize that COP and subsequent restoration efforts will improve both wetland and estuarine plant communities, yielding increased net nutrient uptake, as well as increased soil and sediment stability, which combined should increase wetland and estuarine nutrient sequestration in plants, soils, and sediments. This sequestration will minimize phytoplankton productivity. Furthermore, phytoplankton productivity in Florida Bay is typically P limited, and P inputs from the Everglades to the bay are low and not expected to increase with COP. Phytoplankton productivity in Whitewater Bay and southwest coast riverine estuaries is more N limited, and Shark River Slough waters are relatively rich in N, with high N/P ratios. While N inputs to these estuarine and coastal waters from SRS are not expected to significantly increase with the COP, there is expected to be a potential increase and shift of nutrients delivered to Florida Bay due to the reduction of direct surface water discharges from S-197 (eastern Florida Bay/Barnes Sound). Reduced S-197 discharges will be shifted to overland deliveries through Taylor Slough and the eastern panhandle of ENP to eastern and central Florida Bay. Shifting water flow through Taylor Slough will enable increased natural wetland processes to affect nitrogen cycling. This includes nitrogen uptake by periphyton and vascular plants, with N accumulation in soils, as well as nitrogen fixation that can increase N availability. The net output of N from Taylor slough and adjacent wetlands as a result of changing watershed N inputs plus enhanced biogeochemical processing is uncertain, but analysis of nutrient outputs to Florida Bay through Taylor Slough's mangrove creeks indicated that local nutrient processes in the coastal wetlands has a strong influence on net outputs to the bay. Long-term trend analysis has shown decreasing N concentrations in WCA 3A and ENP (Shark Slough and Taylor Slough) and loads to these areas from canal structures (SFWMD SFER 2020 Volume 1, Chapter 3A). Additionally, with the implementation of the SFWMD's Restoration Strategies and CEPP projects upstream, the nutrient loading delivered from ENP is expected to decrease over time. With this flow and nutrient pattern shift resulting from the implementation of the COP, Florida Bay blooms pattern shifts may nevertheless occur. We expect such blooms will not be significantly more frequent or long lasting than has occurred before the implementation of the COP, but there is a potential for change in bloom activity. It should be noted that the ocean circulation patterns are a more significant contributor of nutrient loading of Florida Bay than is normally associated with sheet flow from relatively pristine areas with no agricultural activity in the Taylor Slough flow path (all agriculture south of 8.5 SMA has been taken off line west of the L-31N/C-111 canal). Surface water runoff nutrient loading from urban and agricultural sources in western Florida Bay is a more significant contributor of nutrient loading to Florida Bay as compared to background nutrient level sheet flow/surface water delivered via the ENP/SRS/Taylor Slough path.

   To address this set of uncertainties, coastal water quality monitoring that includes chlorophyll *a* measurements, and which is currently being conducted by SFWMD, should continue. This water quality sampling was done monthly for about 20 years, but the frequency was then decreased to every two months, except in a subset of eastern and central Florida Bay stations. Given the po-

tential for rapid bloom development, resuming monthly monitoring at stations that may be influenced by COP is recommended in order to estimate bloom frequency, duration and intensity. Additional spatial mapping of chlorophyll *a*, conducted by SFWMD's shipboard Dataflow surveys, should continue in northern Florida Bay and be expanded to include southwest coastal and estuarine waters that appear prone to bloom activity. Source tracking of nutrients could also be considered if there is need to address upstream nutrient sources due to increased bloom activity.

4. Ecological benefits. The primary restoration targets for these coastal and estuarine systems is seagrass habitat and fish populations, including economically important recreational fisheries. Improvement of habitat and fauna is expected in near-shore portions of Florida Bay and the southwest coast. Currently, RECOVER's FHAP project assesses seagrass habitat through most of the area of potential COP influence, with the exception of Long Sound, Joe Bay, and Little Madeira Bay. These northeastern Florida Bay basins, which were previously monitored by Miami-Dade DERM, also should be assessed to address this uncertainty and uncertainty #2 in this Appendix. RECOVER's Juvenile Sportfish monitoring project, Florida Bay Marsh-Mangrove Interface Habitats for Fish project, and Hydrology, Aquatic Vegetation and Fauna in the Southern Everglades project assess fish communities in the COP zone of influence and should be continued.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:

1. Flow to estuaries. USGS directly measures flow to estuaries. Methodologies are established in the USGS Coastal Gradients project, sponsored by USGS and RECOVER. A network of 17 creek stations from Manatee Creek (flowing into Manatee Bay) to Lostman's River monitor flow velocity at approximately 15 min intervals and calculate net creek discharge. Most stations have telemetry with real time data availability. See: https://waterdata.usgs.gov/fl/nwis/current/?type=flow
2. Salinity. Salinity is monitored hourly in Everglades National Park's Marine Monitoring Network. There are 18 stations operated in Florida Bay and 15 stations in the estuaries of the park's southwest coast. See: https://www.nps.gov/ever/learn/nature/flbaymon.htm
3. Algal blooms. Water quality, including chlorophyll *a*, is monitored at a set of fixed sites in Florida Bay and estuaries of the southwest coast. Most stations are monitored every two months, but a subset of stations intended for C-111 Spreader Canal Western and C-111 South-Dade project monitoring are monitored monthly. For a map of stations, see: https://www.sfwmd.gov/sites/default/files/documents/wqm_swgrab1.pdf
   For a description of this coastal monitoring and Dataflow continuous flow spatial mapping, see: https://www.sfwmd.gov/sites/default/files/documents/2018_sfer_florida_bay.pdf
4. Ecological benefits. Assessments of ecological benefits and relationship to COP implementation will depend on the analysis of changing seagrass cover and species and fish population in relation to COP implementation and time series results from monitoring efforts described above. Seagrass and fish in Florida Bay and the southwest coast are monitored in multiple RECOVER projects supporting COP assessment, including monitoring of seagrass habitat cover and community composition; juvenile sportfish abundance, biomass, community composition; mangrove wetland prey base abundance, biomass, and composition with local hydrologic conditions; and wetland and coastal fish utilization of marsh-mangrove habitats, with adult sportfish tracking. Sampling frequency varies among these projects, but generally is seasonal to annual. For details, see the

2014 System Status Report from RECOVER: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/8694

Triggers/thresholds that indicate good project performance or need for adaptive management action: Protective triggers and thresholds, often established by other programs, can help inform COP adaptive management, potentially leading to corrective operational actions or future structural modifications. Minimum Flows and Levels (MFL) is an example of a process developed by the State of Florida outside of the CERP process that was established by SFWMD and FEDP for northeast Florida Bay to prevent significant harm. The MFL for Florida Bay defines a regulatory salinity threshold at a single lower Taylor Slough pond site and an associated guidance threshold for annual (365 day running total) flow into the bay from 5 creeks with USGS velocity meters (https://www.sfwmd.gov/our-work/mfl). COP and subsequent CERP projects will influence salinity and flow in this region and well beyond it. The occurrence of salinity threshold exceedances should trigger scrutiny of COP performance. Guidance from the creek discharge sum may be more useful for COP AM, as this can be used to forecast salinity trajectories. However, the MFL flow threshold (105,000 acre-feet per 365 days) appears to be too low to trigger adaptive actions, as it was not met only once over the past 14 years (in 2015), concurrent with a major seagrass die-off event (an event with significant harm). Based on best professional judgment and given that COP's objectives are to increase flow to advance restoration, a threshold of 200,000 acre-feet may be a more useful flow "floor" for COP guidance.

Protective thresholds for algal blooms have also been established by FDEP for coastal waters influenced by COP (https://floridadep.gov/dear/water-quality-standards/content/numeric-nutrient-criteria-development). For these waters, FDEP numerical nutrient and chlorophyll a criteria are annual geometric means that are not to be exceeded more than once in a 3 year period. Geometric means for numerous sub-regions were derived from SFWMD water quality monitoring network measurements from 1996-2005. This statistical approach entails an underlying assumption that the intensity and frequency of algal blooms in the recent past is acceptable but should not be systematically exceeded. In the context of COP adaptive management, this provides a threshold that can be used to assess whether a "do no harm" objective for coastal water quality is being met. The phytoplankton bloom indicator reported in the Everglades Restoration system-wide ecological indicators report (https://www.evergladesrestoration.gov/sweir/) has similar properties and serves a similar function, although at a coarser spatial scale (especially on the southwest coast).

These and other triggers and thresholds can also be used to indicate good COP performance. This includes trends of increasing freshwater flow, decreasing salinity (especially in areas with extreme hypersalinity), and decreasing chlorophyll *a* in areas with a history of phytoplankton blooms. A set of ecological indicators has also been established to assess restoration progress (https://www.evergladesrestoration.gov/sweir/), including indicators for Florida Bay seagrass habitat, roseate spoonbills, and crocodiles. A juvenile spotted sea trout performance measure has also been established in RECOVER (https://www.saj.usace.army.mil/Portals/44/docs/Environmental/RECOVER/Southern_Coastal_Systems_Seatrout_Performance_Measure_Final_021617_web.pdf?ver=2017-02-21-123410-380). While these ecological indicators do not have specific thresholds to trigger COP adaptive management actions, they collectively can be tracked over time to assess the extent to which COP is driving Everglades Restoration progress in the southern coastal system.

Management options that may be chosen based on test results:

- Modify operations to increase flow either via changing distribution or timing. This includes distribution of water from WCA 3A or WCA 3B to ENP or distribution within ENP (inflow to Shark River Slough vs Taylor Slough). This entails potential modifications of operation of structures along Tamiami Trail and the ENP eastern boundary.
- Additional actions could be taken to improve seepage management, especially on ENP eastern boundary, by raising L-31 and/or C-111 stages or, in future projects, building seepage barriers.

This uncertainty is further summarized in **Table C.2-12**.

Table C.2-12. COP AM Uncertainty ID#24 (salinity, water flow, algal blooms in Whitewater and Florida Bays) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID #24: Water flow, salinity, algal blooms and ecological benefits in Florida Bay, Whitewater Bay and southwest coast estuaries.	Water inflow from creeks and rivers	Flow velocity, with estimates of discharge (approximately 20 minute intervals)	2 to 4 years	Mangrove ecotone of Florida Bay, Whitewater Bay and southwest coast rivers (to Lostman's River)	• Flows insufficient to prevent high salinity events that cause ecological harm. The Minimum Flows and Levels flow threshold can be considered, but for COP success, higher flows (perhaps near the 25th percentile of MFL creek flow data distribution which corresponds to 200,000 acre feet) should trigger adaptive action. • Trend in deviation from expected relationship with rainfall (using double mass curves) could show good or poor performance	Existing (USGS, RECOVER)	• Modify operations to increase flow either via changing distribution or timing. This includes distribution of water from WCA 3A or -3B to ENP or distribution within ENP (inflow to Shark River Slough vs Taylor Slough). This entails potential modifications of operation of structures along Tamiami Trail and the ENP eastern boundary. • Additional actions could be taken to improve seepage management, especially on ENP eastern boundary, by raising L-31 and/or C-111 stages or, in future projects, building seepage barriers.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID #24: as above	Salinity regime	Specific conductivity and temperature to estimate salinity (hourly measurements)	2 to 4 years	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River)	• Minimum Flows and Levels salinity threshold is a starting point, but broader spatial criteria are needed. • Trend in deviation from RECOVER FL Bay salinity performance measure could show good or poor performance	Existing (ENP)	See above
UNC ID #24: as above	Algal blooms	Chlorophyll *a* (monthly for grab sample network; seasonal for spatial mapping)	2 to 5 years	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River)	Chlorophyll *a* concentrations with red stoplight indicator or exceeding Numerical Nutrient Criteria thresholds	Existing (SFWMD); estimated $30,000 for monthly interval change	See above and also consider nutrient source tracking to determine if loading could be reduced if significant uptick in bloom activity is noted
UNC ID #24: as above	Seagrass community	Bran-Blanquet cover metric, species composition (annual)	3 to 5 years	Florida Bay, Whitewater Bay	Trends in seagrass cover scores plus salinity and temperature indicative of increased seagrass die-off risk	Existing (RECOVER)	See above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID #24: as above	Faunal indicators	• Fish abundance, biomass, and species composition (monthly to seasonal) • Fish movement and location relative to salinity (monthly) • Fish prey base concentration with recession (monthly to seasonal) • Roseate spoonbill nesting success (dry season) Crocodile abundance, nesting success, growth and survivorship	1 to 5 years	Florida Bay, Whitewater Bay, Shark River	Trends in fish, spoonbills, or crocodiles could indicate good or poor performance	Existing (RECOVER)	See above

C.2.2.10 COP AM Uncertainty ID #25 (Wading Birds): How much will hydrologic restoration result in potential changes in wading bird foraging conditions and nesting under COP?

COP Objectives and Constraints: COP Objective 3.

Region(s) and Associated Features: While this uncertainty relates to all regions of COP where wading birds foraging and nesting currently take place, it is most specific to WCA 3A and areas in ENP to include NESRS. **Figure C.2-2** illustrates the location of wood stork nests and core foraging areas currently located within the COP study area boundary that may be potentially affected by COP. **Figure C.2-3** shows the current major wading bird colonies locations and where they were historically.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Addressing this uncertainty provides information that will enhance the ability of COP to improve the timing of and spatial patterning of foraging conditions which could help optimize nest initiation increase nest numbers and success for wading birds including the Great Egret, White Ibis and Wood Stork. Wading birds are currently not utilizing the study area for foraging and nesting to the same extent that has been documented to occur prior to implementation of the C&SF project (i.e. formation of wading bird super colonies) (Cook 2018), and model results indicate COP may have an undesirable impact on foraging conditions in WCA 3A. The COP adaptive management plan will provide a way to determine more specifically how operations of current water management infrastructure influence wading bird populations by altering hydrologic parameters (hydroperiod, water depth, and recession rates) and ecological parameters (prey density and vegetation).

Expectations or hypotheses to be tested to address the uncertainty and attribute(s) to be measured to test each: Central to this uncertainty is the hypothesis that more natural hydrologic patterns will improve foraging conditions and increase nest number and nesting success for wading birds such as the wood stork. Restoration of multi-year hydroperiods is expected to result in increases in dry season prey availability, increased nesting, and earlier nest initiation (November/December). Another goal of restoration is to encourage nesting in larger numbers at the historic coastal colonies.

The Wading Bird Distribution Evaluation Model (WADEM) was utilized during plan formulation efforts for COP to identify potential improvements for wading birds within the study area as a result of COP implementation. From 1985-2012, Systematic Reconnaissance Flights (SRF) have been used to document the abundance, flock composition, and spatiotemporal distribution of foraging wading birds across the Greater Everglades system. To develop WADEM (Beerens 2014 and Beerens et al. 2015), SRF occurrence data for great egrets, white ibis, and wood storks, are paired with daily hydrological variables calculated from water depths generated by the Everglades Depth Estimation Network (EDEN). Output from this type of model, averaged over the landscape, serves as a surrogate measure of the abundance of high-quality foraging patches. WADEM was developed to predict how Great Egrets, White Ibis, and Wood Stork distributions respond to prey resources linked to hydrologic variables. Results from the model have been used to determine locations where hydrologic restoration improves the capacity of the habitat to produce prey densities suitable for wading bird foraging success.

Areas expected to offer improved foraging conditions under COP based on WADEM include portions of NESRS within ENP. Potential changes in foraging conditions within WCA 3A and WCA 3B under COP fell within +/- 10% relative to the existing condition baseline (ECB19RR); however decreases in stage and hydroperiod were observed in portions of WCA 3A in the vicinity of the Alligator Alley North Colony

located west of the Miami Canal and north of WCA 3B during modeling efforts to support alternative analysis. While the potential improvement in foraging conditions within NESRS is encouraging, it is not the goal of COP to redistribute wading birds away from the interior colonies (Alley North) and towards the coast. Pre-project monitoring will establish baselines in key areas of the COP study area that are expected to be influenced by COP.

Foraging Conditions, Nesting Success, and Nest Initiation: Where a restored hydrology creates suitable conditions, an increase in prey density is expected. This will be reflected by an increase in the number of wading birds found foraging in those areas and an increase in nesting success. Pre-project monitoring will establish baselines in key areas of the COP study area. The expectation under COP is to maintain and/or increase the total number of pairs of nesting birds in mainland colonies within ENP as determined by pre-project monitoring. Shifting the timing of nesting in mainland colonies to more closely match pre-project conditions is also desirable. Specific recovery objectives would be to initiate nesting no later than January in most years, and as early as December in some years.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A BACI (Before-After-Control-Impact) methodology will be used for testing the model based expectation that COP will affect foraging in some regions thus impacting nesting timing and success in that location. Control and impacted colonies will be chosen based on all the model output used for COP based on predictions that nearby foraging would or would not be impacted. For example, it is clear that the Alley North colony has the potential to be negatively impacted, and the colonies near NESRS may be positively affected. As noted above the USGS's EDEN system and WADEM model as well as the SFWMD's wading bird habitat suitability index (HSI) based on SFWDAT can be used to determine the historical suitability of the hydrologic conditions for foraging near the colonies selected as controls or impacted (Alley North). Baselines can be established from the historical analysis for the colony locations chosen as controls or impacted sites and thresholds of concerns or triggers for action will be established. Problematic will be the lack of SRF flights after 2012 that systematically monitored foraging locations across the Everglades. Current monitoring must be more selective and targeted as time and financial constraints prevent a systematic reconnaissance of the complete Everglades landscape. Therefore the banner wading bird year of WY2018 was not captured in the calibration of WADEM, nor could SRF data be made use of in the future to track the change in foraging locations and change in the number of birds making use a particular habitat over time.

Triggers/thresholds that indicate good project performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology in comparison to established assessment parameters and targets. Results will be provided on an annual basis to COP project managers, agency leads, and the general public through appropriate forums. Conclusions and recommendations for adaptive management actions will be provided and will evaluate the triggers/thresholds that indicate good COP performance.

Management options that may be chosen based on monitoring results: Feedback to COP management will include providing information that can inform project decisions such as timing of water deliveries, or routing water through an area slightly differently than originally specified but within the approved COP study area to improve hydroperiods, water depths and recession rates adjacent to wading bird colonies of concern. The goal is to determine whether such management actions would significantly improve foraging and nesting conditions for wading birds in the study area. Suggested adaptive management options listed below in **Table C.2-13** are not in any particular order and can be implemented simultaneously, as appropriate.

Table C.2-13. COP AM Uncertainty ID#25 (Wading Birds) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #25 – Wading Birds	Wading Birds	Hydroperiod; Water Depth/ Stage; Recession Rates; Numbers of foraging wading birds; Number wading bird nests; and Nesting success (monitoring to include aerial and ground surveys conducted monthly during breeding season)	4 to 6 Years	Wading bird colonies within WCA 3 and ENP	• Decrease or no improvement in numbers of foraging birds based on evaluation of baseline data • Decrease or no improvement in nesting success (nest abandonment) based on evaluation of baseline data	No new monitoring will be required to address this uncertainty. Current on-going RECOVER Monitoring occurs in Lake Okeechobee, the WCAs, ENP, and Florida Bay at a cost estimate of $500,000 per year.	• Evaluate distribution of water between WCA-3, NESRS and Taylor Slough; modify regional operation of the system. • Modify and/or adjust operations to include (1) additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; (2) reduction in flows to NESRS through S-333N/S-333; (3) adjustment in flows at S-335.

C.2.3 Hydrological Adaptive Management Uncertainties

C.2.3.1 COP AM Uncertainty ID #6 (Seepage / Flood Protection): Do COP operations, while leveraging existing seepage management infrastructure, sufficiently support project objectives and constraints?

COP Objectives or Constraints: COP objectives 1a, 1b, 1c, 2.

COP planning constraints related to this uncertainty is as follows:

> #5.1992 MWD GDM (1992 General Design Memorandum): mitigation for project induced flood damages

COP planning considerations related to this uncertainty are as follows:

> #5. Consider compatibility with future restoration actions including CEPP. Reasonably connect the planning under this project authority to other near-term changes that are likely to be implemented in the system in the next few years using an Adaptive Management framework.
>
> #7. Explore opportunities to enhance flood control and mitigation.

Region(s): WCA 3B, Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N, L-30, and C-111 Canals

Associated Features:

- L-30 Canal and associated water control structures (S-335)
- Partial seepage barrier south of Tamiami Trail along L-31N
- L-31N Canal, detention areas, and associated water control structures (S-356 and S-332B/C/D structures).
- 8.5 SMA Canals and associated water control structures (S-357, S-357N).
- C-111 Canals, detention areas, and associated water control structures (S-199, S-200)

Driver or Uncertainty Type: Hydrology/Operations, Flood Control

What is expected to be learned by addressing this uncertainty, i.e., how will the project benefit from addressing this uncertainty? 8.5 SMA: By addressing this uncertainty, the effectiveness of seepage management features, and their effects on regional surface and subsurface hydrology will be better understood. There are remaining uncertainties about the effectiveness of seepage management measures in the project area due to complex interactions among the water control infrastructure, geology, and natural variables. While the numerical models showed any expected seepage should be within authorized level of flood mitigation, the pumping strategies and constraints in the COP are purposely conservative in order to prevent problems due to any potential inaccuracies in the models. Continued monitoring and testing during actual implementation, as conducted during the Incremental Field Test, may show the operations in the COP are overly conservative and additional deliveries into NESRS can be allowed without creating risk for flood mitigation. Such field verification of the models may allow additional operations within WCP flexibility and allowing increases in beneficial flows to NESRS.

L-31-N and C-111: There is uncertainty whether installation of further seepage barriers would be a cost-effective way of reducing seepage management challenges in adjacent developed areas. Investigation of the effectiveness of the installed 5-mile seepage barrier along L-31N versus utilization of detention areas and pumping along the eastern boundary of ENP may indicate whether additional seepage barriers would be beneficial in achieving more environmental benefits in a cost-effective way. The lessons learned could inform the suitability of this type of infrastructure for future planned restoration projects.

A better understanding of effectiveness of COP seepage management measures can also provide information on:

- Extent of the influence of existing seepage management measures.
- If the current level of flood risk management provided by the C&SF system is maintained.
- Volume of surface water lost to the canal system and delivered to various regions of the project.
- Effect of seepage management on regional groundwater flow, wetland hydroperiods, extent of saltwater intrusion, water quality, and water supply availability.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each:

Hypothesis 1: Existing infrastructure and water management operations effectively manage the seepage rates along L-31-N Canal, C-111 Canal, and eastern ENP.

Hypothesis 2: Existing infrastructure and water management operations achieve the authorized level of flood mitigation for 8.5 SMA.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

Assessing the effectiveness of seepage management measures can support:

- Better operation of the water management system and its flood risk management and water supply functions,
- Better accounting of deliveries to various regions of the project area,
- Determination of additional needs for data monitoring or seepage management measures.

What is the time frame in which changes to this attribute are expected to be measurable?

Continuous monitoring under various hydrologic conditions following installation of all monitoring gages (in 8.5 SMA, C-111 detention areas) are needed.

Is this attribute complimented by other monitoring programs within and/or outside of COP?

Continued monitoring data consistent with the requirements of Increment 2 Field test will be needed.

When during COP's life cycle should this monitoring begin and end?

Continuous monitoring of flow rates and water stages will be maintained through the COP process.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Monitored stage and structure flow rates will be analyzed to investigate the effectiveness of installed seepage barrier and operational changes to provide feedback to water managers on operational decisions and their subsequent effect on flood control and water supply for the Lower East Coast. The focus of the analyses will be on:

- The distribution, volume, and timing of surface and groundwater flows and stages at water control structures and select sites.
- Evaluation of stages, and recession and seepage rates for 8.5 SMA to determine:
  - If additional adjustments to the water deliveries are needed to maintain the flood mitigation requirements.
  - If the existing numerical models adequately simulate the field conditions or future refinements of existing models is necessary to better forecast the effects of infrastructure and operational changes.
- Adjustments to canal levels and structure operating ranges to enhance flood control and mitigation within WCP flexibility.
- Comparison of functioning of 5-mile L-31N seepage barrier to control seepage versus the potential use of C-111 detention areas and pumping to the south to build a hydraulic ridge.
- Whether additional seepage barriers further south should be considered for future projects.

Triggers/thresholds that indicate good project performance or need for adaptive management action: The thresholds that signify the need for the implementation of adaptive management measures for project regions are listed below.

- Increased hydroperiod durations and/or peak stages in 8.5 SMA beyond historical observations and modeling results, which may necessitate operational changes in 8.5 SMA and/or S-331 Structure, or reductions in canal stages and flows into NESRS.
- Decreased hydroperiod durations and/or peak stages in 8.5 SMA compared to historical observations and modeling results, which can allow further relaxation of L-29 operational constraints for flows into NESRS.
- Performance evaluation of 2020 COP Biological Opinion RPA, potentially including dry nesting days, discontinuous hydroperiods, and water level reversal west of the C-111 detention areas (update following the ESA consultation).

Management options that may be chosen based on test results:

- Adjustments to operations in the L-29, L-30, L-31N, and C-111 to improve water deliveries to NESRS, Taylor Slough, and Biscayne Bay.
- Adjustments to operations for 8.5 SMA.
- Refinement/improvement of existing numerical models to improve ability to forecast effects of structures and operations, if needed.

- Recommend additional targeted groundwater modeling to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage due to expected increased flows to NESRS.

This uncertainty is further summarized in **Table C.2-14.**

Table C.2-14. COP AM Uncertainty ID#6 (Seepage) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID#6 Seepage	Peak stage; Hydroperiod duration; Dry nesting days; Discontinuous hydroperiods; Occurrence of water level reversals; Flood Risk; Conveyance Capacities; and Flood Stage Duration	Stage and structure flow rates	Event driven but continuous monitoring	WCA 3B; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA); and areas along the L-31N, L-30, and C-111 Canals	• Increased hydroperiod durations and/or peak stages in 8.5 SMA beyond historical observations and modeling results, which may necessitate operational changes in 8.5 SMA and/or S-331 Structure, or reductions in canal stages and flows into NESRS. • Decreased hydroperiod durations and/or peak stages in 8.5 SMA compared to historical observations and modeling results, which can allow further relaxation of L-29 operational constraints for flows into NESRS. • Performance evaluation of 2020 COP Biological Opinion RPA, potentially including dry nesting days, discontinuous hydroperiods, and water level reversal west of the C-111 detention areas (update following the ESA consultation).	Existing	• Adjustments to operations in the L-29, L-30, L-31N, and C-111 to improve water deliveries to NESRS, Taylor Slough, the Biscayne Bay. • Adjustments to operations for 8.5 SMA. • Adjustments to canal levels and structure operating ranges to enhance flood control and mitigation within WCP flexibility • Refinement/improvement of existing numerical models to improve ability to forecast effects of structures and operations, if needed. • Recommend additional targeted groundwater modeling to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage due to expected increased flows to NESRS.

C.2.3.2 COP AM Uncertainty ID #10 (Northeast Shark River Slough [NESRS] and Taylor Slough [TS]): Will increased flows to northeastern Shark River Slough and toward the southeastern Everglades (Taylor Slough and lower C-111 basin) yield natural distribution of waters and moderate recession rates? Are flows towards Taylor Slough sufficient to alter the anticipated flows, stages or observed recession rates?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 2

Region(s): WCA 3A and WCA 3B, ENP (North East Shark River Slough), ENP (Taylor Slough), ENP (Spreader canal), Florida Bay

Associated Features:

- The L-30, L-31N, L-31W, C-111 Canals
- The S-12 Structures (A-D), S-333, S-356, G-211, S-331, S-332D, S-332C, S-332D, S-199, S-200

Driver or Uncertainty Type: Hydrology

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? There appears to be a threshold stage in NESRS that, when reached, Shark River Slough begins to contribute to flows in Taylor Slough. Resource managers think that when 9.7 ft. NGVD is reached at Tamiami Trail, stage levels in the downstream marshes of NESRS should be high enough to contribute flows to Taylor Slough. Monitoring described here should help us identify what stage threshold in NESRS is associated with increased flows to Taylor Slough, and to develop more specific strategies for maintaining hydrologic support for NE and Central Florida Bay. The SFWMD's South Dade Initiative helped regional managers develop a new paradigm for managing canal levels and flood concerns along the eastern boundary of ENP with the intention of delivering more water to Florida Bay, and exploring this uncertainty in COP should enhance and broaden the discussion of how to effectively enhance the volume of water deliveries to the most sensitive portions of Florida Bay.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each:

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- Measuring or estimating the volume of water delivered to Taylor Slough from NESRS should help us recognize the degree to which additional volumes can be delivered to Taylor Slough and Florida Bay. COP increases stages in NESRS to the 8.5 ft. NGVD threshold where a nascent connection between these two basins may occur.

What is the time frame in which changes to this attribute are expected to be measurable?

- We should detect if the connection has occurred by examining data beginning in February 2016 (when 8.5 ft. NGVD at Tamiami Trail was first reached) and in each year when the L29 canal level reached 8.5 ft. NGVD (which occurs in almost all years).

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Coastal creek monitoring by USGS. Stage monitoring throughout ENP, and flow monitoring at Taylor Slough Bridge. ENP hydrologists do not currently think that monitoring flows at Context Road is likely to be sufficient to effectively detect volumetric contributions to Taylor Slough. Context Road is a remnant roadway present in the east Everglades in the area that contributed to Taylor Slough flows.

When during COP's life cycle should this monitoring begin and end?

- Monitoring will be continuous throughout COP, CEPP, and during much of the implementation of CERP.

Additional relevant information from CEPP AM plan: Each seasonal dry down provides an opportunity for ecologists and water managers to evaluate options and possibly pursue operations which address the uncertainty described above. The attributes to be measured and time needed to begin perceiving changes are the following (these time frames are indications of speed of response, not limits on the monitoring to be conducted):

1. Volumes delivered to S-332s (i.e. how much water focused on delivery to Upper Taylor Slough [UTS] actually reaches the marsh, measured each dry season).
2. Recession rates at UTS bridge (each dry season)
3. Estuarine salinity (2 years)
4. Wetland and Canal/Creek Stage (7 days, is a response of dry season deliveries evident?
5. Surface and Groundwater Flow (7 days, is a response of dry season deliveries evident?)
6. Stage / flow relationships between NESRS and eastern ENP including stages at CR2, etc.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: The expectation (hypothesis) is that COP will slow recession rates in UTS and marginally improve salinity ranges in Florida Bay, as evidenced by project alternative plan modeling. The expectation will be verified by using real-time analyses of operational changes to S-333, S-334, S-335, and the S-332 structures and their subsequent effect on surface and ground water flows to the UTS.

Updates to the MD-RSM and the ENP M3ENP may be further supported by the COP AM monitoring.

Triggers/thresholds that indicate good COP performance or need for adaptive management action: Under COP operations we expect less than 1 psu (practical salinity unit) annual average change in Florida Bay over a decadal period. Changes in flows at Taylor Slough Bridge (TSB) and coastal creeks are more likely to be sensitive to COP operations and reveal patterns of change after 1-5 years of COP implementation. Stage levels in Shark River Slough, Taylor Slough, and the C-111 basin are also likely to respond within the first few years of COP implementation.

A summary of flows and stage levels will be presented at the annual PDT plus workshop. The development of thresholds and triggers can be developed by a task team if/when the PDT+ observes that sufficient data is available to identify durable thresholds/triggers. Expectation is that this uncertainty will become more

relevant once Tamiami trail is modified to support 9.7 ft. NGVD stage, after 2024 (current estimate is construction begins in 2020).

Management options that may be chosen based on test results: Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

- Adjustments to operations from WCA 3B at S-335 and WCA 3A at S-334 and then conveyed towards Taylor Slough by the S-332's series of structures.
- Refinement of existing hydrologic and hydrodynamic models in Taylor Slough, the southern coastal wetlands, and Florida Bay.

This uncertainty is further defined in a management option matrix below in **Table C.2-15**

Table C.2-15. COP AM Uncertainty ID #10 (NESRS and TS) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #10 – NESRS and TS	Volumes delivered to S-332s (i.e. how much water focused on delivery to UTS actually reaches the marsh, measured each dry season).	Flow rates and stage measured continuously at structures.	Annual	S-332s	• Under COP operations we expect less than 1 psu (practical salinity unit) annual average change in Florida Bay over a decadal period. Changes in flows at Taylor Slough Bridge (TSB) and coastal creeks are more likely to be sensitive to COP operations and reveal patterns of change after 1-5 years of COP implementation. Stage levels in Shark River Slough, Taylor Slough, and the C-111 basin are also likely to respond within the first few years of COP implementation. • A summary of flows and stage levels will be presented at the annual PDT plus workshop. The development of thresholds and triggers can be developed by a task team if/when the PDT+ observes that sufficient data is available to identify durable thresholds/triggers. Expectation is that this uncertainty will become more relevant once Tamiami trail is modified to support 9.7 ft. NGVD stage by late 2024 (current estimate is construction begins in 2020).	Existing	• Adjustments to operations from WCA 3B at S-335 and WCA 3A at S-334 and then conveyed towards Taylor Slough by the S-332's. Additional NEPA will be needed if varies from the operations already developed in Alt Q, evaluated in the COP EIS, and subsequently included in the WCP • Refinement of existing hydrologic and hydrodynamic models in Taylor Slough, the southern coastal wetlands, and Florida Bay

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Recession rates at UTS bridge	Stage measured continuously at structure	Each dry season	UTS bridge	Same as above	Same as above	Same as above
Same as above	Estuarine Salinity	Salinity (psu)	2 years	NE Florida Bay	Same as above	Same as above	Same as above
Same as above	Wetland and Canal/Creek Stage (is a response of dry season deliveries evident?)	Stage measured at continuously monitored stations	7 days	Taylor Slough	Same as above	Same as above	Same as above
Same as above	Surface and Groundwater Flow (is a response of dry season deliveries evident?)	Stage and ground water levels measured at continuously monitored stages	7 days	Taylor Slough	Same as above	Same as above	Same as above
Same as above	Stage / flow relationships between NESRS and eastern ENP including stages at CR2, etc.	Stage measured at continuously monitored stations	Annual	L-30, L-31N, L-31W, C-111, Canals, S-12s (A-D), S-333, S-356, G-211, S-331, S-332D, S-332C, S-332D, S-199,	Same as above	Same as above	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
				and S-200 structures			

C.2.3.3 COP AM Uncertainty ID #12a (Tamiami Trail Flow Formula-General): Based on consideration of the existing water budget used to formulate COP, is there an opportunity to improve the Tamiami Trail Flow formula such that desired ecological targets are more universally achieved?

COP Objectives or Constraints: COP objectives 1a, 1b, 1c, 2.

Region(s): ENP, WCA 3, southern Shark River Slough, and Florida Bay

Associated Features: All COP features that are included in the Tamiami Trail flow formula: S-333, S12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP,

Potentially also affects inflow structures to WCA 3: S-11 A-C, S-8, and S-140

Driver or Uncertainty Type: Hydrology/Operations

What is expected to be learned by addressing this uncertainty, i.e., how will the project benefit from addressing this uncertainty? For more than two decades, CERP and other plans have sought to implement more robust "rainfall driven operations" to complement traditional regulation schedules and current operational strategies like the Tamiami Trail Rainfall Plan (RFP). In planning, "natural system" and other targets and constraints can be leveraged to drive modeled operations, but the means to translate these concepts into real-time operations is a challenging problem. A variety of tools culminating in the iModel have been pro-actively developed through CERP's Interagency Modeling Center to address these challenges and were applied to support development of the COP. The COP TTFF is driven by the current week rainfall and last week's stage, and compared to the RFP, the formula is less sensitive to rainfall data. The TTFF uses last week's observed flow, in place of the use of last week's predicted flow within the RFP. The TTFF captures a combination of the COP plan's desired natural response combined with the current limited water budget (pre-CERP) and the need for a regulatory component. The development of the COP TTFF was informed by scientifically-based ecological targets (provided by the COP Ecological sub-team) and an understanding of system limitations (including available water budget, flood protection and Zone A of the WCA 3A Regulation Schedule).

During the development of the Tamiami Trail Flow Formula for COP, we explored more than 10 different forms of the Tamiami Trail flow formula. All methods used information from water stages, rainfall, potential evapotranspiration, and recent structure flows to predict upcoming weekly flow target volumes across Tamiami Trail. These approaches were derived from linear regression, non-linear regression, principle components analysis, and segmented regression. The full spectrum of models performed well, but none were clearly superior than all the rest. Instead there were different strengths and weaknesses associated with each different form of the model. Following COP implementation, the COP team recommends conducting an ongoing comparison of these flow formulas with the intention of recognizing and resolving the challenges associated with these variable modeling and statistical approaches, in an effort to normalize the use of some of the more sophisticated models for consideration during future Water Control Plan updates (e.g. CEPP) and/or other temporary planned deviation efforts. Addressing this uncertainty with the TTFF will help the COP Adaptive Management team, RECOVER, and water managers continue to improve operational planning to further enhance the ecological performance of the regional system without violating system constraints or considerations.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Statement of hypothesis: Through additional data analysis and continued collaborative efforts, the Tamiami Trail Flow Formula can be further refined or modified to guide future operational planning studies under COP and/or CERP for deliveries to ENP across Tamiami Trail, and a comparison of different approaches to the TTFF will help the COP Adaptive Management team, RECOVER, and water managers to identify and evaluate other effective strategies for maximizing shared benefits across WCA 3 and ENP.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- Operational planning teams should clearly recognize the relevance of introducing non-linear flow estimates in low-flow conditions, and the subtle challenges of making delivery decisions during period of severe water scarcity.

What is the time frame in which changes to this attribute are expected to be measurable?

- Comparison of different forms of the TTFF should help identify possible improvements to the TTFF within 1-2 years following implementation of the COP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP). Dependent on the nature of the changes to the TTFF, a temporary planned deviation may be considered, similar to the MWD Incremental Field Tests that informed COP development.

Is this attribute complimented by other monitoring programs within and/or outside of COP?

- Yes, our continuous monitoring of structure flows and water surfaces will be used to evaluate any suggested changes to the Flow formula.

When during COP's life cycle should this monitoring begin and end?

- Continuous monitoring of structure flows and water surfaces will continue throughout both COP and CERP activities. Water surface and structure flow monitoring will not end during the COP process.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: The dominant method for testing this uncertainty is using hydrologic modeling simulations (e.g. RSM-GL) and other forms of simulating alternative analytical approaches.

Triggers/thresholds that indicate good project performance or need for adaptive management action: The COP TTFF has been determined to be responsive to the COP project objectives for WCA 3A and ENP, based on hydrologic modeling and technical evaluations conducted during COP development. No triggers or thresholds are appropriate for exploring this uncertainty.

Alternative forms of the TTFF will be analyzed and presented periodically at COP meetings. If/when significant differences between the formulas emerge, then focused hydrologic modeling simulations will be pursued with the results used to discern the likely consequences of employing a different approach.

Management options that may be chosen based on test results:
Option 1: Recommend an alternative form of the Tamiami Trail Flow Formula for making deliveries to ENP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP).

Option 2: Maintain existing approach for TTFF based deliveries, as advocated for initial implementation of the COP TTFF based on technical team evaluations.

This uncertainty is further summarized in **Table C.2-16**.

Table C.2-16. COP AM Uncertainty ID#12a (Tamiami Trail Flow Formula-General) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #12a – Tamiami Trail Flow Formula (TTFF) - General	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	Within 1-2 years	All COP features that are included in the Tamiami Trail flow formula: S-333, S-12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP, Potentially also affects inflow structures to WCA 3: S-11 A through C, S-8, and S-140.	Alternative forms of the TTFF will be analyzed and presented periodically at COP meetings. If/when significant differences between the formulas emerge, then focused hydrologic modeling simulations will be pursued with the results used to discern the likely consequences of employing a different approach.	$50,000	• Option 1: Recommend an alternative form of the Tamiami Trail Flow Formula for making deliveries to ENP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP). • Option 2: Maintain to existing intuitive regression approach for TTFF based deliveries, as advocated for initial implementation of the COP TTFF based on technical team evaluations.

C.2.3.4 COP AM Uncertainty ID #12b (Tamiami Trail Flow Formula [TTFF] and Drought): Is there an opportunity to deliver water to NESRS in a specific manner such that the delivery enhances stages in Shark River Slough, and perhaps freshwater flows to Florida Bay by delivering more water during the dry season without harming the ecological condition of WCA 3?

COP Objectives or Constraints: The COP objectives 1a, 1b, 1c, 3.

Region(s): NESRS, WCA 3, southern Shark River Slough, and Florida Bay

Associated Features: S-333, S-12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP), as well as S-11A-C, S-8, and S-140 (inflows into WCA 3).

Driver or uncertainty type: Hydrology/Operations

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? We are presented with the opportunity to learn whether the style of water delivery can produce measurable responses in southern SRS, and whether these responses can contribute meaningfully to reducing salinity concentrations in the chronically hypersaline portion of central Florida Bay.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: Statement of hypothesis: Can delivering additional flows into NESRS during a transition from the wet season to the dry season result in measurably increased water levels in SRS without increasing detrimental low water impacts to WCA-3 ecological conditions and water supply?

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- If the seasonal timing of delivery to NESRS can be altered to reduce salinity concentrations in central Florida Bay, then water managers will have developed a new tool for protecting Florida Bay during period of moderate water scarcity.

What is the time frame in which changes to this attribute are expected to be measurable?

- During a design test, results should be identifiable during a six month period, starting November and ending in May of the following year.

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Yes, our continuous monitoring of structure flows, water surfaces in terrestrial marshes, and salinity concentrations in coastal embayments will be used to measure the effects of the field test.

When during COP's life cycle should this monitoring begin and end?

- Continuous monitoring of structure flows, water surfaces in terrestrial marshes, and salinity concentrations in coastal embayments will continue throughout both COP and CERP activities. Water surface and structure flow monitoring will not end during the COP process.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: The design test was developed in response to concerns presented during development of the TTFF to better mimic the performance of ALTO. Within the broader context of dynamic review of the COP TTFF planned through the COP Adaptive Management process and prescribed in the COP Adaptive Management and Monitoring Plan, parameters for a design test are proposed to test the hydrological and ecological response during a transition from the wet season to the dry season. The criteria for considering a test are:

Testing only occurs during the period between November 1 – May 30. Testing only occurs after we've had at least 80 days of seasonal closure in WCA 3 in the dry season prior to the test, indicating a dry antecedent condition with likely multi-year impacts requiring special considerations (this occurs only 3 times in the 41 year period of record used in COP simulations (**Figure C.2-5)**. Testing may occur as we move into additional seasonal closures in WCA 3, and testing is considered anytime P35 in ENP is projected to move below 1.0 ft. belowground, or P33 is projected to move below 0.5 ft. belowground.

Testing will be stopped if any of the following drought intensity thresholds are reached:

- 0.8 ft. belowground in northern WCA 3A (WCA 3_NE and WCA 3-3 gages)
- 0.5 ft. belowground in southern/central WCA 3A (WCA 3_3A-28 and WCA 3_69 gages)
- 0.8 ft. belowground in WCA 3B (WCA 3B_71 gage)

These thresholds correspond to the 93th-98th percentile low stage levels of these gages as defined by ALTQ and ALTO of the COP simulation models (**Figure C.2-6**). The triggers are rarely reached in the simulations of COP performance and are important because soil consuming peat fires become a risk when water levels are more than 1.0 ft. belowground, and risk rises significantly after 1.5 ft. belowground threshold is crossed (Smith et al. 2003). Simulations indicate that these thresholds are unlikely to be a concern during the November –January period that would typically be the "early" portion of the design test but would become critically relevant during March – typically the peak of drought intensity in the system.

When the criteria for the design test have been met, the test period will allow general flexibility to: increase the TTFF prescribed deliveries up to 400 cfs above the TTFF recommended flows for significant portions of the period; to introduce nonlinearities in lowest flow conditions (sometimes lower flows than suggested by the TTFF – during the driest of conditions, sometimes tripling-quadrupling very low - 25-100 cfs flows – perhaps during the early onset of the wet season). The ultimate design decisions should be described during the operational period based on comparison of modeled analogous conditions. Although our modeling provides the basis for the design of this field test, the actual implementation of the test must be done in the specific context that occurs, with specific physical limits and constraints imposed upon the test. Because there are strong limits on our ability to accurately forecast rainfall, the designed test is limited in duration to 6-8 week intervals and must be re-evaluated to ensure safe operating conditions every 6-8 weeks.

MONTHLY COUNT OF LOW WATER CLOSURE DAYS in WCA3A
COP ALTQ

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Year													
1965	0	0	0	0	17	15	0	0	0	0	0	0	32
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	1	31	6	0	0	0	0	0	0	38
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	24	31	13	0	16	5	0	0	0	89
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	20	31	30	1	0	0	0	0	0	82
1974	0	0	25	30	31	24	0	0	0	0	0	0	110
1975	0	0	15	30	31	30	1	0	0	0	0	0	107
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	13	20	0	2	4	0	0	0	0	39
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	31	30	20	0	0	0	0	0	81
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	7	19	31	22	0	0	0	0	0	0	79
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	4	20	14	30	17	0	0	0	0	0	85
1990	0	0	9	30	31	20	0	0	0	0	0	0	90
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	8	24	0	0	0	0	0	0	0	32
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	3	3	0	0	0	0	0	0	6
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	60	195	326	223	41	20	5	0	0	0	870

Figure C.2-5. Monthly count of low water closure days in WCA 3 as simulated in COP Alt Q, with years when TTFF drought conditions test would be implemented indicated by heavy black outline. Design test implementable only in 1973-1974, 1989-1990, and 1990-1991.

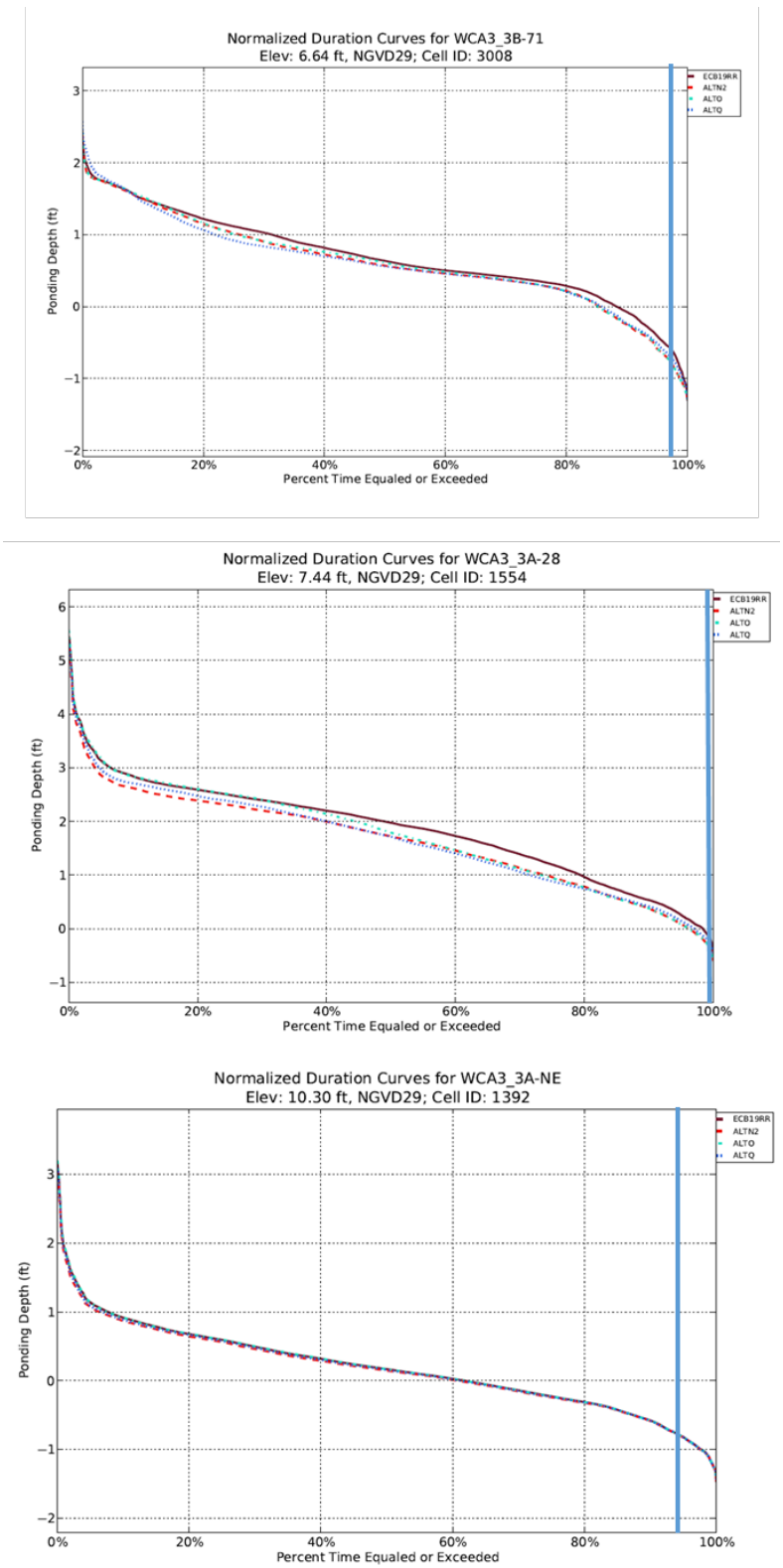


Figure C.2-6. Normalized duration curves of depths at specific gages in WCA 3. a) Gage WCA 3_3B_71 (top), b) WCA 3_3A_28 (middle), and c) WCA 3_3A-NE (lower). Curves for WCA_3_3-69 and WCA 3-3 gages are similar but not shown.

Review of representative years from the modeling indicates that that the field test will increase expected deliveries by 32,000 – 80,000 acre feet over the entire November-May period above the level of delivery by the Tamiami Trail Flow Formula identified in Alt Q (which delivered 75,000 acre ft. in 1973-74, 50,000 acre ft. in 1989-90, and 180,000 acre ft. in 1990-91 respectively during the November 1 – May 30 period). These additional deliveries correspond to the differences in deliveries observed in Alt O and Alt Q during these three specific years identified in **Figure C.2-5** (1973-1974, 1989-1990, and 1990-1991), and the anticipated effect of the design test may result in a minor-negligible effect on WCA 3A, in addition to a minor benefit realized by the SRS portion of ENP. A comparison between alternatives O and Q indicate that maximum effect of the design test would reduce stages in WCA 3A 0.1-0.5 ft. over roughly 35% of WCA 3A. Stage level reductions no more than 0.3-0.5 ft. occur within the first 0.5 miles upstream of the L29 canal, 2-4 miles upstream of the L-67 canal, while 0.1-0.3 ft. stage reductions occur 0.5-3 miles upstream of the L29 canal and 4-10 miles upstream of the L67 canal respectively. Since our ability to predict rainfall volumes over a seasonal dry down is a significant uncertainty, water managers may stop the test if less than 2 inches of basin-wide average rain of WCA 3 in any month and forecast rains present a significant risk of drying WCA 3A beyond the constraint thresholds outlined above.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. These are described in the methodology of the test provided above, since the constraints and thresholds are central to the methodology of the design test.

At each PDT+ meeting the team will identify if a field test is possible in the upcoming wet-dry season transition (based upon closures in WCA 3A during the previous season and anticipated water levels in WCA 3). If suitable conditions appear likely, the managers will be notified of intent to further investigate whether conditions warrant initiation of the field test, and a series of monthly meetings will be used to formulate the specific field test strategy. Results from the test will be summarized in a report and delivered to resource managers no later than 6 months after the completion of the field test, to ensure availability of this information in advance of the next dry season. The report will document the proposed design, the actual operations utilized, the hydrologic and ecologic effects on ENP and WCA 3 (in terms of depth duration effects at key gages identified above).

Management options that may be chosen based on test results.
Option 1: Adopt operational strategy that provides a moderate increase to TTFF inflows into Central and Southern Shark River Slough during seasonal transitions.

Option 2: Based on consideration of constraints and forecast conditions, maintain adherence to the COP TTFF based delivery strategies.

This uncertainty is further defined in a management option matrix below in **Table C.2-17.**

Table C.2-17. COP AM Uncertainty ID #12b (Tamiami Trail Flow Formula and Drought) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #12b – Tamiami Trail Flow Formula (TTFF) and Drought	Seasonal timing of delivery of flows to NESRS	Daily averages of stage.	Event driven when criteria for conducting test occur. Duration of test should be 6 months.	S-333, S-12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP), as well as S-11 A-C, S-8, and S-140 (inflows into WCA 3).	• If test is able to be successfully implemented without unexpected violation of constraints (e.g., causes water quality concerns), then the test operational strategy (with the drought intensity threshold constraints) will become part of the regular water control plan operational strategy. • If unexpected violation of constraints occur that appear unresolvable (e.g., water quality concerns or excessive drying of WCA 3A), then operations will return to using the Tamiami Trail Flow Formula as described in the Water Control Plan.	Existing unless additional model runs are required	• Option 1: Adopt operational strategy that provides a moderate increase to TTFF inflows into Central and Southern Shark River Slough during seasonal transitions. • Option 2: Based on consideration of constraints and forecast conditions, maintain adherence to the COP TTFF based delivery strategies.

C.2.3.5 COP AM Uncertainty ID #5b (Florida Department of Transportation constraint on Tamiami Trail): Can L-29 canal elevations be raised to 8.5 feet NGVD for more than 90 days per water year without adversely impacting safety and stability of the Tamiami Trail roadway between S-333 and S-334? Following completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project, to what extent, if any, does the 8.5 SMA flood mitigation requirement limit the ability to operate the L-29 Canal up to 8.5 feet NGVD beyond the 90-day restriction assumed in place through at least the 2020 wet season?

The evaluation of environmental effects during the COP plan formulation and hydrologic modeling were based on maintenance of the 90-day annual water year restriction, which is anticipated to remain in place through at least the 2020 wet season.

COP Objectives or Constraints: COP objectives 1a, 1b, 1c, 2, and 3.

COP planning considerations related to this uncertainty are as follows:

#8. L-29 Canal maximum stage (8.5 ft. NGVD) (2008 Tamiami Trail LRR);

#9. 2008 Tamiami Trail Modifications Relocation Agreement (FDOT/USA), including coordination conducted between FDOT and the USACE coincident with development of the Increment 2 field test.

Region(s): WCA 3A, Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal

Associated Features:

- L-29 Canal and associated water control structures, S-333, S-356, S-334, and S-335.
- Interim FDOT constraint until completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project. In accordance with this constraint, which was derived from the 2008 Relocation Agreement and coordination conducted between FDOT and the USACE coincident with development of the Increment 2 field test, which are retained for the COP Water Control Plan, the L-29 Canal inflow structures (S-333, S-355A/B, and S-356) will be operated with the intention of limiting event durations with L-29 Canal stages above 8.5 feet NGVD to a target maximum duration of 72 hours. Once the stage in the L-29 Canal reaches a stage of 8.5 feet, NGVD, input from all structures that discharge into the canal (S-333, S-355A/B, and S-356) shall be stopped until the level in the L-29 Canal recedes below 8.5 feet, NGVD. For each water year (May through April), the L-29 Canal inflow structures will be managed to limit the duration of L-29 Canal stages near 8.5 feet (as measured at the S-333 tailwater [TW]), NGVD to 90 cumulative days. The number of cumulative days in each period (only one period per water year) will be measured when L-29 stages exceed 8.3 feet, NGVD. Continued L-29 structure inflows which result in cumulative durations with L-29 Canal stages at 8.5 feet, NGVD for longer than 90 days will require written approval from the FDOT. The L-29 stage will be maintained at or below 8.5 feet, NGVD by ceasing inflow into L-29 when the L-29 stage rises above 8.5 feet, NGVD. Event driven criteria will be followed in accordance with COP Water Control Plan. S-334 may be used to maintain the L-29 Canal stage at or below the FDOT constraint of 8.5 feet, subject to the availability of downstream canal conveyance capacity within the L-31N Canal (details are prescribed in the Increment 2 and COP Operational Strategies). Continued L-29 structure inflows which result in consecutive

durations with L-29 Canal stages above 8.3 feet for longer than 90 days will require written approval from the FDOT, given evaluation of the monitoring data by FDOT. Independent of the concurrence from FDOT, demonstration by the USACE of the capability of the completed MWD Project components (including S-357N) to maintain flood mitigation requirements for the 8.5 SMA under the raised L-29 Canal maximum operating limit of up to 8.5 feet, NGVD29 would also be required.

Driver or uncertainty type: Hydrology/Operations

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Prior to completion of the TTNS roadway re-construction, which is anticipated for completion by late 2024, addressing this uncertainty will resolve whether the canal stages in L-29 can be raised to 8.5 ft. NGVD without adversely impacting safety and stability of the Tamiami Trail roadway between S-333 and S-334. Removal of this constraint will make higher NESRS deliveries possible, when upstream and downstream conditions allow following the TTFF.

Following completion of the roadway re-construction under the DOI Tamiami Trail Next Steps project, addressing this uncertainty will resolve whether the 8.5 SMA flood mitigation requirement limits the ability to operate the L-29 Canal up to 8.5 feet NGVD beyond the 90-day restriction assumed in-place through at least the 2020 wet season? The COP EIS and Water Control Plan allow increased durations up to 8.5 feet NGVD along the L-29 Canal subject to completion of the TTNS roadway re-construction if adherence to the 8.5 SMA flood mitigation constraint is demonstrated during real-time operations while following the evaluation methodology detailed in the COP Hydrometeorologic Monitoring Plan.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each. Hypothesis Statement: Based on the upstream water availability during COP implementation, the maximum operating limit of the L-29 Canal can be raised to 8.5 feet NGVD without adversely impacting safety and stability of the U. S. Highway 41 (Tamiami Trail) roadway in advance of the completion of Tamiami Trail Next Step construction, while managing 8.5 SMA flood mitigation in accordance with the COP Water Control Plan criteria for S-357, S-357N, and S-331

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Operational constraints as outlined within the 2008 Relocation Agreement are minimum protective standards that were required to be included in the Increment 2 Operational Strategy, which initially raised the L-29 Canal maximum operating limit above 7.8 feet NGVD and up to a maximum of 8.5 feet NGVD. In coordination with FDOT, the USACE also implemented additional constraints that were not explicitly spelled out in the Relocation Agreement. Out of concern that the these additional constraints reduce the ability to meet field test goals and objectives of maximizing flows to NESRS, the USACE has worked with technical staff from the FDOT to further refine the restrictions as described within the Increment 2 Operational Strategy and committed to implement expanded hydrologic monitoring of water levels along this section of Tamiami Trail. Data collected in accordance with the Increment 2 monitoring plan developed in consultation with the FDOT were planned to inform L-29 Canal operations to be developed for COP.

In order to ensure no road damage is caused due to extended periods of high water stages, based on coordination with the Florida Department of Transportation (FDOT) concurrent with the development of the COP Operational Strategy, USACE will monitor the effects of the increased L-29 water levels on the Tamiami Trail roadway. To monitor the conditions of the roadway and its subway, piezometers, soil

moisture sensors (installed at the roadway sub-base elevation of 9.5 feet NGVD), and surface water stage recorders were installed during October-November 2018 at specified locations along Tamiami Trail between S-333 and S-334 Spillways, following design, contracting, permitting, and installation facilitated by the DOI. The locations for four transects along which the transducers are installed are provided in **Figure C.2-7.** Locations of four transects of transducers along Tamiami Trail between S-333 and S-356. The transducers are used to monitor moisture levels in soils beneath the road, a good indicator of to monitor road condition. Additional installation details are provided in the COP Adaptive Management and Monitoring Plan.

Figure C.2-7. Locations of four transects of transducers along Tamiami Trail between S-333 and S-356. The transducers are used to monitor moisture levels in soils beneath the road, a good indicator of to monitor road condition.

Real-time monitoring data is continuously recorded at 15-minute intervals at each monitoring location. Soil moisture thresholds are under development in coordination between the USACE and FDOT concurrent with the Increment 2 field test that will continue through COP implementation in 2020. Piezometers along the roadway will be used to confirm that rainfall events which cause temporary exceedances of the L-29 maximum operating limit of 8.5 feet NGVD are able to be effectively managed with water levels receding below 8.5 feet NGVD within 72 hours.

Following the protocols established under the Incremental Field Test, ongoing data evaluations conducted by the USACE, SFWMD, and DOI will continue to be presented and discussed at monthly team meetings, and the conclusions from these evaluations will be reported to the interagency Adaptive Management team on a quarterly basis.

Triggers/thresholds that indicate good COP performance or need for adaptive management action. Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentation was initially available for the 2019 wet season).

Management options that may be chosen based on test results.

- L-29 Stages will remain limited to a maximum operating limit of 8.3 feet (except for the 90 day period each year when 8.5 feet NGVD is allowed) NGVD prior to completion of the Tamiami Trail Next Steps (TTNS) roadway modifications. This operation is consistent with the MWD Increment 2 field test.
- If no harm to the Tamiami Trail Roadway due to extended period of high water stages is observed, removal of FDOT constraint that limits L-29 stages to 8.3 feet NGVD will be recommended.
- For the 8.5 SMA, observed seasonal rainfall and hydro-period events which fall below the lower limit of the “acceptable” performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes

may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints at G-3273 for inflows to NESRS.

- If the 8.5 SMA flood mitigation criteria are determined as limiting the inflows to NESRS when the L-29 Canal is maintained up to 8.5 feet NGVD (the maximum operating limit for the COP Water Control Plan), following the earlier FDOT correspondence recommending removal of the FDOT constraint or completion of the TTNS roadway modifications, additional remedies for the 8.5 SMA flood mitigation will be explored through interagency coordination between USACE, SFWMD, and DOI.

This uncertainty is further defined in a management option matrix below in **Table C.2-18**.

Table C.2-18. COP AM Uncertainty ID #5b (FDOT Constraint on Tamiami Trail) management option matrix.

Uncer-tainty tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attri-butes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Est-imated Annual Cost	Management Action Options Suggestions
UNC #5b – FDOT Con-straint on Tamiami Trail	Duration of stage above 8.3 ft. and 8.5 ft. in L-29; Roadway Stability measures.	Stage in L-29; # cumulative days in water year >8.3 ft.; # days stage > 8.5 ft.; Ground water, surface water and soil moisture levels taken at 4 transect locations; Monitoring is real time in 15 minute intervals.	Event driven.	WCA 3A; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal 4 transect locations on Tamiami Trail road and subway.	Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentatio n was initially available for the 2019 wet season)	Existing	• L-29 Stages will remain limited to a maximum operating limit of 8.3 feet (except for the 90 day period each year when 8.5 feet NGVD is allowed) NGVD prior to completion of the TTNS roadway modifications. This operation is consistent with the MWD Increment 2 field test. • L-29 Stages will be limited to a maximum operating limit of 8.3 feet NGVD prior to completion of the TTNS roadway modifications, if necessary to protect the Tamiami Trail roadway. • If no harm to the Tamiami Trail Roadway due to extended period of high water stages is observed, removal of FDOT constraint that limits L-29 stages to 8.3 feet NGVD will be recommended.

Uncer-tainty tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attri-butes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Est-imated Annual Cost	Management Action Options Suggestions
Same as above	8.5 SMA flood mitigation performance relative to stage in L-29 and stages in NESRS; Hydroperiod performance in NESRS given seasonal rainfall	Stage in L-29; Stage in NESRS gages near and outside 8.5 SMA; Volume, depth, duration of seepage in 8.5 SMA; seasonal rainfall	Event driven	Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal.	Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentation was initially available for the 2019 wet season)	Existing	• For the 8.5 SMA, observed seasonal rainfall and hydro-period events which fall below the lower limit of the "acceptable" performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints at G-3273 for inflows to NESRS. • If the 8.5 SMA flood mitigation criteria are determined as limiting the inflows to NESRS when the L-29 Canal is maintained up to 8.5 feet NGVD (the maximum operating limit for the COP Water Control Plan), following the earlier FDOT correspondence recommending removal of the FDOT constraint or completion of the TTNS roadway modifications, additional remedies for the 8.5 SMA flood mitigation will be explored through interagency coordination between USACE, SFWMD, and DOI.

C.2.3.6 COP AM Uncertainty ID #7 (Saltwater intrusion): What are the effects of sea-level rise on COP operations, resulting salinity patterns in Florida Bay, water supply risks associated with saltwater intrusion, and ability to meet flood protection constraints?

Effects of sea-level rise on COP operations, resulting salinity patterns in Florida Bay, water supply risks associated with saltwater intrusion, and ability to meet flood protection constraints. Many other programs and projects at both the federal and state level have been initiated to investigate and address sea level rise and coastal resilience; as such, the COP AM plan does not seek to duplicate these efforts, but rather to monitor evolving science, programmatic efforts outside of COP and observed change conditions (SLR in coastal areas or movement of the saltwater front). This gathered material combined with observed operational experiences focused on the ability of COP to realize the canal levels and deliveries consistent with the COP WCP will allow AM team members to synthesize risks and formulate adaption efforts if required.

COP Objectives or Constraints: COP objectives 1a, 1b, 2, 3, and 4.

This uncertainty is related to the following COP constraints:
#1. Maintain the authorized purposes of the C&SF project.
#6. Maintain the level of flood reduction associated with the 1994 C-111 GRR: flood damage reduction Project recommended plan.

Region(s): Coastal ENP, Eastern Panhandle of ENP (Spreader canal), and SE Miami-Dade county.

Associated Features: Primary canal reaches within the L-31 and C-111 systems – identify any inability to maintain desired operating ranges due to backwater effects from tidal influences.

Observations of coastal saltwater intrusion into ENP (or associated peat collapse) or landward migration of the aquifer saltwater intrusion front as reported by USGS, SFWMD or Miami-Dade County (Stewart et al. 2002, Fitterman et al. 2011, Zucker et al. 2010).

Additional indicators likely to be developed by interagency team at an appropriate time in the future.

Driver or Uncertainty Type: Hydrology/Operations, Flood Control, and Water supply

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? Two simulation models were presented during the COP process with information relevant to coastal conditions/saltwater intrusion. The RSM-GL – used for regional scale simulations is using a sea-level time series that represents the average condition over the 1965-2005 time period, so we know that sea-level in our simulations is lower than what is expected to occur during COP implementation. A second model – the MDRSM (or Miami-Dade RSM) was used to evaluate the effective level of flood protection to agricultural areas in Miami-Dade County. This model was applied for three recent candidate years representing dry, average, or wet conditions respectively. Observed sea level at outflow structures was used to represent the ocean for these simulations, and these sea-levels are minor underestimates of the sea-level that is likely to be observed during COP operations. We can expect sea-level to vary significantly each day, each year, and among years. Daily variation is associated with tidal cycles, annual differences in sea level are associated with the dynamics of tidal epochs and can be influenced by changing ocean temperatures producing a seasonal peak high tide during September-November, and levels are likely to continue to increase as melting glaciers continue to load the ocean with

more water. By focusing on this uncertainty water managers should learn more about the degree to which coastal structure operations are affecting their ability to remove water from the landscape, as well as identifying the systematic increase of key times when saltwater intrusion risks are particularly high. In addition, work conducted in support of this uncertainty should help us identify the degree to which flood protection operations are challenged by sea-level conditions – a factor that is outside the control of CERP.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: COP operations will be successful at keeping canal operations within expected ranges, thus delivering the expected environmental benefits in ENP coincident with the estimated level of flood protection in the agricultural areas adjacent to ENP while protecting against saltwater intrusion into aquifers and canals and protecting existing water supply sources in Miami Dade County.

What is expected to be learned by measuring this attribute, i.e., how will COP benefit from knowledge gained about this attribute?

- Measuring SLR related operations risks before they become severe and chronic should help water managers and CERP planners recognize, scale, and compensate for SLR risks to the degree that compensation is possible.

What is the time frame in which changes to this attribute are expected to be measurable?

- SLR changes are directly measurable each year through an aggregation of coastal monitoring stations. The observed rate of SLR in the past century is 2.42 mm per year (+/- 0.14 mm), and this rate appears to be accelerating (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8724580). Forecast changes to sea-level have been identified (Park et al. 2017) and there is a clear basis for developing specific expectations of SLR effects. Checking the status of this issue on 5 year intervals seems appropriate for the next decade. Meaningful differences in coastal canal performance may occur at 5 year intervals.

Is this attribute complimented by other monitoring programs within and/or outside of COP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the COP Management Options spreadsheet.

- Yes, water levels around structures are consistently monitored by SFWMD and USACE. Water levels in agricultural areas are monitored by SFWMD.

When during COP's life cycle should this monitoring begin and end?

- Monitoring should be consistent through the COP life cycle and into future operational plans.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: Leveraging the other areas where SLR and coastal resilience are being prioritized, follow up activities for COP include the development of sensitivity simulations focused on a range of future sea-level conditions, potentially interacting with seepage management infrastructure. These sensitivity simulations will likely be pursued by the Interagency Modeling Center of CERP (comprised of SFWMD, USACE and DOI collaborators) to help identify the effects of future sea levels on existing infrastructure and help resource managers recognize if/when critical operational capacities are exceeded as well as a sense of the spatial context of the consequences of exceeding these operational capacities. The MDRSM has been identified as an appropriate candidate tool for conducting these simulations.

Coastal structure condition can be evaluated by comparing hourly headwater/tailwater elevations at each structure and accumulating this information over long time periods in order to determine whether drainage capacity is being diminished.

Flood protection performance can be identified by monitoring wells installed in agricultural areas and summarizing the number of days that groundwater is within 24" of the surface using spatial aggregation tools such as the Water Depth Assessment Tool (WDAT) currently used for C-111 Spreader Canal reporting.

Compiling records of telephone calls reporting flooding concerns along with information about the day/time, specific location, and degree of inundation occurring should help us connect monitoring of representative stations to specific parcels of land that may be experiencing particularly severe challenges.

Triggers/thresholds that indicate good project performance or need for adaptive management action:

- *COP L31 and C-111 Canal Reaches:* Should persistent difficulty be reported by water managers in the attempt maintain the anticipated water levels in the primary canal reaches be observed due to backwater effects from tidal or surge conditions limiting discharges through coastal structures, the COP AM team will summarize and characterize the nature of these limitations. Persistent challenges are explicitly defined as limited capacity to use coastal outflow structures within any 24 hour period, or the inability to drain a canal reach due to surge conditions, or any clear shift in the spatial pattern of flood impacts.
- *Protection of Critical Resources:* Should undesirable trends be observed due to saltwater impacts in the ENP marsh or the Biscayne aquifer, the COP AM team will form a task team to summarize and characterize the nature of these effects (e.g. episodic, exacerbated /accelerating trends, etc.…).

Management options that may be chosen based on test results:

- Identify complementary projects and programs than may help to mitigate the effects. These may include:
  - CERP
  - Federal initiatives such as the USACE Coastal Atlantic or Back-Bay studies
  - State initiatives like the SFWMD's Level of Service program
  - County or local initiatives
- Identify potential operational changes within the scope of the original COP effort for further consideration.
- Identify potential infrastructure or regional operations that could be considered by complimentary efforts.

This uncertainty is further summarized in **Table C.2-19**.

Table C.2-19. COP AM Uncertainty ID#7 (Saltwater intrusion) management options matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC ID#7 – Saltwater Intrusion	"Keep in view" issue using existing monitoring, modeling, analyses, and reports by other entities involving: • Coastal structure difficulties in maintaining target water levels or desired discharge due to tide or surge; • Sea level rise; • Flood protection performance (groundwater monitoring); • Flooding concern reports via telephone	Many other programs and projects at both the federal and state level have been initiated to investigate and address sea level rise and coastal resilience; as such, the COP AM plan does not seek to duplicate these efforts, but rather to monitor evolving science, programmatic efforts outside of COP and observed change conditions (SLR in coastal areas or movement of the saltwater front). This gathered material combined with observed operational experiences focused on the ability of COP to realize the canal levels and deliveries consistent with the COP WCP will allow PDT+ team members	5-10 years	L-31, C-111, southern Miami-Dade County and ENP	• COP L-31 and C-111 Canal Reaches: Should persistent difficulty be reported by water managers in the attempt maintain the anticipated water levels in the primary canal reaches be observed due to backwater effects from tidal or surge conditions limiting discharges through coastal structures, the COP AM team will summarize and characterize the nature of these limitations. Persistent challenges are explicitly defined as limited capacity to use coastal outflow structures within any 24 hour period,	$0, Existing	• Identify complementary projects and programs than may help to mitigate the effects. These may include: ○ CERP ○ Federal initiatives such as the USACE Coastal Atlantic or Back-Bay studies ○ State initiatives like the SFWMD's Level of Service program ○ County or local initiatives • Identify potential operational changes within the scope of the original COP effort

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
		to synthesize risks and formulate adaption efforts if required.			or the inability to drain a canal reach due to surge conditions, or any clear shift in the spatial pattern of flood impacts. • Protection of Critical Resources: Should undesirable trends be observed due to saltwater impacts in the ENP marsh or the Biscayne aquifer, the COP AM team will form a task team to summarize and characterize the nature of these effects (e.g. episodic, exacerbated / accelerating trends, etc.…).		for further consideration. • Identify potential infrastructure or regional operations that could be considered by complimentary efforts.

C.2.4 Water Quality / Hydrological Adaptive Management Uncertainties

C.2.4.1 COP AM Uncertainty #16a (Water Quality in Taylor Slough): Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?

Water quality concerns Taylor Slough and downstream ecological response: Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses? This includes consideration of hydrologic effects on nutrient loading, nutrient release from soils, transport, and water-quality related ecological indicators, such as periphyton tissue nutrients, cattail expansion, and algal bloom events?

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 3.

Region (s): Taylor Slough

Associated Features: S-332D, S-332DX1, S-328, G-737; timing, location, and volume of deliveries

Driver or uncertainty type: Water quality delivered to Taylor Slough has historically been of good quality. However, two new structures, S-328 and G-737, have been added to the suite of structures delivering water to Taylor Slough. These structures deliver water directly to Taylor Slough and the direct impacts are presently unknown. Since 2000, water delivery to Taylor Slough had been through subsurface and rarely surface flow from the S-332D detention basin. Shifting to direct deliveries has the potential to increase nutrient loading in the receiving areas, which may result in unintended adverse biota shifts.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? By observing ecosystem response for this uncertainty, impacts on downstream resources in the Taylor Slough will be illuminated. If adverse impacts are observed and operational deliveries addressed through AM options/strategies that are protective of the ecological values of Taylor Slough, then COP will benefit with higher potential for improved ecological conditions within Taylor Slough.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each: These hypotheses being tested include:

- Increased flow will not alter current periphyton system-wide indicator report status
- Additional flows will not result in an increase in algal bloom events (frequency, spatial extent, duration, and/or magnitude) in Florida Bay and Lower Southwest coast relative to current conditions
- No acceleration in cattail distribution expansion rate relative to current conditions
- No alteration of current spatial distribution of soil and vegetation nutrient pools relative current conditions

What is expected to be learned by measuring this attribute?

- Through monitoring flow and nutrients, COP will learn about nutrient response to structure operations
- Monitoring of periphyton in the downstream marsh will allow COP to learn about changes in the periphyton nutrient content or algal blooms as demonstrated in the CERP RECOVER System Status Report (CERP RECOVER 2014, 2019).
- Monitoring of macrophytes, such as cattail, will allow COP to learn about changes in rates of sensitive macrophyte expansion/retraction relative to current rates or presence/absence.
- Monitoring of the spatial nutrient front will allow COP to learn about movement of the spatial nutrient front or changes in nutrient rates of release from soils along soil and/or vegetation transect relative to existing conditions.

What is the time frame in which changes to this attribute are expected to be measurable?

- Flow and water quality monitoring at existing frequency. Discrete total phosphorus changes can be nearly immediately detected, but determination of any statistically significant change from historic levels could take 3 to 10 years, depending on the change magnitude.
- Periphyton (TP content, biomass, composition): 3 months to 1 year
- Cattail expansion: 3 to 5 years
- Soil nutrient front: 3 to 10 years

Is this attribute complimented by other monitoring programs within and/or outside of COP?

- COP should take advantage of existing monitoring which includes monitoring performed by the South Florida Water Management District, Everglades National Park, and cooperators.

When during COP's life cycle should this monitoring begin and end?

- It has already begun and should continue 10 years after complete implementation of COP.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A baseline monitoring period of 3 years for soil nutrient content (1 every year) to measure long-term nutrient trends and 3 years of bi-annual (wet/dry season) periphyton tissue nutrients in areas of concern (e.g. downstream of S-328, S-332 outflow for G-737, downstream of the southern stretch of L-31W canal) to measure early indication of nutrient changes is recommended to adequately establish existing conditions. Monitoring of soil nutrient content annually and bi-annual periphyton tissue nutrients beginning with implementation of S-328 and/or G-737 and carried through operation and management of COP protocol is necessary to document any changes in nutrient distribution resulting from increases in deliveries into Taylor Slough with each constructed feature.

Triggers/thresholds that indicate good COP performance or need for adaptive management action:

Structure Monitoring:

- Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology;
- Good performance: maintaining or reducing nutrient levels represents good performance

Periphyton:

- TP content
  - Need for adaptive management action: if TP content in periphyton tissue increases above baseline;
  - Good performance: if TP content in periphyton tissue remains or declines below baseline
- Biomass
  - Need for adaptive management action: if biomass decreases below baseline;
  - Good performance: if biomass remains or increases above baseline
- Composition
  - Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline;
  - Good performance: if species composition shifts to more desmids and diatoms relative to baseline

Cattail:

- Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period;
- Good performance: if cattails expansion rate reduces or remains the same as baseline

Soil:

- Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate;
- Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate

Management options that may be chosen based on test results: Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. Conceptually, adjusting water distribution has the ability to reduce or redirect nutrient loading to Taylor Slough. For example, reducing discharges from S-328 or G737 and having that water routed through S-332D into the detention basin prior to delivery to Taylor Slough has the potential to improve water quality delivered.

Table C.2-20 summarizes the monitoring recommendations and provides funding estimates.

Table C.2-20. COP AM Uncertainty ID#16A (Water Quality in Taylor Slough) management option matrix.

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #16a – Water Quality in Taylor Slough	TP concentration at structures plus additional water quality measures	Flow, TP nutrient concentration, turbidity and other water quality measures in water flowing into park	3 to 10 years	ENP- Taylor Slough	• Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology; • Good performance: maintaining or reducing nutrient levels represents good performance	Existing	Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes
Same as above	Periphyton • TP content • Biomass • Composition	Periphyton in downstream marsh, biannual	3 months to 1 year	ENP- Taylor Slough areas of concern (e.g. downstream of S-328, S-332 outflow for G-737, downstream of the southern stretch of L-31W canal)	• TP content ○ Need for adaptive management action: if TP content in periphyton tissue increases above baseline; ○ Good performance: if TP content in periphyton tissue remains or declines below baseline • Biomass ○ Need for adaptive management action: if biomass decreases below baseline; ○ Good performance: if biomass remains or increases above baseline • Composition	Existing	Same as above

Uncertainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Timeframe to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
					○ Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; ○ Good performance: if species composition shifts to more desmids and diatoms relative to baseline		
Same as above	Cattail expansion	Local mapping of cattail in downstream marsh	3-5 years	Same as above	• Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period; • Good performance: if cattails expansion rate reduces or remains the same as baseline	$0, Existing	Same as above
Same as above	Soil nutrient front	Soil nutrient content in downstream marsh, annual	3-10 years	Same as above	• Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate; • Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate	$0, Existing	Same as above

C.2.4.2 COP AM Uncertainty #16b (Water Quality in NESRS): Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses?

Water quality concerns at S-333 and S-12D and downstream ecological response: Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, that result in detrimental effects on nutrient movement, availability, and ecological responses? This includes consideration of hydrologic effects on nutrient loading, nutrient release from soils, transport, and water-quality related ecological indicators, such as periphyton tissue nutrients, cattail expansion, and algal bloom events.

COP Objective or Constraint: COP Objectives 1a, 1b, 1c, 3.

Region(s): Northeast Shark River Slough (NESRS)

Associated Features: S-12s, S-333, S-334, S-356; timing, location, and volume of deliveries

Driver or uncertainty type: Operational driver. Water quality at S-333 tends to degrade when water levels at the structure are low, resulting in spikes of nutrient, specifically total phosphorus concentrations, when these waters are delivered to NESRS. This affect is also observed at the S-12 structures with declining impacts on total phosphorus from west (S-12D) to east (S-12C). Spikes in total phosphorus delivered to NESRS result in excess phosphorus loads (above levels protective of the marsh) and thus a potential for the cascade of nutrient impacts described in this uncertainty.

What is expected to be learned by addressing this uncertainty, i.e., how will COP benefit from addressing this uncertainty? By observing ecosystem response for this uncertainty, impacts on downstream resources in the NESRS marsh will be illuminated. If the operational deliveries for S-333 are addressed through alternative management options/strategies that are protective of the ecological values of NESRS, then COP will benefit with higher potential for improved ecological conditions within NESRS.

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each:

- Increased flow will not alter current periphyton system-wide indicator report status
- Additional flows will not result in an increase in algal bloom events (frequency, spatial extent, duration, and/or magnitude) in Florida Bay and Lower Southwest coast relative to current conditions
- No acceleration in cattail distribution expansion rate relative to current conditions
- No alteration of current spatial distribution of soil and vegetation nutrient pools relative current conditions
- Discharging through S-333 and S-12D at headwater conditions proposed by COP (stage above headwater trigger more often and for longer duration) will not result in degraded water quality and/or adverse ecological response in the marsh.

*Note. For practical operations, several stage triggers shall be established for conditions when stages are declining and separately for conditions when stages are rising. Continued data collection will be used to refine these triggers. The current guideline is conditions should be closely monitored by the water quality team when the S-333 HW stages are descending towards 9.2 feet NGVD. When the ascending S333 HW stages are above or closely approaching 9.2 feet NGVD, and following review of the actual water quality data by the water quality team confirming the improved condition, the water quality data will not need to be as closely tracked.

What is expected to be learned by measuring this attribute?

- Through monitoring flow and nutrients, COP will learn about nutrient response to structure configuration (i.e., S-333 and S-334 flowing or S-333 and S-334 closed; S-333N versus S-333 operations) and operations. While the pre-COP testing generally addressed the water quality questions regarding S-356 pumping (no negative impacts noted), the S-356 pumping and nutrient response should continue to be monitored/evaluated.
- Monitoring of periphyton in the downstream marsh will allow COP to learn about changes in the periphyton nutrient content or algal blooms as demonstrated in the CERP RECOVER System Status Report (see CERP RECOVER 2014, 2019).
- Monitoring of macrophytes, such as cattail, will allow COP to learn about changes in rates of sensitive macrophyte expansion/retraction relative to current rates or presence/absence.
- Monitoring of the spatial nutrient front will allow COP to learn about movement of the spatial nutrient front or changes in nutrient rates of release from soils along soil and/or vegetation transect relative to existing conditions.

What is the time frame in which changes to this attribute are expected to be measurable?

- Flow and water quality monitoring at existing frequency. Discrete total phosphorus changes can be nearly immediately detected, but determination of any statistically significant change from historic levels could take 3 to 10 years, depending on the change magnitude.
- Periphyton (TP content, biomass, composition): 3 months to 1 year
- Cattail expansion: 3 to 5 years
- Soil nutrient front: 3 to 10 years

Is this attribute complimented by other monitoring programs within and/or outside of COP?

- COP should take advantage of existing monitoring which includes monitoring performed by the South Florida Water Management District, United States Geological Survey, Everglades National Park, and cooperators.

When during COP's life cycle should this monitoring begin and end?

- It has already begun and should continue 10 years after complete implementation of COP.

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: A baseline monitoring period of 3 years for soil nutrient content (1 every year) to measure long-term nutrient trends and 3 years of bi-annual (wet/dry season) periphyton tissue nutrients in areas of concern (e.g. downstream of S-12D, NESRS NCTransects) to measure early indication of nutrient

changes is recommended to adequately establish existing conditions. Monitoring of soil nutrient content annually and bi-annual periphyton tissue nutrients beginning with implementation of S-356/G-3273 Relaxation Increment 1 test and carried through operation and management is necessary to document any changes in nutrient distribution resulting from incremental increases in deliveries past Tamiami Trail with each constructed feature.

Triggers/thresholds that indicate good performance or need for adaptive management action in response to COP:

Structure monitoring:

- Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology;
- Good performance: maintaining or reducing nutrient levels represents good performance

Periphyton:

- TP content
  - Need for adaptive management action: if TP content in periphyton tissue increases above baseline;
  - Good performance: if TP content in periphyton tissue remains or declines below baseline
- Biomass
  - Need for adaptive management action: if biomass decreases below baseline;
  - Good performance: if biomass remains or increases above baseline
- Composition
  - Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline;
  - Good performance: if species composition shifts to more desmids and diatoms relative to baseline

Cattail:

- Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period;
- Good performance: if cattails expansion rate reduces or remains the same as baseline

Soil:

- Need for adaptive management action: if soil nutrient front expansion rate exceeds the baseline rate;
- Good performance: if soil nutrient front expansion rate remains or reduces below baseline rate

Management options that may be chosen based on test results: Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. The overarching goal is to avoid delivering water

with elevated concentrations of TP to NESS, while minimizing the effect on the overall volume of water delivered to ENP. Specific operational options include:

1. maintain discharges below 150 cfs through the combined S-12D and S-333 when S-333 headwater stage is below a level historically associated with elevated phosphorus concentrations (in the range of 9.2 ft or below for the S333 HW stage); this action will cease when either a) or b) occur:
    a) S-333_H stage increases to 9.2 ft. or higher or
    b) S-333_H stage increases 1 ft. above the May 15th stage.
2. shift a fraction of the S-12D discharges to S-12C, and/or
3. reduce dry-season recession rates by reducing outflow volumes in WCA 3A through S-12s and S-333 between December and May in water years with December stage lower than 10 feet NGVD29 (3 gage average in WCA 3A) to maintain higher stages in L-29 coming out of the dry season and reduce frequency and/or duration of low stage conditions associated with elevated phosphorus.

*Note that implementation of option 3 will require close coordination between USACE, SFWMD, and ENP senior leadership to apply and will be re-evaluated by interagency staff at a frequency not to exceed every 4 weeks. The intent of the adaptive management measures, if implemented, is that any temporary reduction in volumes delivered to the ENP due to the water quality adaptive management strategies will be limited in duration. Because stages in WCA 3A and ENP affect the weekly flow volumes calculated by the TTFF, short-term flow reductions would be naturally corrected by the weekly TTFF delivery calculation. Any reduction in deliveries would not need to be explicitly accounted for or replaced by deliveries independent of the TTFF weekly calculation. If implemented for longer durations, the adaptive management measures do have a greater potential to reduce the volume of water delivered to ENP, which is not the intent of the measure and one of the reasons for periodic re-evaluation. If it becomes clear that TTFF deliveries will need to be reduced over an extended period (more than 4 weeks), the interagency team will need to carefully weigh the risks of receiving water with elevated TP concentrations versus over drying Shark Slough and other downstream areas. When reductions in volumes delivered to the ENP exceeds 4 weeks due to the implementation of the water quality adaptive management measures, significant alterations to annual deliveries to the ENP will be documented, and the adaptive management implementation will include a plan to mitigate impacts, if observed.

Additional options that have not been tested and will require additional analysis, NEPA review, and deviation to the Water Control Plan for implementation include:

4. avoid first flush events through S-333 following low stage-low flow periods at the S-333 headwater,
5. avoid discharges greater than 150 cfs through S-333 for a period of one to two week to allow water levels at the S-333 headwater to increase above a stage historically associated with elevated phosphorus concentrations,
6. utilize the S-333N discharge structure in place of S-333 assuming the low stage impact on phosphorus concentrations has a lower magnitude of increase.

Decision-Making Process: Once the WCA 3A stages are declining towards 9.2 feet NGVD and before reaching 9.2 feet NGVD at the S-333 Headwater during the dry season to wet season transition and/or when the WCA 3A three gage average is at 10 feet or below on December 1, a water quality group consisting of the DOI, the SFWMD, the FDEP and other agencies with expertise in water quality (led by the

USACE) will initiate discussions to evaluate conditions for potential recommendations to implement the above strategies. This group shall then further coordinate these recommendations to determine suitability for implementation. The duration of any water quality adaptive management measures shall be initially evaluated at an interval not to exceed four weeks (can be shorter duration). Additional increments, if implemented, shall also be evaluated at least every four weeks. These strategies will only be implemented on a case by case basis and will include evaluation of the near real time water quality conditions provided by the SFWMD (preliminary water quality data from the S-333, S-152, S-12's and other appropriate structures), weather forecasts, water supply conditions, etc. Recommendations from the water quality team will be shared with the USACE water managers and then brought forth to the periodic scientist meeting for WCA 3A prior to implementation of these water quality strategies. USACE, after receiving input, shall make the operational decision whether or not to implement the water quality strategy in consideration of water quality and all authorized project purposes.

Table C.2-21 summarizes the monitoring recommendations and provides funding estimates.

Table C.2-21. COP AM Uncertainty ID#16b (Water Quality in NESRS) management option matrix.

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
UNC #16b – Water Quality in NESRS	TP concentration at structures plus additional water quality measures	Flow, TP nutrient concentration, turbidity and other water quality measures in water flowing into park	3 to 10 years	ENP-Northeast Shark River Slough, at structures S-12D, S-333	• Need for adaptive management action: increases if nutri-ents above existing conditions indicates potential for ad-verse impacts to downstream ecol-ogy; • Good performance: maintaining or re-ducing nutrient lev-els represents good performance	Existing	Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. 1. Maintain discharges below 150 cfs through the combined S-12D and S-333 when S-333 headwater stage is below a level historically associated with elevated phosphorus concentrations; this action will cease when either a) or b) occur: a) S-333_H stage increases to 9.2 ft. or higher or b) S-333_H stage increases 1 ft. above the May 15th stage. 2. Shift a fraction of the S-12D discharges to S-12C, and/or 3. Reduce dry-season recession rates by reducing outflow volumes for WCA 3A through S-12s and S-333 between December and May in water years with December stage lower than 10 feet NGVD29 (3 gage average in WCA 3A) to maintain higher stages in L-29 coming out of the dry season and reduce frequency and/or duration of low

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
							stage conditions associated with elevated phosphorus.* *Note that implementation of option 3 will require close coordination between USACE, SFWMD, and ENP senior leadership to apply and will be re-evaluated by interagency staff at least every 4weeks. The intent of the adaptive management measures, if implemented, is that any temporary reduction in volumes delivered to the ENP due to the water quality adaptive management strategies will be limited in duration. Because the stages in WCA 3A and ENP affect weekly flow volumes calculated by the TTFF, short-term flow reductions would be naturally corrected by the weekly TTFF delivery calculation. Any reduction in deliveries would not need to be explicitly accounted for or replaced by deliveries independent of the TTFF weekly calculation. If implemented for longer durations, the adaptive management measures do have a greater potential to reduce the volume of water delivered to ENP, which is not the intent of the measure and one of the reasons for periodic re-evaluation. If it becomes clear that TTFF deliveries will need to be reduced over an extended period (more than 4 weeks), the interagency team will need to carefully weigh the risks of receiving water with elevated TP concentrations versus overdrying Shark Slough and other downstream areas. When reductions in volumes delivered to the ENP exceeds 4 weeks due to the implementation of the water quality adaptive management measures, significant alterations to annual deliveries to the ENP will be documented, and the adaptive management implementation will include a plan to mitigate impacts, if observed. 4.

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
Same as above	Periphyton • TP content • Biomass • Composition	Periphyton in downstream marsh, bi-annual	3 months to 1 year	ENP-Northeast Shark River Slough, downstream of S-12D, NESRS NCTransects	• TP content ○ Need for adaptive management action: if TP content in periphyton tissue increases above baseline; ○ Good performance: if TP content in periphyton tissue remains or declines below baseline • Biomass ○ Need for adaptive management action: if biomass decreases below baseline; ○ Good performance: if biomass remains or increases above baseline • Composition ○ Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline;	Existing	Same as above

Uncer-tainty tracking ID#	Attribute or indicator	Specific Property to be Measured and Frequency	Time-frame to detect change of attributes	Region or Specific Area (Locations to Monitor)	Decision Criteria: Trigger(s) for Management Action	Estimated Additional Annual Cost	Management Action Options Suggestions
					○ Good perfor-mance: if species composition shifts to more desmids and diatoms rela-tive to baseline		
Same as above	Cattail expansion	Local mapping of cattail in downstream marsh	3-5 years	Same as above	• Need for adaptive management action: if cattails expansion rate increases above rates observed dur-ing the base period; • Good performance: if cattails expansion rate reduces or re-mains the same as baseline	Existing	Same as above
Same as above	Soil nutrient front	Soil nutrient content in downstream marsh, annual	3-10 years	Same as above	• Need for adaptive management action: if soil nutrient front expansion rate ex-ceeds the baseline rate; • Good performance: if soil nutrient front expansion rate re-mains or reduces below baseline rate	Existing	Same as above

C.2.5 Uncertainties screened out of the COP AAMP

The uncertainties screened out as being of lower priority to COP are provided in **Table C.2-22**. Screening them out of COP does not mean that they are unimportant, but that they are do not create a high level of risk to COP meeting its objectives. Reasons for screening out each uncertainty are provided. In some cases, the uncertainty was deemed more appropriate to the performance monitoring or constraint monitoring section.

Table C.2-22. Uncertainties screened out of the COP AMMP.

Uncertainty ID#	Region	Category	Uncertainty	Meeting Notes and Discussion	Rationale for Screening
3	ENP-Taylor Slough	Hydrological Ecological	Flow adjustments & Fish: Adjusting water levels recession rates - which are better for fish in ENP?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty. (Risk=low to medium, Knowledge=medium, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
4	ENP	Ecological	Exotic Fish: What are most cost effective methods to remove exotic fish or restrict exotic fish from entering ENP?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty as workshop attendees felt was outside scope of COP. (Risk= medium, Knowledge=medium to high, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
5a	ENP	Hydrological	FDOT constraint on Tamiami Trail - 8.5 ft. maximum constraint on canal stage: L-29 may need to go to 8.5 from October through March to accommodate El Nino events. Extending elevated canal levels between 8.3 and 8.5 for more than 90 days will depend on real-time monitoring of the US 41 roadway subbase	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as it was felt this uncertainty was already mostly resolved and any monitoring would be compliance/constraint monitoring. (Risk=low, Knowledge=high, Relevance=high).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
11b	ENP	Ecological	Resolve tradeoffs between COP and other local wetlands and Biscayne Bay: Will the constructed and operational features of COP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 and L-31-N in areas such as Biscayne Bay?	This was originally brought in as a possible adaptive management uncertainty in pre-workshop list from CEPP Uncertainty ID#62. Workshop attendees split impacts to Pennsuco Wetlands from impacts to Biscayne Bay and other local wetlands and ranked them separately. (Risk=low, Knowledge=medium, Relevance=low to high).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
13	ENP	Hydrological Ecological	NESRS/TS Priority for FL Bay: Is it better to put more freshwater into Taylor Slough or Northeast Shark River Slough to avoid hypersalinity conditions in Florida Bay?	This was originally brought in as a possible adaptive management uncertainty in pre-workshop list. Workshop attendees decided to combine this with Uncertainty ID#10.	Redundant with Uncertainty #10.
14	ENP	Ecological	CSSS and COP: Effects of COP on CSSS subpopulations	This was originally brought in as a possible uncertainty in pre-workshop list. Workshop attendees felt the level of knowledge was high and this was better addressed as compliance/constraint monitoring rather than an adaptive management uncertainty.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees. Identified as being important for compliance/constraint monitoring.

Uncertainty ID#	Region	Category	Uncertainty	Meeting Notes and Discussion	Rationale for Screening
15	ENP	Water Quality	Water Quality in Detention Areas: Water quality levels in detention areas. Can differing water management affect levels?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty. (Risk=low, Knowledge=high, Relevance=high).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
17	ENP	Water Quality	Fire & Nutrients: Can fire management be used to effectively manage small excess nutrient loads?	This was originally brought in as a possible uncertainty in pre-workshop list but was not ranked highly as an uncertainty. (Risk=low, Knowledge=low, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
19	East of WCA 3A, WCA 3B and ENP	Hydrological	Water supply to wellfields east of WCA and park	This was added as a possible uncertainty during the workshop but was not ranked highly as an uncertainty. (Risk=low to medium, Knowledge=medium, Relevance=high). May be better addressed as compliance monitoring.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
21	ENP	Hydrological Ecological	Groundwater salinity, water quality and ecological consequences	This was added as a possible uncertainty during the workshop and ranked as Tier 1 / 2. However, the ecological breakout group decided this was redundant to uncertainty #1 and combined the two uncertainties.	Redundant with Uncertainty ID #1.
22	WCA 3A	Ecological	Python increase in Northern WCA 3A	This was added as a possible uncertainty during the workshop but was not ranked highly as an uncertainty. (Risk=medium, Knowledge=medium, Relevance=low).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
26	WCA 3A, WCA 3B, ENP	Ecological	Freshwater fish	Although ranked as Tier 1 during the workshop, the ecological breakout group decided this topic was better addressed as a performance measure.	Changed to ecological performance measure.
27	WCA 3A, WCA 3B, ENP	Ecological	Crocodilians	This was added as a possible uncertainty during the workshop. Attendees decided the time frame for response was too long to be relevant to COP. Fish and wading birds were felt to show responses in a shorter time span. (Risk=low to medium, Knowledge=medium to high, Relevance=low to medium).	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
28	ENP	Hydrological	Priority use of structures 332B, 332C, or 332D to send water to Taylor Slough	This was added as a possible uncertainty during the workshop. However only on person provided rankings during workshop with risk = low, Knowledge=medium and relevance=high.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.
29	East of ENP	Hydrological	Effect of operations on wetlands in 8.5 square mile area	This was added as a possible uncertainty during the workshop. However, no attendees decided to provide rankings and the issue was dropped.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees and not pursued further.

Uncer-tainty ID#	Region	Category	Uncertainty	Meeting Notes and Discussion	Rationale for Screening
30	WCA 3A, WCA 3B and ENP	Ecological	Snail Kites	This was added a possible uncertainty during the workshop. Workshop attendees felt this was better addressed as compliance/constraint monitoring rather than an adaptive management uncertainty.	Ranked into Tier 3 group by Adaptive Management Workshop Attendees. Identified as being important for compliance/constraint monitoring.

C.2.6 COP Adaptive Management and Monitoring Plan Implementation

Adaptive Management (AM) provides an interdisciplinary, integrated, structured process for lowering risk, increasing certainty and informing decisions. For AM to be successful in ensuring the delivery of intended benefits and avoiding unintended negative impacts of COP, mechanisms must be in place to collect, manage, analyze, synthesize, coordinate, and integrate new information into management decisions. Following the types of decisions, the institutional structure, and costs associated with adaptive management are described. Relevant costs and feedback into management of the COP Ecological Monitoring Plan and the COP Water Quality and Hydrology Monitoring Plan are also included as the adaptive management process involves the evaluation of program performance and compliance with constraints as well as resolving remaining critical uncertainties.

C.2.6.1 Types of Adaptive Management Options and Links to NEPA

The adaptive management options associated with each uncertainty may be classified into one or more of the following categories in **Table C.2-23** depending on whether additional NEPA permitting and review will be required.

(A) Adaptive Management Options Defined in Water Control Plan and supported by EIS: proposed management options in the COP AMMP are defined within the COP Water Control Plan and supported in the environmental effects analysis contained in the EIS.

(B) Adaptive Management Options Not Defined in Water Control Plan and not supported by EIS: proposed management options in COP AMMP are not defined within the COP Water Control Plan and are not supported in the environmental effects analysis contained in the EIS. Proposed management option may require supplemental NEPA permitting and review.

(C) Adaptive Management Options Not in COP Authority: management options in COP AMMP are proposed as a subsequent planning effort and do not currently fall under the authority of COP (i.e. would require subsequent authorization/study). May require supplemental NEPA, permitting and review.

Table C.2-23. Adaptive management actions identified as requiring further NEPA or no further NEPA review. The table provides a link between adaptive management uncertainties, and their corresponding actions, and whether additional NEPA permitting and review would be required.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
UNC #1 /#21 – (Flows, salinity & peat collapse)	• Salinities in brackish marsh ≥20 psu ≥2 months in 2 consecutive years • Median daily water level 0cm or below ground >2 months in brackish water marsh (Nine Mile Pond station; ENP) • Change in soil P from the prior 2 years of the period of record • Decrease in below ground resistivity (i.e., increase in conductivity) from the prior 2 years of the period of record • Any loss of elevation from a previous measurement at a specific location • Change in accretion rate in low-flow continuously inundated SET <1.2 mm/yr. (e.g., Highway Creek.) • Visual evidence of peat collapse along vegetation transects (e.g., exposed *Cladium* culms • Transition of vegetated marsh habitat to open water in 5-year aerial vegetation mapping • Decreased sawgrass density along annual vegetation transects • Retraction or decreasing density of Eleocharis (spike rush) in freshwater marsh and Taylor Slough	1. Spatial redistribution of water into less sensitive areas 2. Reduce discharges (e.g., S-12A, S-12B, S-12C, S-12D) and shift more water to the Blue-Shanty flowway 3. Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries 4. Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast 5. Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #8 Tree Islands.	• Change in tree island number, size, and boundary firmness that indicates ecological degradation of tree islands is occurring (tree island loss, area of tree islands reduction, boundary between tree islands and marsh firmness loss) and where the degradation is occurring. Specific thresholds for vegetation change to be developed as part of CEPP.	6. Landscape Assessment (LILA) Everglades ecological experiments. 7. Increase operational flexibility to maximize flow velocities in the key areas including: 1) hydrological pulsing, 2) Vegetation clearing or management.	#6,#7,#8, #9 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
		8. Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP. 9. Adjust operations along the northern boundary of WCA 3A by redistributing water into the S-8. 10. Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded	water management operating criteria. #10 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #20 –WCA 3B Vegetation	• Signs of significant slough loss from remote sensing or results from the multistate model could provide a trigger for more water to be allowed into WCA 3B.	11. More water could be provided to WCA 3B through the S-152. This water would reach the southwestern side of WCA 3B that has the most remnant sloughs.	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #2 –S-197 / Manatee Bay Discharges	For S-197, discharges into Manatee Bay that: • cause rapid salinity changes sufficient to cause a faunal or seagrass mortality event; • water column stratification with development of hypoxic or anoxic bottom waters; • chlorophyll *a* concentrations with red stoplight indicator or exceeding Numerical Nutrient Criteria thresholds	12. Operate structures in ways less likely to damage the ecosystem, e.g., 13. Avoid discharges through S-197 in order to maintain sufficient flows in Taylor Slough and into northeastern Florida Bay and avoid eastward seepage of water from Taylor Slough. 14. If discharges through S-197 are unavoidable and when not otherwise constrained by safety and flood control requirements,	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
		○ Minimize discharge rates and durations, especially over 800 cfs and over a week duration. Several smaller releases (e.g., < 500 cfs) are preferred over large, pulsed releases. ○ Avoid two or more discharge events within six months that are magnitude 800 cfs or more for a week duration	
UNC #9 Hydrologic Transmissivity	• Difference in stage at canal to 10 km downstream is greater than expected or takes longer to achieve expected stages downstream than expected compared with historical datasets	15. Conduct a dye study to determine where water flow is being impeded. 16. Managing agency conducts controlled fire to remove impeding vegetation.	#15= (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #16 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #11 –Pennsuco Wetlands	• Deviation from historic conditions	Modify and/or adjust operations to include 17. Additional flows through S-151 to reduce potential negative effects on areas of decreased hydroperiod and water depths; 18. Reduction in flows to Taylor Slough through S-335	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #23: Soil oxidation and peat fires	• Statistically significant decrease in soil moisture content • Organic soil content decrease	Modify and/or adjust operations to include 19. Additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential	#19, #20, #21= (B) AM Option Not defined in Water Control Plan - additional NEPA

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	• Sediment elevation decrease in ridges and tree islands • Statistically significant increase in frequency of peat soil consuming fires. • Monitor key indicator regions that act as sentinel sites to determine severity of drought. If groundwater drops one foot below ground during the spring dry season (January-June) in 2 out of 5 years, then an AM option should be triggered	negative effects on areas of decreased hydroperiod and water depths; 20. Alteration in flows to NESRS through S-333N/S-333; 21. Adjustment in flows at S-335 22. Prioritize backfilling of Miami canal to reduce dryout of northern WCA 3	dependent on degree of proposed change to water management operating criteria. #22 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #18 – Wading Birds in Alligator Alley North Colony	• Evaluation of foraging conditions, nesting effort, previous years foraging conditions	Modify and/or adjust operations to include 23. additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; 24. reduction in flows to NESRS through S-333N/S-333; 25. Adjustment in flows at S-335	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC ID #24: Water flow, salinity, algal blooms and ecological benefits in Florida Bay, Whitewater Bay and southwest coast estuaries.	• Flow criterion based on Florida Bay Minimum Flows and Levels (MFL) criterion, but with a higher discharge to minimize harm and promote restoration. • Salinity criterion based on Florida Bay MFL, combined with salinity-rainfall trend analysis. • Algal bloom criterion based on the southern coastal systems (SCS) bloom indicator and FDEP Numerical Nutrient Criteria • Seagrass and faunal indicator trends, using system-wide indicators SCS and RECOVER juvenile sea trout performance measure.	26. Modify operations to increase flow to Florida Bay and/or southwest coast estuaries either via changing distribution or timing. This includes distribution of water from WCA 3A or -3B to ENP or distribution within ENP (inflow to Shark River Slough vs Taylor Slough). This entails potential modifications of operation of structures along Tamiami Trail and the ENP eastern boundary. 27. Additional actions could be taken to improve seepage management, especially on ENP eastern boundary, by raising L-31 and/or C-111 stages.	#26 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #27 = (C) AM Option not under authority of COP. May require supplemental NEPA.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
UNC #25 –Wading Birds	• Decrease or no improvement in numbers of foraging birds based on evaluation of baseline data • Decrease or no improvement in nesting success (nest abandonment) based on evaluation of baseline data	28. Evaluate distribution of water between WCA 3, NESRS and Taylor Slough; modify regional operation of the system. Modify and/or adjust operations to include 29. additional flows through S-150 and/or S-11A, S-11B, S-11C to reduce potential negative effects; 30. reduction in flows to NESRS through S-333N/S-333; 31. adjustment in flows at S-335.	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #6 – Seepage.	• Increased hydroperiod durations and/or peak stages in 8.5 SMA beyond historical observations and modeling results, which may necessitate operational changes in 8.5 SMA and/or S-331 Structure, or reductions in canal stages and flows into NESRS. • Decreased hydroperiod durations and/or peak stages in 8.5 SMA compared to historical observations and modeling results, which can allow further relaxation of L-29 operational constraints for flows into NESRS. • Performance evaluation of 2020 COP Biological Opinion RPA, potentially including dry nesting days, discontinuous hydroperiods, and water level reversal west of the C-111 detention areas (update following the ESA consultation).	32. Adjustments to operations in the L-29, L-30, L-31N, and C-111 to improve water deliveries to NESRS, Taylor Slough, the Biscayne Bay. 33. Adjustments to operations for 8.5 SMA. 34. Refinement/improvement of existing numerical models to improve ability to forecast effects of structures and operations, if needed. 35. Recommend additional targeted groundwater modeling to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage due to expected increased flows to NESRS.	#32, #33, #34 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #35 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #10 – Northeast Shark River Slough (NESRS) and Taylor Slough (TS)	• Under COP operations we expect less than 1 psu (practical salinity unit) annual average change in Florida Bay over a decadal period. Changes in flows at Taylor Slough Bridge (TSB) and coastal creeks are more likely to be sensitive to COP operations and reveal patterns of change after 1-5 years of COP implementation. Stage levels in Shark River Slough, Taylor	36. Adjustments to operations from WCA 3B at S-335 and WCA 3A at S-334 and then conveyed towards Taylor Slough by the S-332's. Additional NEPA will be needed if varies from the operations already developed in Alt Q, evaluated in the COP EIS, and subsequently included in the WCP	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	Slough, and the C-111 basin are also likely to respond within the first few years of COP implementation. • A summary of flows and stage levels will be presented at the annual PDT plus workshop. The development of thresholds and triggers can be developed by a task team if/when the PDT+ observes that sufficient data is available to identify durable thresholds/triggers. Expectation is that this uncertainty will become more relevant once Tamiami trail is modified to support 9.7 ft. NGVD stage by late 2024 (current estimate is construction begins in 2020).	37. Refinement of existing hydrologic and hydrodynamic models in Taylor Slough, the southern coastal wetlands, and Florida Bay	
UNC #12a – Tamiami Trail Flow Formula (TTFF) and Drought	• Alternative forms of the TTFF will be analyzed and presented periodically at COP meetings. If/when significant differences between the formulas emerge, then focused hydrologic modeling simulations will be pursued with the results used to discern the likely consequences of employing a different approach.	38. Option 1: Recommend an alternative form of the Tamiami Trail Flow Formula for making deliveries to ENP. Implementation of these refinements and/or modifications to the TTFF is likely to occur during a project-specific update to COP, including supplemental NEPA as required, or as part of other future Water Control Plan updates (e.g. CEPP). 39. Option 2: Maintain to existing intuitive regression approach for TTFF based deliveries, as advocated for initial implementation of the COP TTFF based on technical team evaluations.	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria.
UNC #12b – Tamiami Trail Flow Formula (TTFF) and Drought	• If test is able to be successfully implemented without unexpected violation of constraints (e.g., causes water quality concerns), then the test operational strategy (with the drought intensity threshold constraints) will become part of the regular water control plan operational strategy.	40. Option 1: Adopt operational strategy that provides a moderate increase to TTFF inflows into Central and Southern Shark River Slough during seasonal transitions.	(A) AM Option Defined in Water Control Plan – evaluated in supporting EIS

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	• If unexpected violation of constraints occur that appear unresolvable (e.g., water quality concerns or excessive drying of WCA 3A), then operations will return to using the Tamiami Trail Flow Formula as described in the Water Control Plan.	41. Option 2: Based on consideration of constraints and forecast conditions, maintain adherence to the COP TTFF based delivery strategies.	
UNC #5b – Florida Department of Transportation constraint on Tamiami Trail	• Criteria for damage to the roadway or its subbase, which will continue to be developed through review of the monitoring data collected during the Increment 2 field test (instrumentation was initially available for the 2019 wet season). • Criteria for seepage/flooding in 8.5 SMA greater than historical levels.	42. For the 8.5 SMA, observed seasonal rainfall and hydro-period events which fall below the lower limit of the "acceptable" performance threshold following the conclusion of the corresponding wet or dry season period provide an indication that further operational changes are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. Operational changes may include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints at G-3273 for inflows to NESRS. 43. If the 8.5 SMA flood mitigation criteria are determined as limiting the inflows to NESRS when the L-29 Canal is maintained up to 8.5 feet NGVD (the maximum operating limit for the COP Water Control Plan), following the earlier FDOT correspondence recommending removal of the FDOT constraint or completion of the TTNS roadway modifications, additional remedies for the 8.5 SMA flood mitigation will be explored through	#42 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #43 = (C) AM Option not under authority of COP. May require supplemental NEPA.

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
		interagency coordination between USACE, SFWMD, and DOI.	
UNC #7 –Saltwater intrusion	• COP L-31 and C-111 Canal Reaches: Should persistent difficulty be reported by water managers in the attempt maintain the anticipated water levels in the primary canal reaches be observed due to backwater effects from tidal or surge conditions limiting discharges through coastal structures, the COP AM team will summarize and characterize the nature of these limitations. Persistent challenges are explicitly defined as limited capacity to use coastal outflow structures within any 24 hour period, or the inability to drain a canal reach due to surge conditions, or any clear shift in the spatial pattern of flood impacts. • Protection of Critical Resources: Should undesirable trends be observed due to saltwater impacts in the ENP marsh or the Biscayne aquifer, the COP AM team will form a task team to summarize and characterize the nature of these effects (e.g. episodic, exacerbated / accelerating trends, etc.…).	44. Identify potential operational changes within the scope of the original COP effort for further consideration. 45. Identify complementary projects and programs than may help to mitigate the effects. These may include: a. CERP b. Federal initiatives such as the USACE Coastal Atlantic or Back-Bay studies c. State initiatives like the SFWMD's Level of Service program d. County or local initiatives 46. Identify potential infrastructure or regional operations that could be considered by complimentary efforts.	#44 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria. #45, #46 = (C) AM Option not under authority of COP. May require supplemental NEPA.
UNC #16a – Water Quality in Taylor Slough	• TP concentration at structures plus additional water quality measures ○ Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology; ○ Good performance: maintaining or reducing nutrient levels represents good performance • Periphyton TP content	47. Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes	(B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree of proposed change to water management operating criteria

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	○ Need for adaptive management action: if TP content in periphyton tissue increases above baseline; ○ Good performance: if TP content in periphyton tissue remains or declines below baseline • Periphyton Biomass ○ Need for adaptive management action: if biomass decreases below baseline; ○ Good performance: if biomass remains or increases above baseline • Periphyton Composition ○ Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; ○ Good performance: if species composition shifts to more desmids and diatoms relative to baseline • Cattail Expansion ○ Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period; ○ Good performance: if cattails expansion rate reduces or remains the same as baseline		
UNC #16b – Water Quality in NESRS	• TP concentration at structures plus additional water quality measures ○ Need for adaptive management action: increases in nutrients above existing conditions indicates potential for adverse impacts to downstream ecology; ○ Good performance: maintaining or reducing nutrient levels represents good performance • Periphyton TP content	Adjust operations to change spatial and/or temporal distribution of water; model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes. 48. Maintain discharges below 150 cfs through the combined S-12D and S-333 when S-333 headwater stage is below a level historically associated with elevated phosphorus concentrations; this action will cease when either a) or b) occur:	#48, #49, #50 = (A) AM Option Defined in Water Control Plan – evaluated in supporting EIS. # 51, #52, #53 = (B) AM Option Not defined in Water Control Plan - additional NEPA dependent on degree

Uncertainty or Performance Measure ID#	Decision Criteria: Trigger(s) for Management Action	Management Action Options Suggestions	Additional NEPA permitting and review required
	○ Need for adaptive management action: if TP content in periphyton tissue increases above baseline; ○ Good performance: if TP content in periphyton tissue remains or declines below baseline • Periphyton Biomass ○ Need for adaptive management action: if biomass decreases below baseline; ○ Good performance: if biomass remains or increases above baseline • Periphyton Composition ○ Need for adaptive management action: if species composition shifts to more cyanobacteria relative to baseline; ○ Good performance: if species composition shifts to more desmids and diatoms relative to baseline • Cattail Expansion ○ Need for adaptive management action: if cattails expansion rate increases above rates observed during the base period; ○ Good performance: if cattails expansion rate reduces or remains the same as baseline	a) S-333_H stage increases to 9.2 ft. or higher or b) S-333_H stage increases 1 ft. above the May 15th stage. 49. Shift a fraction of the S-12D discharges to S-12C, and/or 50. Reduce dry-season recession rates by reducing outflow volumes for WCA 3A through S-12s and S-333 between December and May in water years with December stage lower than 10 ft. NGVD29 to maintain higher stages in L-29 coming out of the dry season and reduce frequency and/or duration of low stage conditions associated with elevated phosphorus. Additional options that have not been tested and will require additional analysis and NEPA review for implementation include: 51. Avoid first flush events through S-333 following low stage-low flow periods at the S-333 headwater, 52. Avoid discharges greater than 150 cfs through S-333 for a period of one to two week periods to allow water levels at the S-333 headwater to increase above a stage historically associated with elevated phosphorus concentrations, 53. Utilize the S-333N discharge structure in place of S-333 assuming the low stage impact on phosphorus concentrations has a lower magnitude of increase.	of proposed change to water management operating criteria.

C.2.6.2 Adaptive Management Institutional Structure and Feedback Loops

To facilitate implementation of the COP AMMP, the implementing agencies will continue weekly operations meetings and assign staff, establish Periodic Science Calls every three to four weeks and a COP Project Delivery Team Plus with a minimum of an annual meeting, and publish a Biennial Combined Operations Plan Report: Operations, Monitoring, and Adaptive Management.

Weekly Operations Meetings: The operations managers at the SFWMD meet on a weekly basis to evaluate how to operate the water control structures using the Water Control Plan in light of the current status of the system (hydrologic quality), expected weather (short term meteorological), constraints (water supply, flood control, environmental), and goals and objectives (water supply, environmental).

Periodic Science Calls (PSC): Monitoring results and forecasts will be discussed in a PSC forum held approximately every three to four weeks which includes all stake holders. PSCs are a requirement of the 2016 ERTP BO and will continue to be held per requirements of the 2020 COP BO... This meeting involves scientists from COP implementing agencies and participating agencies (USACE, SFWMD, NPS, USFWS, FDEP, FWC, Native American Tribes). The PSCs makes recommendations to the operations managers for changes in operations within the approved operations strategies framework. The COP implementing agencies and participating agencies shall identify representatives or persons they delegate to attend these meetings. Such meetings can be divided into multiple groups when the number and diversity of issues warrant (e.g., water quality, wildlife, wading birds).

Wildlife Coordination Calls: The COP AMMP assumes the Wildlife Coordination Calls (USFWS, ACOE, SFWMD, NPS and others) will continue in order to evaluate the influence of operations on multiple species and their habitats. These calls vary from weekly to monthly depending on the time of year and provide recommendations to both the operations managers and to the Periodic Science Calls.

COP Project Delivery Team Plus Meetings: A COP Project Delivery Team Plus (COP-PDT+) will succeed the COP Project Development Team and will consist of representatives of COP implementing agencies, oversight agencies, and stakeholder groups similar in composition to the pre-implementation COP Project Development Team. The COP PDT+ will meet at least once annually as part of assessing and reporting COP's performance to discuss results. Meetings may occur more frequently during the first 2-3 years of COP implementation, for example at the beginning of the wet season and beginning of the dry season. The meeting goal will be to understand status and trends and potential causes of performance issues and/or success, as well as discuss the reality of what options (COP and non-COP related) are available to improve performance if needed. The COP PDT+ will receive reports from scientists, hydrologists, engineers and water managers, summarizing operational activities during the previous period, the status of meeting COP goals and objectives and constraints, any problems that occurred during the year, results of adaptive management monitoring (targeted studies) and resolving of adaptive management uncertainties, the status and results of implementation of any adaptive management actions during the year, the need for any emergency deviations, and any recommendations for changes that go beyond the Water Control Plan and COP AMMP. Monitoring results will be presented in the context of goals, thresholds, or triggers. The COP PDT+ will review the results and accompanying report and provide feedback on the effectiveness of the implementation of COP, changes that can be made within the constraints of the Water Control Plan, and make recommendations to the senior level implementing agency leads regarding implementing adaptive management options or dealing with new unanticipated uncertainties. Additional and/or

emergency meetings of the COP-PDT+ may be called to address complex, urgent, or emergency situations. Similar to the Project Development Team, the PDT+ can designate sub-teams to more effectively develop and report back on issues.

Types of adjustments to management actions: Suggested types of adaptive management options to adjust implementation with associated decision groups are provided in **Table C.2-24** and more specific links between the adaptive management uncertainties and the likely most relevant evaluation and decision level are included in **Table C.2-25**.

This is the first time an adaptive management process is being considered for C&SF operations in south Florida related to the MWD and C-111 South Dade projects. The PDT+ team expects to learn quite a bit about how to effectively connect the different teams that have meaningful recommendations to make to water managers. While it is recognized that the USACE is the ultimate decision authority for the operations the C&SF water management infrastructure, one of the goals of the COP AMMP is to broaden the awareness and understanding of operational strategies/constraints to include land management agencies and stakeholder groups. The adaptive management process in the COP does not seek to take control over water management out of the hands of system operators, instead it seeks to inform their decisions with expertise on wildlife, biogeochemistry, and ecology. Establishing feedback between hydrologic system operators and these other groups, documenting the record of how feedback is acted upon, and summarizing these actions in periodic reports is how the COP AMMP hopes to increase awareness of challenges present in the system and to use this awareness to systematically improve ecological outcomes in the future. Enhanced awareness could be applied to future project designs, the schedule of implementation of future projects, or the design of future operational plans.

The COP AMMP will only be able to address uncertainties that occur as a result of naturally varying climate during the period in which the COP is the governing operational strategy. Because the natural system exhibits high interannual variability in rainfall, the project team has tried to integrate monitoring for the COP into our long term system-level monitoring in as much as possible. Many uncertainties with system performance can be enhanced through the implementation of CERP projects, and that is the primary driver of system enhancements moving forward. Continuing to implement CERP projects and integrate these projects into system operations is among the most important tactic for addressing the uncertainties associated with the COP.

Modifications to the monitoring and/or implementation of the management options identified in the COP AMMP will be coordinated with the South Atlantic Division (SAD), as the SAD provides the approval authority for the 2020 COP Water Control Plan.

Table C.2-24. Management options included in the COP Adaptive Management Plan and implementing group.

Type of Decision	Deciding Level
Inform Operational Decisions– results inform changes to operations within the flexibility already allowed for within the Water Control Plan (WCP).	*Weekly Operations Meetings – agencies implement within boundaries of WCP.* *Periodic Science Call - reviews and makes recommendations for adjustments every three to four weeks within boundaries of WCP.*
NEPA Covered COP Adaptive Management Contingency Options - results may suggest a need to implement contingency options described within the adaptive	*Periodic Science Call - reviews and makes recommendations to operators, PDT+ and senior agency officials.*

Type of Decision	Deciding Level
management strategies or Management Options Matrix. Such contingency options that are described in sufficient detail and do not require construction modifications would not require additional permitting beyond this document.	*PDT+ reviews and makes recommendations to operators and senior agency officials.* *Senior agency officials can implement. Requires notification and coordination with SAD.*
Actions requiring additional NEPA permitting and review – Some actions not covered with sufficient specificity in the EIS/PIR will require additional environmental review and public comment and potentially additional modeling or analyses.	*Periodic Science Call - reviews and makes recommendations to operators, PDT+ and senior agency officials.* *PDT+ makes recommendations to senior agency officials.* *Senior agency officials can implement starting new NEPA permitting and review processes and seek funding. Requires notification and coordination with SAD.*
Informing CEPP or Other Project Implementation - results may inform CEPP or other agencies regarding the next phase of CEPP project sequencing or other advisable actions that are beyond the scope of COP, such as construction of additional seepage barriers	*PDT+ makes recommendation to CEPP or other project planning efforts and senior agency officials. Requires notification and coordination with SAD.*

Biennial Combined Operations Plan Report: Operations, Monitoring, and Adaptive Management: A biennial COP summary report will be submitted to the COP-PDT+ of the actions taken under the COP Water Control Plan and AMMP including justification and result of any deviations; monitoring of performance and constraints; status of plan in meeting its objectives; results of monitoring and status of resolving adaptive management uncertainties; implementation and results of any adaptive management actions; recommendations for future actions within the constraints of the Water Control Plan; and recommendations for actions that would require additional NEPA or other funding, permitting, and review outside of the COP AMMP. When development of this report coincides with the CERP RECOVER System Status Report, this report may be included as part of that System Status Report, e.g., as an appendix.

COP AM core staff: The implementing agencies (USACE, ENP, and the SFWMD) and partner agencies, if interested, shall assign staff who will have sufficient time dedicated to PSC and PDT+ meetings, writing the Combined Operations Plan Annual Operations, Monitoring, and Adaptive Management Report, and organizing the annual COP-PDT+ meeting. It is anticipated that staff from the implementing agencies (the USACE, ENP, and the SFWMD) will coordinate a kickoff meeting immediately following the implementation of the COP to develop the framework of the above referenced report.

Table C.2-25. Linking adaptive management uncertainties, compliance, and performance monitoring evaluation and response to most relevant institutional groups. "X" = will typically be discussed in this group. "--" = typically, will not be discussed in this group (but still could be).

Uncertainty or Type of Monitoring	Operations meetings (Weekly)	Periodic Science Call and Wildlife Coordination Call (Weekly to Monthly	PDT plus (1-2 times per year)	PDT plus task team (as assigned)
Ecological Uncertainties	--	--	--	--

Uncertainty or Type of Monitoring	Operations meetings (Weekly)	Periodic Science Call and Wildlife Coordination Call (Weekly to Monthly	PDT plus (1-2 times per year)	PDT plus task team (as assigned)
UNC # 1 and #21 (Flows, salinity, peat collapse)	--	--	X	X
UNC #8 (Tree Islands)	--	--	X	X
UNC #20 (WCA 3B Vegetation)	--	--	X	X
UNC #2 (S197/Manatee Bay)	--	X	X	X
UNC #9 (Hydrologic Transmissivity)	--	--	X	X
UNC #11a (Pennsuco Wetlands)	X	--	X	--
UNC ID #23 (Soil oxidation and peat fires)	X	X	X	--
UNC ID#18 Wading Birds in Alligator Alley North Colony)	--	X	X	X
UNC ID #24 (Salinity, water flow, algal blooms in Whitewater Bay and Florida Bay)	--	X	X	X
UNC ID #25 (Wading Birds)	--	X	X	--
Hydrological Uncertainties	**--**	**--**	**--**	**--**
UNC ID #6 (Seepage / Flood Protection)	X	--	X	--
UNC ID #10 (Northeast Shark River Slough (NESRS) and Taylor Slough (TS))	--	--	X	X
UNC ID #12a (TTFF - General)	--	--	X	X
UNC ID #12b (TTFF and Drought)	--	--	X	X
UNC ID #5b (Florida Department of Transportation constraint on Tamiami Trail)	X	--	X	--
UNC ID #7 (Saltwater intrusion)	--	--	X	X
Water Quality Uncertainties	**--**	**--**	**--**	**--**
UNC #16a (Water Quality in Taylor Slough)	X	X	X	as needed
UNC #16b (Water Quality in Northeast Shark River Slough)	X	X	X	as needed
Performance and Compliance	**--**	**--**	**--**	**--**
Performance and compliance monitoring	X	X	X	--

C.2.6.3 COP Adaptive Management and Monitoring Plan Cost Estimate

Identification of the COP AMMP contained in **Appendix C** was guided partly by two objectives. First, it must be complete from a COP perspective in that it must provide the monitoring required to address COP-specific needs. Second, it must be integrated with other Everglades monitoring to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and insure cost-effectiveness. These two objectives guided development of the adaptive management plan, ecological monitoring plan, hydrometeorological monitoring plan, water quality monitoring plan, and cultural resources monitoring plan. Where possible,

COP will rely on existing monitoring resources such as physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies (see for example **Figure C.2-8**). Therefore, the monitoring described in the COP AMMP is limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address COP-specific questions. It is assumed that the monitoring programs will continue for at least the time needed by COP. The additional cost estimate for the COP AMMP can be found in

Table C.2-26 with a more complete linkage to existing monitoring programs provided in **Table C.2-27**. RECOVER monitoring currently being performed within WCA-3 and ENP is addressed within RECOVER's MAP and the Central Everglades Planning Project Integrated Project Implementation Report and Environmental Impact Statement Adaptive Management and Ecological Monitoring Plan (USACE 2014) and COP will draw heavily on this existing monitoring.

While most of the monitoring for the eighteen adaptive management uncertainties will rely on continuation of existing monitoring efforts, five uncertainties identified the need for additional monitoring. The total estimated cost for proposed new monitoring and modeling in the COP AMMP (**Table C.2-26**) is approximately $280,000 per year for at least 5 years following COP implementation plus $50,000 for supplemental hydrologic modeling costs. This does not include direct labor costs for meetings and staff time to write reports, which would be funded by each supporting agency. Remaining funding for MOD Waters will be insufficient to cover these costs. COP would need to seek additional funding to cover all the uncertainties. No new additional ongoing performance or constraint monitoring are expected although some costs are being shifted among agencies. Costs for some adaptive management actions that go beyond shifting of flows would need to be determined based on the actual management actions chosen. Implementation of the management actions are also subject to funding availability. If funding is provided and not sufficient to execute all proposed monitoring identified in Table C.2-26, staff from the implementing agencies (the USACE, ENP, and the SFWMD) will need to prioritize the recommended monitoring

USFWS BO costs based on monitoring requirements identified in the 2020 COP BO and reflected in **Table C.3-3** have an estimated cost of $845,800 per year. Estimated costs for annual population surveys for federally listed threatened and endangered species as mandated by the 2020 BO are incorporated into **Section C.3** (**Ecological Monitoring Plan**). Monitoring identified in the 2020 COP BO is consistent with that required by the prior 2016 ERTP BO and does not represent a cost increase over current monitoring efforts. The USACE currently funds surveys for the CSSS, Everglade snail kite, to include an apple snail monitoring program, and the wood stork. The 2020 COP BO requires continuation of these efforts and is currently funded by Aquatic Ecosystem Restoration (AER) O&M. Some of the monitoring is legally required by the 2020 COP BO.

Table C.2-26. Estimated proposed new COP monitoring costs and proposed costs for optional adaptive management actions. TBD=To Be Determined.

COP ID#	COP AM Uncertainty	Proposed New COP Monitoring costs	Adaptive Management Action Costs
1 & 21	**Flows, Salinity and Peat Collapse:**	**$180,000/yr. for 5-10 yrs.**	Possible modeling costs
8	Tree Islands	$0, Existing	TBD but will be external to COP
20	WCA 3B Vegetation	$0, Existing	$0
2	**S-197 / Manatee Bay Discharges**	**$20,000/yr. for 5-10 years**	$0
9	Hydrologic Connectivity	$0, Existing	TBD but will likely be external to COP.
11a	Pennsuco Wetlands	$0, Existing	$0
23	Soil Oxidation and Peat Fires	$0, Existing	TBD but will be external to COP
18	**Wading Birds in Alligator Alley North Colony**	**$50,000 / yr.**	TBD but any costs will be external to COP: e.g., temporary pumps; Additional canal plug.
24	**Salinity, water flows, algal blooms in Whitewater Bay & FL Bay**	**$30,000/yr. for 5 years**	Possible modeling costs
25	Wading Birds	$0, Existing	TBD
6	Seepage/Flood Protection	$0, Existing	Possible modeling costs. Seepage barrier costs external to COP
10	NESRS & TS	$0, Existing	Possible modeling costs.
12a	**Tamiami Trail Flow Formula-General**	**$50,000 (modeling costs)**	$0
12b	Tamiami Trail Flow Formula and Drought	$0, Existing	$0
5b	FDOT constraint on Tamiami Trail	$0, Existing	Possible modeling costs.
7	Saltwater intrusion	$0, Existing	TBD but will be external to COP
16a	Water Quality in Taylor Slough	$0, Existing	TBD
16b	Water Quality in NESRS	$0, Existing	TBD

Figure C.2-8. Map of Hydrology Stations grouped by region in Everglades National Park and nearby vicinity.

C.2.6.4 Addressing future unidentified uncertainties.

Because new information is continually becoming available, the COP AMMP must be recognized as a living document that is improved upon through incorporation of new information. While every effort has been made to identify and address any remaining critical uncertainties regarding the implementation of COP, future unexpected problems will inevitably arise. Some problems may result in emergency deviations. For other situations the uncertainty should be raised to the PSCs and the PDT for recommendations on the best path forward to address the uncertainty. This could include, for example, the identification of the critical uncertainty, developing a modeling services request, evaluating the results, implementing field testing if necessary, and updating implementation in the water control plan. The implementing agencies (USACE, SFWMD) will determine if such novel uncertainties require an EA or EIS as appropriate.

Table C.2-27. Adaptive management uncertainties linked to existing monitoring programs and estimated new costs.

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #1 & 21 Flows, salinity & peat collapse	Inundation Duration and Salinity in Coastal Marsh	Water level and salinity measured continuously at permanent installed hydro gages NMP and NP62, others as identified	NESRS, ENP(TS)	$0, Existing	-	-	-	-
UNC #1/#21 Continued	Discharge and salinity from Taylor Slough	Discharge (flow rate) and salinity measured continuously at permanent installed Hydro gage NP-TSB (northern Taylor Slough), ENPTR (Taylor River) and TaylorS3 (downstream near Florida Bay)	ENP(TS)	$0, Existing	ENP maintains these stations	ENP	Perm	Damon Rondeau / DataForever and DBHydro
UNC #1/#21 Continued	Soil P pool relation to groundwater salt wedge	soil, surface water, and groundwater P, surface and groundwater conductivity, groundwater resistivity monitored with quarterly samples in "areas of concern (e.g., Model Lands, Lostman's River)"	NESRS, ENP(TS), ENP(SC)	$100,000	NEW	NEW	--	--
UNC #1/#21 Continued	Soil elevation and depth change	Soil elevation and depth at SETs established along the southern coast, NMP station in brackish marsh	ENP(TS), ENP(SC), Florida Bay	$0, Existing	USGS, SFWMD	USGS, SFWMD	Temp	Carlos Coronado (SFWMD)

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #1/#21 Continued	mangrove-white zone movement and marsh vegetation changes	Mangrove-white zone movement; marsh vegetation composition and density; open-water area in marsh at mangrove-white zone at Everglades-Florida Bay transition zone; monitored with 5 year aerial vegetation mapping surveys and annual vegetation transect surveys	ENP, ENP(TS), ENP(NESRS), ENP(SC), Florida Bay	$80,000	ENP	USACE and ENP	Temporary – as needed	David Rudnick, SFNRC servers
UNC #1/#21 Continued	Source of freshwater (Tentative/if necessary)	Normalized isotopic compositions (stable isotopes (18O and 2H)) in surface water and rainfall grab samples at "areas of concern (e.g., Model Lands, Lostman's River)".	NESRS, ENP(TS), ENP(SC)	Cost range depending on scale of investigation is between $50,000 and $100,000	NEW	NEW	--	--
UNC #8 Tree Islands.	Tree island size, Structural complexity, Species composition Boundary shifts	Mapping every 2-3 years of change in tree island boundaries and area maximum tree height/island, functional vegetation composition (e.g., presence of short hydroperiod, late	WCA 3A, WCA 3B, ENP-SRS	$0, Existing	FIU – Jay Sah	RECOVER	Perm	FIU, USACE, South Florida Environmental Report

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
		succession hardwood hammock species) locations of additional new or missing tree islands						
UNC #20 - WCA 3B Vegetation	Slough percent coverage (filling in of the sloughs); multistate transition probabilities for slough to ridge	WCA 3B sloughs mapped every year using remote sensing and compared with multi-state transition model run.	Within remnant ridge and slough section of WCA 3B (southwest)	$0, Existing	SFWMD	SFWMD	During period of CEPP imple-menta-tion	Christa Zweig / SFWMD
UNC #20 Continued	Hydroperiod	EDEN gages and surfaces within WCA 3B	WCA 3B	$0, Existing	EDEN (sofia.usgs.gov/eden)) by USGS	USGS, SFWMD	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro
UNC #2 –(S-197 / Manatee Bay Discharges)	C-111, S-197, and adjacent or downstream creek discharge	Discharge estimates (daily, monthly, and annual) from flow velocity or rating curve, with tracking of proportion of total discharge from S-197 and specified creeks.	S-18C, S-197, Manatee Bay Creek, West Highway Creek, Trout Creek	$0, Existing	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #2 Continued	Continuous Salinity and Temperature Monitoring	Daily average: Temperature, Conductivity, salinity	Manatee Bay, Barnes Sound, Little Blackwater Sound, Trout Cove	$0, Existing	ENP	ENP	Perm	Damon Rondeau / DataForever and DBHydro https://www.sfwmd.gov/science-data/dbhydro;
UNC #2 Continued	Seagrass habitat, light	Seagrass cover, community composition, light attenuation	Manatee Bay, Barnes Sound, Long Sound, Little Blackwater Sound, Joe Bay, Trout Cove	Existing plus $10,000 / year for seasonal sampling	SFWMD	SFWMD	Temp	Chris Madden
UNC #9 – Hydrologic Trans-missivity	Flow velocity at Tamiami Trail	Flow velocity through culverts; Difference in stage drop north to south of Tamiami trail versus expectations compared with historical datasets.	ENP - Vegetation "halos" immediately south of water control structures and culverts along Tamiami Trail.	$0, Existing	USGS S-12 B/C Gages & TT Culverts (USGS); NE-1,NE-2 (USGS) NP-201 (NPS)	USGS	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro; http://www-sfnrc.nps.gov/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #11 – Pennsuco Wetlands	Hydroperiod; Water Depth	Hydroperiod (Surface and Ground water) observed across a water year as measure at an identified set of gages in the study area. Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. Depth and duration of dry season below ground across a year, as measured at an identified set of gages in the study area.	Pennsuco wetlands	$0, Existing	S-356, S-141, S-337, S-335 (SFWMD) G-975, G-3818 (USGS)	SFWMD, USGS	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro
UNC #23 - Soil oxidation and peat fires	Hydroperiod, Water Depth, Soil Oxidation, Peat Accretion, Fire Frequency	Hydroperiod (Surface and Ground water) observed across a water year as measure at an identified set of gages in the study area. Depth Water depth (surface and ground water) observed across a water year as measured at an identified set of gages in the study area. Depth and duration of dry season below ground	Areas directly west of the Miami Canal and north of WCA 3B and northern WCA 3B are of particular concern due to observed model results	$0, Existing	NESRS-2, G-620, Site 62, Site 63, Site 64, Site 65, 3A-2, 3A-3, 3A-4, 3A-28 (USGS); G-3273 (SFWMD); NP-201, NP-33, NP-	CERP-RECOVER, ENP, SFWMD	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro; http://www-sfnrc.nps.gov/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
		across a year, as measured at an identified set of gages in the study area. Soil moisture content Peat accretion Fire mapping Soil decomposition	Areas within NESRS and Taylor Slough in ENP are most likely to be affected; however, monitoring within all of WCA 3 and ENP should be conducted		36, NP-38, NP-67 (NPS); 3A-NW, 3A-28, 3B-SE (SFWMD)			
UNC #18 – Wading Birds in Alligator Alley North Colony	Wading bird presence. Foraging conditions. Nest initiation.	Nesting numbers, nesting success, water depth/stage, recession rate.	WCA 3A – Alligator Alley North colony and surrounding marsh	9 X surface water wells and sondes. EDEN gages and SFWMD wading bird surveys are part of on-going monitoring .	SFWMD EDEN	SFWMD and RECOVER	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
				Added cost= $50,000/ yr.				
UNC ID #24: Changes in water flow, salinity, algal blooms and ecological benefits in Florida Bay, Whitewater Bay and southwest coast estuaries.	Water inflow from creeks and rivers	Flow velocity, with estimates of discharge (approximately 20 minute intervals)	Network of 17 creek stations: Mangrove ecotone of Florida Bay, Whitewater Bay and southwest coast rivers (to Lostman's River)	$0, Existing (USGS, RECOVER)	USGS	USGS / RECOVER	Temp	https://waterdata.usgs.gov/fl/nwis/current/?type=flow http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro;
UNC #24 Continued	Salinity regime	Specific conductivity and temperature to estimate salinity (hourly measurements)	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River). 18 stations in Florida Bay, 15 stations in SW coast estuaries	$0, Existing (ENP)	ENP Marine Monitoring Network; SFWMD shipboard dataflow surveys	ENP, SFWMD	Temp	https://www.sfwmd.gov/science-data/dbhydro; http://www-sfnrc.nps.gov/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #24 Continued	Algal blooms	Chlorophyll *a* (monthly for grab sample network; seasonal for spatial mapping)	Florida Bay, Whitewater Bay, southwest coastal rivers (to Lostman's River)	Existing (SFWMD); estimated $30,000 for monthly interval change	SFWMD stations, SFWMD shipboard Dataflow Surveys	SFWMD	Temp	https://www.sfwmd.gov/science-data/dbhydro
UNC #24 Continued	Seagrass community	Bran-Blanquet cover metric, species composition (annual)	Florida Bay, Whitewater Bay	$0, Existing (RECOVER)	FHAP project (RECOVER) Expand to cover Long Sound, Joe Bay, Little Madeira Bay;	RECOVER	Temp	USACE
UNC #24 Continued	Faunal indicators	Fish abundance, biomass, and species composition (monthly to seasonal) Fish movement and location relative to salinity (monthly) Fish prey base concentration with recession (monthly to seasonal) Roseate spoonbill nesting success (dry season) Crocodile abundance, nesting success, growth	Florida Bay, Whitewater Bay, Shark River	$0, Existing (RECOVER)	Juvenile sport fish (RECOVER), Florida Bay Marsh-Mangrove Interface Project (RECOVER); Hydrology, Aquatic Vegetation and Fauna in SE (RECOVER)	RECOVER	Temp	USACE

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
		and survivorship (dry season?)						
UNC #25 – Wading Birds	Wading Birds	Hydroperiod Water Depth/Stage Recession Rates Numbers of foraging wading bird, wading bird nests, and nesting success (monitoring to include aerial and ground surveys conducted monthly during breeding season)	Wading bird colonies within WCA 3 and ENP	$0, Existing	SFWMD EDEN ENP	RECOVER	Perm	http://sofia.usgs.gov/eden; https://www.sfwmd.gov/science-data/dbhydro;
UNC ID#6 Seepage	Peak stage, hydroperiod duration Dry nesting days; Discontinuous hydroperiods; Occurrence of water level reversals	Stage and structure flow rates	WCA 3B; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA); and areas along the L-31N, L-30, and C-111 Canals	$0, Existing	SFWMD, USACE, and ENP	RECOVER	Perm	https://www.sfwmd.gov/science-data/dbhydro;
UNC #10 – NESRS and TS	Volumes delivered to S-332s (i.e. how much water	Flow rates and stage measured continuously at structures.	S-332s	$0, Existing	SFWMD	SFWMD	Perm	http://sofia.usgs.gov/eden;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
	focused on delivery to UTS actually reaches the marsh, measured each dry season).							https://www.sfwmd.gov/science-data/dbhydro;
UNC #12a – Tamiami Trail Flow Formula (TTFF) - General	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	All COP features that are included in the Tamiami Trail flow formula: S-333, S-12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP, Potentially also affects inflow structures to WCA 3: S-11 A through C,	$50,000	SFWMD and USACE	RECOVER	Perm	https://www.sfwmd.gov/science-data/dbhydro;

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
			S-8, and S-140.					
UNC #12b – Tamiami Trail Flow Formula (TTFF) and Drought	Seasonal timing of delivery of flows to NESRS	Daily averages of stage	S-333, S-12 C and D (outflow of WCA 3/inflow to Shark River Slough portion of ENP), as well as S-11 A-C, S-8, and S-140 (inflows into WCA 3).	Existing unless additional model runs are required	SFWMD	RECOVER	Perm	https://www.sfwmd.gov/science-data/dbhydro;
UNC #5b – FDOT Constraint on Tamiami Trail	Duration of stage above 8.3 ft. and 8.5 ft. in L-29; Roadway Stability measures	Stage in L-29; # cumulative or consecutive days in water year >8.3 ft.; # days stage > 8.5 ft.; Ground water, surface water and soil moisture levels taken at 4 transect locations; Monitoring is real time in 15 minute intervals.	WCA 3A; Northeast Shark River Slough (NESRS); 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal 4 transect	$0, Existing	ENP and USACE	ENP and USACE	Temp	https://respec.eagle.io/

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
			locations on Tamiami Trail road and subway.					
UNC #5b Continued	8.5 SMA flood mitigation performance relative to stage in L-29 and stages in NESRS; Hydroperiod performance in NESRS given seasonal rainfall	Stage in L-29; Stage in NESRS gages near and outside 8.5 SMA; Volume, depth, duration of seepage in 8.5 SMA; seasonal rainfall	Northeast Shark River Slough (NESRS), 8.5-Square-Mile Area (8.5 SMA), and areas along the L-31N Canal.	$0, Existing	ENP and USACE	ENP and USACE	Temp	https://www.sfwmd.gov/science-data/dbhydro;
UNC ID#7 – Saltwater Intrusion	"Keep in view" issue using existing monitoring, modeling, analyses, and reports by other entities involving: Coastal structure difficulties in maintaining target water levels or desired	"Keep in view" issue using existing monitoring, modeling, analyses, and reports.	L-31, C-111, southern Miami-Dade County and ENP	$0, Existing	NOAA, SFWMD, USACE plus various researchers	NOAA, SFWMD, USACE	Perm	https://www.sfwmd.gov/science-data/dbhydro; https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8724580

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
	discharge due to tide or surge; Sea level rise; Flood protection performance (groundwater monitoring); Flooding concern reports via telephone							SFWMD Operations managers RECOVER SSR and other agency and university reports and papers Interagency Modeling Center of CERP (SFWMD, USACE, DOI)
UNC #7 Continued	Agricultural Areas: Frequency and number of Days Groundwater < 24" from soil surface	Stage at interior structures; Groundwater wells: frequency of water levels above a set of belowground thresholds – 24", 18", 12", 6", and 0"; Reports from growers of flooding	S-176, S-177, S-18C, S-197, S-331, S-334, S-333 and S-335, plus for agricultural water level monitoring stations.	$0, Existing	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro; https://www.sfwmd.gov/science-data/modeling/wdat

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #16a – Nutrient Loading in Taylor Slough	TP concen-tration at structures	Flow, TP nutrient concentration in water flowing into park	ENP- Taylor Slough	$0, Existing	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro;
UNC #16a Continued	Periphyton TP content Biomass Composition	Periphyton in downstream marsh, biannual	ENP- Taylor Slough areas of concern (e.g. downstream of S-328, S-332 outflow for G-737, downstream of the southern stretch of L-31W canal)	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers
UNC #16a Continued	Cattail expansion	Local mapping of cattail in downstream marsh	Same as above	$0, Existing	ENP	ENP	Temp	Jed Redwine, SFNRC servers
UNC #16a Continued	Soil nutrient front	Soil nutrient content in downstream marsh, twice per year	Same as above	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers

Uncertainty Tracking ID#	Attribute or Indicator	Specific Property to be Measured and Frequency	Region or Specific Area (Locations to Monitor)	Est. Addi-tional Annual Cost	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (Temp/ Perm)	Project Manager / Data Storage Location
UNC #16b – Water Quality in NESRS	TP concentration at structures plus additional water quality measures	Flow, TP nutrient concentration, turbidity and other water quality measures in water flowing into park	ENP-Northeast Shark River Slough, at structures S-12D, S-333	$0, Existing	SFWMD	SFWMD	Perm	????, https://www.sfwmd.gov/science-data/dbhydro;
UNC #16b Continued	Periphyton TP content Biomass Composition	Periphyton in downstream marsh, bi-annual	ENP-Northeast Shark River Slough, downstream of S-12D, NESRS NCTransects	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers
UNC #16b Continued	Cattail expansion	Local mapping of cattail in downstream marsh	Same as above	$0, Existing	ENP	ENP	Temp	Jed Redwine, SFNRC servers
UNC #16b Continued	Soil nutrient front	Soil nutrient content in downstream marsh, annual	Same as above	$0, Existing	ENP	ENP	Temp	Dilip Shinde, https://www.sfwmd.gov/science-data/dbhydro; and SFNRC servers

C.3 Ecological Monitoring Plan

C.3.1 Ecological Performance Measure Monitoring and USFWS Biological Opinion Monitoring

The primary objectives of the COP Ecological Monitoring Plan (COP-EMP) are to identify the monitoring necessary to inform decision-makers, COP partner agencies, and the public on whether COP is achieving its environmental restoration related goals and objectives and whether it is meeting its regulatory compliance and legal constraints. The ecological monitoring and the monitoring identified in the COP Adaptive Management Plan (Section C.2) are not one-and-the-same, because the COP-EMP focuses on COP's success at meeting project objectives (per WRDA 2007 guidance) while the monitoring specified in the Adaptive Management Plan focuses on addressing project uncertainties (per WRDA 2007 guidance) whose resolution may improve the ability of COP to meet its objectives.

The COP - EMP contains the monitoring and associated costs required under the USFWS Biological Opinion (BO) and other agency permits that are needed to protect and conserve natural resources.

Development of the computer models to assess alternatives for COP resulted in the identification of an agreement upon key indicators of the ecosystem that are closely tied and responsive to changes in water management by COP. These indicators were used as the basis for creating performance monitoring recommendations. Thus, the indicators that were used to assess the success of different alternatives are the primary indicators that will inform the performance of COP when implemented in the real world. This will allow feedback not only on the performance of COP but also upon the strengths and weaknesses of the modeling process which in turn can inform future projects undertaken by CERP which are being assessed by the same or similar models. In addition to hydrological monitoring, two biological endpoints are included as performance measures including freshwater fish and wading bird colonies as these are key indicators of the overarching reasons for conducting restoration in the Everglades. However, changes in such biological endpoints will take longer to detect than the more immediate hydrological parameters. Given uncertainty about how long COP is expected to last (likely 10 years or less) these two biological endpoint indicators were deemed sufficient when combined with the recommendations of the USFWS BO for the Cape Sable seaside sparrow, Everglades snail kite, wood stork, and tree islands.

Table C.3-1 identifies the ecological monitoring to be conducted for the plan. All the monitoring gages and necessary data collection are already in existence through existing agencies or funded via CERP RECOVER. No additional monitoring needs were identified for the COP ecological performance monitoring. The primary added cost will be generating reports plus staff time participating in meetings associated with adaptive management. COP assumes this monitoring will proceed.

USFWS BO costs based on monitoring requirements identified in the 2020 COP BO and reflected in **Table C.3-2** have an estimated cost of $845,800 per year. Monitoring identified in the 2020 COP BO is consistent with that required by the prior 2016 ERTP BO and does not represent a cost increase over current monitoring efforts. The USACE currently funds surveys for the CSSS, Everglade snail kite, to include an apple snail monitoring program, and the wood stork. The 2020 COP BO requires continuation of these efforts and is currently funded by Aquatic Ecosystem Restoration (AER) O&M. Some of the monitoring is legally required by the 2020 COP BO.

As a portion of the monitoring described in this portion of the COP AMMP is already existing, the data management and QA/QC will remain as specified by the implementing entities. Multi-agency hydrological data is stored in the SFWMD database DBHYDRO (https://www.sfwmd.gov/science-data/dbhydro). Data collected by Everglades National Park is stored within the National Park Service database DATAForEVER (http://www-sfnrc.nps.gov/). The USACE will maintain contract deliverables associated with monitoring conducted in compliance with RECOVER contracts and the 2020 COP BO on a server as deliverables are submitted including but not limited to: (1) quarterly status reports; (2) draft and final annual reports; (3) and associated data Information associated with the contract deliverable and/or the above mentioned databases may be requested by other Federal and state agencies, including members of the public, and will be disseminated by the USACE along with the implementing agencies (ENP and the SFWMD) as appropriate

C.3.2 Baseline for Ecological Monitoring

If monitoring data is available and unless otherwise specified, the baseline for comparison of ecological monitoring and determination whether change has occurred will be the ten year period prior to COP implementation.

C.3.3 Management Options

The management options to be taken if a performance measure is not being met or a compliance or constraint threshold is approaching violation are generally the same across all indicators and include:

1. Determine what operational decision resulted in outcome and document.
2. Make changes in operations within the limited flexibility provided in the COP
3. Evaluate scope of issue such as:
    a. Whether a COP EIS covered or non-covered adaptive management uncertainty applies
    b. Whether adjustments in the Tamiami Trail Flow Formula or Water Control Plan are needed beyond those allowed for in COP and require additional NEPA permitting and review,
    c. Whether fixing the issue is beyond the scope of COP, i.e. an additional structure is needed such as a seepage barrier or additional water in the system is needed and speeding up implementation of CEPP projects would alleviate issue,
    d. Whether additional information is needed to assist effective operations such as an additional hydrologic gaging station in a critical location or a critical assumption must be tested using modeling.
    e. Whether an emergency deviation is needed together with a required EA or EIS.
4. Elevate issue to policy/principles of agencies who will decided if an EA or EIS is appropriate and whether action is necessary.

Table C.3-1. Ecological performance measures.

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-1. Inundation Duration in the Ridge and Slough Landscape	NESRS Central SRS; North WCA 3A; South WCA 3A; WCA 3B; Taylor Slough	1a, b, c, 2, 3, 4	What is duration of hydroperiod (by region) relative to baseline?	hydroperiod	3-5 years	water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden) or specific gages at NESRS: hydro gages NE-2, NE-1, G-3660, and J-47 Central SRS: hydro gages P-35, P-36 North WCA 3A: hydro gages 3A-NW, 3A-NE, 3A-11, 3A-2 South WCA 3A: hydro gages 3A-3, E4,3A-S, 3A-4, 3A-28 WCA 3B: Hydro gages 3B-71, Shark1, 3B-S1W1 Taylor Slough: P-37, CY-3, NP-46, NP-67, TSH, R-127, E-146

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-2. Amount and distribution of Flows into Everglades National Park	NESRS, west SRS	1a, b, c, 2, 3	What is the volume, timing, duration, and proportion of flow into east versus west Shark River Slough across Tamiami Trail relative to baseline?	Volume, Timing, Duration, and Distribution of flow south from Tamiami Trail	3-5 years	water stage elevation measured continuously at structures, use rating curves to estimate daily flow rates	Permanent installed gages near structures; Continuous measurements	West SRS - Tamiami Trail: (S-12A/B/C/D + S-343A/B East SRS - S-333 + S-356 - S-334) EDEN daily water surfaces (sofia.usgs.gov/eden)
PM-2 Continued	Taylor Slough	1a, b, c, 2, 3	What is the volume, timing, duration of flow at Taylor Slough Bridge relative to baseline?	volume, timing of flow	3-5 years	water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	TSB (Taylor Slough Bridge gage) EDEN daily water surfaces (sofia.usgs.gov/eden)
PM-3. Frequency and Duration of Dry Events in Shark River Slough	NESRS	1a, b, c, 3	Is the area, duration, and frequency of dry events (below ground surface) in northeast Shark River Slough changing compared with baseline?	Occurrence, area and duration of dry events	3-5 years	water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	NESRS: gages NESRS-2 EDEN daily water surfaces (sofia.usgs.gov/eden)

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-4. Soil Oxidation	NESRS Central SRS North WCA 3A Central WCA 3A South WCA 3A WCA 3B Taylor Slough	1a, b, c, 2, 3	What are the number of ft.*day's water level is below ground per year compared with baseline?	Drought Intensity	3-5 years	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed minimum level gages in marsh; Continuous measurements	NESRS: Minimum level gages NESRS-2, Marl Prairies: Minimum level gages G-3273, NP-201, G-620 Central SRS: Minimum level gages NP-33, NP-36, NP-38 North WCA 3A: Minimum level gages 3A-NW, 3A-NE, 3A-2,3A-3 Central WCA 3A: 3A-4 South WCA 3A: minimum level gages 3A-28 WCA 3B: minimum level gage 3B-SE Taylor Slough: NP-67

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-5. Slough Vegetation Suitability	NESRS Central SRS North WCA 3A South WCA 3A WCA 3B Taylor Slough	1a, b, c, 2, 3	In sloughs is the average wet season (June-October) water depths between 2-3 ft. and average dry season (November-May) water depths between approximately 1.5-2 ft.? Are there limited dry down events where water is <0.7 ft. above the ground surface? Are there near continuous 365 day calendar year hydroperiods with water above ground surface? The above measures are compared with baseline.	Wet season average depth (June-October); Dry season average depth (November - May); Hydroperio d; Drydown events	3-5 years	water stage elevation measured continuously; local marsh elevation measured in past decade	Vegetation mapping in NESRS, collected every 2-3 years. Vegetation monitoring in RECOVER using GRTS panels, each region visited each year, revisit every 5 years. Also, water level information from EDEN, continuously collected.	EDEN daily water surfaces (sofia.usgs.gov/eden) for Indicator Regions or specific gages in RECOVER indicator regions: 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, and 160 NESRS: NE-2, P-33 WCA 3A: 3A-NW, 3A-NE, 3A-11, 3A-3, EDEN-4 WCA 3A-South: 3A-SW, 3A-4, 3A-S, A-W2, 3A-28 WCA 3B: 3B-71 Taylor Slough: CP, TSH

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-6. Florida Bay Salinity	Craighead Basin, Taylor Slough, Eastern Panhandle Manatee Bay North FL Bay Central FL Bay West FL Bay	1a, b, c, 2, 3, 4	What is the volume, timing, and distribution of flows into Florida Bay in total and by region compared with baseline?	Timing, volume of flow / discharge	3-5 years	creek flow monitoring meters installed at 5 coastal creeks into Florida Bay	Permanent installed gages in marsh; Continuous measurements	Inland hydrology: TSB, P-37, CP, E-146, OL, TR, Coastal Discharge Station: ALC, MCC, TRE, ECR, MUD, TROUT, HCW
PM-6 Continued	Northeast FL Bay East FL Bay East-Central Florida Bay Central FL Bay South FL Bay West FL Bay	1a, b, c, 2, 3, 4	Are salinity regimes (25-75th percentiles) consistent with or show shifts to lower salinity regimes during dry season than baseline? Are high salinities reaching into the damaging salinity event range and what is the duration? Are low salinities reaching into	Dry Season Regime Overlap Wet Season Regime Overlap Dry Season High Salinity Wet Season High Salinity	3-5 years	June-Oct: Wet season salinity: Salinity Mean (June-Oct), Monthly mean, 25th percentile, 75th percentile, maximum, minimum Nov-May: Dry Season Salinity: Salinity Mean (June-Nov), Monthly mean, 25th percentile, 75th percentile, maximum, minimum	Permanent water quality monitoring stations	North FL Bay: LM, JB, TC, LS East FL Bay: BS, LB, MB, TP East-Central FL Bay: DK, BN Central FL Bay: BK, GB, TB, WB South FL Bay: BA, West FL Bay: MK, JK, LR, PK

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
			the damaging salinity event range in Manatee Bay and what is the duration?					
PM-7. Wood stork & Wading Birds	WCA 3A ENP	3	What is the status and trends in the number of wading bird colonies and distribution of wading bird colonies compared with baseline? What colonies are new? What colonies have disappeared?	Number and distribution of Wading Bird Colonies with any nests with 50 or more nests	3-10 years	Number and Locations of wading bird colonies	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Suitable habitat in WCA-3 and ENP

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-7 Continued	WCA 3A ENP	3	What are the status and trends in the number of nesting pairs detected by colony and across colonies for wood storks, ibis, great egrets, snowy egrets compared with baseline? What is the status and trend in the timing of wood stork nesting? What is the frequency of occurrence and location of White Ibis super colonies?	3 year running average of number of nesting pairs of key wading bird species; timing of initiation of wood stork nesting; super colonies	3-10 years	Maximum number of active nests detected by species	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Wading bird colonies in WCA-3 and ENP

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-8. Tree Islands	WCA 3A, WCA 3B, ENP	1a, b, c, 3, 5	What is the percent of mapped tree islands in each area that are inundated less than 10% period of record (POR) each year? What is the distribution of inundation of mapped tree islands?	Percent of tree islands inundated	5-10 years	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden)
PM-9. Flows to Eastern Panhandle and at S-197	Eastern Panhandle	1a, b, c, 2, 4	Are flows across the Eastern Panhandle towards Florida Bay increasing compared with the baseline?	C-111 spreader canal overland flow: volume and timing of overland flow as measured by the difference between flows at S-18C and S-197	3-5 years	Daily average water stage elevation measured continuously	Permanent installed gages at structures; Continuous measurements	S-18C, S-197

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-9 Continued	S-197	1a, c, 2, 4	Are number of days with 0 flow increased and number of days with >0 to 400 cfs, >400 to 800 cfs, and > 800 cfs decreased compared with baseline?	S-197 Daily Flow Distribution in cfs	3-5 years	Daily average water stage elevation measured continuously	Permanent installed gages in marsh; Continuous measurements	S-197 Gage
PM-10. High-Low Closure Criteria for Everglades Wildlife Management Areas	WCA 3A	1a, 3, 5	Are the frequency of occurrence and the number of days closed due to low water per water year the same or less than expected compared with baseline?	Days closed due to low water	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A
PM-10 Continued	WCA 3A	1a, 3, 5	Are the frequency of occurrence and the number of days closed due to high water per water year the same or less than expected under baseline?	Days closed due to high water	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-10 Continued	WCA 3A	1a, 3, 5	Is the Number of High Water Closures the same or less than expected under baseline?	Number of High Water Closures	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A
PM-10 Continued	WCA 3A	1a, 3, 5	Is the Number of Damaging High Water Closures (>60 days) the same or less than expected under baseline?	Number of Damaging High Water Closures (>60 days)	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A
PM-10 Continued	WCA 3A	1a, 3, 5	Is the Number of Low Water Closures the same or less than expected under baseline?	Number of Low Water Closures	3-5 years	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A
PM-11. Biscayne Bay Critical Flows	Biscayne Bay-North Central South	Constr aint	Is the flow volume, timing, and distribution maintained or changed compared with baseline?	Flows/Disch arge	3-5 years	total discharge	Based upon water stage elevation measured continuously	North: S-25 + S-25B + S-27 + S-28 + S-29 Central: G-93 + S-22 + S-123 South: S-20F + S-20G + S-21 + S-21A

Performance Measure	COP Region or Area	COP Objec-tive	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
PM-12. Freshwater Fish	ENP	1a, b, c, 2, 3	Are fish communities showing changes in abundance of small sized freshwater fish (less than 8 cm adult standard length; primarily livebearers and killifishes) similar to predicted by simulations?	Freshwater fish community composition	3-10 years	Fish species counts and fish lengths. Monitored annually.	Annual, 1 m^3 throw traps	long term prey base fish stratified random monitoring stations located throughout NESRS marsh

Table C.3-2. Estimated monitoring required for USFWS Biological Opinion.

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
BO1. Wood storks and Wading Birds	WCA 3A	Is the incidental take trigger met that water depths are not greater than 16 inches (41 cm) occur from March 1 through May 31 throughout WCA 3A as measured by the two gage average 3A-3 and 3A-4 (based upon a ground surface elevation of 8.4 feet NGVD) If not, has this trigger not been met for 2 consecutive years?	Number of days water depth exceeds 16 inches (March 1-May 31)	3-5 years	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	Gages 3A-3 and 3A-4
BO1 Continued	WCAs	What is the status and trends in the number of wood stork nests and locations of nests?	Wood stork and wading bird reproductive effort	3-5 years	Count and locations of wood stork nests	Monthly systematic aerial surveys January to June coupled with airboat surveys	Colonies in WCA 1, WCA 2, WCA 3
BO2. Cape Sable Seaside	Pop A, Ax	Is the hydrologic target met that the absolute area and	Absolute area and percent of subpopulation	3-5 years	Daily average water stage elevation	Permanent installed gages in marsh;	EDEN daily water surfaces (sofia.usgs.gov/eden).

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
Sparrow (CSSS)		percent of area within and adjacent to subpopulation A and Ax habitat with 90 consecutive dry nesting days between March 1 and July 15 is greater than 24,000 acres (40%) respectively?	A, Ax habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15		measured continuously; local marsh elevation measured in past decade	Continuous measurements	Also, specific gages at: NP-205, NP-TMC, NP-34
BO2 Continued	Pop's B-F	Is the hydrologic target met that at least 40 percent of designated CSSS Critical Habitat has 90 consecutive dry nesting days between March 1 and July 15?	Absolute area and percent of habitat for each of population B-F habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15	3-5 years	Daily average water stage elevation measured continuously water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also, specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3
BO2 Continued	Western Marl Prairie (Populations A, Ax)	Is the hydrologic target met that at least 24,000 acres of suitable habitat within and adjacent to CSSS	Area of Discontinuous Hydroperiod	3-5 years	Daily average water stage elevation measured continuously; local marsh	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at: NP-205, NP-TMC, NP-34

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
		subpopulation A must show a 4-year running average discontinuous hydroperiod range of 90-210 days, with no 2 consecutive years failing to meet this target?			elevation measured in past decade		
BO2 Continued	Pops B-F	Is the hydrologic target met that at least 40 percent of each designated CSSS critical habitat unit must show a 4-year running average discontinuous hydroperiod range of 90-210 days, with no 2 consecutive years failing to meet this target.	Area of Discontinuous Hydroperiod	3-5 years	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3
BO2 Continued	Populations A-F	What are the status and trends in relative CSSS abundance detected per	CSSS Abundance	4-10 years	Relative Abundance of Singing Males detected within	7 Minute Point Counts of Singing Males; Annual (April - May)	Sampling design is a systematic design of permanent locations, spaced 1 km apart in each CSSS population A-

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
		population and across populations compared baseline?			each population		F habitat. Total number of point counts is approximately 500 / year.
BO2. Continued.	ENP	How is vegetation changing within CSSS population in response to hydrologic change?	Relative proportion and absolute cover of species indicating different hydroperiods and optimal or sub-optimal CSSS habitat	3-5 years	Species cover, community structure	Vegetation Transects	CSSS subpopulations A-F in ENP
BO3. Everglades Snail Kite	WCA 3A	Is the incidental take trigger met that water depths remain at or below 9.2 ft. NGVD at gage 3AS3W1 April 15 - May 31? If not, has this trigger not been met for 2 consecutive years?	Dry season high water frequency	3-5 years	Gage 3AS3W1 High Water Peak Stage (feet, NGVD); Number of Days Gage 3AS3W1 > 9.2 feet, NGVD (April 15-May 31)	Permanent installed gages Continuous measurements	Gage 3AS3W1
BO3 Continued	WCA 3A	Is the constraint met that water depths >10.5 ft. at gage 3AS3W1 are less than 60 days between June 1 -	Wet season high water frequency	3-5 years	Gage 3AS3W1 High Water Peak Stage (feet, NGVD); Number of Days Gage	Permanent installed gages Continuous measurements	Gage 3AS3W1

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
		December 31? If not, has this trigger not been met for 2 consecutive years?			3AS3W1 > 10.5 feet, NGVD (June 1-December 31)		
BO3 Continued	WCA 3A	Is the incidental take trigger met that the stage difference should not recede by more than 1.7 ft. between Jan 1 - May 31 (or onset of wet season) as measured at gage(s) closest to kite nesting, as determined by the Service?	Recession / Dry Season Amplitude	3-5 years	Daily average water stage elevation measured continuously at gage(s) closest to kite nesting, as determined by the Service.	Permanent installed gages Continuous measurements	Gages closest to kite nesting as determined by the USFWS (e.g., 3A-S, 3A-28, 3A-4)
BO3 Continued	WCA 3A	What are the status and trends in number of Everglades Snail Kite nests counted and the proportion of successful nests?	Snail Kite nest counts, proportion of successful nests	4-10 years	Count and locations of snail kite nests, Number successful and unsuccessful nests in fledging	Multiple consecutive surveys throughout designated wetlands from March 1st to June 30, 2-3 week intervals, each year.	Initial nesting surveys throughout WCA 3A, 3B northern ENP

Compliance Measure	COP Region or Area	Monitoring Question	Attribute or Indicator of interest	Timeframe to Detect Change of Attributes	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor
BO3 Continued	WCA 3A	What are the status and trends in in apple snail density relative to hydrological changes?	Apple snail density	1-2 years	Apple snail surveys February through June	Apple snail surveys February through June	WCA 3A

C.3.4 Ecological Monitoring Plan Additional Cost Estimate and Links to Existing Monitoring Programs

Monitoring identified in the ecological monitoring plan for the COP-ENP is already existing prior to the beginning of COP and is assumed to continue. Thus, no additional costs are assumed due to ecological performance monitoring. USFWS BO costs based on monitoring requirements identified in the 2020 COP BO and reflected in **Table C.3-2** have an estimated cost of $845,800 per year. Monitoring identified in the 2020 COP BO is consistent with that required by the prior 2016 ERTP BO and does not represent a cost increase over current monitoring efforts. The USACE currently funds surveys for the CSSS, Everglade snail kite, to include an apple snail monitoring program, and the wood stork. The 2020 COP BO requires continuation of these efforts and is currently funded by Aquatic Ecosystem Restoration (AER) O&M. Some of the monitoring is legally required by the 2020 COP BO. Links to existing monitoring programs are provided in **Table C.3-3.**

Table C.3-3. Ecological Performance Measure (PM) and estimated USFWS Biological Opinion (BO) linked to existing monitoring.

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-1. Inundation Duration in the Ridge and Slough Landscape	Hydro-period	Water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden) or specific gages at NESRS: hydro gages NE2, NE1, G3660, and J47 Central SRS: hydro gages P35, P36 North WCA 3A: hydro gages 3A-NW, 3A-NE, 3A-11, 3A-2 South WCA 3A: hydro gages 3A-3, E4,3A-S, 3A-4, 3A-28 WCA 3B: Hydro gages 3B-71, Shark1, 3B-S1W1 Taylor Slough: P37, CY3, NP 46, NP-67, TSH, R127, E146	USGS, ENP, SFWMD	RECOVER, SFWMD, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-2. Amount and distribution of Flows into Everglades National Park	Volume, Timing, Duration, and Distribution of flow south from Tamiami Trail	Water stage elevation measured continuously at structures, use rating curves to estimate daily flow rates	Permanent installed gages near structures; Continuous measurements	West SRS - Tamiami Trail: (S-12A/B/C/D + S-343A/B East SRS - S-333 + S-356 - S-334) EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP, SFWMD	RECOVER, SFWMD, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-2 Continued	Volume, timing of flow	Water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	TSB (Taylor Slough Bridge gage) EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-3. Frequency and Duration of Dry Events in Shark River Slough	Occurrence, area and duration of dry events	Water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	NESRS: gages NESRS-2 EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP,	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-4. Soil Oxidation	Drought Intensity	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed minimum level gages in marsh; Continuous measurements	NESRS: Minimum level gages NESRS-2, Marl Prairies: Minimum level gages G-3273, NP-201, G-620 Central SRS: Minimum level gauges NP-33, NP-36, NP-38 North WCA 3A: Minimum level gages 3A-NW, 3A-NE, 3A-2,3A-3 Central WCA 3A: 3A-4 South WCA 3A: minimum level gages 3A-28 WCA 3B: minimum level gage 3B-SE Taylor Slough: NP-67	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-5. Slough Vegetation Suitability	Wet season average depth (June-October); Dry season average depth (November - May); Hydroperio d; Drydown events	Water stage elevation measured continuously; local marsh elevation measured in past decade	Vegetation mapping in NESRS, collected every 2-3 years. Vegetation monitoring in RECOVER using GRTS panels, each region visited each year, revisit every 5 years. Also, water level information from EDEN, continuously collected.	EDEN daily water surfaces (sofia.usgs.gov/eden) for Indicator Regions or specific gages in RECOVER indicator regions: 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, and 160 NESRS: NE-2, P-33 WCA 3A: 3A-NW, 3A-NE, 3A-11, 3A-3, EDEN-4 WCA 3A-South: 3A-SW, 3A-4, 3A-S, A-W2, 3A-28 WCA 3B: 3B-71 Taylor Slough: CP, TSH	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-6. Florida Bay Salinity	Timing, volume of flow / discharge	Water stage elevation measured continuously	Permanent installed gages in marsh; Continuous measurements	Inland hydrology: TSB, P37, CP, E146, OL, TR, Coastal Discharge Station: ALC, MCC, TRE, ECR, MUD, TROUT, HCW	USGS, ENP, SFWMD	RECOVER, SFWMD, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-6 Continued	Dry Season Regime Overlap Wet Season Regime Overlap Dry Season High Salinity Wet Season High Salinity	June-Oct: Wet season salinity: Salinity Mean (June-Oct), Monthly mean, 25th percentile, 75th percentile, maximum, minimum Nov-May: Dry Season Salinity: Salinity Mean (June-Nov), Monthly mean, 25th percentile, 75th percentile, maximum, minimum	Permanent water quality monitoring stations	North FL Bay: LM, JB, TC, LS East FL Bay: BS, LB, MB, TP East-Central FL Bay: DK, BN Central FL Bay: BK, GB, TB, WB South FL Bay: BA, West FL Bay: MK, JK, LR, PK	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro;
PM-7. Wood stork & Wading Birds	Number and distribution of Wading Bird Colonies with any nests with 50 or more nests	Number and Locations of wading bird colonies	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Suitable habitat in WCA 3 and ENP	ENP, SFWMD, and FAU	RECOVER, and ENP	Perm	SFWMD server, published in Wading bird report;

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-7 Continued	3 year running average of number of nesting pairs of key wading bird species; timing of initiation of wood stork nesting; super-colonies	Maximum number of active nests detected by species	Annual region wide survey to detect colonies, Monthly aerial surveys of nesting colonies during breeding season; summarized in annual Wading bird report	Wading bird colonies in WCA 3 and ENP	ENP, SFWMD, and FAU	RECOVER, and ENP	Perm	SFWMD server, published in Wading bird report;
PM-8. Tree Islands	Percent of tree islands inundated	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden)	USGS, ENP, SFWMD	RECOVER, and ENP	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro, and sofia.usgs.gov/eden
PM-9. Flows to Eastern Panhandle and at S-197	C-111 spreader canal overland flow: volume and timing of overland	Daily average water stage elevation measured continuously	Permanent installed gages at structures; Continuous measurements	S-18C, S-197	ENP and SFWMD	ENP, SFWMD, and RECOVER	Perm	DataForever and DBHYDRO https://www.sfwmd.gov/science-data/dbhydro,

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
	flow as measured by the difference between flows at S-18C and S-197							
PM-9 Continued	S-197 Daily Flow Distribution in cfs	Daily average water stage elevation measured continuously	Permanent installed gages in marsh; Continuous measurements	S-197 Gage	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
PM-10. High-Low Closure Criteria for Everglades Wildlife Management Areas	Days closed due to low water	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-10 Continued	Days closed due to high water	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-10 Continued	Number of High Water Closures	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-10 Continued	Number of Damaging High Water Closures (>60 days)	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-10 Continued	Number of Low Water Closures	Days closed; Daily average water stage elevation measured continuously	Daily closure determination; Based upon water stage elevation measured continuously	WCA 3A	FFWCC	FFWCC	Perm	Announced publicly, summary provided by FFWCC
PM-11. Biscayne Bay Critical Flows	Flows/Discharge	Total discharge	Based upon water stage elevation measured continuously	North: S-25 + S-25B + S-27 + S-28 + S-29 Central: G-93 + S-22 + S-123 South: S-20F + S-20G + S-21 + S-21A	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
PM-12. Freshwater Fish	Freshwater fish community composition	Fish species counts and fish lengths. Monitored annually.	Annual, 1 m^3 throw traps	Long term prey base fish stratified random monitoring stations located throughout NESRS marsh	USACE and ENP	ENP, CERP-RECOVER	Temp	USACE
BO1. Wood storks	Number of days water depth exceeds 16 inches (March 1-May 31)	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	Gages 3A-3 and 3A-4	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
BO1 Wood Stork Continued	Wood stork reproductive effort	Count and locations of wood stork nests	Monthly systematic aerial surveys January to June coupled with airboat surveys	WCA 1, WCA 2, and WCA 3	USACE	USACE - Requirement of 2020 COP BO.	Perm	USACE
BO2. Cape Sable Seaside Sparrow (CSSS)	Absolute area and percent of subpopulation A, Ax habitat (marl prairie) with 90 consecutive dry days between	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also, specific gages at: NP-205, NP-TMC, NP-34	USACE and ENP	USACE and ENP	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
	March 1 and July 15							
BO2 Continued	Absolute area and percent of habitat for each of population B-F habitat (marl prairie) with 90 consecutive dry days between March 1 and July 15	Daily average water stage elevation measured continuously water stage elevation measured continuously, local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). Also specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3	USACE and USGS	USACE	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/
BO2 Continued	Area of Discontinuous Hydro-period	Daily average water stage elevation measured continuously; local marsh elevation measured in past decade	Permanent installed gages in marsh; Continuous measurements	EDEN daily water surfaces (sofia.usgs.gov/eden). or specific gages at: NP-205, NP-TMC, NP-34	USACE and USGS	USACE	Perm	https://www.sfwmd.gov/science-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/
BO2 Continued	Area of Discontinuo	Daily average water stage	Permanent installed gages	EDEN daily water surfaces	USACE and USGS	USGS	Perm	https://www.sfwmd.gov/scie

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
	us Hydro-period	elevation measured continuously; local marsh elevation measured in past decade	in marsh; Continuous measurements	(sofia.usgs.gov/eden). or specific gages at: Pop B: NP-46 Pop C: NP-N10, NTS-1, R3110 Pop D: SWEVER4 POP E: NP-206, NP-A13, NP-CR3				nce-data/dbhydro, Sparrow Viewer: https://sofia.usgs.gov/eden/csss/
BO2 Continued	CSSS Abundance	Relative Abundance of Singing Males detected within each population	7 Minute Point Counts of Singing Males; Annual (April - May)	Sampling design is a systematic design of permanent locations, spaced 1 km apart in each CSSS population A-F habitat. Total number of point counts is approximately 500 / year.	USACE and ENP	USACE and ENP - Requirement of 2020 COP BO.	Temp	USACE and ENP
BO2 Continued	CSSS Vegetation	Evaluate CSS habitat conditions in response to hydrologic change	Species cover, community structure	Transects in CSSS subpopulations A-F	USACE	USACE - Requirement of 2020 COP BO.	Perm	USACE
BO3. Everglades Snail Kite	Dry season high water frequency	Gage 3AS3W1 High Water Peak Stage (feet, NGVD); Number of Days Gage 3AS3W1 > 9.2 feet, NGVD (April 15-May 31)	Permanent installed gages Continuous measurements	Gage 3AS3W1	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
BO3 Continued	Wet season high water frequency	Gage 3AS3W1 High Water Peak Stage (feet, NGVD); Number of Days Gage 3AS3W1 > 10.5 feet, NGVD (June 1-December 31)	Permanent installed gages Continuous measurements	Gage 3AS3W1	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
BO3 Continued	Recession / Dry Season Amplitude	Daily average water stage elevation measured continuously at gage(s) closest to kite nesting, as determined by the Service.	Permanent installed gages Continuous measurements	Gages closest to kite nesting as determined by the USFWS (e.g., 3A-S, 3A-28, 3A-4)	SFWMD	SFWMD	Perm	https://www.sfwmd.gov/science-data/dbhydro,
BO3 Continued	Snail Kite nest counts, proportion of successful nests	Count and locations of snail kite nests, Number successful and unsuccessful nests in fledging,	Multiple consecutive surveys throughout designated wetlands from March 1st to June 30, 2-3 week intervals, each year.	Initial nesting surveys throughout WCA 3A, 3B northern ENP	USACE	USACE – requirement of 2020 COP BO	Perm	USACE

Performance Measure or Biological Opinion Number	Attribute or Indicator of interest	Specific Property to be Measured and Frequency (or targeted study)	Monitoring Methodology & Frequency	Specific Locations to Monitor	Entity Imple-menting Existing Monitoring	Entity Funding Existing Monitoring	Time-frame (temp/ perm)	Project Manager / Data Storage Location
BO3 Continued.	Apple Snail (as prey for Everglades Snail Kite)	Apple snail density and egg cluster production	Apple snail surveys February through June	WCA 3A	USACE	USACE – requirement of 2020 COP BO	Perm	USACE

C.4 Water Quality and Hydrology Monitoring Plan

C.4.1 Summary

The water quality and hydrology monitoring plan presented here for the Combined Operational Plan (COP) was developed by an interagency team from SFWMD, USACE, DOI, and FDEP in support of the MWD Incremental field tests from 2015 through 2020. The COP water quality and hydrology monitoring plan is principally a continuation of the plan that was put forward in the latest Increment 2 field test, including continuation of monitoring requirements along the Tamiami Trail Roadway, the 8.5 SMA interior flood mitigation area, and within the C-111 South Dade Northern and Southern Detention Areas. The operation of the system according to the requirements of the COP Water Control Plan will depend on the future hydro-meteorological conditions and water availability in the project area. Due to the several temporary water management deviations coincident with the field test increments, there have not been long enough time periods to operate the system in accordance with the prescribed field test operational criteria to observe the long term effects of the project components. Hydrologic response uncertainties which were unable to be comprehensively analyzed during the field tests will be carried forward through the continuation of the monitoring plan and/or through the COP Adaptive Management Plan.

The proposed water quality monitoring plan will provide data to: 1) Track compliance with Settlement Agreement monitoring requirements, 2) Monitor potential impacts to the NESRS and ENP SRS (includes monitoring of S-333 and S12's and other applicable structures), 3) Track S-356 discharges to ensure WQ continues to be representative of seepage from WCA 3A and ENP, and 4) Perform WQ monitoring required by C-111 SD EO 9.

Source attribution and characterization are needed to guide water quality management efforts in the future under COP implementation. The proposed monitoring plans for surface water and groundwater hydrology, which have been generally remained consistent throughout the MWD Incremental field tests and proposals for the COP, will provide data to: (1) assess the zone of influence of the S-356 pump station under a range of pumping scenarios; (2) develop water budgets of the L-31N Canal (north and south of the S-331 pump station) and the C-111 Canal (between S 176 and S-177) under representative operational scenarios; (3) assess performance of the 8.5 SMA project components, including S-357 and S-357N (construction completed in February 2018), to maintain the surface water and groundwater levels within the project areas of the 8.5 SMA, between the L 357W Levee and the L-31N Levee at the same levels as existed prior to the implementation of any MWD Project components; (4) demonstrate S-356's ability to manage additional seepage caused by increased MWD flows into NESRS under a range of hydrologic conditions; (5) quantify the net effects within the L-31N Basin (south of S-331 and north of S-176) and the C-111 Basin (south of S-176) from the of reduced WCA 3A regulatory discharges to NESRS combined with increased flood control releases from S-331/S-173 and increased seepage to the L-31N Canal south of S-331, including the capability of the S-332B/C/D pump stations and the C-111 South Detention Area to manage potential additional flows into the L-31N Canal under certain operational conditions; and (6) incorporate the ongoing SFWMD operations, monitoring, and performance assessments conducted as part of the CERP C-111 Spreader Canal Western Project. Items (5) and (6) are addressed within Section C.5 of the monitoring plan. The analysis of the collected data and their interpretation is contingent upon the existence of hydro-meteorological conditions that are relevant to the intended flow levels and flow rates in the project site. Since the inception of the incremental tests, the unusually wet conditions in South Florida did not allow the S-356 stations to be operated for extended periods of time until completion of the C-111 South Dade project features in August-September 2018; S-356 operations continued until the onset of the dry season in late October 2018, and then re-started with the start of the

2019 wet season in mid-June 2019. In developing the original Increment 1 field test monitoring plan (Appendix C of the May 2015 EA), which provided the monitoring plan foundation throughout the incremental field test period from 2015-2020, the interagency teams reviewed the ongoing monitoring efforts within the study area as of October 2014 to determine what existing and additional monitoring would likely be required to fully evaluate the hydrologic and water quality impacts associated with relaxing the G-3273 operations constraint and raising the L-29 Canal maximum operating limit. Additional monitoring requirements were incorporated based on the operational strategies for Increment 1.1 and 1.2 and Increment 2, which included consideration of new information and an expanded monitoring network.

Six additional monitoring wells were identified in the revised monitoring plan with Increment 2: 2 additional wells within the expanded C-111 South Dade Northern Detention Area, 2 additional wells in the Southern Detention Area, and 2 additional wells within the 8.5 SMA interior. While raising the maximum operating limit for the L-29 Canal, the L-29 Canal will be operated to ensure the stability and safety of the Tamiami Trail (U.S. 41) Highway between S-333 and S-334, in accordance with the September 25, 2008 Relocation Agreement, the Tamiami Trail Modifications Contract between the Government and the Florida Department of Transportation (FDOT) and any subsequent amendments executed to support implementation of the Proposed Action. To address FDOT concerns with raising L-29 operating stages and potential effects on the road base, the Increment 2 monitoring plan was expanded to include six additional locations along Tamiami Trail between S-333 and S-334 with real-time monitoring of groundwater levels and soil moisture conditions. Since the L-29 Canal maximum operating stage limit was raised up to 8.5 feet NGVD in September 2018, the Increment 2 hydrologic monitoring plan components have demonstrated suitability to meet the monitoring needs of Increment 2 and the future COP. As such, this plan incorporates the best information available; however, as the COP operations are implemented, this plan may require revision.

Late in the development of the original Increment 1 monitoring plan, the formulation efforts recommended consideration of a change to the operational criteria of the S-197 structure. This change precipitated the need to amend the water quality and hydrology monitoring plan to incorporate additional monitoring south of the S-331 structure. Rather than re-write the monitoring plan, the additional monitoring required due to changed operations at S-197 are detailed in Section C.5 of this plan. Since this monitoring plan construct has supported nearly 5 years of monitoring during the incremental field test, a similar monitoring plan is proposed for the COP.

While the near record-high WCA 3A stages during February-March 2016 and the wet season following June 2017 created many water management challenges, temporary emergency deviations executed in response to these conditions provided valuable information on the responses within ENP and the SDCS system to raising of the L-29 Canal, including evaluation of operational limitations of the 8.5 Square Mile Area (SMA) flood mitigation project prior to completion of the MWD and C-111 South Dade projects. Based on information gained during implementation of the 2016 Emergency Deviation and the subsequent expanded recovery period, in addition to the inclusion of additional operational flexibility within the Operational Strategy for Increment 1.2 allowing operation of the L-29 Canal to a maximum operating limit of 7.8 feet NGVD, an expanded hydrologic monitoring plan for the 8.5 SMA was previously established to complement the revised objectives of the Increment 1.1 and 1.2 Operational Strategy. The supplemental monitoring requirements for the 8.5 SMA are detailed in Section C.6.

C.4.2 Glossary/Acronyms

ADaPT – Automated Data Processing Tool software, for quality control analysis of analytical data

Assessment – to interpret responses in natural and/or human systems based on data acquired though monitoring activities.

ADVM – Acoustic Doppler Velocity Meter, for measurement of surface water flow velocity.

BWRF – Biweekly if Recorded Flow – Sampling frequency to collect sample on bi-weekly basis if flow has occurred in the past week.

Constraint – a condition that is to be minimized or avoided in the plan formulation and selection process to ensure that the project component does not result in undesirable changes in the project area or downstream waters. Example: The component shall not cause or contribute to a violation of state water quality standards.

DOI – Department of Interior

Data Qualifiers: a code that is added to data to serve as an indication of the quality of the data.

Data Quality Objectives (DQO) – a process that identifies the intended use of the data including the types of decisions that will be made based on the results. The analytes of interest, corresponding action levels, sampling design and quality control measures are also identified as well as data repositories into which the data will be entered, the mechanisms used to ensure that the data are accurately entered into a database and to verify that the data in the database are correct, and the level of data quality acceptable for this project.

EB – Equipment Blank, collected to monitor on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

EM – Engineering Manual: USACE documents that provide guidance on various aspects of project design and implementation.

ENP – Everglades National Park

FB - Field Blank, collected to monitor on-site sampling environment, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

FCEB – Field Cleaned Equipment Blank, collected to monitor on-site sampling environment, sampling equipment decontamination in the field, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

FDACS – Florida Department of Agriculture and Consumer Services.

FDEP – Florida Department of Environmental Protection.

FWM – Flow Weighted Mean: Average concentration computed by multiplying individual concentration data points by corresponding flow data and dividing by the total flow.

Local Sponsor – the agency responsible for matching the Federal funding available for a project. The South Florida Water Management District (SFWMD) is the local sponsor for the majority of CERP projects.

LTL – Long Term Limit: 1991 Settlement Agreement compliance concentration limit for flows into Everglades National Park at Northeast Shark River Slough.

Matrix – refers to the material from which the sample is taken, such as surface water, groundwater, pore water, sediment, soil or air.

MWD – Modified Waters Delivery project, also known as the Project.

Monitoring – all of the activities required to acquire, process, store, retrieve and analyze data used to assess the status of water resources. It includes data collection, data analysis, data validation, and data management.

Monitoring Data – data that are collected for the purpose of determining the effects of CERP projects at a given location.

Monitoring Plan – the plan to acquire additional meteorological, hydrologic, hydraulic, water quality or ecological data. It includes considerations of sampling location, frequency, method, parameters and duration. It is based on the elements identified in the development of data quality objectives for the project.

NESRS – Northeast Shark River Slough, in Everglades National Park.

Objective – a measurable element of the goal(s) of a project or plan. Project objectives and constraints are identified in the Project Management Plan (PMP).

Permit Requirement – certain analytes are sampled, tested and results reported to state and/or federal agencies as a condition of a permit to build or operate a project.

PLMP – Project-Level Monitoring Plan.

Project-level – A project has a defined scope, quality objectives, schedule, and cost. Project-level activities refer to those that are within the scope of a specific project.

QA – Quality Assurance: the system of management activities and quality control procedures implemented to produce and evaluate data according to pre-established data quality objectives.

QAOT – Quality Assurance Oversight Team, comprised of representatives from USACE, SFWMD, FDEP, and USEPA, ultimately responsible oversight of the implementation of the quality system for CERP.

QASR – Quality Assurance System Requirements, the CERP Quality manual that establishes minimum criteria for environmental data quality.

QC – Quality Control: The system of measurement activities used to document and control the quality of data so that it meets the needs of data users as specified by pre-established data quality objectives.

RACU – Remote Acquisition and Command Unit. A device used for data acquisition and remote system control.

RECOVER – REstoration COordination and VERification (RECOVER) is a process that evaluates and assesses CERP performance by linking scientific and technical information throughout the planning and implementation period to ensure that a system-wide perspective is maintained throughout the restoration program.

RECOVER AT - The RECOVER Assessment Team is a standing, interagency, interdisciplinary team of scientists and resource specialists who are responsible for achieving the five primary tasks of RECOVER: 1) create, refine and provide documentation for a set of conceptual ecological models for the total system and a set of attribute-based biological performance measures for the Comprehensive Plan; 3) design and review the system-wide monitoring and data management program needed to support the Comprehensive Plan; 4) use the information coming from the system-wide monitoring program to assess actual system responses as components of the Comprehensive Plan are implemented and produce an annual assessment report describing and interpreting these responses; and 5) coordinate all scientific peer reviews of

RECOVER documents.

RS – Replicate samples defined as two additional samples collected in addition to the routine sample.

Sampling Frequency – how often samples are collected.

Sampling Methods – the methods used to collect samples in the field. The methods should be standard methods, methods based on a standard operating procedure, or a method that has been approved by the participating agencies.

SDCS – South Dade Conveyance System.

SFWMD – South Florida Water Management District

TOC – Technical Oversight Committee: Coordinates the administration of compliance verification of the 1991 Settlement Agreement.

TP – Total Phosphorus

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

USGS – United States Geological Survey

WBS – Work Breakdown Structure: The WBS specifies a hierarchy of tasks and activities necessary to fulfill the objectives of the project. The WBS is structured in levels of work detail, beginning with the deliverable itself, and is then separated into identifiable work elements.

WCA – Water Conservation Area

WRF – Weekly if Recorded Flow: Sampling frequency to collect a sample if flow has occurred in the past week.

Zone of Influence – the area over which a project alters or impacts the environment.

Additional terms and definitions for CERP can be found in CGM 13 – Acronyms and Glossary of Terms (http://www.cerpzone.org/documents/cgm/cgm_013.03.pdf)

C.4.3 Introduction

This document serves as a reference for monitoring water quality and hydrology during the COP. Monitoring will be conducted to evaluate the long-term COP performance with regard to operational constraints, restoration goals and regulatory requirements. Specifically, the COP Water Control Plan makes permanent the previous field test operations which incrementally redistributed flows from WCA 3A into Everglades National Park (ENP) as construction activities progressed and culminated in raising of the L-29 Canal up to the 8.5 feet NGVD maximum operating limit envisioned following completion of the MWD Tamiami Trail roadway modifications. The redistribution of flows into ENP and higher stages should contribute to the restoration of the original hydrologic patterns within the Everglades freshwater wetlands, particularly in Northeast Shark River Slough (NESRS). The COP area of influence is primarily in the area of WCA 3A, ENP, and the L-29 and L-31N Canals.

The incremental approach to the development of the COP was projected to 1) allow interim benefits towards restoration of the natural systems, 2) reduce uncertainty of operating the components of the MWD and C-111 South Dade Projects, and 3) provide information to complete the COP efficiently. The increments included conducting field tests for existing structures, developing operating criteria for existing and planned structures, and ultimately updating the 2012 Water Conservation Areas, ENP, and ENP to South Dade Conveyance System (SDCS) Water Control Plan (hereafter referred to as the 2012 Water Control Plan) (USACE 2012c). Previous regional operational planning efforts—Interim Operational Plan (IOP), Combined Structural and Operational Plan (CSOP) and Everglades Restoration Transition Plan (ERTP)—have also recommended field testing S-356 to aid in determining real-time operational protocols, despite significant hydrologic modeling efforts conducted under each of these projects.

The proposed water quality monitoring plan will provide data to: (1) assess achievement of phosphorus target for S-356 discharges, (2) distinguish water sources for S-356 if possible, (3) quantify water quality interactions associated with the test through detailed analysis of chemical and physical parameters, (4) characterize water quality of the S-328 discharges and perform WQ monitoring required by C-111 SD EO #9 and Permits for the S-328. Source attribution and characterization is needed to guide water quality management efforts in the future. Investigation of historic data collected for Na: Ca ratios at S-335, S-356, and G-211 with limited data showed that there can be distinctions in ratios at these structures. Monitoring Na, Ca and other ions, as well as specific conductance at the boundaries of the test area (S-335, S-336 [replaced with L30MILE0 as surrogate], G-211 [replaced with L-31NMILE5 as surrogate], and S-356) should provide additional data for source assessments. Determining sources could prove essential for developing management strategies should achievement of phosphorus targets prove problematic. However, the ability to determine various sources can be very difficult via either ratios or various forms of mass balances. The monitoring plan is designed to provide enough data and supporting information to allow a reasonable chance for successful estimates and future planning.

Quantifying seepage from ENP requires the development of a water budget and chemical mass balance. For chemical mass balance to be successful in quantification of seepage, noticeable differences in the concentration from various sources are needed in the observed values. Concentrations for a full suite of ions (Na, Ca, Mg, K, Cl, SO_4, and Total Alkalinity) along with nutrients and specific conductance at selected surface water and groundwater monitoring locations will be used for these purposes. For water budgets and chemical mass balances, the first five miles of L-31N will be divided into five sections with mile markers serving as boundaries. Each section will be treated as an individual mixing cell with inflow and outflow for the north and south boundaries represented by the flows measured at the mile markers. Surface water flow rates will be used to estimate inputs and outputs to each cell for water and chemical

budgets if possible. Groundwater volumes will be estimated indirectly from the budget. The water budget will be refined by using the water quality data and chemical mass balances. A similar approach to water budget development will be applied to the L-29 canal, between the S-356 pump station westward to the eastern terminus of the Tamiami Trail Bridge, and in the L-30 Canal between the S-335 and S-356 structures. After the initial testing period, detailed data evaluation attempted to fulfill the three basic objectives (water budget, mass balance, seepage quantification) and also provide information to modify the monitoring plan for future, longer-term operational periods. Data analysis efforts to develop detailed water budgets were unsuccessful during the MWD incremental field test due to operational variability, but these efforts may be further pursued under the COP AMMP. The primary water quality concern of pulling undesirable high phosphorus water into S-356 with subsequent discharge into ENP was determined to not occur during the very extensive pumping operations conducted under the testing leading up the COP. While determining the exact source composition of S-356 would have provided interesting information, once it was determined that S-356 was not pulling undesirably high nutrient laden water from the urban areas and the deeper aquifer, this objective became essentially non-essential.

C.4.4 Project Description

The MWD project and the associated COP is primarily intended to increase water deliveries from WCA 3A to ENP through NESRS for the benefit of natural resources. The Increment 2 field test, which started in February 2017 and extends through COP implementation, continued the process of small incremental steps toward achieving that goal by reducing the number of times S-333 discharges are limited by the existing G-3273 stage constraint of 6.8 feet NGVD. G-3273 lies within eastern ENP, directly west of the 8.5 Square Mile Area (8.5 SMA). The G-3273 constraint of 6.8 feet NGVD was originally established as a flood protection measure. Prior to the MWD incremental field tests, a stage of 6.8 feet NGVD at this gage had been used since 1985 as a trigger to cease S-333 discharges from flowing south into NESRS as a protective measure for residential areas to the east, particularly the 8.5 SMA. During the incremental field tests, additional seepage was expected to augment flows in the L-31N canal. To ensure that the existing level of flood protection is maintained in the L-31N basin, the S-356 pump station is operated to return seepage to the L-29 canal where it can flow south into NESRS. To ensure that the existing level of flood mitigation is maintained in the 8.5 SMA, S-357, S-331, and S-357N are operated to maintain water control levels as specified within the field test Operational Strategy.

Water deliveries to ENP and NESRS are subject to the water quality limit for total phosphorus (TP) defined in Appendix A of the 1991 Settlement Agreement. Appendix A compliance is currently assessed by comparing the Long Term Limit (LTL) against the 12-month flow-weighted mean (FWM) TP concentration in parts-per-billion (ppb). The LTL is calculated using the measured total annual flows from the S-12A, S-12B, S-12C, S-12D, and S-333 structures that historically distributed flows from WCA 3A into Shark River Slough. The 12 month FWM is currently computed using the annual flows of the S-12's, S-333 and S-355 A and S-355B. The S-334 flows/loading are subtracted out of the 12 month FWM. An additional method to compute the 12 month FWM, incorporating the S-356 flows into the LTL and the 12 month FWM is currently being evaluated as a potential modification to the computation of the 12 month FWM. The LTL equation from Appendix A has an inverse relationship with flow: as flow into Shark River Slough increases, the LTL gradually falls until reaching 7.6 ppb for flow volumes equal or greater than 1,061,000 acre-feet per year. Although the effect of the increment tests is largely to redistribute existing flows, with respect to the Appendix A LTL, Increment 2 operations are expected to continue to result in higher flow volumes through the S-333 structure, lower flow volumes through the S-334 structure, and moderately lower flow volumes through the S-12D structure. In view of known patterns of TP concentrations across inflow structures, it is anticipated that these flow changes are likely to cause some increase in the FWM TP

concentration and a decrease in the associated LTL due to increased flow volumes. Given that the FWM TP concentration for SRS was at or just below the LTL for four of the past seven years prior to the initiation of Increment 1, it is possible that COP operations will increase the risk of exceeding the LTL limit. However, the WQ sensitivity runs developed and analyzed for the preferred alternative indicated the risk of exceeding the LTL could be mitigated for using adaptive management. Rainfall patterns are a significant factor in the nutrient concentration of the water deliveries to the SRS. If there is a gradual transition from dry season conditions to wet season condition, upstream marsh areas have more time to recover nutrient uptake capability. If the rainfall pattern similar to WY 2017 occurs (drought conditions followed by record high rainfall early in the wet season), higher concentrations of phosphorus will be routed to the SRS due to the lack of marsh nutrient uptake recovery time.

At present, TP concentrations measured at the S-356 pump station are not included in the Appendix A calculation. However, in light of this, the Technical Oversight Committee (TOC) is evaluating how this structure will be incorporated in future Appendix A calculations. The TOC will also continue to evaluate Appendix A compliance during Increment 2 and after COP is implemented. The proposed methodology is expected to require that the S-356 flow-weighted mean total phosphorus (FWM TP) concentration not exceed 11 ppb on an annual basis and the annual FWM TP concentration not exceed 9 ppb on a three-year average basis. The TOC has proposed various methods to incorporate S-356 flows/concentrations into the SRS compliance and is in the process of finalizing the method to be used. For S-356, it was anticipated and observed throughout the Incremental field tests that the FWM TP concentrations through the structure meet the proposed compliance evaluation as part of FDEP test authorization since this flow is largely expected to be composed of seepage water from NESRS and WCA 3B. The concentration of seepage water in this portion of the Everglades is generally expected to be less than 9 ppb. Hydrologic and water quality data collected under the Increment 1 and 2 testing will be assessed to discern sources of water pumped by S-356, if undesirable water quality is noted during S356 operations. Water quality during S356 pumping indicated the phosphorus concentrations were representative of seepage from WCA 3B and the ENP (low phosphorus concentrations) and not representative of urban runoff/ground water concentrations (higher than the ENP/WCA 3B). Water quality results during the first year of testing (Oct 2015 - Oct 2016) indicated a FWM of ~ 6ppb for the S-356 flows. Further total phosphorus data collected through 2019 at the S356 (with flow conditions) indicated relatively low phosphorus conditions with typical total phosphorus concentrations below 10 ppb during flow conditions.

It is important to note that the ecological monitoring discussed later in this appendix is designed specifically to address the challenges of managing the ecological response of the wetland landscape as it transitions back to a wetter condition with occasional pulses of elevated phosphorus.

Water quality monitoring and analyses during Increment 2 testing was used to help identify potential changes to the operating rules that could increase the probability of water quality compliance for additional flows entering NESRS that would be implemented in the Combined Operations Plan. No concerns with the S-356 flows have been identified at this time from the incremental testing that would indicate any changes to the S-356 operations related to water quality concerns. A water quality assessment has been evaluated at the S-356 pump station in accordance with the FDEP authorization to conduct Increment 2 testing. Concurrently, compliance with the LTL will be determined in accordance with the Settlement Agreement Appendix A requirements on an annual basis during Increment 2 testing, and this will continue after the implementation of COP. Per the Settlement Agreement, new sources, such as the S-356, to the SRS must be included in the compliance calculation. The TOC is evaluating how to include the S-356 flows into the compliance calculations and in the interim, SFWMD is reporting compliance with and without S-356 flows. Thus far, no significant difference has been noted between the

two methods. Both the water quality assessment of S-356 and the Appendix A compliance calculations are based on the same annual period of October 1st through September 30th. During Increment 2 test operations, as originally planned, the USACE has not imposed operational constraints for water quality that could restrict or otherwise limit inflows to NESRS. Indications thus far does not support the need for the USACE to impose operational constraints on the S-356 related for WQ once COP is implemented.

C.4.5 Primary Objectives of Water Quality and Hydrology Monitoring Plan

The objectives of the COP water quality and hydrology monitoring plan were carried forward from the previous field test increments. The first six objectives listed below were originally identified in the Increment 1 monitoring plan, and the seventh objective for S-328 was added for Increment 1.1 and 1.2; the objectives were unchanged for Increment 2 and are carried forward as applicable for COP. Additional objectives are included in Section C.5 of this monitoring plan for the hydrologic monitoring plan components south of S-331.

1. Characterize surface water quality and volume discharged from the S-356 pump station into Northeast Shark River Slough (NESRS). Evaluate how pumping affects water quality of the surface water flowing into the ENP Shark River Slough. This objective is no longer applicable to COP based on the testing results. Testing results indicated seepage water from WCA 3B and ENP were the primary source of S-356 intake water. If there are significant changes in S-356 WQ (higher than expected for seepage), this objective may need to be revisited.
2. Identify sources of the S-356 pump intake water. Define, to the maximum extent practical, the percentage of groundwater from WCA 3B seepage versus ENP seepage and how these percentages vary with different operations and different stage conditions experienced during the field test. This objective is was determined to be impracticable without significantly more resources and effort. If there are significant changes in S-356 WQ (higher than expected for seepage) this objective may need to be revisited for COP.
3. Support water quality compliance determination for Settlement Agreement and OFW compliance at S-356, S-12's and S-333.
4. To determine, to the maximum extent practical, the area of influence of S-356 pump station operations in the Biscayne Aquifer. This objective is no longer applicable to COP based on the testing results. If there are significant changes in S-356 WQ (higher than expected for seepage) this objective may need to be revisited for COP.
5. Ensure existing levels of flood protection are maintained within the northern L-31N Basin (between S-335 and S-331).
6. Ensure existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA.
7. Evaluate water quality at the S-328 to determine if this structure needs to be included as new inflow point into the Taylor Slough for Settlement Agreement compliance.

Regarding objective #7, the monitoring regime has been developed by ENP/SFWMD/FDEP in support of the SFWMD initiative to increase flows to Taylor Slough and Florida Bay. Concurrence with the monitoring regime has been obtained with these agencies and the USACE, the S-328 operational criteria identified in the Operational Strategy (Appendix A of the draft Supplemental EA) was included within Increment 2. Pending completion of all required reviews, the final monitoring requirements will be detailed in the final EA report. Monitoring and reporting requirements for S-328 are the responsibility of SFWMD.

C.4.6 Active Mandates and Permits

Monitoring of inflows to ENP and park marsh stations is generally governed by the 1992 Consent Decree, the TP Rule (by way of Appendix A), and the 2012 Consent Order. The Increment 2 testing included the establishment of six new monitoring locations; however, in most instances, the pre-existing network of monitoring stations was able to be utilized to demonstrate the effects of Increment 2 on hydrology and water quality as well as compliance with water quality standards. Authorization to implement the COP will be obtained from the FDEP prior to implementation and this monitoring plan is likely to be included in that authorization by reference. The USACE intends to seek this authorization in form of a Coastal Zone Management Consistency (CZM) determination by the State of Florida. If the State of Florida does not provide CZM, the USACE will confirm that the CZM consistency has been met to the maximum extent practical. The individual structures (e.g., S-333 and S-356 etc.) authorizations will be reviewed and changes to each operational authorization will be reviewed and modified through coordination with FDEP if necessary.

C.4.7 Monitoring Components

C.4.7.1 Project Baseline Monitoring

Existing water quality and hydrology data that have been collected by the SFWMD in the L-29, L-30 and L-31N basins over the last 10-15 years (including the three increments of the MWD field test) will serve as the baseline data COP, similar to the approach used during the field tests.

C.4.7.2 Construction Monitoring

Construction of the S-356 structure was completed in 2002. No construction phase monitoring is anticipated for COP.

C.4.7.3 Post-Construction Monitoring (Effectiveness Monitoring)

Based on the water management and data evaluations conducted during Increment 2, the water quality and hydrologic monitoring plan has been reviewed to match the needs of the COP update to the Water Conservation Areas - Everglades National Park - Everglades National Park to South Dade Conveyance System Water Control Plan.

C.4.7.4 Inventory of Existing Monitoring Networks

C.4.7.4.1 Surface Water Hydrology

At flow control structures, surface water hydrology measurements include headwater stage, tailwater stage, and flow rate. At non-structure monitoring locations, surface water hydrology measurements include stage. **Table C.4-1** shows a list of the existing, established hydrologic monitoring locations within the COP area of interest. Real-time monitoring data for these hydrologic monitoring locations will be relied on by USACE, SFWMD, and ENP water managers and the COP Adaptive Management team to evaluate implementation of COP operations relative to the goals, objectives, and constraints, as described in the COP Water Control Plan; reference maps which show these hydrologic monitoring locations are included in Appendix C (**Figure C.4-1** through **Figure C.4-5**).

Table C.4-1. Gages and sensors for surface water hydrologic monitoring during COP.

Feature	Parameter	Purpose
S-12A	HW, TW, Q[1]	Flow Volume (Tamiami Trail Flow Formula, TTFF)
S-12B	HW, TW, Q	Flow Volume (TTFF)
S-12C	HW, TW, Q	Flow Volume (TTFF)
S-12D	HW, TW, Q, Precipitation	Flow Volume (TTFF)
S-343A	HW, TW, Q	Flow Volume
S-343B	HW, TW, Q	Flow Volume
S-344	HW, TW, Q	Flow Volume
SRS1	Stage	Depth, Duration, Recession
3B-71	Stage	Depth, duration, recession
S-151	HW, TW, Q	Flow Volume (to L-31N/S-356 or Taylor Slough)
S-337	HW, TW, Q	Flow Volume (to L-31N/S-356 or Taylor Slough)
S-335	HW, TW, Q	Flow Volume (to L-31N/S-356 or Taylor Slough)
S-333	HW, TW, Q	Canal Level, Flow Volume (TTFF)
S-334	HW, TW, Q	Canal Level, Flow Volume
S-336	HW, TW, Q	Canal Level, Flow Volume
S-355A	HW, TW, Q	Canal Level, Flow Volume
S-355B	HW, TW, Q	Canal Level, Flow Volume
S-356	HW, TW, Q	Canal Level, Flow Volume
G-3273	Stage	Depth, Duration, Recession
S-357N	HW, Q	Canal Level, Flow Volume
S-357	HW, TW, Q	Canal Level, Flow Volume
S-331	HW, TW, Q, Precipitation	Canal Level, Flow Volume
S-338	HW, TW, Q	Canal Level, Flow Volume
S-332B	HW, TW, Q	Canal Level, Flow Volume
S-332C	HW, TW, Q	Canal Level, Flow Volume
S-194	HW, TW, Q	Canal Level, Flow Volume
S-196	HW, TW, Q	Canal Level, Flow Volume
S-332D	HW, TW, Q	Canal Level, Flow Volume
S-328	HW, TW, Q	Flow Volume
RG4	Stage	Depth, Duration, Recession
NTS18	Stage	Depth, Duration, Recession
S-332DX1	HW, TW, Q	Depth, Duration, Recession, Flow Volume
G-3574	Stage	Depth, Duration, Recession
G-3576	Stage	Depth, Duration, Recession
G-3577	Stage	Depth, Duration, Recession
G-3578	Stage	Depth, Duration, Recession
G-3272	Stage	Depth, Duration, Recession
G-596	Stage	Depth, Duration, Recession

Feature	Parameter	Purpose
G-3626	Stage	Depth, Duration, Recession
G-3627	Stage	Depth, Duration, Recession
G-3628	Stage	Depth, Duration, Recession
G-3437	Stage	Depth, Duration, Recession
Angel's Well	Stage	Depth, Duration, Recession
LPG1	Stage	Depth, Duration, Recession
LPG2	Stage	Depth, Duration, Recession
LPG3	Stage	Depth, Duration, Recession
LPG5	Stage	Depth, Duration, Recession
LPG7	Stage	Depth, Duration, Recession
LPG8	Stage	Depth, Duration, Recession
LPG11	Stage	Depth, Duration, Recession
LPG12	Stage	Depth, Duration, Recession
LPG13	Stage	Depth, Duration, Recession
LPG14	Stage	Depth, Duration, Recession
LPG15	Stage	Depth, Duration, Recession
LPG16	Stage	Depth, Duration, Recession
LPG17	Stage	Depth, Duration, Recession
NE1	Stage	Depth, Duration, Recession
NE2	Stage	Depth, Duration, Recession
NE4	Stage	Depth, Duration, Recession
G-3557	Stage	Depth, Duration, Recession
G-3558	Stage	Determine Duration, Recession Rates
S-177	HW, TW, Q	Canal Level, Flow Volume
S-178	TW, Q	Canal Level, Flow Volume
S-18C	HW, TW, Q, Precipitation	Canal Level, Flow Volume
S-197	Q	Flow Volume
S-357N	Q	Flow Volume
G-613	Stage	Depth, Duration, Recession
G-864A	Stage	Depth, Duration, Recession
G-3336	Stage	Depth, Duration, Recession
G-3338	Stage	Depth, Duration, Recession
G-3350	Stage	Depth, Duration, Recession
G-3355	Stage	Depth, Duration, Recession
G-3620	Stage	Depth, Duration, Recession
G-3901	Stage	Depth, Duration, Recession
G-789	Stage	Depth, Duration, Recession
ENP-TSB	Stage	Depth, Duration, Recession
C-358	Stage	Canal Level
G-211	HW, TW, Q	Canal Level, Flow Volume

Feature	Parameter	Purpose
S-199	HW, TW, Q	Canal Level, Flow Volume
S-200	HW, TW, Q	Canal Level, Flow Volume
NDA1W	Stage	Depth
NDA1E	Stage	Depth
SDA1	Stage	Depth
SDA2	Stage	Depth

Notes: [1]HW– headwater stage; TW– tailwater stage; Q– flow rate

Sensors that measure surface water stage and flow rate usually are located at or near existing structures. Additional flow data at non-structure locations is considered to be critical to preparing a mass balance assessment that will characterize from where the flows at S-356 are sourced along the L-30 and L-31N canals. Surface water flow is measured continuously with acoustic Doppler Velocity Meters (ADVMs) by the USGS at five locations along the L-31N canal (south of L-29 at miles 1, 3, 4, 5, 7). USGS ADVM data are transmitted by telemetry to their National Water Information System (NWIS) where they can be accessed through their web portal at http://waterdata.usgs.gov/fl/nwis/current/?type=flow. Two other existing ADVM stations are located at mile 0 and mile 2 along the L-31N canal. These stations are maintained by the Miami-Dade Limestone Products Association (MDLPA), and data are available on request. The MDLPA ADVM stations may be removed at their discretion.

The USGS has installed two ADVM stations on L-29, at the eastern and western ends of the 1-mile bridge between structures S-333 and S-334.

C.4.7.4.2 Surface Water Quality

Water quality monitoring efforts identified for the L-29 canal, L-30 canal, L-31N canal, and Northeastern Shark River Slough as part of previous increments are retained for the COP. **Figure C.4-1** through **Figure C.4-5** show the existing surface water monitoring network for WCA-3 and ENP. The monitoring stations shown in these figures are required to demonstrate compliance with the non-Everglades Construction Project Permit (Non-ECP permit), the 1992 Consent Decree (commonly referred to as the "Settlement Agreement"), Emergency Order 9 for C-111 features (intended to be replaced by a ERP or CERPRA permit once COP is completed) and/or the Everglades Forever Act (TP-rule). **Figure C.4-1** shows the existing structure monitoring locations in WCA 3A, which is north of the study area. Monitoring at these structure locations is generally required by the Non-ECP permit. Figure **C.4-2** shows the existing structure monitoring locations on the north and eastern boundaries of the ENP, along the L-29 levee (S-12s, S-333, S-334, S-355A/B, S-356) and along the L-31N/C-111 levee canal (S-332s, S-176, S-18C, S-197). **Figure C.4-3** shows the existing marsh monitoring locations within WCA-3, and **Figure C.4-4** shows the existing marsh monitoring locations within ENP. On these two figures (**Figure C.4-3**, Figure **C.4-4**), the monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis. **Figure C.4-5** shows existing locations for surface water flow velocity measurements using ADVMs along L-31N canal.

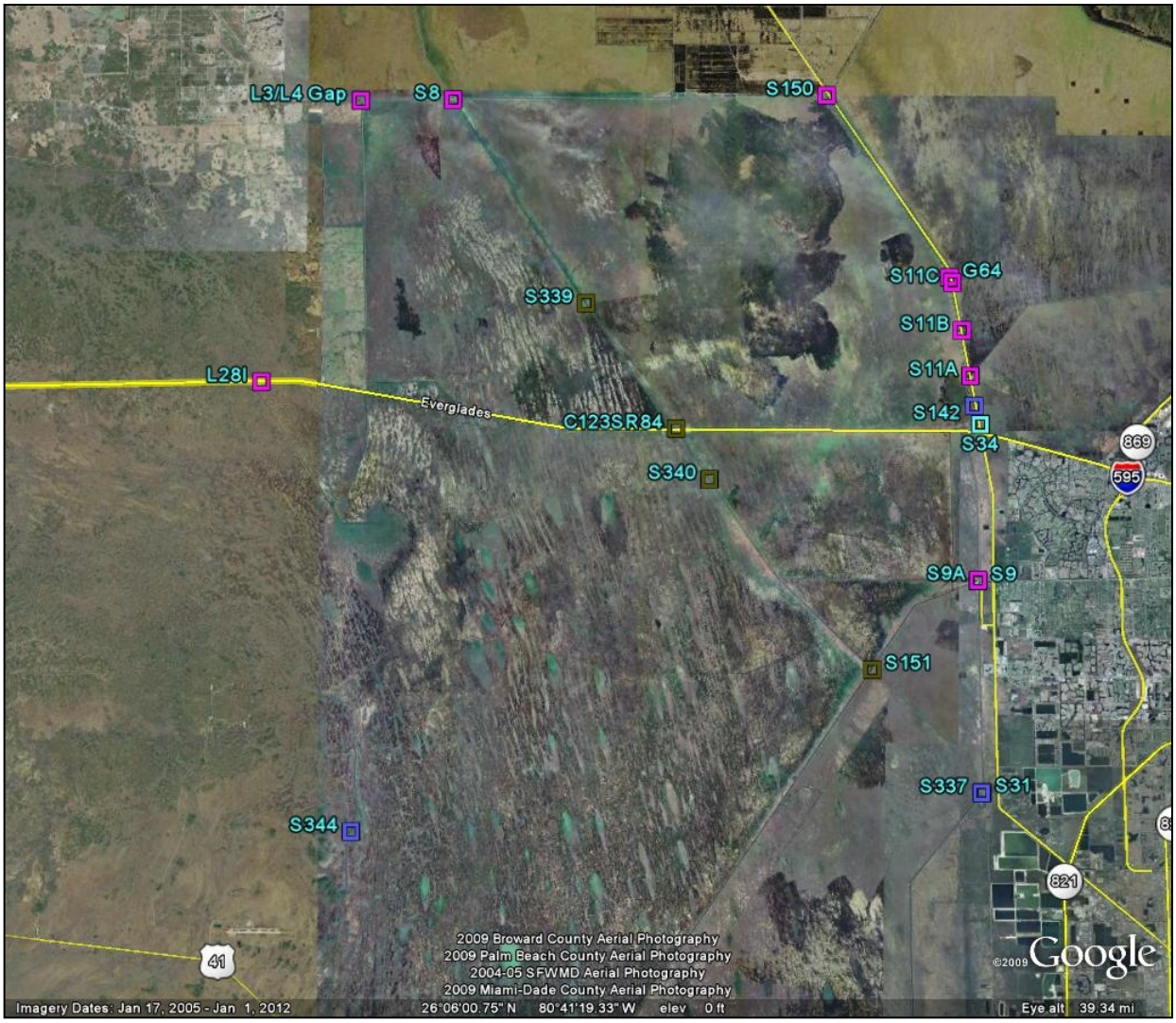


Figure C.4-1. Existing surface water stage and flow monitoring locations at structures in WCA 3A/3B.

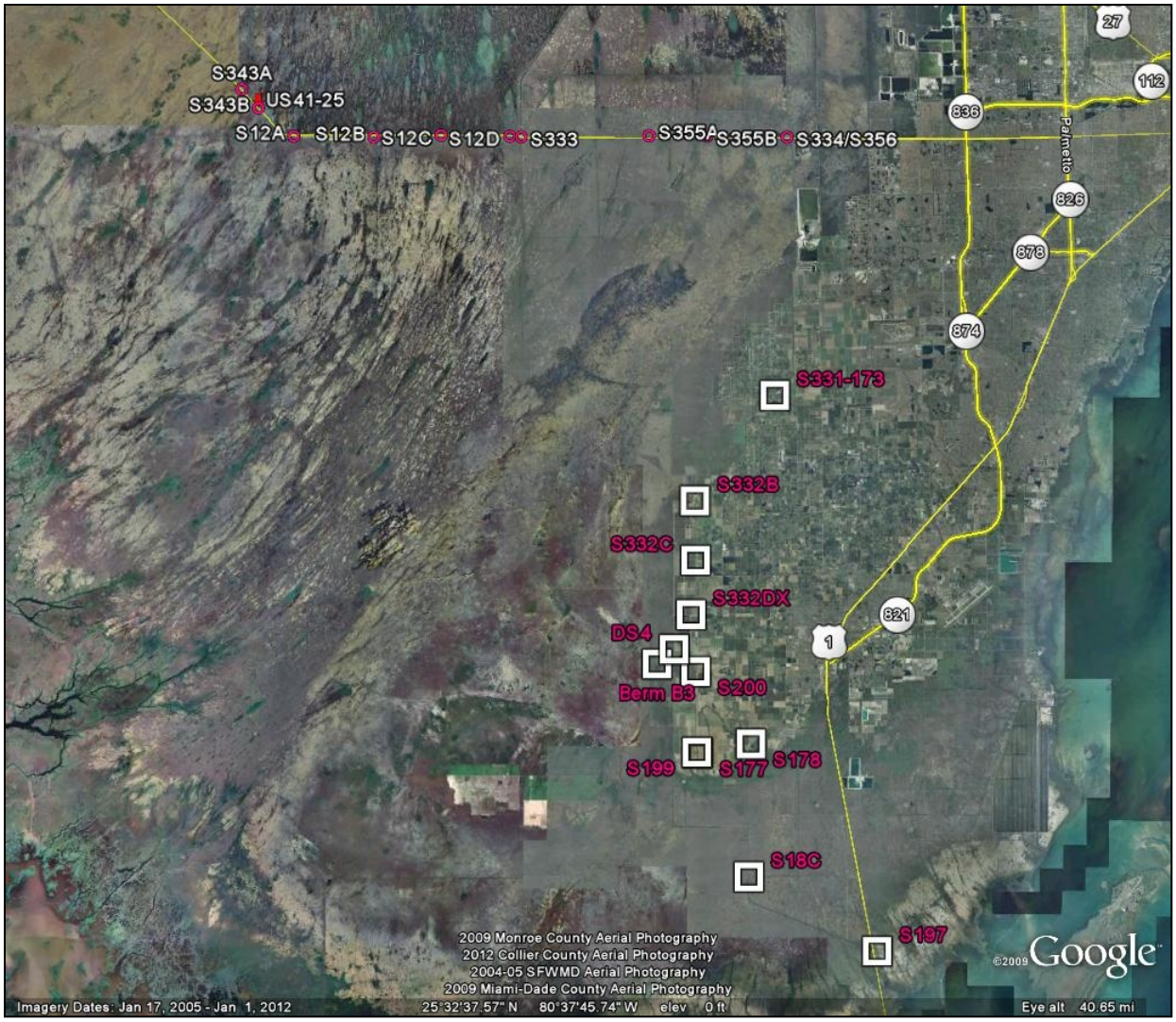


Figure C.4-2. Existing surface water stage and flow monitoring locations at structures along the northern and eastern boundary of ENP.

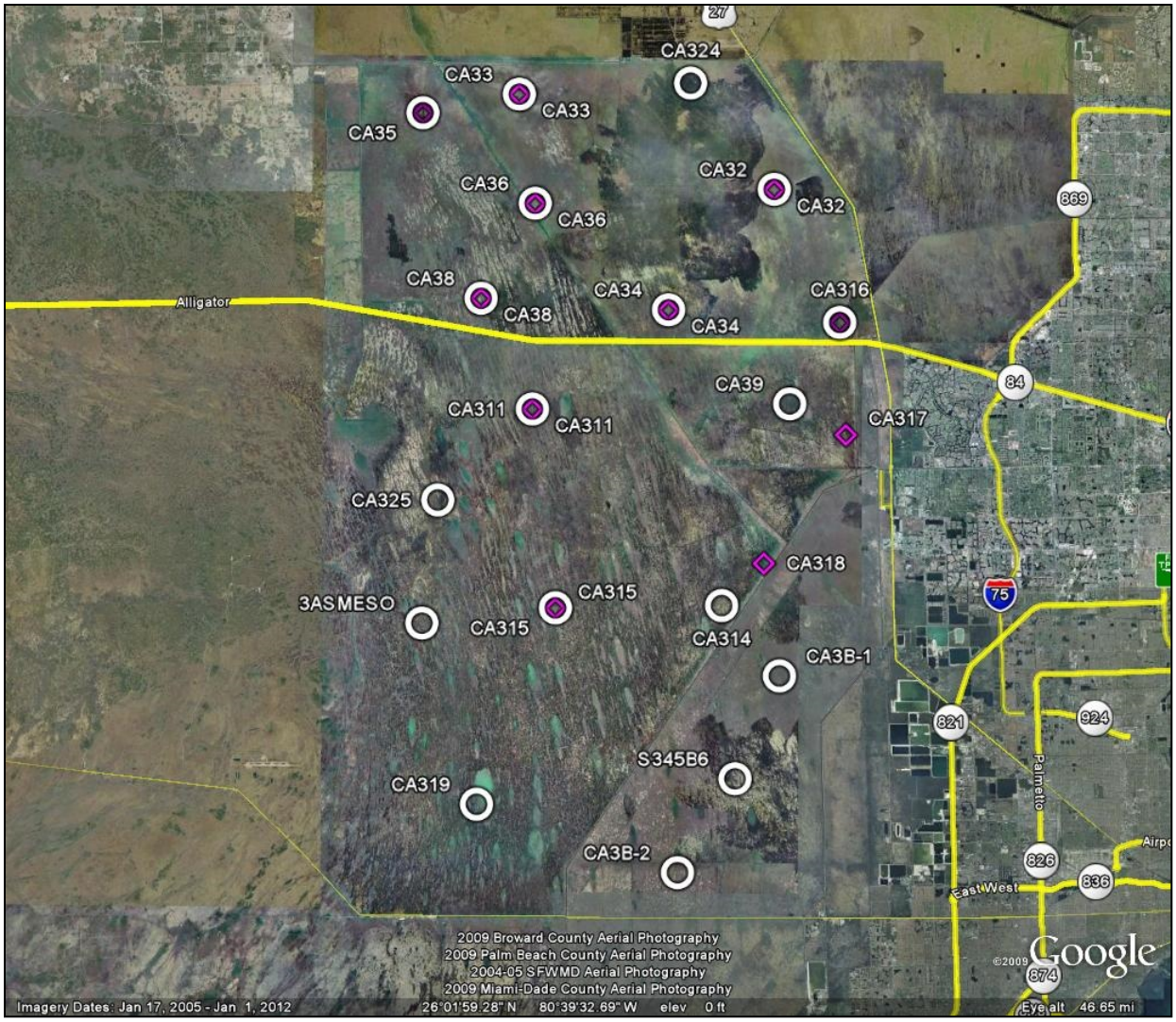


Figure C.4-3. Existing surface water stage monitoring at marsh locations in WCA 3A and WCA 3B. Monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis.

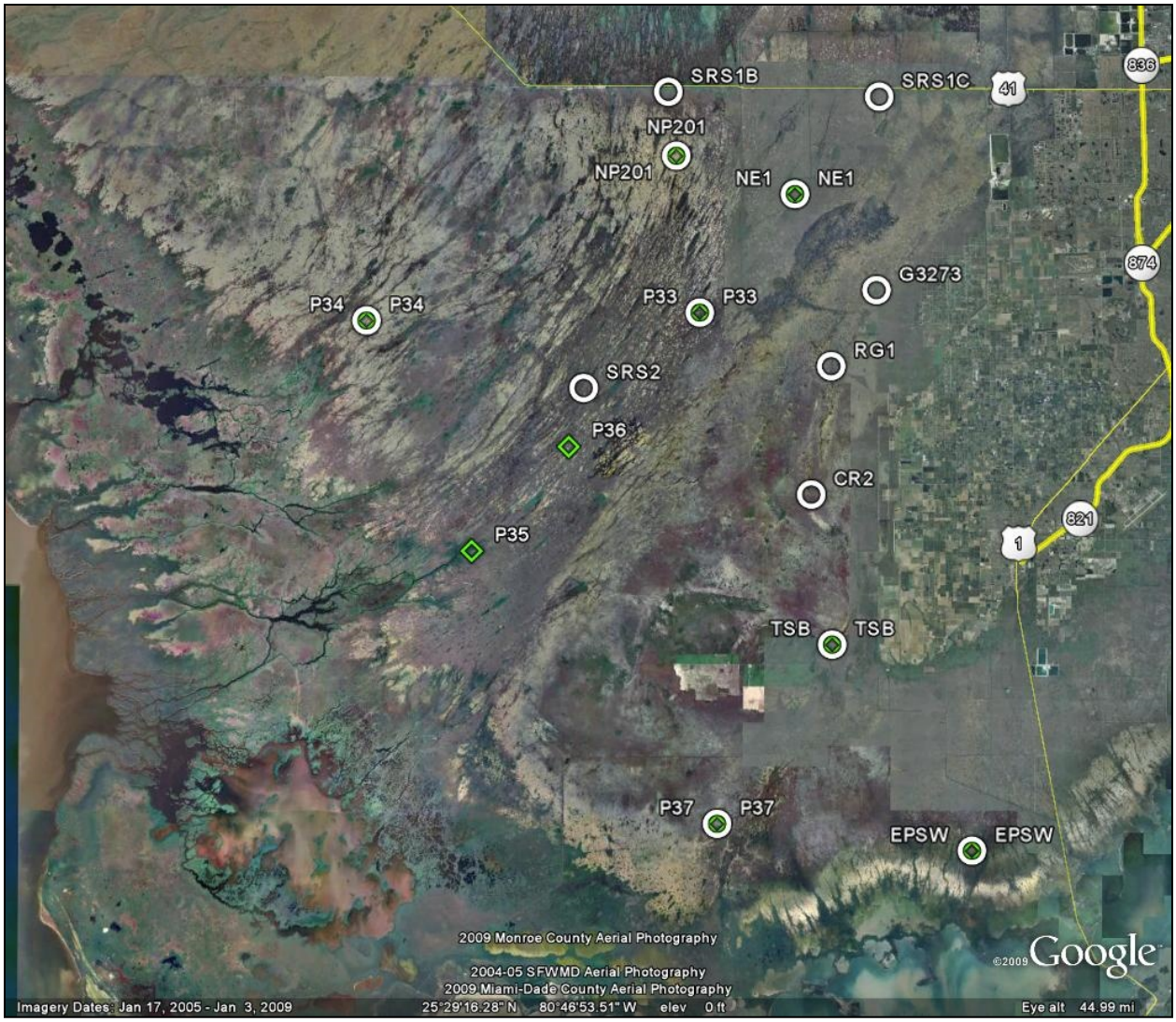


Figure C.4-4. Existing surface water stage monitoring at marsh locations in ENP. Monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, specific conductance, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), calcium (Ca), chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), color, total suspended solids (TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and turbidity. This monitoring is done on either a monthly or bi-weekly basis.

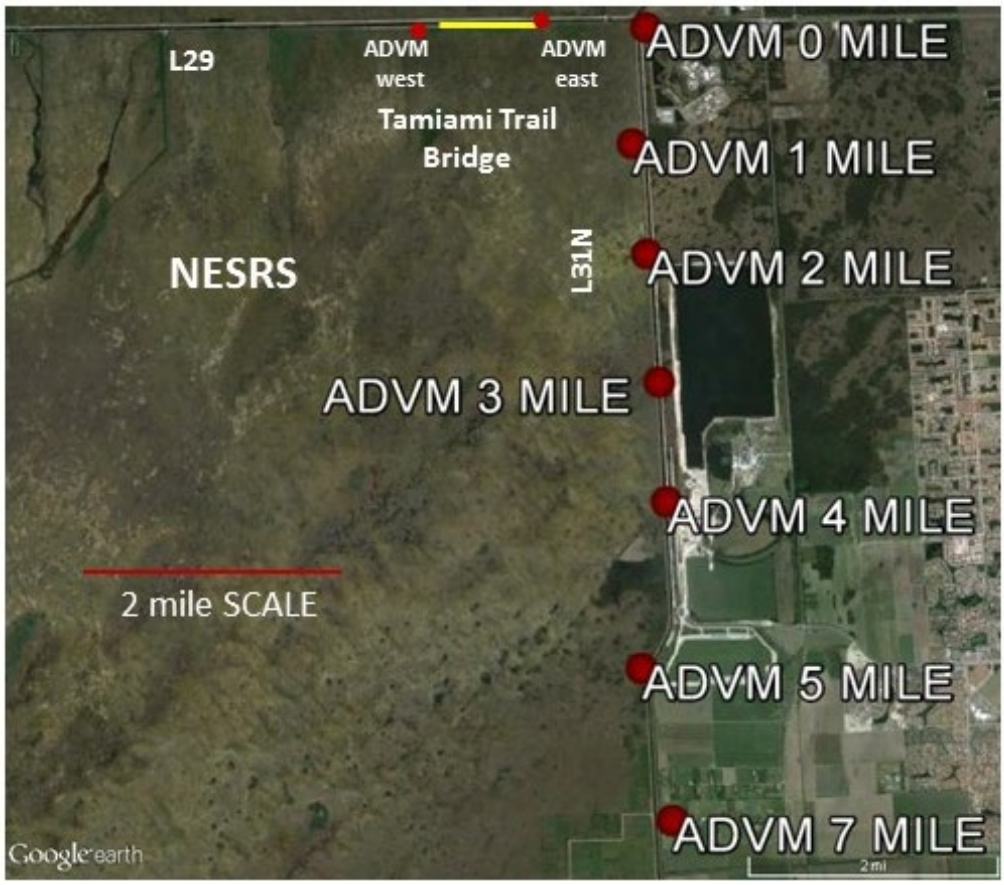


Figure C.4-5. Existing surface water flow velocity monitoring along L-29 and L-31N with ADVMS.

C.4.7.4.3 Groundwater Hydrology

Several State and Federal agencies have constructed groundwater monitoring wells along Tamiami Trail in WCA 3B and adjacent to ENP. Monitoring wells were constructed for different projects during the last two decades. This proposed groundwater monitoring plan will coordinate data acquisition from all wells shown in **Figure C.4-6**. The result is a comprehensive groundwater monitoring network that will provide detailed data to evaluate effects of S-356 pump station operation. **Table C.4-2** lists monitoring wells and clusters by location, and the types of data that are measured at each well. All wells listed in **Table C.4-2** were evaluated during throughout the MWD Incremental field test. Hydrologic responses to S-356 pumping stresses in surrounding monitoring wells will continue to be reviewed in context of seasonal water level changes and other distal pumping stresses (mining operations or MDWSD northwest wellfield) before deletion from the monitoring program. Those wells that show no response to S-356 operation will be deleted from the groundwater monitoring program. It is likely that the only monitoring wells to be deleted will be those located several miles away from the S-356 (for example, in Pennsuco wetlands or the Miami-Dade northwest wellfield). Monitoring wells located along L-29, L-30, L-31N, WCA 3B and NESRS will be retained throughout the study.

Hydrologic conditions in WCA 3B and the NESRS are controlled by interactions between surface water and groundwater of the Biscayne Aquifer. To evaluate these interactions and their effects on regional flows between WCA 3B and NESRS, a groundwater monitoring program is proposed using existing instrumented wells. Instrumented monitoring wells are located mostly north and south of Tamiami Trail near or on the

L-30 and L-31N levees, and on tree islands in southeast WCA 3B (**Figure C.4-6**[1]). The L-30 and L-31N monitoring wells are instrumented with vented pressure transducers that measure groundwater levels. Groundwater levels are measured every 15 minutes, and data are transmitted through a SCADA system to an off-site receiver or are downloaded manually at monthly frequency. Groundwater level data are evaluated by a Contractor for quality control, then packaged and delivered monthly in spreadsheets. Groundwater monitoring locations can be grouped according to sampling objective, and these groups are shown on **Figure C.4-6**.

Groundwater level data at monitoring locations in WCA 3B and along L-30 (**Figure C.4-6**[1]) will characterize seepage in upgradient and background positions, and also will define the S-356 zone of influence north of the pump station. Groundwater level data obtained in northern NESRS and along the northern and southern portions of L-31N (**Figure C.4-6**[2] and **Figure C.4-6**[4], respectively) will characterize seepage in downgradient positions, and also will define the S-356 zone of influence south of the pump station. Hydrologic effects of the MDLPA seepage barrier along L-31N also will be evaluated from these data. Groundwater level data obtained near the Miami-Dade Water and Sewer Department (MDWSD) northwest wellfield (**Figure C.4-6**[3]) will characterize water level responses to pumping stresses at that facility.

Local to sub-regional pumping stresses are known to perturb groundwater flow direction and level in the study area. Examples of pumping stresses include the MDWSD northwest wellfield (Sonenshein and Hofstetter, 1990; Krupa et al., 2001), Lake Belt mining operations (**Figure C.4-6**[3]), and S-7 Pump Station operations (Krupa and Hill, 2002). Groundwater level, and flow rate and direction changes were observed at the onset of pumping at the MDWSD northwest wellfield, currently permitted at 90 million gallons per day (MGD; equal to 139 cfs). However, these effects were limited to regions east of the Dade-Broward levee, and drawdown of groundwater did not impinge on the L-30 Canal or ENP (Sonenshein and Hofstetter, 1990; Krupa et al., 2001). Operation of pump station S-7 (2,490 cfs; Broward and Palm Beach Counties) showed perturbations to groundwater flow and also surface water quality. Operational testing at the S-7 pumping station showed significant mixing of ground and surface water in the headwater side of the pump station, and significant seepage when head and tailwater elevations differed more than 3 feet. High head differences between head and tailwater can drive seepage of anoxic, higher specific conductance groundwater into the tailwater pool. The hydrogeologic setting of the S-7 pumping station differs from that of S-356 and has five times its pumping capacity. Water-quality changes observed at S-7 are not directly applicable to the field test proposed in this document. The existing 2015-2019 groundwater quality dataset will be interpreted in the context of concurrent S-356 pump station operation in order to detect any groundwater quality changes.

Figure C.4-6. Existing groundwater monitoring wells in the project area. Left, base map showing all well locations. Right, four inset maps: 1) instrumented monitoring wells along L30 and WCA 3B (Tree Island wells); 2) Approximately 1 mile south of Tamiami Trail, along L-31N between ENP and the L-31N Canal; 3) East of L30 proximal to the Miami-Dade Water and Sewer Department Northwest Well Field; 4) Approximately 4 miles south of Tamiami Trail, along L-31N between ENP and the L-31N canal.

Table C.4-2. Hydrologic characteristics measured in existing monitoring wells.

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3778	L-31NN cluster (L-31NN-GW1) 1 mi S of TT	-85.7 to -87.7	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3779	L-31NN cluster (L-31NN-GW2) 1 mi S of TT	-36.5 to -38.5	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3780	L-31NN cluster (L-31NN-GW3) 1 mi S of TT	-15.7 to -17.7	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3781	L-31NN cluster (L-31NN-GW4) 1 mi S of TT	-0.6 to -2.6	PVC	Yes	No	No	dbhydro search for site name "L-31NN"
G-3784	L-31NS cluster (L-31NSGW1) 4 mi S of TT	-83.1 to -85.1	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
G-3785	L-31NS cluster (L-31NSGW2) 4 mi S of TT	-27.2 to -29.2	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
G-3786	L-31NS cluster (L-31NSGW3) 4 mi S of TT	-11.1 to -13.1	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
S-356-GW1	Well cluster at S-356 pump station	-40.24 to -42.24	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
S-356-GW2	Well cluster at S-356 pump station	-33.75 to -35.75	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
S-356-GW3	Well cluster at S-356 pump station	-9.75 to -11.75	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
S-356-GW4	Well cluster at S-356 pump station	+2.25 to +4.25	PVC	Yes	No	No	Dbhydro search for sitename “S-356%”
G-3787	L-31NS cluster (L-31NSGW4) 4 mi S of TT	-1.5 to -3.5	PVC	Yes	No	No	dbhydro search for sitename "L-31NS"
3BS1-GW1	Dual zone monitor well in WCA 3B tree	upper: -8.77 to -9.77 lower: -	PVC	Yes in both	No	Yes in both	dbhydro search for site name "3BS%"

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
	island north of TT	27.00 to -29.00		interv als		interv als	
3BS1-GW2	Dual zone monitor well in WCA 3B tree island north of TT	upper: -7.14 to -8.14 lower: -22.76 to -24.76	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
3BS1-GW3	Dual zone monitor well in WCA 3B tree island north of TT	upper: -8.35 to -9.35 lower: -20.72 to -22.72	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
3BS1-GW4	Dual zone monitor well in WCA 3B tree island north of TT	upper: -3.18 to -4.18 lower: -22.56 to -24.56	PVC	Yes in both interv als	No	Yes in both interv als	dbhydro search for site name "3BS%"
G-1488	Krome Ave. 3.9 mi. north of TT Latitude 25°49'06.7", Longitude 80°28'56.4"	Maximum depth -12.57	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=254830080284201 and Dbhydro
G-3253	At MDWASD North Wellfield Latitude 25°50'29.0", Longitude 80°24'58.4"	Maximum depth -29.21	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255027080245501 and DBHydro
G-3273	ENP: latitude 25°37'49.381", longitude -80°34'33.21"	Maximum depth -8.23	PVC	Yes	No	No	http://www.sfwmd.gov/dbhydroplsql/show_wilma_info.report_process?v_output_format=summary&v_os_code=win&v_station=G-3273
G-3259A	At MDWASD North Wellfield Latitude 25°50'27.0", Longitude 80°24'09.6"	Maximum depth -54.9	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255027080245501 and DBHydro

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3551	4.2 miles S of TT and 100-ft west of L-31N canal	-6.7 to -11.7	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254158080294501&PARAmeter_cd=72020,62611 and Dbhydro
G-3553	0.38 mi. E of Krome Ave., 0.11 mi. S SW 72nd St. Latitude 25°41'53.3", Longitude 80°28'21.6"	Maximum depth -13.7	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/nwismap/?site_no=254152080282101&agency_cd=USGS and DBHydro
G-3557	ENP: 5.2 miles S of TT, and 100-ft west of L-31N Canal	-7.9 to -12.9	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254112080294201&PARAmeter_cd=72020,62611 and DBHydro
G-3558	NE corner of FP&L service road next to Bird Dr. extension canal and SW 177th Ave/Krome Ave	-5.67 to -10.67	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254334080284401&PARAmeter_cd=72020,62611 and DBHydro
G-3559	ENP: 1 mile S of TT and 100-ft west of L-31N Canal	-5.9 to -10.9	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254445080295001&PARAmeter_cd=72020,62611 and DBHydro
G-3575	ENP: 4.07 mi S of TT on the S side of levee at L-31N Canal	-3.8 to -3.8 ft. open end well	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L-31N Canal.	-3.6 to -3.6 ft. open-end well	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PARAmeter_cd=72020,62611 and DBHydro

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
G-3574	ENP: 1.06 mi. S of TT on L-31N levee	Stilling well - 0.6 ft.	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254446080295501&PARAmeter_cd=72020,62611 and DBHydro
G-3575	ENP: 4.07 mi S of TT on the S side of levee at L-31N Canal	-3.8 to -3.8 ft. open end well/piezometer	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L-31N Canal.	-3.6 to -3.6 ft. (possibly an open-end well/piezometer)	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PARAmeter_cd=72020,62611 and DBHydro
G-3577	ENP: 4.08 mi S of TT and 0.24 mi. W of levee on the W side of L-31N canal.	-2.0 to -2.0 ft. (possibly an open-end well/piezometer)	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro
G-3578	ENP: 4.02 mi south of TT and 1.01 mi. W of levee on west side of L-31N Canal	0 to 0 ft. (possibly an open-end well/piezometer)	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254210080304801&PARAmeter_cd=72020,62611 and DBHydro
G-3676	At Rinker Materials Mine, approx. 2 mi N of TT, 3.7 mi E of Krome Ave.	Maximum depth -22.4	PVC	Yes	No	No	http://sofia.usgs.gov/eden/station.php?stn_name=G-3676
G-3761	1 mi. W of MDWASD NW Wellfield at NW 74th St. Latitude 25°50'30.1", Longitude 80°26'00.7"	Maximum depth -11.3	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255035080255402
G-3818	Latitude 25°50'36.8", Longitude	Maximum depth -14.9	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/nwismap/?site

Well	Location	Open Interval (feet NGVD29) from land-surface elevation	Casing Con-struc-tion	Real-time GW Level	Specific Conduc-tance	Tem-pera-ture	Access Data (real-time or near-time) and comments
	80°27'04.3" 2.25 mi. due W of G3253/MDWASD NW well field, 5.3 mi N of TT in Pennsuco wetlands						_no=255036080270501&agency_cd=USGS
G-3898	Latitude 25°41'52.82", Longitude 80°28'25.68" 0.17 mi. W of intersection of SW 72nd St. & SW 172nd Ave.	Maximum depth -15.8	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/nwismap/?site_no=254152080282601&agency_cd=USGS
G-618	Latitude 25°45'39.2", Longitude 80°34'37.8", south side of TT next to Coopertown Airboat Ride, 6.3 mi W of Krome Ave.	Maximum depth -12.6	PVC	Yes	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=254500080360001
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L-31N Canal.	-3.6 to -3.6 ft. open-end well	PVC	Yes	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PARAmeter_cd=72020,62611 and DBHydro

In July 2012, the MDLPA completed construction of a 2-mile long seepage barrier along the northern terminus of the L-31N levee, south of Tamiami Trail. In April 2016, the MDLPA completed construction of a 3-mile long extension (5-mile total length) to the seepage barrier along the northern portion of the L-31N levee, south of Tamiami Trail. The seepage barrier is composed of cement-bentonite slurry that is pumped into a pre-excavated trench. The dimensions of the seepage barrier are: 5-miles long, 32-inches wide, and 35-feet deep below land surface (to approximately -30 feet NGVD29). The primary objective of this seepage barrier is to reduce groundwater flow rate eastward out of NESRS. This objective is currently under evaluation by the USACE in support of implementation of the Central Everglades Planning Project (CEPP) under the Comprehensive Everglades Restoration Plan (CERP).

C.4.7.4.4 Groundwater Quality

Biscayne Aquifer water quality has moderate carbonate alkalinity, low chloride, sulfate and total phosphorus concentrations, and low specific conductance values (**Figure C.4-7**). Precipitation percolates through the peats and limestones in the recharge areas of western Miami-Dade County, dissolving mineral constituents as groundwater flows to the east and southeast toward the coast. Monthly and quarterly groundwater quality data were obtained from July 2015 through September 2017 as part of the Increment 1 monitoring effort. Commencing in November 2017, the groundwater monitoring program was revised under Increment 2 and retained for COP monitoring. Revisions to the groundwater monitoring program are listed in subsection C.4.8.4.1.

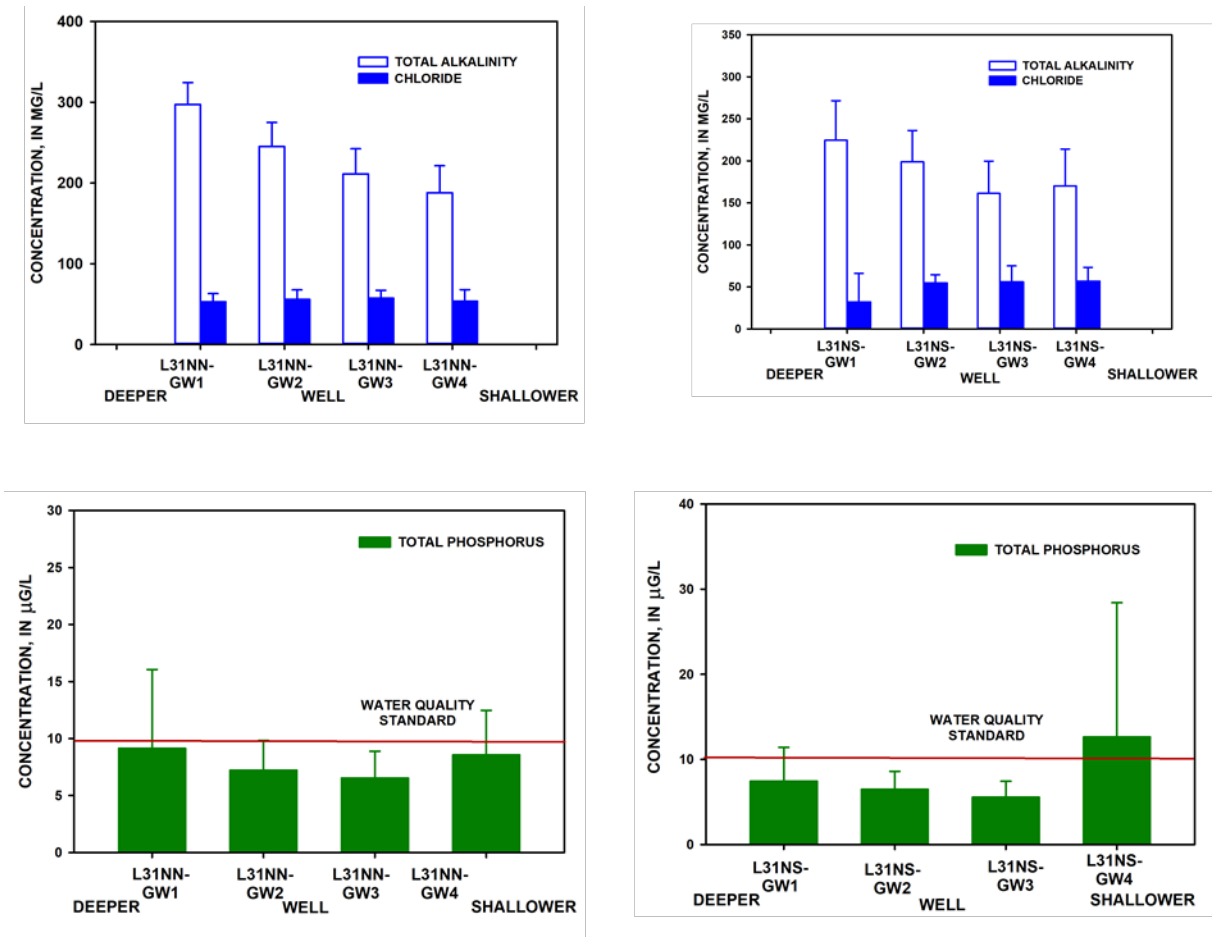


Figure C.4-7. Bar diagrams showing selected groundwater quality data at different depths from Biscayne Aquifer monitoring well clusters L-31NN and L-31NS.

C.4.7.5 Integration of Monitoring Components

New monitoring stations (refer to Section C.4.7) proposed as part of this project were selected based upon a review of the ongoing monitoring and the expected compliance requirements associated with the planned project features. Staff from SFWMD, USACE, DOI, and FDEP worked together to ensure that the new monitoring stations were consistent with the permit requirements and not duplicative of ongoing monitoring at existing stations.

C.4.8 Duration

This monitoring program was conducted during the Increment 2 testing period, which commenced in February 2018 and was completed in May 2019. At the completion of Increment 2 testing, a portion of the additional monitoring proposed in this plan may be carried forward to COP or other operating conditions that may follow.

C.4.8.1 Modification or Termination Conditions

Modification of the water quality monitoring plan will be determined annually by the needs of the project, and the water quality monitoring plan will be completely reassessed after the Increment 2 test is complete. At this time the WQ sub team anticipates no changes are necessary to the existing surface WQ monitoring in the project area. This plan will be changed to reflect any future design changes (new discharge structures into the L-29 canal, etc.) or permit requirements. It also may be terminated according to permit expiration dates. Decisions to adjust the monitoring plan will be coordinated through the project partners as well as the FDEP.

Monitoring plans for previous increments were developed assuming that major, ongoing monitoring programs that were not previously funded directly by the Project would continue to collect data relevant to the Project. Should any of these programs be discontinued or significantly curtailed, then the Federal and local sponsors of the COP Project will reevaluate monitoring priorities.

C.4.9 Monitoring/Sampling Locations and Naming Convention

A description of new monitoring or modifications to existing monitoring is provided below. Costs associated with the proposed monitoring are not provided in this document.

C.4.9.1 Surface Water Hydrology

C.4.9.1.1 Flow Measurements along L-29 and L-31N

Flow velocity measurements are critical to quantify westward flows that result from pump station operation. Currently, flow velocity measurements are made periodically along the reach of L-29 between structures S-333 and S-334. The bi-weekly USGS flow data collection effort will be coordinated with the water quality sampling schedule.

C.4.9.1.2 L-29 Canal Morphology

Following the prolonged use of S-356 Pump Station, stream channel morphology will be monitored in the L-29 Canal immediately downstream of the structure during the test for possible scouring. Monitoring for potential scour effects is an appropriate precaution since the structure discharge pipes are not submerged. Channel condition will be documented by photographs and field measurements before test initiation. If channel morphology changes during the field test, these features will be documented as appropriate. Stream channel morphology is defined at five surveyed cross-sections located downstream (west) of the S-356 pump station, between the outflow and the 1-mile Tamiami Trail Bridge (**Figure C.4-8**).

The USGS measured four transects at increasing distance from the tailwater of the S-356 pump station test in October 2015, prior to the initiation of Increment 1. These cross-sections will define baseline channel morphology. A second series of cross-sections was measured in July 2019 after prolonged

operation of the S-356 pump station. A USGS report comparing the two sets of cross-sections will be delivered in 2020.

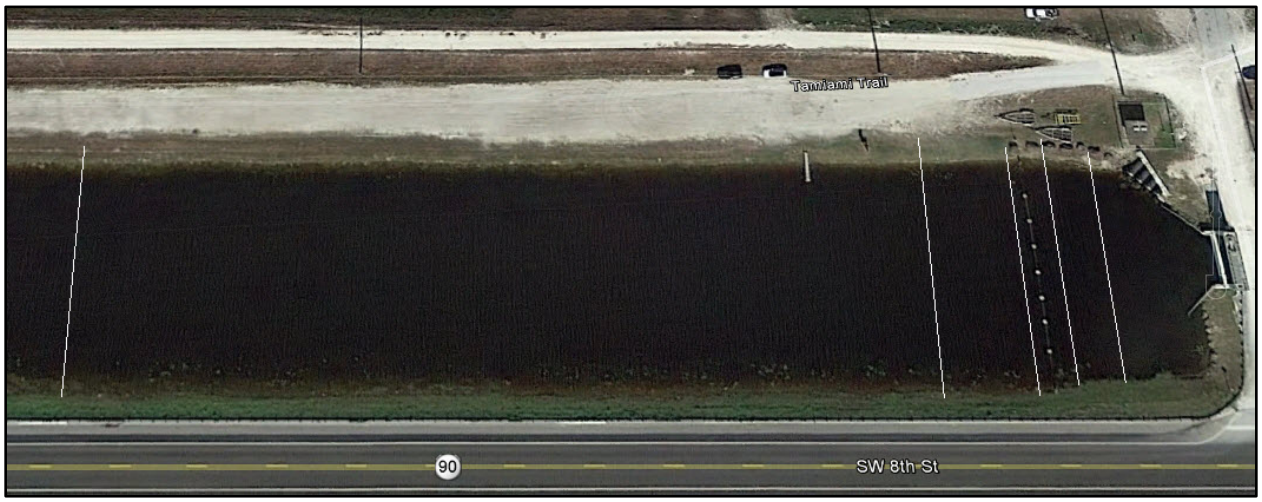


Figure C.4-8. Cross-section locations in the L-29 canal tailwater of the S-356 pump station.

Increment 2 allowed for temporary raising the maximum operating limit for the L-29 Canal, which runs parallel to the Tamiami Trail, up to 8.5 feet NGVD. In order to ensure no road damage is caused due to extended periods of high water stages, based on coordination with the Florida Department of Transportation (FDOT) concurrent with the development of the Increment 2 Operational Strategy, USACE coordinated with the Department of the Interior (DOI) to install six pressure transducers in four transects along the Tamiami Trail to monitor the effects of the increased L-29 water levels on the roadway (**Figure C.4-9**). Piezometers, soil moisture sensors, and surface water stage recorders were installed at specified locations along Tamiami Trail between S-333 and S-334 Spillways. The piezometers and soil moisture sensors were installed along FDOT right-of-way along the Tamiami Trail. Installation of the additional roadway monitoring was completed in November 2018. Phase 2 of the DOI Tamiami Trail Next Steps' (TTNS) project recommended 5.5 miles of additional bridging and roadway reconstruction for the remaining un-bridged portions of the eastern Tamiami Trail roadway between S-333 and S-334. DOI is currently proceeding with the engineering design efforts, with a construction contract award planned for July 2020. The TTNS Phase 2 roadway modifications will adhere to FDOT roadway design standards for a design high water condition of 9.7 feet NGVD in the L-29 Canal. After completion of the TTNS Phase 2 roadway modifications, the piezometer and soil moisture information is no longer needed, and the USACE will continue to coordinate with FDOT through the Increment 2 field test and COP to ensure roadway concerns are effectively managed leading up to the roadway reconstruction, or the FDOT roadway constraints for COP may be removed earlier if demonstrated through the evaluation of the monitoring information.

Figure C.4-9. Transect locations for piezometer installation along the Tamiami Trail.

C.4.9.2 Surface Water Quality Monitoring Plan

There is an extensive and robust surface water quality monitoring program currently in place with sampling routinely conducted for all relevant parameters at all key structures in the C&SF water management system. No additional surface water quality monitoring was added for the MWD incremental field test or the COP. Current surface water quality monitoring is focused toward meeting permit and other mandate requirements, as well as providing information for water management, infrastructure management and environmental restoration. Monitoring mandates include the Everglades Settlement Agreement/Consent Decree (1995), the Total Phosphorus Rule, the Non-Everglades Construction Project (NECP) Permit, and the Canal-111 Emergency Order #9 (Exhibit B of Executive Order (E.O.) 9). Monitoring required by the aforementioned mandates is described in the South Florida Water Management District's (SFWMD) monitoring projects: Conservation Area Materials Budget, Park Inflows North, Park Inflows East, Everglades Protection Area, Phosphorus Source Control Project, and NECP. **Figure C.4-10** shows physical locations of these stations. **Table C.4-3** lists the sample monitoring locations in the vicinity of L-29 and L-31N. The table includes information on the parameters of interest, frequency of sampling, and entity conducting the efforts. The color coding in this table indicates whether the station is a currently active monitoring station, if it is a new station, new parameters added to existing stations, and responsible parties. For several of the existing monitoring stations, the parameter list was amended to include additional analytes necessary to meet the plan objectives.

C.4.9.2.1 Surface Water Quality Monitoring Stations

The justifications for the new monitoring stations are described in terms of how they contribute to the three monitoring plan objectives.

Objective 1: S-356 Surface Water Flow and Quality

<u>S-356:</u> To characterize the quality and volume of flow discharged at the S-356 pump station, weekly surface water quality grab sampling combined with an ADT autosampler for time-dependent TP monitoring will be conducted at the S-356 structure. The weekly TP grab sample data will be used to evaluate compliance with the DEP permit conditions and the autosampler TP data will be used in evaluating the daily variability in water quality which will be useful in determining if factors such as pumping rate or headwater stage affect TP concentrations.

L29C1 (formerly TAMBR1), L29C4 (formerly TAMBR4), NE0: Water in the L-29 canal between the S-334 structure and S-333 is characterized by existing monitoring conducted at the Safari, Glader, Coopertown, and S-355A/B stations shown in **Figure C.4-10**. All of these existing stations are located at least 3 miles west of the S-356 pump. To characterize the quality of water that enters NESRS in close proximity to the S-356 pump, two new L-29 monitoring locations were proposed (TAMBR1 and TAMBR4). The proposed TAMBR1 station is at the US Highway 41 culvert located 500 meters west of the S-334 structure. This location will be used to characterize flows entering NESRS at this culvert.

The newly proposed NE0 monitoring station, located 500 meters south of L-29 in ENP, will be used to characterize the impact of flows through the TAMBR1 culvert as this water enters ENP. The TAMBR4 monitoring station will be located at the western end of the 1-mile bridge and will fill the gap between TAMBR1 and S-355B monitoring locations.

Objective 2: Sources of S-356 Flows

L-31NMile0, L-31NMile1, L-31NMile2, L-31NMile3, L-31NMile4, and L-31NMile5: Water pumped at S-356 will potentially be sourced from L-30 flows, groundwater in the vicinity of the pump, seepage from WCA 3B into L-30 canal, and seepage from ENP into the L-31N canal. The existing surface water quality monitoring network may be augmented to include two new stations (L-31NMile0 and L-30Mile0 (surrogate for S-336)) at the confluence of the C4, with the L-31N and L-30 canals, respectively and along the L-31N canal (L-31NMile1, L-31NMile2, L-31NMile3, L-31NMile4, and L-31NMile5). The five new monitoring sites along the L-31N canal are located at existing acoustic velocity meter stations that are used to estimate canal flow. The combined water quality and flow data at each of these stations will be used in the proposed mass balance analysis to determine the extent to which the sources of canal flow vary as a result of changing hydrologic and operating conditions that will occur over the course of the testing period. The first draft of this monitoring plan included additional new surface water quality monitoring sites such as S-336, S-21A, L-31NMile7, G-211, and S-338. The water quality monitoring team replaced with surrogates or removed these stations from the final plan after determining that these stations were not essential to meeting the monitoring plan objectives. Data analysis efforts to develop detailed water budgets were unsuccessful during the MWD incremental field test due to operational variability, but these efforts may be further pursued under the COP AMMP.

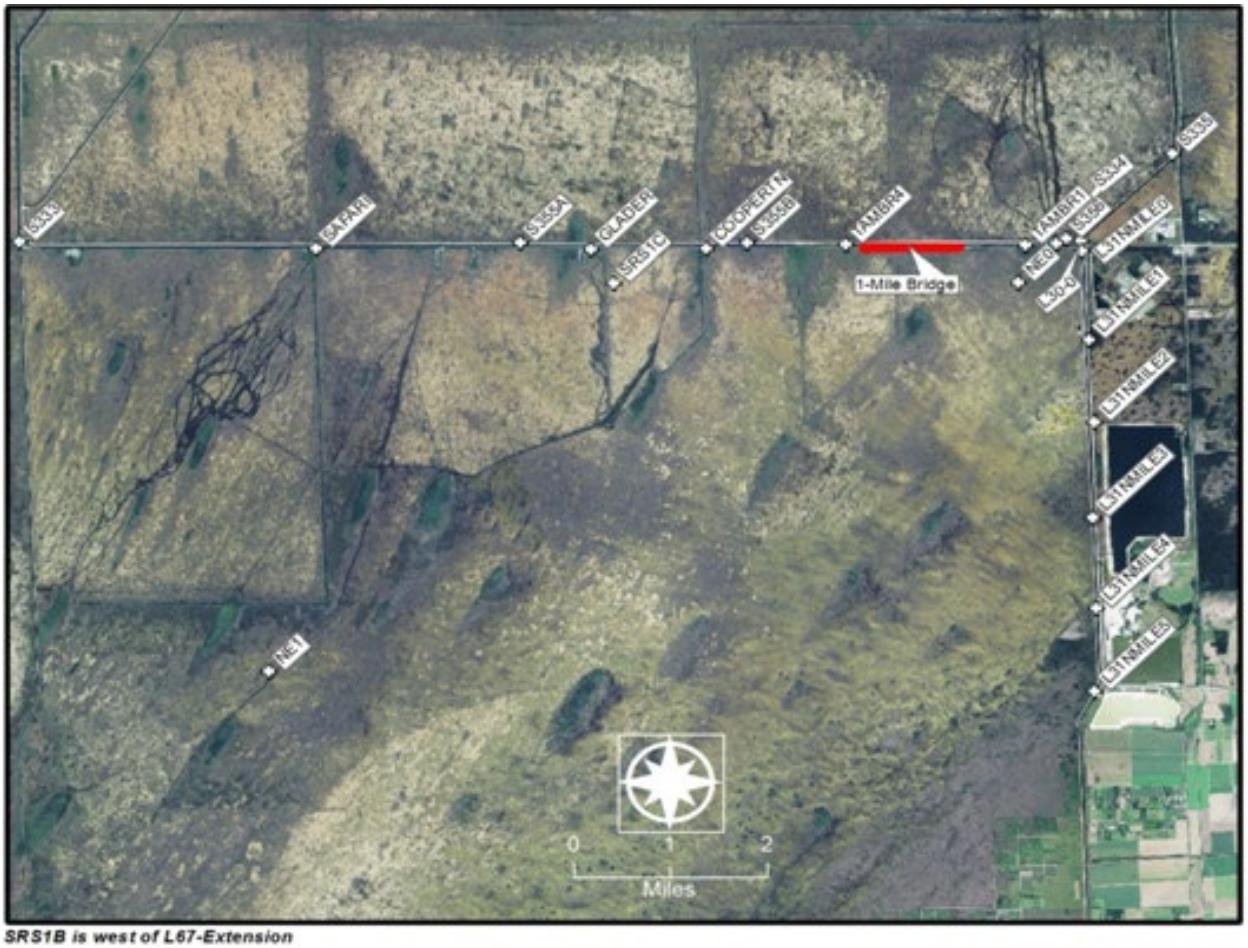
(Details on groundwater flow quantification are provided in the groundwater monitoring plan below.)

Objective 3: Water Quality Compliance

Most of the existing surface water quality monitoring efforts at structures discharging into NESRS support the 1991 Settlement Agreement Appendix A compliance calculation. The mandated monitoring includes bi-weekly sampling when flowing at the S-12X, S-333, S-334, and S-355A/B structures. New sources to the SRS must also be included in the mandated monitoring. The SFWMD has been supplementing the required TP monitoring at these structures by collecting weekly samples at the S-12 structures and at the S-333 structure. While this additional monitoring is not mandated, the weekly resolution of this dataset may prove useful in evaluating the effect of shifting flows from the S-12s to S-333.

The collection of flow and TP concentration data at the S-356 structure will be used to demonstrate compliance with OFW requirements for discharges from this structure. The OFW compliance assessment requires that the flow-weighted mean TP concentration at the S-356 be less than 11 ppb on an annual basis and less than 9 ppb on a three year average annual basis. The calculation will be performed for the

Federal Water Year (October through September) by the USACE and the results will be available in March of the following year.



SRS1B is west of L67-Extension

Figure C.4-10. Surface water quality monitoring station locations along Tamiami Trail.

Table C.4-3. Proposed surface water quality monitoring for G-3273/S-356 Increment 2 test.

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
L29C1 (TAMBR1)	Existing	L-29 north bank, directly across from culvert under US 41; 0.3 mi. west of S-334; a.k.a. FDOT Culvert 59	TPO4 , OPO4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L29C4 (TAMBR4)	Existing	L-29 north bank, directly across from culvert under US 41; 2.2 mi, west of S-334; a.k.a. Culvert 56	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
NE0	Existing	NESS marsh site 0.5 km south of FDOT Culvert 59 (TAMBR1)	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection by ENP and analyses by SFWMD	Monthly; grab; collection by ENP and analyses by SFWMD
L30 Mile0	Existing	L-30 canal/L-29 juncture NW corner; 25° 45’ 41.93” N, 80° 29’ 53.70” W	TPO4 , OPO4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-355A	Existing	Approximately 5.5 mi. west of S-356. Tail Water	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-355B	Existing	Approximately 3.25 mi. west of S-356. Tail Water	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
SAFARI	Existing	Downstream of culvert south of L-29, approximately 8 mi. west of L-31N.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
GLADER	Existing	Downstream of culvert south of L-29, approximately 5-1/4 mi. west of L-31N.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
COOPERTN	Existing	Downstream of culvert south of L-29, approximately 4 mi. west of L-31N.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-333	Existing	SE Corner of WCA 3A at L-29.	DO, SC, pH, Turb, TSS, NOx, TKN, OPO4, TPO4,	Weekly when flowing;	Monthly grab; collection and

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
			Na, K, Ca, Mg, Cl, SO4, Alk	otherwise monthly; grab	analyses by SFWMD
S-333	Existing	SE Corner of WCA 3A at L-29.	TPO4, TKN, NOx	Time-proportional autosampler: weekly	Monthly grab; collection and analyses by SFWMD
S-334	Existing	On L-29 approximately 1/4 mile west of L-31N. Head Water.	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-335	Existing	On L-30 north of L-29. Tail Water (and Head Water).	TPO4 , OPO4, Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S-356	Existing	On L-29 approximately 1/4 mi. west of L-31N.	DO, SC, pH, Turb, TSS, NOx, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4, Alk	Weekly when flowing; otherwise monthly; grab	Monthly grab; collection and analyses by SFWMD
S-356	Existing	NOTE: Autosampler on site.	TPO4, TKN, NOx	Time-proportional autosampler: weekly	Monthly grab; collection and analyses by SFWMD
S-197	Existing	On C-111 approx .15mile east of US 1/C-111 juncture: 25° 17’ 13.46” N, 80° 26’ 29.94” W	DO, SC, pH, TSS, NOx, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4, TURB, SO4,	Biweekly if flowing	Quarterly
L-31NMile0	Existing	0.06 miles south of the intersection of L-29 and L-31N – Stage gage; 25° 45’ 36.25” N, 80° 29’ 53.32” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile1	Existing	One mile south of the intersection of L-29 and L-31N - miles south of the intersection of L-29 and L-31N – Stage gage; 25° 44’ 46.75” N, 80° 29’ 51.46” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile2	Existing	Two miles south of the intersection of L-29 and L-31N - miles south of the intersection of L-29	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
		and L-31N – Stage gage; 25° 43’ 54.75” N, 80° 29’ 48.72” W			
L-31NMile3	Existing	Three miles south of the intersection of L-29 and L-31N - miles south of the intersection of L-29 and L-31N – Stage gage; 25° 43’ 03.32” N, 80° 29’ 47.57” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile4	Existing	Four miles south of the intersection of L-29 and L-31N - miles south of the intersection of L-29 and L-31N – Stage gage; 25° 42’ 06.82” N, 80° 29’ 45.23” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L-31NMile5	Existing	Five miles south of the intersection of L-29 and L-31N – Stage gage; 25° 41’ 09.81” N, 80° 29’ 50.10” W	TPO4 , Na, Ca, Mg, K, Cl, SO4, Alk, SC, DO, pH, SC, T	Monthly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
NE1	ENP Collects SFWMD Analysis	In the Park marsh, 4.67 miles south of the L-29 canal	Turb, TSS, NOX, NO2, NH4, TKN, OPO4, TPO4, Na, K, Ca, Mg, Cl, SO4, (Hard), Alk, (NO3), T, DO, SC, pH	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD
SRS1C	ENP Collects SFWMD Analysis	In the Park marsh, 0.42 miles south of L-29 canal	TPO4, DO, pH, SC, T	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD
SRS1B	ENP Collects SFWMD Analysis	In the Park marsh, 0.31 miles south of L-29 canal	TPO4, DO, pH, SC, T	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD
S-328	Existing	Gated Culvert Structure(8x60”) w/inS-332D detention	Monitoring regime being developed by ENP/SFWMD/FDEP	Autosampler proposed for composite	N/A

Station	Status	Location	Water Quality Parameters	Frequency and Sample Type – Flowing	Frequency and Sample Type – Non-Flowing
		area , discharges to L-31W	concurrent with draft EA (final monitoring requirements will be detailed in the final EA)	timed sample along with. Biweekly grab	

C.4.9.3 Groundwater Hydrology

All existing groundwater monitoring stations described in Section C.4.5.4.3 were included during the initial months of Increment 1 of the S-356 pump station field test. Distal well locations may be eliminated (as included in **Table C.4-2**) if no response is shown to S-356 operation.

C.4.9.4 Groundwater Quality

Groundwater quality was monitored on a monthly or quarterly basis between July 2015 and May 2019, and these data currently are under review. For the COP AMMP, the existing surface water quality monitoring program established under increment 2 is expected to continue on an as needed basis. The intent of the final product increment 2 testing was to provide a mass balance model that defines relative volumes of surface water and groundwater seepage as these waters flow through the canals and into ENP, before and during the S-356 pump station operation. Due to the lack of water quality problems caused by the operational testing of the S-356, the necessity for this mass balance may no longer exist. If future water quality problems are linked to the S-356 pumping, the requirement for a mass balance may need to be revisited.

C.4.9.5 Access

New monitoring stations located at water control structures will be accessed via existing levees or public roadways. To perform environmental sampling within ENP, a sampling and access permit will first be obtained from the National Park Service.

C.4.10 Project Reporting

Technical reporting and evaluations were reported by USACE during the MWD Incremental field tests in accordance with FDEP permit requirements, and the monitoring results were updated to the COP interagency PDT through regular quarterly meetings for the duration of the field tests. Information gained through the field test monitoring has been incorporated into the COP alternative formulation and hydrologic modeling process, culminating in the COP Recommended Plan detailed in the EIS and the supporting COP Water Control Plan and COP AMMP. No further hydrologic data reporting will be conducted under COP based on the hydrometeorologic monitoring plan; rather, further reporting will be conducted in accordance with the commitments identified in the COP Adaptive Management Plan.

Reporting for project monitoring conducted to comply with the Settlement Agreement, C-111 SD EO 9 (until replace with an ERP or CERPRA issued to the SFWMD) Non-ECP permit, or EFA will be performed in accordance with the applicable requirements. Project monitoring that is not tied to those requirements

will be reported on in accordance with the applicable Comprehensive Everglades Restoration Plan Regulation Act (CERPRA) permit requirement.

The Settlement Agreement, Non-ECP or EFA reports would be prepared and provided to FDEP by SFWMD on an annual basis with a target delivery date of April of each year. The S-356 monitoring will continue to be included into the annual SFWMD Settlement Agreement report in the future. The reporting period would be the federal water year for Appendix A and S-356 compliance assessments.

C.4.10.1 Frequency

Monitoring results will be reported no less frequently than annually, and informal updates may be provided quarterly, in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan. Hydrometeorological monitoring information routinely tracked for assessment by USACE, SFWMD, and ENP water managers (refer to Section C.4.8.2.1) will be updated on a daily basis and available for review on the Jacksonville District Water Management web pages:

http://www.saj.usace.army.mil/Missions/CivilWorks/WaterManagement.aspx

C.4.10.2 Content and Format

C.4.10.2.1 Hydrometeorological Analysis and Reporting

The Monitoring Plan contains a list of gages in **Table C.4-1** to be used to evaluate COP water management operations. During the development of the original Increment 1 field test Operational Strategy (refer to Appendix A of the Increment 1.0 Environmental Assessment), the operations sub-team identified a preliminary list of analyses to be conducted to inform future water management actions within the Increment 1, Increment 1.1 and 1.2 test, and Increment 2.0 field test operations, as described below as analysis items A through J. The analyses were developed to complement the overall monitoring plan and evaluate implementation of field test water management operations relative to its goals, objective and constraints.

Consistent with prior coordination protocols, COP water management operations updates and action items will be discussed on a weekly basis between water managers from USACE and SFWMD, as well as ENP when needed, to provide collective interpretation of results and evaluate implementation of operations relative to the goals, objectives, and constraints identified in the COP Water Control Plan. USACE, SFWMD, and ENP water managers will participate in technical team meetings and periodic interagency meetings, in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan under the COP "PDT+" established format. Established meetings (e.g., WCA-3 Periodic Scientists Calls) may also support evaluation of the COP implementation and/or provide additional forums for periodic updates on the monitoring and assessment results. The synchronization of the COP adaptive management and monitoring plan commitments with existing stakeholder meeting forums (with moderate changes to prior established meeting purpose statements and potential changes to the invitation list) will be finalized concurrent with publication and review of the COP Final EIS.

Preliminary methodologies developed to analyze the Incremental field test and evaluate implementation of operations relative to the field test goals, objectives, and constraints are listed below as tasks labeled (A) through (J). Refined methodologies and results for each of these tasks have been discussed using the monthly field test coordination meetings (USACE/SFWMD/ENP/FDEP) and periodically out-briefed to the interagency PDT using the standing quarterly meetings established for the duration of the field tests.

These tasks are not intended to be further pursued distinctly under COP at this time, but key elements with continued implementation uncertainties are integrated in the COP Adaptive Management and Monitoring Plan. The water quality concerns of the S-356 pump station mobilizing higher phosphorus content water from the deeper strata in the aquifer and from the eastern urban areas were not found to occur during the incremental testing. As a failsafe, water quality monitoring at the S-356 will continue and the data will be evaluated to confirm nothing unexpected is occurring with the S-356 water quality. Thus far during the approximate 4.5 years of MWD field tests (started October 2015), the water quality delivered by the S-356 has been reflective of relatively clean seepage water characteristic of ENP SRS and WCA 3B water quality. If there are unexpected water quality results (higher than expected and what has been measured during the incremental testing, the analyses and investigations described below and conducted during the incremental testing may need to be restarted.

These analyses conducted during the incremental testing were developed to complement the overall monitoring plan and were used to assess and evaluate the achievement of several of the stated water management objectives from the field test monitoring plan, including to: (1) ensure existing levels of flood protection are maintained within the northern L-31N Basin (between S-335 and S-331); (2) ensure existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA; (3) determine whether the field test contributes to flooding within the C-111 basin; and (4) determine whether the field test operational changes at S-197 ensure existing levels of flood protection are maintained within the C-111 Basin (south of S-176); the evaluation will include assessment of the trigger criteria used for S-197 gate openings and their beneficial effects on Manatee Bay. The monitoring plans which accompanied each iteration of the incremental field tests recognized that modifications to the methodologies for the analyses listed here may be necessary due to data limitations or inconclusive results realized during implementation of field tests. The analyses account for average monthly historic rainfall as measured at available rainfall gages (S-12D, S-331, S-18C, and basin-wide NEXRAD rainfall datasets), compared to the average monthly rainfall observed at available rainfall gages during this Field Test. The following analysis items were tracked on a real-time basis during the field tests, through and including Increment 2: C, D, E, F, G, and H. The remaining analysis items (A, B, I, and J), which require extended periods of data collection and analysis, were assessed and summarily reported at appropriate, periodic intervals during the field test. With the emphasis on real-time incorporation of field test monitoring information through extensive interagency PDT and technical sub-team and working group meetings throughout the COP plan formulation and hydrologic modeling effort, during development of Water Control Plan, and during development of the Adaptive Management and Monitoring Plan, no further documentation on the Increment 2 field test hydrologic analysis items below were included as a compendium to the Final COP EIS.

A. TASK 1: Develop an accurate water budget for the period of the Field Test from surface water and groundwater monitoring flow and water-quality data. The water budget will quantify contributions of surface and groundwater flow at important reaches surrounding the S-356. Water budget calculations will be developed at the following reaches: 1) along L-31N between S-335 and G-211/S-331; and 2) along L-29 from S-334 to S-333, and 3) along L-30 canal between S-335 and S-356 pump stations.

   METHODOLOGY: Surface water data will be provided by USACE Water Management Section for all structures in the three indicated reaches mentioned on a quarterly basis. The USACE Engineering sub-team will develop a surface-groundwater budget through coordination with the USACE/ENP water quality sub-team monitoring efforts. Daily flow data along L-29 culverts and the bridge is not available. USACE Water Management Section reviewed results to support ongoing adaptive management operational adjustments, as needed, during the test.

TASK 2: Identify the zone of influence of the S-356 pump station. Seepage direction and seepage flow rates from proximal and distal groundwater monitoring wells will be assessed during S-356 pump operation and compared to pre-test baseline data.

METHODOLOGY: Spatial extent of zone of influence due to variable operations of S-356 and regional hydrologic conditions will be analyzed by USACE Engineering sub-team. USACE will review this information to support ongoing adaptive management operational adjustments, as needed, during the test, including influence of S-356 on hydro-period conditions within southeastern WCA 3B.

B. Identify the area of influence for hydrologic effects resulting from increased water deliveries from WCA 3A to NESRS following changes to the G-3273 constraint. Hydrologic effects within the South Dade Basin from reduced deliveries from WCA 3A to the SDCS and use of S-331 to provide flood mitigation for the 8.5 SMA will also be assessed.

METHODOLOGY: Prior to the start of Increment 1.0, USACE completed the following analyses to establish Increment 1.0 pre-project base conditions for the project area: (1) Tabulate data from all regional surface water and groundwater gages (as identified in monitoring plan Appendix C) which include at least 5 years of record for the period July 2002 through May or June 2015; (2) Develop intra-annual stage frequency exceedance curves to demonstrate long-term hydrologic statistics during IOP and ERTP operations (Increment 1 pre-project base conditions); (3) Provide tabular summary of monthly rainfall amounts for the IOP/ERTP period at regional rainfall monitoring locations to establish pre-project rainfall record; and (4) Estimate intra-annual frequency for 2002-2015 rainfall, based on 30-day moving average. During the field test implementation, USACE will provide plots of regional water levels (for all surface water and groundwater gage locations identified in the monitoring plan) and rainfall (30-day moving average and monthly totals) for comparison against the corresponding stage in intra-annual stage frequency curves developed for the pre-project base conditions (stage and rainfall). Water levels observed during the Increment 2 field test will be evaluated using the rainfall frequency data and comparison with the corresponding stage level in the intra-annual stage frequency curves developed for the pre-project base conditions. The zone of influence will be interpreted by water managers from USACE, SFWMD, and ENP, with assistance from the USACE Engineering sub-team.

UPDATE: This analysis item will be superseded with implementation of the COP. Hydrologic modeling was used during the COP Round 2 and Round 3 modeling, including sensitivity simulations, to more comprehensively assess the effects of changes to ENP and SDCS operational changes on flood risk management performance within the South Dade Basin, compared to both the authorized 1994 GRR Base Condition performance levels and the COP 2019/2020 Existing Condition Baseline. The results of the modeling analyses are comprehensively detailed in **Appendix I**, and combined lessons learned from real-time water management operations and modeling assessments were incorporated into the operations included in the COP criteria.

C. Compare the volume of water sent to NESRS (S-333, S-355A, S-355B, S-356) during this Field Test (G-3273 above 6.8 feet) to the historical volume (G-3273 operationally maintained below the 2012 WCP constraint of 6.8 feet, except under Column 2 operations) of water that was sent to NESRS (S-333, S-355A, S-355B).

METHODOLOGY: Show S-333 (minus S-334) discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015).

D. Compare the volume of water sent from WCA 3A to the SDCS (S-334) during this Field Test (revised Column 2 and S-334 operational criteria) to the historical volume (Column 2 operations used if G-3273 above 6.8) of water that was sent to the SDCS (S-334).

METHODOLOGY: Same as C. for S-334 discharges (minus water supply).

E. Quantify the effect of S-356 operation on the L-29 Canal stage and describe conditions under which S-356 may limit the ability to discharge the WCA 3A Rainfall Plan target releases at S-333.

METHODOLOGY: Develop relationship between S-356 discharges and L-29 Canal rise. Estimate the reduction in discharges from S-333 due to rise in tailwater stage in the L-29 Canal. USACE may reference the previous S-356 pump-test report for July 2006 operations (report was included in Appendix C of the 2006 IOP Final Supplemental EIS) as a template. Evaluations will complement the assessment of post-rainfall event responses at LPG-1 and LPG-2, including evaluation of recession rates and hydroperiod response at LPG-1 and LPG-2, which were established by the USACE during the 2016 Emergency Deviation and subsequent extended recovery period. The assessments of post-rainfall event responses, which is further detailed in Section C.6, are needed to ensure that existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA.

F. Compare the volume of water sent to the 8.5 SMA detention area (S-357) during this Field Test (G-3273 above 6.8 feet) to the historical volume (G-3273 operationally maintained below the 2012 WCP constraint of 6.8 feet, except under Column 2 operations) of water that was sent to the 8.5 SMA detention area. The analysis will describe how the operational triggers and/or constraints for S-357 (C-357/C-358 canal stages, gradient between Angel's Well stage and LPG-1 stage, 8.5 SMA detention area stage, and/or S-357N operations) are influenced by the Increment 2 operations within the L-29 Canal and NESRS. The frequency of the applicability of the 8.5 SMA detention area stage constraint will provide information to assess potential effects following future construction and operation of the C-111 South Dade Project Northern Detention Area (NDA).

METHODOLOGY: Show S-357 discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015). Develop intra-annual stage exceedance frequency curves for C-357 stage, gradient, detention cell stage (based on availability of records), including comparison to pre-project baseline developed for analysis item B. Find characteristics of data during current test, compared to pre-test conditions. Evaluations will complement the assessment of post-rainfall event responses at LPG-1 and LPG-2, including evaluation of recession rates and hydroperiod response at LPG-1 and LPG-2, which were established by the USACE during the 2016 Emergency Deviation and subsequent extended recovery period. The assessments of post-rainfall event responses, which is further detailed in Section C.6 (initially established for Increment 1.1 and 1.2), are needed to ensure that existing levels of flood mitigation are maintained within the protected portion of the 8.5 SMA.

G. Compare the volume of water sent to the L-31N/C-1W (S-331, S-338) during this Field Test (G-3273 above 6.8 feet) to the historical volume (G-3273 operationally maintained below the 2012 WCP constraint of 6.8 feet, except under Column 2 operations) of water that was sent to L-31N/C

1W (S 331, S 338). The analysis will describe the effects of pumping constraints at S-357 (C-357 canal stage, gradient between Angel's Well stage and LPG-1 stage, and 8.5 SMA detention area stage) on the L-31N Canal operating range for S-331 and associated S-331 discharges.

METHODOLOGY: Show S-331 and S-338 discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015). Capture volume of water to L-31N if S-356 is not in use due to operational constraints (L-29 or WCA 3A). Find characteristics of data during current test, compared to pre-test conditions.

H. The effect of the water management operating criteria, including S-357N and S-357, on water levels within the perimeter levee of the 8.5 SMA and the 8.5 SMA detention area will be assessed relative to G-3273 relaxation (G-3273 target stage from 6.8 feet up to 7.5 feet) prior to completion of the C-111 South Dade Project NDA.

METHODOLOGY: Show groundwater/surface water contours and other flood mitigation metrics previously determined needed per the USACE 2009 report on 8.5 SMA operational testing (Increment 2 has similar constraints); the 2009 report was included as Appendix I of the June 2011 Environmental Assessment for the 8.5 SMA Interim Operating Criteria.

UPDATE: This analysis item was superseded during the field test. Refer to Section C.6 for detailed methodology for real-time assessment of 8.5 SMA flood mitigation requirements. This analysis item will be superseded with implementation of the COP. Hydrologic modeling was used during the COP Round 2 and Round 3 modeling, including sensitivity simulations, to more comprehensively assess the effects of changes to S-357, S-357N, S-331, and L-29 Canal operations on flood mitigation performance within the 8.5 SMA, compared to the authorized 1983 Base Condition performance levels. The results of the modeling analyses are comprehensively detailed in **Annex 6 of Appendix H**, and combined lessons learned from real-time water management operations and modeling assessments were incorporated into the operations included in the COP criteria.

I. Quantify the effects of the revised trigger criteria for S-197 discharges on flood damage reduction performance within the C-111 South Dade Basin and describe observed ecological effects within the ENP Taylor Slough Basin, ENP Eastern Panhandle, and Manatee Bay/Barnes Sound.

METHODOLOGY: The Florida Department of Agriculture and Consumer Services (FDACS) and the SFWMD requested inclusion of operational changes to the C-111 Canal structures, including S-18C and S-197, within the field test due to their concerns over water levels experienced within agricultural lands located east of ENP. Water levels observed at the following monitoring gauge locations during the Increment 2 field test (if data is available) were be evaluated using the rainfall frequency data and comparison with the corresponding stage level in the intra-annual stage frequency curves developed for the pre-project base conditions (pre-project base condition analysis methodology was previously summarized under item B): G-613, G-3350, TSB, G-864A, G-3620, G-3355, G-3901, G-789, G-3336, and G-3338; the initial set of wells recommended to assess regional groundwater levels in the South Dade area was developed following coordination with the SFWMD. Show S-177, S-178, S-18C, and S-197 discharges under this test (monthly/seasonal/annual) and also tabulate/plot to compare with intra-annual flow frequency exceedance curves for pre-project base conditions (July 2002 through May or June 2015). Identify

timing and frequency of the revised trigger criteria during the Increment 2 field test. Assessment by water managers will be integrated with input from the ecological monitoring sub-team.

UPDATE: This analysis item was superseded during the field test. Hydrologic modeling was used during the COP Round 1 and Round 2 modeling, including sensitivity simulations, to more comprehensively assess the effects of changes to S-197 operations on upstream canal levels and adjacent urban and agricultural lands. The lessons learned were incorporated into the operations included in the COP criteria.

J. Develop an accurate water budget for the period of the Field Test from surface water and groundwater monitoring flow and water-quality data. The water budget will quantify contributions of surface and groundwater flow at important reaches surrounding the S 332B, S-332C, S-332D, S-199, and S-200 pump stations. Water budget calculations will be developed at the following reaches: 1) along L-31N/C-111 between S-331 and S 176; and 2) along the C-111 Canal from S-176 to S-177.

METHODOLOGY: The extent (stress and duration) of testing will be constrained by the limited hydraulic testing latitude prescribed within the framework of the Increment 2 Operational Strategy and the associated EA. With these constraints it is expected that additional, expanded future testing will be required to definitively explore how effectively increased pumping can further separate the canal levels from the water levels along the eastern boundary of ENP during the testing. The hydraulic testing with Increment 2 is essentially limited to better controlled and monitored existing operations. Better controlled operation would consist of hydraulic testing with representative regional conditions and more steady pumping rates. For example, operations may target pumping with steady flow rates at S-332B North, S-332B West, S-332C, S-332D, S-199, and S-200 during hydraulic testing. Hydraulic testing constraints realized with Increment 2 was planned if necessary, expanded future testing in subsequent years of Increment 2, which would be accompanied by appropriate NEPA analysis and documentation. It was determined this was not necessary to continue beyond increment 2

Hydraulic testing of the pump stations should consider the locations of the detention areas receiving their discharges. Since the S-332D pump station discharges into the S-332D Detention Area, which is located south of S-176 (the southern terminus of the L-31N and the northern terminus of the C-111 Canal), discharges from S-332D affect both the L-31N Canal (lowering water levels) and the C-111 Canal between S-176 and S-177. Based on preliminary analysis by SFWMD water managers, the historical flow data for periods with low rainfall has consistently shown that, in absence of the operation of S-200, approximately half of the water pumped into the S-332D Detention Area flows as groundwater to the C 111 Canal. Based on this information, testing of S-332D should include testing of the C-111SC S-200 pump station (225 cfs design capacity) and its associated Frog Pond Detention Area (FPDA). Also, since the C-111 SC S-199 pump station and its associated Aero-Jet Flow Way/Canal are operated in concert with S-200, operations consistent with the C-111 SC Preliminary Project Operating Manual operational criteria for S-199 and S-200 was planned during Increment 2 hydraulic testing. The S-332B West (two diesel and one electric pump; 325 cfs design capacity) and S-332C (four diesel and one electric pump; 575 cfs design capacity) pump stations discharge into the C-111 South Dade Project SDA. Up to about 250 cfs from S-332D can be routed to the SDA through S-332DX1. Based on this information, the hydraulic testing program was b planned with the following separate or combined tests areas:

1. Testing of the Detention Areas between S-331 and S-176. Testing of the interim S-332B North detention area, which will be replaced by the C-111 South Dade Project NDA, and

SDA should be done together. During this testing period, operations at S-331 and S-357 should be representative of normal operations while remaining as steady as practicable.

2. Testing of the Detention Areas between S-176 and S-177. Testing of the S-332D Detention Area and S-200 FPDA should be done together. During this testing period, operations at S-200 and S-199 should be representative of normal operations while remaining as steady as practicable.
3. Testing of the Detention Areas between S-331 and S-177. If there is sufficient water available and representative conditions are achievable, it would be both more efficient and representative to perform the test simultaneously on all of the detention areas.

A reconnaissance test to explore the ability of the detention areas to separate the ENP stage from the L-31N/C-111 Canal stage(s) would be best performed at the start of the dry season when stages along the eastern boundary of ENP are still relatively high. This test would start with the pump stations operating at or near their full capacity (75 to 100 percent of capacity) while maintaining the canals within the identified operational range (e.g. Column 2) and minimizing the volume of water delivered through G-211. This initial phase would be maintained for one week followed by a phase with the total pumping rates reduced by about 25 percent. The inflow through G-211 would be reduced to the extent that it does not cause the canal stage(s) to fall below the bottom of the acceptable range (e.g. Column 2). A goal would be to keep the inflow from G-211 and the S-357 and S-173/S-331 inflows as steady as practicable. This intermediate rate would be maintained for at least one week to allow stages in ENP (lowering), the detention areas (lowering), and the canal (rising) to reach equilibrium. A second reduction in pumping rate by about 25 percent would be performed when the stage in ENP allows the reduction of discharges while maintaining the canal stages within ranges with steady pumping. This phase would be also be maintained for at least one week to allow stages to reach equilibrium. It is expected that at this rate of pumping (approximately half of design pump capacity), the flow through G-211 would be minimized. During these tests, temporary stage monitoring may be installed in some of the existing agricultural wells to help identify flow patterns (drawdown and capture distances). This information may be helpful in identifying the best location for more permanent stage monitoring for subsequent tests.

A reconnaissance test to explore the ability of lower pumping rates (e.g. one electric or one diesel per pump station) to slow the decline of water levels in ENP during the transition from flood control to water supply and during water supply periods may be worthwhile, if further hydraulic testing is able to be conducted within the planned one month duration during Increment 1. Once the water level in the L-31N Canal falls below the pumping range and no water is available to maintain the stage in the detention areas, the L-31N and C-111 canals begin to directly pull water from ENP as they recede to water supply stages.

UPDATE: Delays with the completion of the C-111 South Dade construction until September 2018 precluded application of hydraulic testing during the incremental field test, and hydraulic testing is not recommended for continued inclusion within the COP Water Control Plan. Water budget information will be reported in accordance with the methodology developed for item (A) above.

C.4.10.3 Revisions and Modifications

A surface water and groundwater data collection effort commenced in July 2015 in support of the Increment 1.1/1.2 field test, which was continued through Increment 2 and the future COP. In addition to the ongoing high water levels in the WCAs throughout the 2017 wet season, a prolonged period of high

water levels occurred from November 2015 through April 2016. These conditions limit the duration of S-356 pump station operation, and consequently the evaluation of the test results. However, it was possible to assess the limited dataset in order to identify redundancies and to assess sensor performance. As a result, there are changes in the surface water and groundwater monitoring plans. These changes are identified in the following sections. Revisions to the Groundwater Monitoring Plan were implemented upon completion of the groundwater quality monitoring contract in May 2019. These revisions are:

- Deletion of the groundwater quality monitoring project along L-29, L-30, L-31N, and WCA 3B.
- Installation of up to seven additional monitoring wells identified in this revised monitoring plan: 3 additional wells within the expanded C-111 South Dade Northern Detention Area, 2 additional wells in the Southern Detention Area, and up to 2 additional wells within the 8.5 SMA interior.
- Installation of six groundwater monitoring wells and soil moisture sensors along the Tamiami Trail to address FDOT concerns with raising L-29 operating stages and potential effects on the road base.

C.4.11 Administration and Implementation of the Monitoring Plan

Training or Certification: Field and laboratory training requirements are specified in the FDEP SOPs and FSQM for the field and in the NELAP standard and CLQM for the laboratory.

C.4.11.1 Organization Structure and Responsibilities

This monitoring effort is intended to be collaborative effort of the USACE, SFWMD, and ENP. The roles and responsibilities for field collection, laboratory analysis, and reporting are detailed by activity in **Table C.4-4**. The sampling plan relies heavily upon the ongoing regulatory compliance monitoring conducted by the SFWMD. Field sampling responsibilities are split between the USACE, SFWMD, and ENP. Most of the surface water quality field sampling that is specific to the Increment 2 test is currently scheduled to be conducted by the SFWMD. SFWMD and ENP entered into a five-year cooperative agreement (June 2015 - June 2020), "Cooperative Monitoring, Assessment and Modeling to Support Everglades Restoration: Incremental Testing of G-3273 Constraint Relaxation/S-356 and S-357N Operation and Development of a Combined Operational Plan". This Cooperative Agreement covers additional monitoring of surface water and groundwater quality monitoring identified in this monitoring plan. Any surface water sampling within the Park will be conducted by ENP staff or ENP contractors. The USACE will conduct the groundwater level monitoring. The ADVM monitoring is scheduled to be conducted by the USGS though there is no formal agreement with the USACE or ENP that this work continues for the duration of Increment 2. The MDLPA groundwater monitoring is expected to be conducted for the duration of Increment 2 though there is no contract or guarantee that this will be performed.

For consistency purposes, the plan specifies that all water quality laboratory analysis will be performed by the SFWMD. Regardless of the agency performing the work, field activity will be conducted in general accordance with the SFWMD's Field Sampling Quality Manual (FSQM). Laboratory analysis and data validation responsibilities will be done in accordance with the SFWMD's Chemistry Laboratory Quality Manual (CLQM). These documents define the procedures used by SFWMD personnel to meet the Florida Department of Environmental Protection's (FDEP) Quality Assurance Rule, Florida Administrative Code (F.A.C.) 62-160.

Table C.4-4. Agency roles and responsibilities for each activity.

Activities	Station Registration in DBHYDRO	Field Collection & Lab Reporting	WQ Lab Analysis & Lab Reporting	Analysis and Reporting of Collected Data
Ongoing Surface Water Quality Compliance Monitoring	--	SFWMD	SFWMD	SFWMD**
Ongoing NESRS Water Quality Monitoring	--	ENP	SFWMD	USACE, ENP
Ongoing ADVM Monitoring of Flow in L-29 and L-31N	SFWMD	USGS	N/A	USACE, ENP
Ongoing Groundwater Stage Monitoring	--	USACE, SFWMD, ENP, MDLPA	N/A	USACE, ENP
Increment2 Specific Groundwater Stage Monitoring	SFWMD	USACE	N/A	USACE, ENP
C-111 Spreader Canal Monitoring / Reporting per PIR & USACE Regulatory Permit **	--	--	--	SFWMD

* Does not include QA/QC samples or field analytes. Computed using the frequency, number of stations, number of individual laboratory analytes, and two year duration of monitoring

** SFWMD will continue to separately provide the annual South Florida Environmental Report and the annual Settlement Agreement Report. In addition, the SFWMD will provide USACE with quarterly monitoring reports in accordance with the requirements of the Department of Army permit for C-111 Spreader Canal.

C.4.11.1.1 Monitoring Program Team Assignments

For this project, the monitoring will be conducted by personnel from the USACE, SFWMD, DOI, as well as contractors. Each agency will be responsible for identifying their monitoring team members and assigning responsibilities and reporting chains.

C.4.11.1.2 Implementation

This monitoring plan is part of a federal-state cost shared project. The USACE has completed construction of the MWD and C-111 South Dade project features, with assistance from SFWMD. Monitoring efforts will likely be conducted by the SFWMD given its extensive experience conducting on-going environmental monitoring.

C.4.11.1.3 Program and Protocol Review

Review Summary:

- October 2019: Monitoring plan revised for COP updates (previous update completed for Increment 2 in November 2017).

The surface water quality sub team has reviewed the existing monitoring plan in place for increment 2 and determined the existing monitoring regime is sufficient for COP at this time. No changes are proposed

at this time to the surface WQ monitoring plan for the project area. As new features are added to the system or modifications to the operational plan are proposed or new permits are issued for features in the project area, the monitoring plan will be reviewed and modified as necessary.

C.4.12 Cost Estimates

Estimated costs are not available at this time.

C.4.13 Data Quality Objectives for Water Quality Data

While it is recognized that data quality objectives (DQOs) are typically developed separately for each specific monitoring project, all mandated monitoring conducted by the SFWMD must meet the objectives conveyed in the FDEP's Quality Assurance Rule, 62-160 F.A.C. The SFWMD has adopted a uniform set of DQOs following criteria detailed within the "Analytical Methods and Default QA/QC Targets" table of the SFWMD's Chemistry Laboratory Quality Manual (CLQM). For those samples analyzed by the FDEP Laboratory, the SFWMD has adopted the DQOs within the most recent version of the FDEP's Laboratory Chemistry Quality Manual.

Water Quality and sediment samples, including field testing and field quality control samples, are collected in accordance with the FDEP Quality Assurance Rule, 62-160 F.A.C. and the current version of the Field Sampling Quality Manual (SFWMD-FIELD-QM-001) (FSQM). Applicable sections of the FSQM include, but are not limited to, field sample collection procedures, decontamination procedures, field testing, quality control requirements, and documentation requirements.

The DQOs of the field testing parameters for this project are specified in the field testing section of the FSQM. This manual is updated annually, and therefore, the most recent version of the FSQM details the specific field testing data quality objectives for this project at the time of sample collection.

Samples are analyzed according to the provisions within the FDEP Rule 62-160 F.A.C. and the CLQM. This manual is annually updated, and therefore, the most recent version of the CLQM details the specific laboratory analyses' DQOs for this project at the time of sample collection

Data not meeting the quality objectives must be qualified using standard FDEP qualifier codes (F.A.C. 62-160) and corrective actions may be taken as outlined in the SFWMD's FSQM and CLQM and Data Validation and Reporting Sections SOPs.

C.4.14 Monitoring Data Elements/Indicators

Monitoring proposed for this project includes existing monitoring required for compliance with existing or future permits or the Settlement Agreement. In addition to demonstrating compliance with water quality criteria, the data collected under this plan will be used to assess overall water quality impact associated with operating the S-356 pump station, raising the L-29 Canal maximum operating limit, and removing the G-3273 stage limit at S-333.

C.4.15 Procedures and Methods

Sampling methods will follow well-defined methodologies that have been approved by Federal and state regulatory agencies. The SFWMD's FSQM shall be used for all water quality and sediment sampling procedures. Once the DQOs are established, the QASR should be consulted to identify the analytical

methods that will meet the project objectives. Methods specified in the CLQM or their equivalent shall be used when specified.

The laboratory that processes the samples collected in this plan will report data using ADaPT (Automated Data Processing Tool) software. Staged Electronic Data Deliverable (SEDD) (http://www.epa.gov/fem/pdfs/sedd_adr_imp_overview.pdf) or the Automated Data Review (ADR) software may be used in addition to ADaPT.

Each discrete sample will be assigned a unique sample identification number that ensures that it can eventually be retained as a unique database record linked to a specific location. All these activities regarding a sample will be documented in a format that assures that the resulting data are traceable and of known and documentable quality.

C.4.15.1 Laboratory Qualifications

Laboratories used in this plan will be certified by the Florida Department of Health Environmental Laboratory Certification Program (FDOH ELCP). At the time the laboratory(s) are selected, this plan will be updated to include the laboratory certifications by the test method, analytes/parameters and matrix that are reported for the project. As specified by the CERP QASR Chapter 4.0, laboratories used for analysis of environmental samples will be pre-approved and subjected to comparative testing if available, such as the performance evaluations overseen by the QAOT. These requirements shall be defined in the laboratory's contract or work order with the contracting agency.

C.4.15.2 Rationale for Indicator Selection

Field and laboratory analytes are collected per the requirements of the EFA, Settlement Agreement, and anticipated CERPRA and EFA permits. The focus of the monitoring efforts is on the collection of macronutrients as they are used as indicators of restoration success or project impact.

C.4.15.3 Sampling Frequency and Duration

Sampling frequencies proposed in this monitoring plan are either directly the result of the requirements of the EFA, Settlement Agreement, or Non-ECP permit, or are anticipated to be required for future EFA or CERPRA permits. See **Table C.4-2** and **Table C.4-3** for water quality sampling programs.

C.4.15.4 Assessment Process and Decision Criteria (triggers and thresholds)

Assessment frequency is annual as established by the requirements of the EFA, Settlement Agreement or Non-ECP permit. Decision criteria are established by the compliance values from these cited permits and settlements.

C.4.16 Data Collection

C.4.16.1 Sample/Data Collection Standards and Ethics

Every person performing field sampling must commit to following project specific requirements, SFWMD's FSQM, field SOPs, QASR requirements, and other instructions as issued, to assure that samples collected are of known and documented quality and are defensible.

C.4.16.2 Sample Submission

Requirements for sample handling, custody and analysis holding times are detailed in the SFWMD's Chemistry Laboratory Quality Manual and FDEP SOPs (DEP-SOP-001/01).

C.4.16.3 Chain of Custody

The Chain of Custody (COC) must accompany all samples submitted to internal or external laboratories. A COC form documents the possession of the samples from the time of collection to receipt in the laboratory. A COC form will be utilized and must be signed by the collector before it is relinquished to the laboratory. Field documentation must conform to the requirements specified in FDEP SOP FD1000 and the field documentation section of the SFWMD FSQM.

C.4.16.4 Quality Control of Samples

C.4.16.4.1 Laboratory Quality Control

Laboratories must meet NELAC requirements, the requirements detailed in Chapter 4 of the CERP QASR (http://www.evergladesplan.org/pm/program_docs/qasr.aspx) and applicable requirements as detailed in FDEP's Quality Assurance Rule, 62-160 F.A.C. All laboratory and applicable quality control data shall be submitted to the District in the ADaPT compatible format.

C.4.16.4.2 Field Quality Control Samples

Field Quality control samples will comply with the Field Quality Control section of the FSQM, Florida Department of Environmental Protection (FDEP) requirements (DEP-SOP-001/01,), and those developed in the DQO process. All requirements in the FDEP's Quality Assurance Rule should also be followed.

C.4.16.4.3 Field Record and Data Review

Field record and data review procedures are specified in the SFWMD FSQM and associated SOPs Responsibilities of the Laboratory Data Validation.

Data validation shall be performed in accordance with the requirements detailed in Chapter 5 of the CERP QASR. When preparing the ADaPT file the laboratory will review the data for completeness and accuracy.

C.4.16.5 Data Storage and Archiving

Long-term maintenance and management of digital information are vital to all PLMPs. Maintaining and managing digital data, documents, and objects that result from projects and activities is the responsibility of all parties involved. CGM54 will be followed to help ensure the continued availability of crucial project information and permit a broad range of users to obtain, share, and properly interpret that information. After the data validation process, all data are maintained so that end users can retrieve and review all information relative to a sampling event. Field notes are maintained on an internal server either by scanning actual field note pages or by uploading narratives from field computers path to server. All analytical data and field conditions are sent to the SFWMD database (DBHYDRO) for long-term storage and retrieval. If data are not suitable for DBHYDRO they will be entered into the CERP Integrated Database (CID) on CERPZone through the Morpho interface.

SFWMD or its surrogate shall maintain records of field notes and copies of all records relative to the chain of custody and analytical data. It is the responsibility of the SFWMD or its surrogate to maintain both current and historical method and operating procedures so that at any given time the conditions that

were applied to a sampling event can be evaluated. Upon completion of the project, the collecting agency shall provide all original field notes to the District's WQB for permanent archival.

Records shall be maintained for the life of the project and five years thereafter, in a manner that will protect the physical condition and integrity of the records. Storage shall follow the District's records storage procedure. Access to archived methods shall be through designated records custodian. Corrections of data or records shall follow the established SFWMD SOPs.

C.4.17 Documentation

Field records shall be documented in accordance with the procedures specified in the SFWMD FSQM.

C.4.18 Quality Assurance and Quality Control

C.4.18.1 Laboratory and Field Audits

Audits will be performed according to the SFWMD FSQM and associated SOPs. Audit reports will be provided to the project manager. The authority of the auditor to stop work for processes that impact the quality of the data will also be defined, along with how and to whom the audit findings are reported and distributed.

C.4.19 Data Analysis and Records Management

The SFWMD has adopted a uniform set of DQOs following criteria detailed by the table entitled Field Quality Assurance Objectives found in the field testing section of the FSQM and within the "Analytical Methods and Default QA/QC Targets" table of the CLQM.

C.4.19.1 Data Quality Evaluation and Assessment

The data quality assessment (DQA) process uses scientific and statistical data evaluation procedures to determine if the data are of the right type, quantity, and quality to support their intended use. The DQA process is discussed in the QASR Chapter 11 and detailed guidance is described in EPA QA/G9R, Data Quality Assessment: A Reviewer's Guide (EPA, 2006a) http://www.epa.gov/quality/qs-docs/g9r-final.pdf.

The Science Policy Council has defined general data quality assessment factors (EPA, 2003) http://www.epa.gov/osa/spc/pdfs/assess2.pdf) that should be considered during the DQA process. These include soundness, applicability and utility, clarity and completeness, uncertainty and variability, and evaluation and review.

C.4.20 Adaptive Management Considerations

This monitoring is proposed for the duration of COP. As the data collected during COP becomes available, the monitoring regime may be modified, based on the evaluation of the data. Any changes to monitoring mandated by FDEP permits or other required monitoring regimes will need to be coordinated for approval with the appropriate agencies. Monitoring that is not mandated is subject to available funding. Modifications to the monitoring and/or implementation of the management options identified in the COP AMMP will be coordinated with the South Atlantic Division (SAD), as the SAD provides the approval authority for the 2020 COP Water Control Plan.

C.5 Water Quality and Hydrology Monitoring Plan South of S-331

C.5.1 Introduction

The main water quality and surface hydrology monitoring plan document for Increment 2 (Appendix C.4) addresses monitoring required for areas primarily located north of the S-331 station. Section C.5 addresses water quality and hydrologic monitoring in areas south of the S-331 structure that may be affected by operations. Hydrologic and water quality monitoring is required south of the S-331 structure to assess the impact of operations, if any, on flooding within South Dade Agricultural area from south of the S-331 structure to the S-197 structure. This need was identified by FDACS, during discussions with PDT agency members participating in Increment 1 development, who were concerned that this project and the recently constructed C-111 Spreader Canal project might cause or contribute to flooding of nearby agricultural lands. To address this concern, the USACE will continue to rely upon the SFWMD to continue monitoring and to perform the flood impact analysis required in the C-111 Spreader Canal Western Project and codified through the requirements of the Department of Army permit for C-111 Spreader Canal which includes quarterly monitoring reports.

During the field test, USACE supplemented the SFWMD flood impact analysis with an assessment of groundwater stages and structure flows that occur in areas south of the S-331 structure, north of the S-176 control structure. The test did not significantly alter existing flow paths and for this reason, the existing water quality monitoring efforts south of the S-331 structure will not be augmented for this project.

C.5.2 Project Description

With implementation of the original Increment 1 field test, the sole change to the 2012 Water Control Plan for structures located south of the S-331 pump station during testing was the modification of opening criteria for the S-197 structure. This modification is likely to result in additional discharge at S-197 under hydrologic conditions and upstream operations that could result in increased potential risk of flooding of agricultural lands east of the C-111 canal. The modification was intended to ensure that flood impacts, if any, from test operations north of S-331 are mitigated through increased use of low level freshwater releases from the S-197 structure to the downstream Manatee Bay and Barnes Sound. Consistent with the requirements of the 2016 USFWS Biological Opinion, Increment 1.1 and 1.2 included additional operational changes to the 2012 Water Control Plan for S-332B, S-332C, and S-332D which moderately lowered the L-31N Canal to aid with achievement of the desired stage targets and recession rates for the Eastern CSSS sub-populations (C, E, and F) during the CSSS nesting window (mid-February through July) and to maintain the hydraulic ridge, extend hydroperiods, and promote more flow toward ENP during the months of August through mid-February; additional operational changes at S-194, S-196 and S-338 were also included for conditions when the capacity at S-332B, S-332C, and S-332D is unable to maintain the L-31N operational range (S-338 is located north of S-331).

The revised operating rules for S-197 include trigger criteria under Increment 1 were based on WCA 3A high water conditions, full gate openings at S-18C, and stage criteria in the C-111 basin at the S-178 tailwater to establish target flows at S-197. The Increment 1 operational plan also limited the Level 1 releases to 500 cfs for S-197 gate openings triggered by the S-178 tailwater stage. For Increment 1.1/1.2,

the revised operating rules for S-197 included trigger criteria to achieve interim goals detailed in the operational strategy based on WCA 3A high water conditions and stage criteria in the C-111 basin at the S-18C headwater (including comparison of observed headwater compared to the historical monthly median stage) to establish target flows at S-197. The plan also capped the Level 1 releases to 500 cfs for S-197 gate openings triggered by the S-18C headwater stage criteria. Ideally, the complex operating rules at S-197 and for G-3273 constraint relaxation operations will provide discrete periods when potential effects from the C-111 Spreader Canal Western Project are separable from potential effects of the G-3273 relaxation operations.

Increment 2 further expanded the use of low-volume S-197 operations to include drier periods under Condition 1 when the stage at G-3273 is below 6.6 feet, NGVD and the WCA 3A stage is below the Increment 1 and 2 Action Line. The Increment 1.1 and 1.2 operational changes at S-332B, S-332C, and S-332D are retained for Increment 2.

To ensure that the existing level of flood protection is maintained within the C-111 Basin and adjacent areas potentially affected by the C-111 Spreader Canal Western Project, the Increment 2 monitoring plan will incorporate the ongoing SFWMD operations, monitoring, and performance assessments conducted as part of the CERP C-111 Spreader Canal Western Project. Extensive hydrologic modeling and socio-economic evaluations of the C-111 South Dade flood risk management performance was conducted during the parallel development of the COP.

C.5.3 Primary Objectives of Water Quality and Hydrology Monitoring Plan South of S-331

This is a supplemental monitoring effort associated with potential impacts to surface water and groundwater conditions south of the S-331 structure. There are four primary objectives:

1. Ensure existing levels of flood protection are maintained within the southern L-31N Basin (between S-331 and S-176).
2. Ensure existing levels of flood protection are maintained within the C-111 Basin (south of S-176).
3. Determine whether the COP operations contribute to flooding within the C-111 basin.
4. Determine whether the COP operational changes at S-197 ensure existing levels of flood protection are maintained within the C-111 Basin (south of S-176), including assessment of the trigger criteria used for S-197 gate openings.
5. Active Mandates and Permits (water quality monitoring)

Water quality monitoring of inflows to ENP and park marsh stations is generally governed by the 1992 Consent Decree, and the TP Rule, and the 2012 Consent Order. Hydrologic monitoring in the lower L-31 basin and C-111 basins is primarily conducted to facilitate the complex structure operations. Continuing from Increment 2, COP will utilize a network of monitoring stations to demonstrate the effects of operations on hydrology and water quality as well as compliance with water quality standards. Authorization to conduct the Increment 2 test was be obtained from the FDEP and this monitoring plan was included in that authorization by reference. The COP WQ monitoring plan for the S-356 and other regional structures is already established and include in the existing FDEP operational authorizations or the Settlement Agreement monitoring requirements.

C.5.4 Monitoring Components

C.5.4.1 Project Baseline Monitoring

Existing water quality and hydrology data that have been collected in the L-31N and C-111 basins over the last 10-15 years (including the three increments of the MWD field test) will serve as the baseline data for the COP, similar to the approach used during the field tests. Refer to Section C.4.10.2.1 of Appendix C for additional details.

C.5.4.2 Construction Monitoring

Construction of the C-111 South Dade Project was completed in August 2018. No construction phase monitoring is anticipated for COP.

C.5.4.3 Post-Construction Monitoring (Effectiveness Monitoring)

Based on the water management and data evaluations conducted during Increment 2, the water quality and hydrologic monitoring plan for south of S-331 has been reviewed to match the needs of the COP update to the Water Conservation Areas - Everglades National Park - Everglades National Park to South Dade Conveyance System Water Control Plan.

C.5.4.4 Inventory of Existing Monitoring Networks

C.5.4.4.1 Surface Water Hydrology

At flow control structures, surface water hydrology measurements include headwater and tailwater stage and flow volume. At non-structure monitoring locations, surface water hydrology measurements include stage. **Table C.5-1** shows a list of the existing, established hydrologic monitoring locations within the COP area of interest south of the S-331 pump. Reference maps which show these monitoring locations are included in **Figure C.5-1**, **Figure C.5-2**, and **Figure C.5-3**.

Table C.5-1. Gages and sensors for surface water hydrologic monitoring during the COP located south of S-331.

Feature	Parameter	Purpose	Responsible Party
S-331	HW, TW, Q	Canal level, flow volume	SFWMD
S-357	HW, TW, Q	Canal level, flow volume	SFWMD
G-3628	Stage	Depth, duration, recession	USGS
G-3437	Stage	Depth, duration, recession	USGS
S-332B	HW, TW, Q	Canal level, flow volume	SFWMD
S-332C	HW, TW, Q	Canal level, flow volume	SFWMD
S-194	HW, TW, Q	Canal level, flow volume	SFWMD
S-196	HW, TW, Q	Canal level, flow volume	SFWMD
S-332D	HW, TW, Q	Canal level, flow volume	SFWMD
S-332DX1	HW, TW, Q	Southern Detention Area water level, flow volume	SFWMD
S-328	HW, TW, Q	Flow volume	SFWMD
RG4	Stage	Southern Detention Area water level	ENP

Feature	Parameter	Purpose	Responsible Party
NTS18	Stage	Southern Detention Area water level	ENP
G-789	Stage	Depth, duration, recession	USGS
G-864A	Stage	Depth, duration, recession	USGS
G-613	Stage	Depth, duration, recession	USGS
G-3620	Stage	Depth, duration, recession	USGS
G-3355	Stage	Depth, duration, recession	USGS
G-3901	Stage	Depth, duration, recession	USGS
G-3627	Stage	Depth, duration, recession	USGS
S-176	HW, TW, Q	Canal level, flow volume	SFWMD
S-177	HW, TW, Q	Canal level, flow volume	SFWMD
S-178	HW, TW, Q	Canal level, flow volume	SFWMD
S-199	HW, TW, Q	Canal level, flow volume	SFWMD
S-200	HW, TW, Q	Canal level, flow volume	SFWMD
S-18C	HW, TW, Q, Precipitation	Canal level, flow volume	SFWMD
S-197	HW, TW, Q	Canal level, flow volume	SFWMD
ENP-TSB	Stage	Marsh water level	ENP
EVER8	Stage	Marsh water level	ENP
L31N to S-331*	Q	ADVMS (3) to measure flow volume	USACE
LPDC2	Stage	Water Level in 8.5 SMA Detention Cell and NDA Western Flow way	USACE
NDA1W	Stage	Water Level Monitoring in NDA Western Flow way	USACE
NDA1E	Stage	Water Level Monitoring in NDA Eastern Flow way	USACE
SDA1	Stage	Water Level Monitoring in SDA Western Flow way	USACE
SDA2	Stage	Water Level Monitoring in SDA Western Flow way	USACE

Notes: HW– headwater stage; TW– tailwater stage; Q– discharge (cfs)
* Proposed

C.5.4.4.2 Surface Water Quality

No new water quality monitoring efforts are planned for the COP for areas south of the S-331 structure. The Increment 2 testing did not significantly affect water quality conditions south of the S-331 structure. For this reason, the existing water quality monitoring program which includes the collection of biweekly or monthly samples at the canal control structures will be sufficient for the purposes of this project. Readers are referred to the SFER report (SFWMD, 2013) for specifics on the location, frequency, and historic sampling results of monitoring performed at stations south of the S-331 structure.

C.5.4.4.3 Groundwater Hydrology

Several State and Federal agencies have constructed groundwater monitoring wells along the L-31N and C-111 canals. **Table C.5-2** lists the existing groundwater level monitoring in these areas. The proposed groundwater monitoring plan will coordinate data acquisition from all wells shown in **Figure C.5-1**, **Figure**

C.5-2, **Figure C.5-3**, **Figure C.5-4** and **Figure C.5-5**. The result is a comprehensive groundwater monitoring network that will provide detailed data to evaluate effects of COP on the lower L-31 basin and C-111 basin.

C.5.4.4.4 Groundwater Quality

No new groundwater quality monitoring efforts are planned for the COP for areas south of the S-331 structure. The COP is not expected to significantly affect groundwater quality conditions south of the S-331 structure. For this reason, the existing water quality monitoring program which includes the collection of biweekly or monthly samples at the canal control structures will be sufficient for the purposes of this project. Readers are referred to the SFER report (SFWMD, 2013) for specifics on the location, frequency, and historic sampling results of monitoring performed at stations south of the S-331 structure.

Table C.5-2. Existing active and inactive monitor wells with real-time groundwater level data in the southern L-31N and C-111 basins.

Well	Location	Open Interval (ft. NGVD29)	Access Data (real-time or near-time) and comments
G-613	25°24'27.4"N, 80°31'27.2"W; N side SR 9336 (Ingraham Hwy), 4 mi SW of Florida City	-10.8 to -12.9	http://waterdata.usgs.gov/nwis/uv?agency_code=USGS&site_no=252425080320001
G-3355	25°23'35.9"N,80°30'03.3"W, 40351 SW 192 Ave Everglades Alligator Farm	Total Depth - 7.4	http://waterdata.usgs.gov/nwis/inventory/?site_no=252332080300501&agency_cd=USGS
G-3620	25°23'07.5"N,80°32'29.3"W, S terminus SW 217th Ave 1.25 mi S of SR 9336	Total Depth - 5.5	INACTIVE:http://waterdata.usgs.gov/nwis/inventory/?site_no=252312080320301&agency_cd=USGS; well planned to be re-activated to support ongoing CERP C-111 Spreader Canal monitoring plan
G-3901	25°25'06.66"N,80°30'06.2”W SW 192nd Ave and SR 9663	Total Depth - 14.3	http://waterdata.usgs.gov/nwis/inventory/?site_no=252506080300601&agency_cd=USGS
G-864	Navy Wells Pineland Preserve, SW 354th St 25°26'20.8"N 80°30'30.4"W	Total Depth - 11.1	http://waterdata.usgs.gov/nwis/inventory/?site_no=252612080300701&agency_cd=USGS
G-864A	Navy Wells Pineland Preserve, SW 354th St 25°26'20.8"N 80°30'30.4"W	Total Depth - 11.7	http://waterdata.usgs.gov/nwis/inventory/?site_no=252619080310201&agency_cd=USGS
G-3437	25°34'01.2"N, 80°34'01.5"W, 0.17 mi N of SW 232nd Ave & SW 216th St	Total Depth - 5.86	http://waterdata.usgs.gov/nwis/inventory/?site_no=253400080340401&agency_cd=USGS
G-789	25°29'28.7"N, 80°33'19.6"W Homestead Gen. Aviation Airport S	Total Depth - 22.4	http://waterdata.usgs.gov/nwis/inventory/?site_no=252928080332401&agency_cd=USGS
G-3336	25°20'16.1"N,80°33'56.3"W ENP: 2.6 mi WNW of S-18C	Total Depth - 33.5	http://waterdata.usgs.gov/nwis/inventory/?site_no=252007080335701&agency_cd=USGS
G-3338	25°20'15.86"N, 80°28.753”W, C-111 canal north of S-18C	Total Depth - 48.15	http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.date_selection?v_category=SW&v_category=GW&v_js_flag=Y&v_db_request_id=3647509&v_parameter_string=&v_dbkey=QS2

Well	Location	Open Interval (ft. NGVD29)	Access Data (real-time or near-time) and comments
			74&v_frequency=&v_sdate=20031106&v_edate=20150426
G-1251	25°19'15.9"N,80°33'56.7"W, ENP: 2.7 mi WSW of S-18C	Total Depth - 55.8	http://waterdata.usgs.gov/nwis/inventory/?site_no=251922080340701&agency_cd=USGS
G-3628	25'38.83"N, 80°32'04.74"W ENP: Eureka Dr 0.1 mi S of 8.5SMA detention area	Total Depth - 4.9	http://waterdata.usgs.gov/nwis/inventory/?site_no=253539080320501&agency_cd=USGS
G-3627	25°36'31.3"N,80°30'11.7"W Richmond Dr & SW 192nd Ave 0.46 mi SE of S-331	Total Depth - 4.1	http://waterdata.usgs.gov/nwis/inventory/?site_no=253632080321101&agency_cd=USGS
C111AW	25°23'35.5"N 80°33'13.4"W SW 224TH AVE 0.7 MI S OF SR 9336	Approximately -2 to -12	http://www.sfwmd.gov/dbhydroplsql/show_wilma_info.report_process?v_output_format=summary&v_os_code=win&v_station=C111AW
C111AE	25°23'33.4"N 80°32'29.8"W SW 217TH AVE 0.77 MI S OF SR 9336	Approximately -2 to -12	http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_js_flag=Y&v_category=SW&v_category=GW&v_station=C111AE&v_dbkey_list_flag=Y&v_order_by=DBKEY
G-3349_G	25°20'27.0"N 80°29'37.0"W 2.1 MI ENE OF S-18C ON C-110	Total Depth - 59	INACTIVE:http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=G-3349_G&v_js_flag=N
G-3350	25°21'15.0"N 80°29'35.0"W 1.4 MI S OF SW424TH ST ON C-110	Approximately 0.25 to 80.6	http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=G-3350_G&v_js_flag=N
G-3354_B	25°18'42.4"N 80°28'38.0"W 0.82 mi N of Aerojet Canal 1.1 mi E of C-110	Not reported	INACTIVE:http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=G-3354_B&v_js_flag=N
P-1, P-2, P-3, P-4, P-5, P-6, P-10*	CERP C-111 Spreader Canal Project Area (east of the L-31N Canal, located between S-331 and S-18C)	Design in Progress	Proposed wells may be installed by SFWMD contractors, concurrent with Increment 1.1/1.2 field test; well information may be incorporated into the Increment 1.1/1.2 monitoring, if available.
L31NW02 GW1; L31NW02 GW2; L31NW02 GW3 (prior P-2)	252933.3, 803233.3 (1.5 mi NE of S-332D)		C-111 Spreader Canal monitoring well completed by SFWMD in April 2017 (GW1 depth is 15 feet; GW2 depth is 35 feet; GW3 depth is 55 feet) http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=L31NW02GW1
L31NW03 GW1; L31NW03 GW2; L31NW03 GW3	252717.6, 803224.1 (2.5 mi SE of S-332D)		C-111 Spreader Canal monitoring well completed by SFWMD in March 2017 (GW1 depth is 15 feet; GW2 depth is 35 feet; GW3 depth is 55 feet)

Well	Location	Open Interval (ft. NGVD29)	Access Data (real-time or near-time) and comments
(prior P-3)			http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=L31NW03GW1
L31NW06	253247.0, 803242.5 (1.3 mi E of S-332B)		C-111 Spreader Canal monitoring well completed by SFWMD in February 2017. (Depth is 15 feet) http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=L31NW06GW
C111W11	252558.8 803237.8 (1.25 mi SE of S-200)		C-111 Spreader Canal monitoring well completed by SFWMD in February 2017. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=C111W11
C111W12	252453.1, 803127.1 (2.4 mi NE of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in June 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_station_info?v_station=C111W12
C111W14	252438.9, 803201.1 (1.6 mi NE of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in August 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=C111W14&v_js_flag=N
C111W15	252413.1, 803040.6 (2.9 mi E of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in August 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=C111W15&v_js_flag=N
C111W16	252419.7, 802957.9 (3.7 mi E of S-199)		C-111 Spreader Canal monitoring well completed by SFWMD in May 2015. http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.show_dbkeys_matched?v_station=C111W16&v_js_flag=N
NDA1W	805066.7 452368.8 (NDA Western Flow Way)		DBHYDRO
NDA1E	805035.2 452240.2 (NDA Eastern Cell)		DBHYDRO
SDA1	797311.6 436248.9 SDA Western Flow Way)		DBHYDRO
SDA2	797469 426568.4 (SDA Western Flow Way)		DBHYDRO

NOTE: Additional resources will be required to activate those monitor wells indicated above as “INACTIVE”.

* Proposed new wells for CERP C-111 Spreader Canal project monitoring (wells are designated with interim well names).

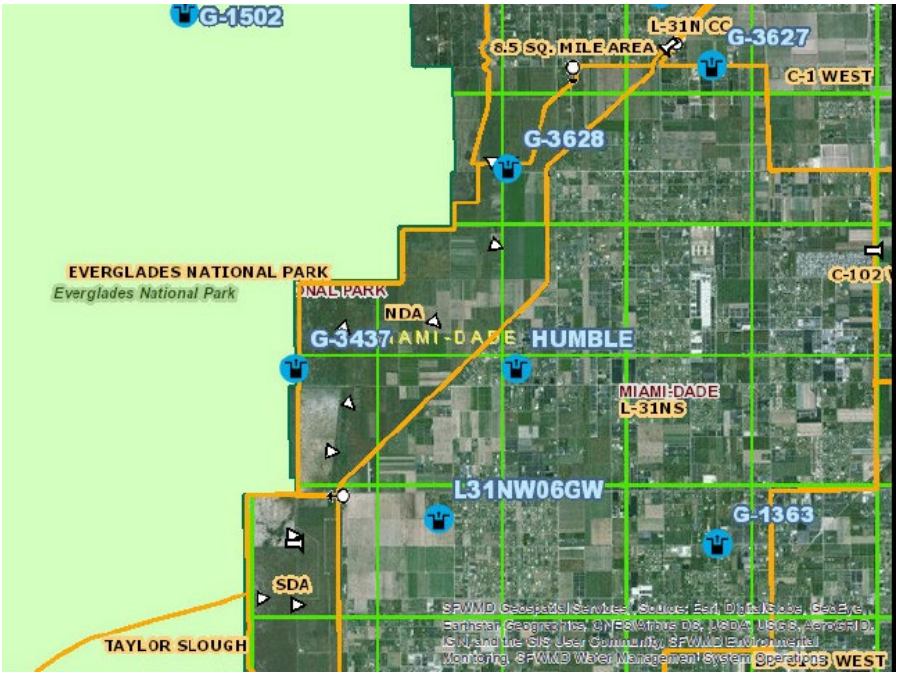


Figure C.5-1. Selected real-time groundwater monitoring stations and structures in southern L-31N basin.

Figure C.5-2. Selected real-time groundwater monitoring stations and structures in the northern C-111 basin.

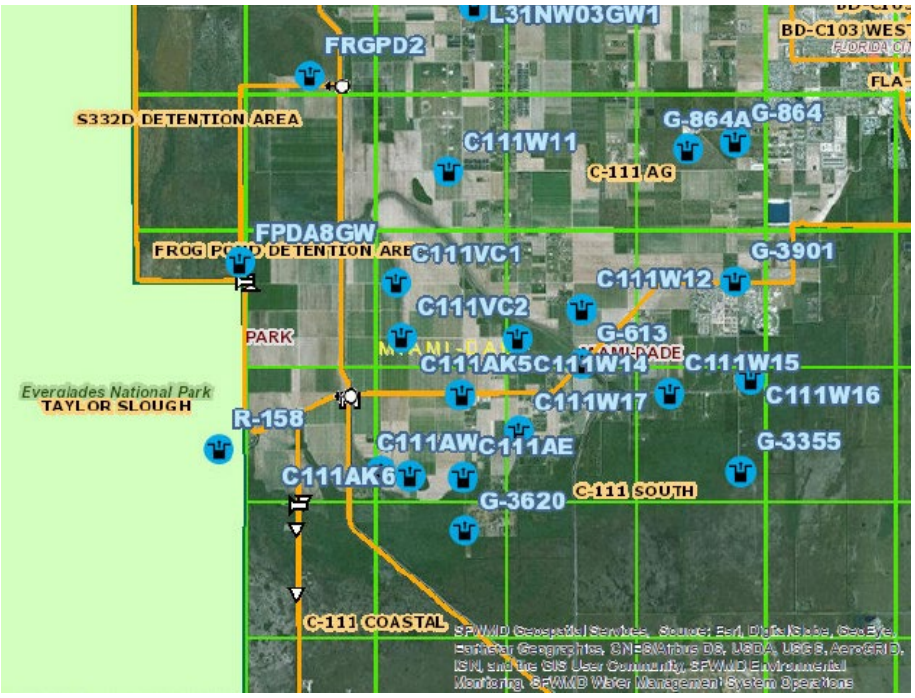


Figure C.5-3. Selected real-time groundwater monitoring stations and structures in the central C-111 basin.

Figure C.5-4. Selected real-time groundwater monitoring stations and structures in the southern C-111 basin.

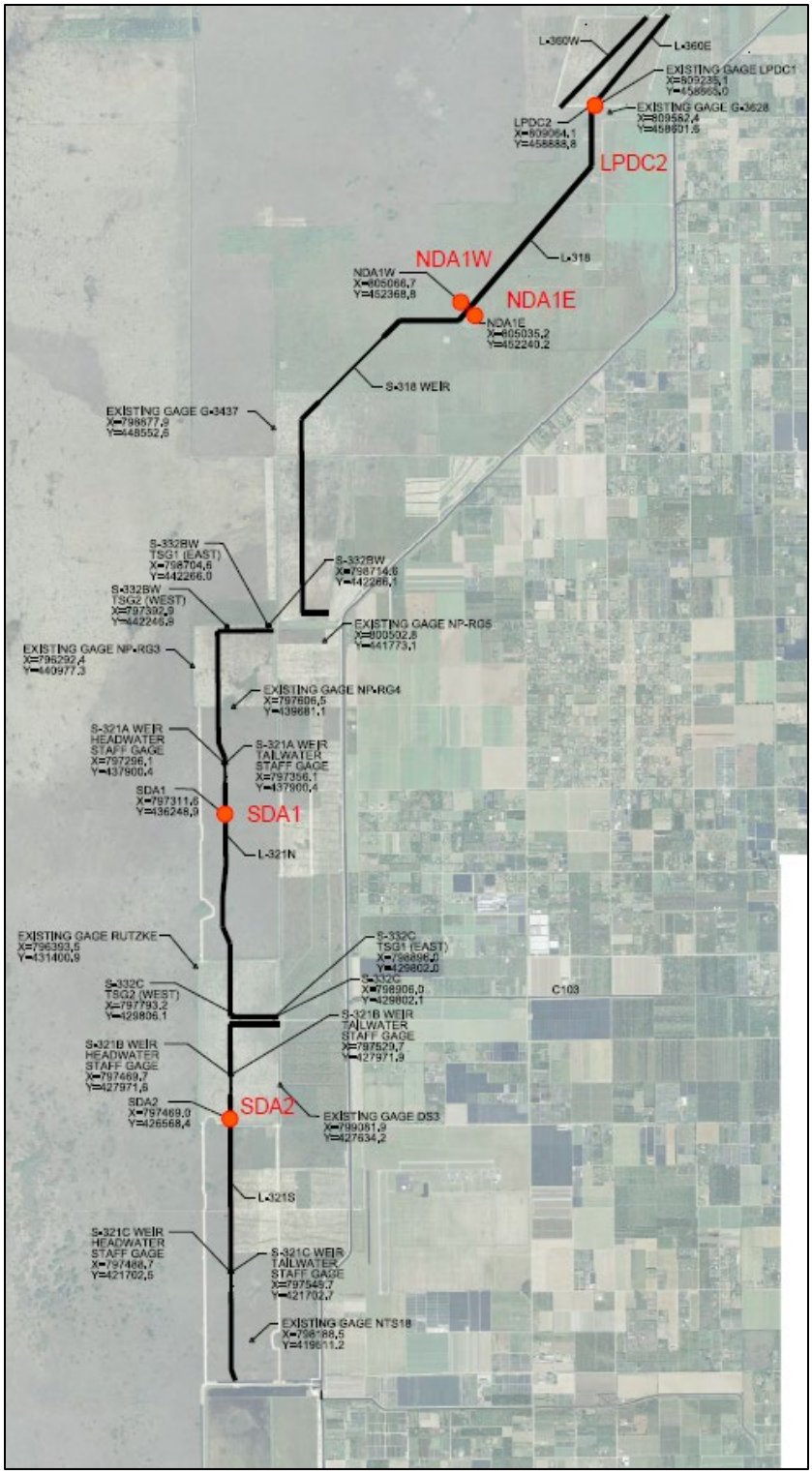


Figure C.5-5. Locations for the new monitoring stations in the C-111 Detention Areas.

C.5.4.5 Integration of Monitoring Components

New monitoring stations (refer to Section C.4.9) proposed as part of this project were selected based upon a review of the ongoing monitoring and the expected compliance requirements associated with the planned project features. Staff from SFWMD, USACE, DOI, and FDEP will work together to ensure that the new monitoring stations were consistent with the permit requirements and not duplicative of ongoing monitoring at existing stations.

C.5.5 Duration

This monitoring program was conducted during the Increment 2 testing period, which is expected to last up to implementation of COP. The Increment 2 test commenced prior to March 1, 2018. At the completion of Increment 2 testing, some of the new elements of this monitoring plan may be incorporated into the ongoing compliance monitoring efforts and/or ongoing water management operational assessments within the study area. At this time the Increment 2 surface water quality monitoring plan is expected to continue with the start of COP. Following implementation of COP, some of the surface water monitoring may be reduced in the future based on ongoing evaluations of requirements.

C.5.5.1 Modification or Termination Conditions

Modification of the water quality monitoring plan will be determined annually by the needs of the project, and the water quality monitoring plan has completely reassessed after the Increment 2 testing and no surface water quality monitoring changes are proposed. This monitoring plan may be changed to reflect any future design changes or permit requirements. It also may be terminated according to permit expiration dates or changes to the COP objectives. Decisions to adjust the monitoring plan will be coordinated through the project partners as well as the FDEP.

Monitoring plans for previous increments were developed assuming that major, ongoing monitoring programs that were not previously funded directly by the Project would continue to collect data relevant to the Project. Should any of these programs be discontinued or significantly curtailed, then the Federal and local sponsors of the COP Project will reevaluate monitoring priorities.

C.5.6 New Monitoring/Sampling Locations and Naming Convention

A description of new monitoring locations, or modifications to existing monitoring locations are provided below. Costs associated with the proposed monitoring plan are not provided in this document.

C.5.6.1 Surface Water Hydrology

C.5.6.1.1 Flow Measurements Along L-31N and C-111 South of the S-331 Structure

The flow measurements taken at the S-332X pump stations, S-331, S-176 are expected to be sufficient to characterize flow conditions in this reach of L-31N. Measurement of flows at the S-199, S-200, S-178, S-177, S-18C, and S-197 structures is sufficient to characterize flow conditions within the C-111 canal. In stream flow velocity measurements were considered during the development of this plan; however, several PDT members stated that it would be difficult to interpret this information given the transverse flow from the groundwater system to the canal system. No additional installation of new ADVM sensors along L-31N was conducted during the field tests.

C.5.6.2 Surface Water Quality Monitoring Plan

No supplemental water quality monitoring below the S-331 structure is included in the plan.

C.5.6.3 Groundwater Hydrology

All existing groundwater monitoring stations described in Section C.4.7.4.3 will be included in COP.

C.5.6.4 Groundwater Quality

No supplemental groundwater quality monitoring is included for areas below the S-331 structure.

C.5.6.5 Access and Authority

New monitoring stations located at water control structures or along the L-31N Canal, if necessary, will be accessed via existing levees or public roadways. To perform environmental sampling within ENP, a sampling and access permit will first be obtained from the park service.

C.5.7 Project Reporting

Technical reporting and evaluations were reported by USACE during the MWD Incremental field tests in accordance with FDEP permit requirements, and the monitoring results were updated to the COP interagency PDT through regular quarterly meetings for the duration of the field tests. Information gained through the field test monitoring has been incorporated into the COP alternative formulation and hydrologic modeling process, culminating in the COP Recommended Plan detailed in the EIS and the supporting COP Water Control Plan and COP AMMP. No further hydrologic data reporting will be conducted under COP based on the hydrometeorologic monitoring plan; rather, further reporting will be conducted in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan.

In addition to current operational monitoring along L-31N (north of S-176), this monitoring plan relies upon the continued monitoring and flood impact analysis reporting conducted by the SFWMD for the C-111 Spreader Canal Western Project. No water quality assessment will be specifically performed to identify COP impacts for areas below S-331. The SFER and Settlement Agreement Reporting for Taylor Slough will be referenced for water quality assessment in this area.

C.5.7.1 Frequency

Data will be analyzed during COP as described in this monitoring plan and operational strategy (Appendix C), in accordance with the commitments identified in the COP Adaptive Management and Monitoring Plan. Hydrometeorological monitoring information routinely tracked for assessment by USACE, SFWMD, and ENP water managers (refer to Section C.4.10.2.1 of Appendix C) will be updated on a daily basis and available for review on the Jacksonville District Water Management web pages:

http://www.saj.usace.army.mil/Missions/CivilWorks/WaterManagement.aspx

C.5.7.2 Content and Format

These details are provided in the main monitoring report (Section C.4.10 of Appendix C).

C.5.7.3 Revisions and Modifications

- November 2016: Monitoring plan revised for Increment 1.1/1.2 updates. There was no significant changes in monitoring requirements. Only changes were addition of Western Shark Slough per 2016 USFWS BO and S-328 per SFWMD Florida Bay Initiative.
- November 2017: Five more wells were added to C-111 Basin monitoring as shown in Figure C.5-5: Three additional wells within the expanded C-111 South Dade Northern Detention Area and two additional wells in the Southern Detention Area. Installation of two additional wells within the 8.5 SMA interior is under consideration.
- October 2019: Monitoring plan revised for COP updates.

C.5.7.4 SFWMD C-111 Spreader Canal Reporting

Concurrent with the COP, the SFWMD will continue to operate the C-111 Spreader Canal Western Project. Consistent with the requirements of the February 2017 re-issued C-111 Spreader Canal regulatory permit from the USACE, the SFWMD is continuing to assess south Miami-Dade water conditions and existing operations, including those of the C-111 Spreader Canal Project, on a quarterly basis for a minimum of five years to ensure project features are constructed and operated not to adversely affect adjacent lands outside and within the C-111 Spreader Canal Western Project boundary with regards to water quantity, water quality, and/or flooding. The purpose of the assessment and quarterly reports are to ensure the SFWMD has the best available information to determine what operational system changes, if any, are necessary to avoid adverse water levels on adjacent lands. The enhanced reporting by SFWMD has benefited the monitoring objectives of the Increment 1.1 and 1.2 field test and the Increment 2 field test. Information generated from the ongoing SFWMD monitoring within the C-111 Spreader Canal Western Project area was considered during development of the COP. The SFWMD quarterly assessment reports include discussion of project operations, Hydrometeorological monitoring, observed environmental conditions (e.g., rainfall), and water management activities. Quarterly reporting of water management operations within the South Dade Conveyance System described below will be based on the daily average canal stages along the eastern boundary of ENP, the time of year, forecasts, availability of water, and preparation for transitional operations.

- The operational range for the L-31N from S-331 to S-176 will be from 4.0 to 4.6 feet NGVD, as maintained by the S-332B, S-332C, and S-332D pump stations in combination with the S-176 spillway.
- The operational range for the C-111 from S-176 to S-177 will be from 3.0 to 3.6 feet NGVD, as maintained by the S-200 and S-199 pump stations in combination with the S-177 spillway.
- The operational range for the C-111 from S-177 to S-18C will be from 2.0 to 2.6 feet NGVD, as maintained by the S-18C spillway.

The SFWMD is also continuing collection of groundwater monitoring data at the identified wells adjacent to the South Dade Conveyance System. This information is then utilized in the SFWMD Water Depth Assessment Tool (WDAT) South Florida tool. The WDAT-South Florida interpolates between existing ground water level gauges to produce spatially continuous estimates of mean daily groundwater elevations for the C-111 Basin. The gauges used for WDAT water level mapping vary depending on the activation, which is periodically re-assessed. Water depth surfaces are calculated by subtracting known ground surface elevations (or gridded elevation models) from the interpolated water elevation surfaces,

and the resultant water levels reported on color ramped maps. WDAT can be accessed at the link: https://www.sfwmd.gov/science-data/modeling/wdat

C.5.8 Administration and Implementation of the Monitoring Plan

Training or Certification: Field and laboratory training requirements are specified in the FDEP SOPs and FSQM for the field and in the NELAP standard and CLQM for the laboratory

C.5.8.1 Organization Structure and Responsibilities

This monitoring effort is intended to be collaborative effort of the USACE, SFWMD, and ENP. The roles and responsibilities for field collection, laboratory analysis, and reporting are detailed by activity in **Table C.5-3**. The sampling plan relies heavily upon the ongoing regulatory compliance monitoring conducted by the SFWMD as well as the monitoring and analysis conducted by the SFWMD as part of the C-111 Spreader Canal project. Field sampling responsibilities are split between the USACE, SFWMD, and ENP. The USACE or SFWMD are likely to be the responsible parties if new monitoring wells are constructed in the areas that are useful to the Increment 2 test project. If the USACE installs new wells, they will likely contract with the USGS to conduct the stage monitoring and reporting of these wells. The USACE will provide information to the SFWMD so that additional stations can be registered in DBHYDRO.

Table C.5-3. Agency roles and responsibilities for each activity for monitoring south of the S-331 structure.

Activities	Installation of New Monitoring Locations	Station Registration in DBHYDRO	Field Collection & Lab Reporting	Well Installation	Analysis and Reporting of Collected Data
1. Ongoing Surface Water Quality Compliance Monitoring and Reporting per PIR and USACE Regulatory Permit	--	--	SFWMD	--	SFWMD
2. Ongoing C-111 Spreader Canal Monitoring*	--	--	SFWMD	--	SFWMD
3. Increment 2 Specific Groundwater Level Monitoring	USACE	SFWMD	USGS	USACE	USACE, ENP

*SFWMD will continue to separately provide the annual South Florida Environmental Report and the annual Settlement Agreement Report. In addition the SFWMD will provide USACE with quarterly monitoring reports in accordance with the requirements of the Department of Army permit for C-111 Spreader Canal.

C.6 Water Quality and Hydrology Monitoring Plan for 8.5 SMA Flood Mitigation

C.6.1 Purpose

While the near record-high WCA 3A stages during February-March 2016 created many water management challenges, the 2016 Temporary Emergency Deviation executed in response to these conditions provided valuable information on the responses within ENP and the South Dade Conveyance System (SDCS) to raising of the L-29 Canal, including evaluation of operational limitations of the 8.5 Square Mile Area (SMA) flood mitigation project prior to completion of the Modified Water Deliveries (MWD) and Canal 111 (C-111) South Dade projects. Based on information gained during operation during the 2016 Temporary Emergency Deviation and the subsequent expanded recovery period, in addition to the inclusion of additional operational flexibility within the Operational Strategy for Increment 1.2 allowing operation of the L-29 Canal to a maximum operating limit of 7.8 feet NGVD, an expanded hydrologic monitoring plan for the 8.5 SMA (including quantitative flood mitigation criteria as described herein) was developed to complement the revised objectives of the Increment 1.1/1.2 Operational Strategy starting in February 2017. The expanded hydrologic monitoring plan and real-time application of the quantitative flood mitigation criteria during the extreme rainfall event during 01-08 June 2017 and Hurricane Irma in August 2017 provided operational experience with applying the 8.5 SMA quantitative flood mitigation criteria during the MWD Increment 1.1/1.2 Field Test. Following the successful application of the criteria to inform real-time water management operations in response to these extreme rainfall events, the expanded hydrologic monitoring plan for the 8.5 SMA was continued to inform water management decisions under Increment 2, starting in February 2018. Following completion of the C-111 South Dade Northern Detention Area (NDA) and Southern Detention Area (SDA), the L-29 Canal maximum operating limit was incrementally raised to 8.0 feet NGVD in July 2018, 8.25 feet NGVD in August 2018, and up to the MWD Tamiami Trail roadway design limit of 8.5 feet NGVD in September 2018. The maximum operating limit of 8.5 feet NGVD will govern Increment 2 operations through the implementation of the COP in 2020.

The monitoring plans for surface water hydrology and groundwater hydrology for the MWD Incremental Field Tests will continue to provide data to assess performance of the 8.5 SMA project components, including S-357 and S-357N, to maintain the surface water and groundwater levels within the project areas of the 8.5 SMA, between the L-357W Levee and the L-31N Levee at the same levels as existed prior to the implementation of any MWD Project components. As retained throughout the MWD incremental field tests, Increment 2 enabled water managers to implement a testing protocol to assist in defining operating criteria for the new 8.5 SMA S-357N water control structure following completion of the structure construction in February 2018.

The preliminary recession rate and hydroperiod target limits identified within this Section C.6 will continue to be evaluated for the duration of the MWD Incremental Field Test. Ongoing hydrologic monitoring, data evaluation, and water management experience over the previous 3 years have demonstrated the robustness of these targets to guide weekly water management decisions and ensure continued compliance with the 8.5 SMA authorized flood mitigation requirements. Development of the COP was informed by the MWD Increment 1, Increment 1.1/1.2 and Increment 2 field tests. The COP development utilized regional hydrologic modeling in order to balance the ecological restoration objectives of the MWD and C-111SD projects while demonstrating compliance with the project constraints, which included requirements to maintain the mitigation for project induced flood damages in the 8.5 SMA and to maintain the level of flood damage reduction associated with the 1994 C-111 GRR Recommended Plan. The results from the COP MD-RSM modeling were used to update the flood mitigation analysis for the

MWD 8.5 SMA GRR (refer to Appendix H, Annex 6 of the COP EIS) and to update the flood risk management analysis from the 1994 C-111 South Dade GRR (refer to Appendix I of the COP EIS). Additional water management assessment criteria and/or further refined target limits may be incorporated in future updates to this monitoring plan, if needed to respond to new information collected during the Increment 2 field test or during implementation of the COP Adaptive Management and Monitoring Plan. Periodic updates will continue to be provided at the interagency PDT+ meetings.

C.6.2 History and Background

The 8.5 Square Mile Area (8.5 SMA), also referred to as the Las Palmas Community, is an inhabited area bounded on the west by the ENP and separated from more intensively developed urban lands to the east by the L-31N Levee and borrow canal. In 1992, a flood mitigation plan was authorized for the 8.5 SMA as part of the MWD to ENP Project. The 1992 General Design Memorandum (GDM) plan included the construction of a protective levee and seepage canal around the north and west perimeter of the 8.5 SMA that would mitigate for higher stages associated with implementing the MWD Project. The GDM also included a 950 cfs pump station along L-31N to convey flood mitigation discharges from the 8.5 SMA into the L-29 Canal and the ENP NESRS. The 1992 GDM plan did not provide a hydraulic connection between the MWD 8.5 SMA and the C-111 South Dade Northern Detention Area (NDA).

In 2000, the USACE prepared the MWD General Reevaluation Report (GRR) and a Final Supplemental Environmental Impact Statement (SEIS) to assist in the selection of a Recommended Plan for providing flood mitigation to the 8.5 SMA while allowing for restoration of the Northeast Shark River Slough (NESRS) as authorized by the MWD Project. Consistent with the 1992 GDM analysis, it was a requirement of the reevaluation to analyze alternatives that provided no increase in flooding above and beyond what existed prior to the authorization of the MWD Project. The GRR recommended plan, Alternative 6D, included construction of a perimeter levee (Levee 357W [L-357W]), internal levees, an interior seepage collection canal (C-357), a new pump station (S-357), and a detention area (8.5 SMA Detention Cell) that would discharge into the proposed C 111SD NDA. The GRR/SEIS presented hydrologic modeling simulations, social impact assessments, policy analysis, real estate information, engineering design and cost analysis, environmental impact assessment, economics calculations and review of public concerns. The Record of Decision (ROD) for the 8.5 SMA GRR/SEIS stated that it would be implemented with added assurances and conditions described there in. One of those assurances and conditions is that “periodic flooding of landowners east of the proposed levee, before and after project implementation, will remain unchanged from conditions in existence prior to implementation of the MWD Project except where flowage easements are required.” The ROD further prescribed that: “Implementation of the Recommended Plan should not adversely impact the restoration levels of Everglades National Park's hydrology greater than that simulated through modeling of Alternative 6D” (the GRR Recommended Plan); “A monitoring, evaluation, and reporting program shall be implemented to ensure operations are consistent with these levels”; and “No deviations are intended from the operations specified in the Manual (i.e., increased pumping in the seepage canal or the inclusion of additional pumps) due to anticipated public demand for increased flood relief inside the perimeter levee of the 8.5 SMA Project.” The Hydraulic and Hydrogeologic Model Report (Appendix A) for the 2000 GRR also recognized that the final operation of the C-111SD pump stations and detention areas would require further study beyond the scope of the GRR effort, while also including recognition that the C-111SD components represented a large change in the local flow regime which could affect the study area.

The USACE completed construction of the 8.5 SMA features identified in the 2000 GRR in 2009. The features were operated and monitored under a testing mode, and the USACE and South Florida Water

Management District (SFWMD) concluded that additional features were necessary to ensure the proper required level of mitigation is provided to the 8.5 SMA. The USACE completed construction of the final physical features of the MWD Project (Structure S-357N and Canal C-358) in February 2018. The completed MWD Project will provide additional inflows to ENP by conditionally raising the maximum operating limit of the L-29 Canal up to 8.5 feet NGVD following the acquisition of the required real estate interests along the Tamiami Trail roadway by the USACE and DOI/ENP (completed in 2017) and functional completion of the C-111 NDA (completed in 2018), while maintaining adherence to both the FDOT constraints for protection of the Tamiami Trail roadway and the 8.5 SMA flood mitigation constraints. The Combined Operational Plan (COP) will implement a comprehensive integrated water control plan for the operation of the water management infrastructure associated with the MWD and C-111 South Dade Projects.

The 8.5 SMA is designed to provide mitigation for the increased water levels that will occur once the MWD project is fully implemented and the associated additional water flows are delivered to ENP. The 8.5 SMA flood mitigation features do not work independently, as full mitigation is dependent on both the MWD 8.5 SMA features and the C-111 South Dade project features. The MWD project and the C-111 South Dade project work together, and implementation of a Water Control Plan which provides more water deliveries (out of WCA 3A and into the ENP) could not occur without adversely impacting private property within the 8.5 SMA until the C-111 South Dade NDA is constructed, operational, and connected to the 8.5 SMA Detention Cell. The hydraulic connection between the 8.5 SMA and the NDA, which was envisioned by the 2000 MWD GRR/EIS for the 8.5 SMA, creates an interdependency between MWD and C-111SD project operations which affects the flood mitigation performance for the MWD 8.5 SMA components, the flood protection performance of the C-111SD project components, and the hydrologic/ecological benefits for both the MWD and C-111SD projects. Completion of the C-111 South Dade new NDA detention area and additional interior berms within the existing SDA was determined to be functionally complete in August 2018.

The full implementation of the MWD Project, including operations of the L-29 Canal up to the MWD Tamiami Trail roadway design limit of 8.5 feet NGVD, was limited prior to providing flood mitigation to the 8.5 SMA, and 8.5 SMA flood mitigation requirements were a constraint throughout all increments of the MWD field test and during development of the COP. With respect to operation of the L-29 Canal, the COP Water Control Plan includes: (1) raising of the maximum operational limit in the L-29 canal up to 8.5 feet NGVD; and (2) removal of the 6.8 foot NGVD constraint at G-3273; (3) priority use of the S-357 and S-357N water control structures to provide flood mitigation to the 8.5 SMA interior; and (4) conditional use of the S-331 pump station to provide supplemental assistance to S-357/S-357N during periods of extreme high water conditions within the 8.5 SMA interior flood mitigation area. Throughout all phases of the MWD field test and under COP implementation, USACE operations cannot cause the 8.5 SMA to endure a greater duration of high water and higher flood stages than they would have experienced prior to MWD implementation of increased flows to ENP. Given the nature of these constraints, raising of the L-29 Canal maximum operating limit under the COP requires continuous monitoring of conditions both along the Tamiami Trail roadway and within the 8.5 SMA.

Within the 2000 GRR, the simulated water levels within the 8.5 SMA for the Recommended Plan were shown to be at or below simulated pre-MWD water levels (referred to in the GRR as the “1983 Base”), using the 1995 rainfall as representative of wet hydrologic conditions. The “1983 Base” assumptions included no inflows from WCA 3A to the Northeast Shark River Slough, with S-333 and S-334 only used to provide water supply deliveries to the South Dade Conveyance System. The hydrologic modeling in the GRR, which utilized the USACE MODBRANCH model, evaluated the following:

- Spatial extent of flooding across the 8.5 SMA protected area and agricultural areas located northeast of the 8.5 SMA;
- Flood duration/hydroperiod and recession rates assessed for May through September 1995 (week 21 through 37);
- Flood inundation depths, which were used to compute economic damages and flowage easement requirements (an event which approximated a Standard Project Flood event was used to assess achievement of flood mitigation – mitigation was assumed achieved if week 26 stages below "Base 1983").

The COP development utilized regional hydrologic modeling in order to balance the ecological restoration objectives of the MWD and C-111SD projects while demonstrating compliance with the project constraints, which included requirements to maintain the mitigation for project induced flood damages in the 8.5 SMA and to maintain the level of flood damage reduction associated with the 1994 C-111 GRR Recommended Plan. The results from the COP MD-RSM modeling were used to update the flood mitigation analysis for the MWD 8.5 SMA GRR (refer to Appendix H, Annex 6 of the COP EIS) and to update the flood risk management analysis from the 1994 C-111 South Dade GRR (refer to Appendix I of the COP EIS), which did not then identify inter-basin transfer of water from the MWD 8.5 SMA to the C-111SD Project lands. Development of the COP was informed by the MWD Increment 1, Increment 1.1/1.2 and Increment 2 field tests. Constraints included in the monitoring plans for the field tests and COP may result in discontinuation of the field tests if adverse impacts to flood damage reduction are indicated as a result of the field test operations. The COP modeling analysis quantitatively characterizes the degree to which operational constraints for the Tamiami Trail roadway and/or the 8.5 SMA limit inflows and associated potential restoration benefits within Northeast Shark River Slough, if applicable.

C.6.3 Assessment Methodology

C.6.3.1 Recession Rates at LPG-1 and LPG-2

Local rainfall is a significant source of freshwater in the 8.5 SMA. Prior to construction of the MWD 8.5 SMA components, after intense precipitation, surface water was removed through evapotranspiration, seepage to the underlying Biscayne Aquifer, or drainage through the L-31N canal along the eastern portion of the 8.5 SMA (located 1.5 to 2.5 miles east of the western-most portion of the current 8.5 SMA protected area). Excess rainfall, particularly during the wet season, often inundated most of the 8.5 SMA, which historically contributed to the sheet flow that supplied surface water to the ENP on a regional scale. Canals, such as L-31N, tend to speed surface water drainage and preclude the natural seepage process to the underlying aquifer.

The 8.5 SMA S-357 pump station was initially operated in June 2009. Prior to completion of the COP, since no new comprehensive hydrologic modeling study for the 8.5 SMA has been completed since the 2000 GRR, pre-project conditions are characterized using the historical response of the 8.5 SMA basin to rainfall events prior to completion of the MWD 8.5 SMA levees, seepage collection canals, and pump station. Angel's Well, located 0.25 miles west of the current 8.5 SMA leveed area, provides a surrogate for pre-project inundation duration (hydroperiod above ground surface) within the western 8.5 SMA (the area closest to ENP, where MWD will increase water levels); the current LPG-1 and LPG-2 monitoring gauges were not installed until 2009. Daily precipitation at the S-331 pump station, which is located adjacent to the southeast corner of the 8.5 SMA, provides a long-term record to correlate to the hydroperiods experienced at Angel's Well. The coincident period of record for Angel's Well and S-331 precipitation,

prior to initial operation of the 8.5 SMA S-357 pump station (1991 through 2009), was used to establish general recession rate targets and acceptable hydroperiod durations to facilitate real-time assessment of flood mitigation performance. Although the Interim Operating Plan for the 8.5 SMA was identified in June 2011, data from the interim testing period from June 2009 through May 2011 was excluded from the pre-project assessment. Monitoring location G-1502, which has a period of record extending back to 1973, was not used for this analysis since this gauge is located nearly 3 miles west of the current 8.5 SMA perimeter levee and benefits from enhanced drainage associated with the historical Northeast Shark River Slough channel.

The following process, illustrated in **Figure C.6-1**, was used to characterize the pre-project hydrologic response for the 8.5 SMA.

- Recession event defined as consecutive days with decreasing groundwater elevation at Angel that occurs above ground surface elevation (6.3 feet NGVD);
- Hydroperiod defined as days above ground surface elevation;
- Precipitation total is the sum of daily rainfall that preceded the recession event;
- Evaluate top 90% of recession events (eliminate slowest observed recessions, as non-indicative of typical hydrologic response);
- Excluded daily rainfall less than 0.1 inch when establishing rainfall duration.

The pre-project response delineated target operational criteria for both a “target” performance range and an “acceptable” performance range during Increment 1 operations. Hydrologic response is intended to be continually analyzed across a wide range of temporal scales, including daily (early detection metrics), weekly, monthly, seasonal, and annual (water year) periods to inform real-time operations and identify potential performance limitations of the current 8.5 SMA and C-111 South Dade infrastructure configuration.

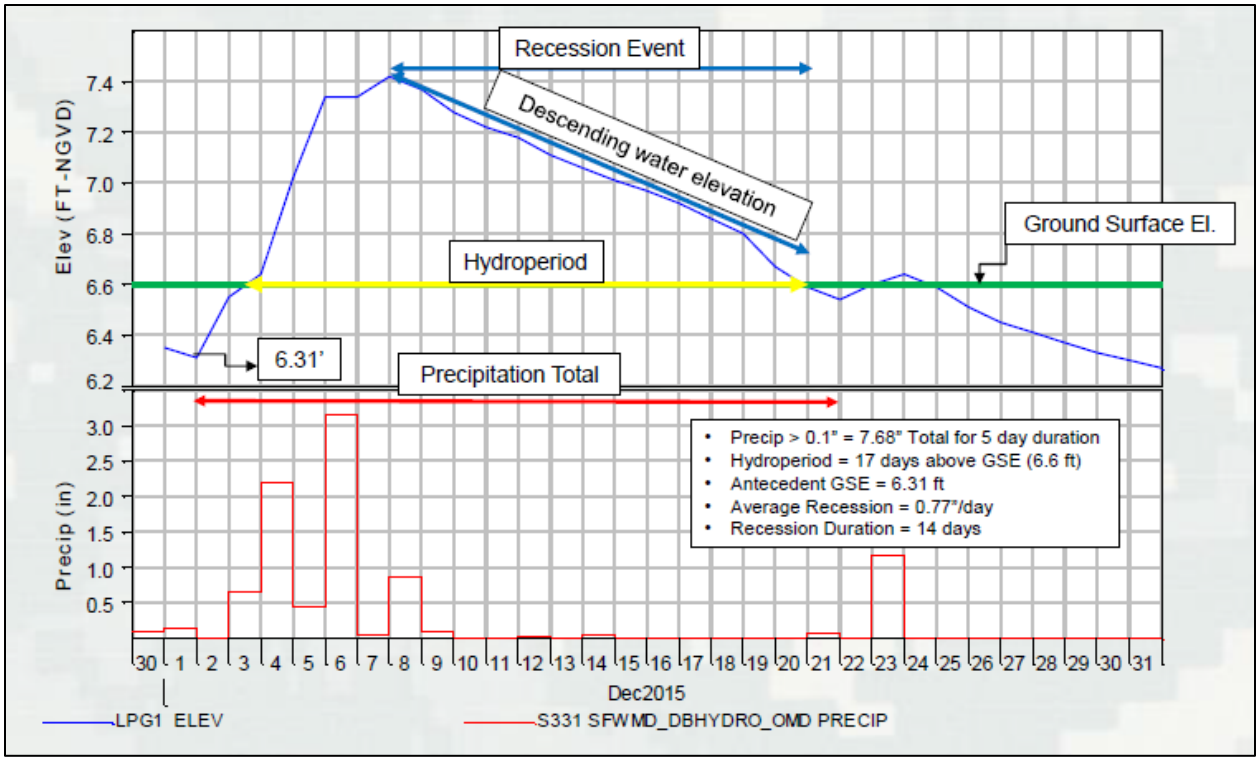


Figure C.6-1. Terminology for 8.5 SMA flood mitigation assessment.

With the configuration of the 8.5 SMA flood mitigation project under Increment 1.1 and 1.2, prior to operation of the C-111 South Dade NDA, water levels inside the 8.5 SMA were observed to be affected by the following factors: direct rainfall (westward drainage toward ENP may be restricted by the L-357 Levee); surface and groundwater levels within ENP (the G-3273 constraint of 6.8 feet NGVD limited water levels in NESRS prior to the Increment 1 field test, except during IOP/ERTP Column 2 operations); surface water levels inside the 8.5 SMA Detention Cell (which can result in increased return seepage into the C-358 Canal and around the southwest corner of the current L-357 Levee); and L-31N Canal stages, which are controlled by G-211 and S-331 east of the 8.5 SMA and controlled by S-332B, S-332C, S-332D and S-176 southeast of the 8.5 SMA and east of the 8.5 SMA Detention Cell.

For short duration direct rainfall events (less than 7 days of continuous inundation within the 8.5 SMA interior flood mitigation area), the analysis of pre-MWD project data (1991-2009) indicated that: (1) the recession rate is generally inversely related to rainfall accumulation, for a given duration; and (2) the recession rate is also affected by available groundwater storage (e.g., antecedent conditions). Antecedent conditions were classified as providing limited groundwater storage and infiltration capacity if groundwater levels were within 1.0 feet of the ground surface elevation at Angel's Well (6.3 feet NGVD). **Table C.6-1** was derived from analysis of the pre-project data to provide performance recession rate targets for short duration rainfall events. The recession rate targets derived from this analysis have been used to inform operation of S-357 and S-331 during the MWD Incremental field test, based on real-time monitoring of recession rate responses at LPG-1 and LPG-2 following rainfall events which trigger pump operations at S-357 and/or S-331. For example, if recession rate targets are not achieved following a rainfall event which results in less than 7 days of continuous inundation within the 8.5 SMA interior flood mitigation area (assuming no continued rainfall), pumping at S-357 may be initially increased by lowering the C-357 target canal stage; if recession rate targets continue to not be achieved with increased pumping

at S-357, then S-331 may be temporarily operated to lower L-31N Canal levels to improve the pump efficiency at S-357 to lower water levels at LPG-1 and/or LPG-2; if recession rates continue to not be achieved following lowering of both C-357 and L-31N, then inflows into the L-29 Canal may be temporarily reduced if necessary. This general sequence for operational priority was included within the Operational Strategy for Increment 1.1/1.2 and Increment 2, and the sequence is retained for the COP Water Control Plan. Recession rate targets for 1-3 day rainfall events are shown on **Figure C.6-2**, and recession rate targets for 4-7 day rainfall events are shown on **Figure C.6-3**.

The COP Water Control Plan includes operational flexibility to consider lowering the S-357 headwater stage range to a minimum limit of 2.3 to 3.0 feet NGVD and lowering of the S-331 headwater stage range to a minimum limit of 2.8 to 3.5 feet NGVD when the G-3273 stage is greater than 7.5 feet NGVD and the LPG-2 (or future in-kind replacement locations) stage trend is not expected to recover in accordance with the 8.5 SMA flood mitigation criteria; these operations may be continued until LPG2 (or future in-kind replacement locations) can be maintained between 6.2 and 6.6 feet NGVD. Based on operational experience, at elevated water levels above 7.5 feet NGVD at G-3273, both S-357 and S-331 pump stations will need to be operated in tandem in order to manage the increased seepage from NESRS and L-31N Canal into 8.5 SMA while providing the required flood mitigation. The operating intent is to transition S-331 to normal operations prior to S-357 returning to normal operations.

Table C.6-1. Preliminary recession rate targets for short duration rainfall events.

Rainfall Duration	Rainfall Volume	Recession Rate (in/day) when Antecedent Conditions > 1 ft. below GSE	Recession Rate (in/day) when Antecedent Conditions < 1 ft. below GSE
1 - 3 days	0 - 2.5”	1.20	0.4
1 - 3 days	> 2.5”	0.84	0.4
4 - 7 days	> 2.5”	0.60	0.4

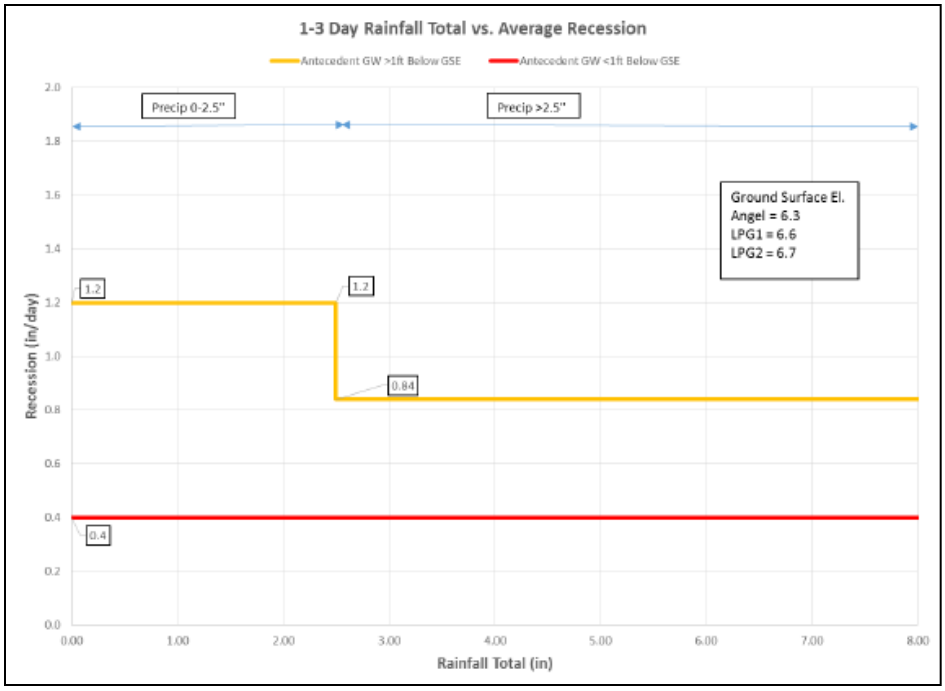


Figure C.6-2. Preliminary recession rate targets for rainfall events with duration of 1 to 3 days.

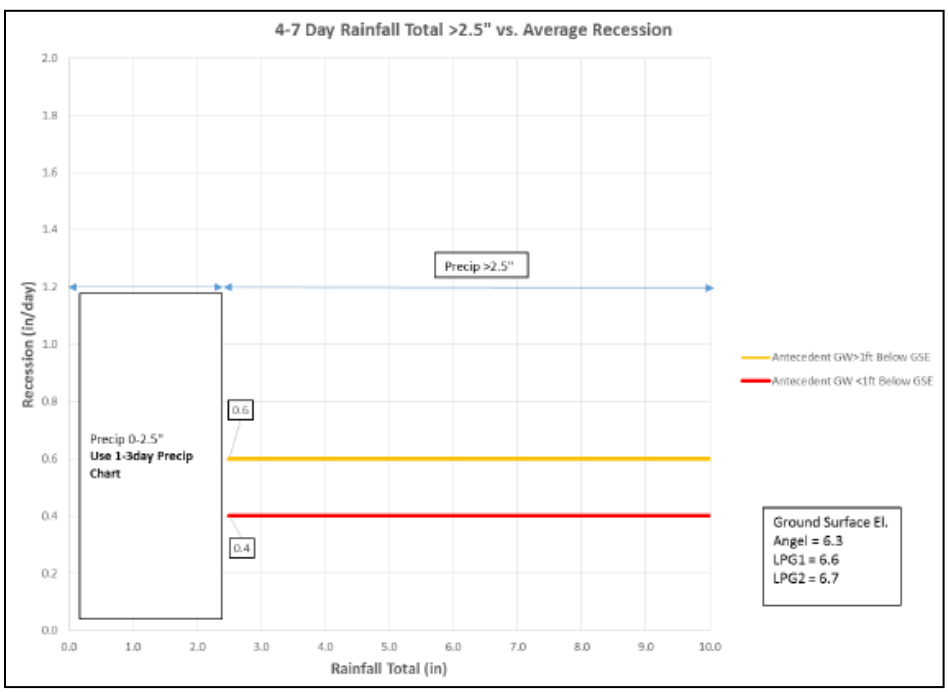


Figure C.6-3. Preliminary recession rate targets for rainfall events with duration of 4 to 7 days.

C.6.3.2 Hydroperiod Response to Rainfall Events

Hydrologic response within the 8.5 SMA immediately following isolated rainfall events which result in less than 7 days of continuous inundation within the 8.5 SMA interior flood mitigation area will be tracked using the recession rate targets identified in Section C.6.3.1. The cumulative number of consecutive days

with water stages above ground at LPG-1, LPG-2, LPG-17 and other 8.5 SMA interior monitoring stations will also be monitored in response to longer-term accumulations of rainfall, including 15-day, 30-day, and 60-day rainfall totals using the hydroperiod response to accumulated rainfall shown in **Figure C.6-4. Figure C.6-4** was generated from an assessment of historical S-331 daily rainfall and historical rainfall events (1991 through 2009) which resulted in a prolonged continuous hydro-period at Angel's Well at any time during the water year. To develop this graphic, and to account for the cumulative effects of continuous wet season rainfall patterns typical of South Florida: the maximum 15-day running rainfall total was computed for each hydroperiod event with durations less than 15 days; the maximum 30-day running rainfall total was computed for each hydroperiod event with durations between 16 and 30 days; and the maximum 60-day running rainfall total was computed for each hydroperiod event with durations greater than 30 days. Historical events with hydroperiods greater than 30 days are labeled with the corresponding event date. The lower limit for "acceptable" performance threshold (above the yellow line) was delineated using historical events within 0.5 standard deviations of the average for all historical events; this threshold represents the "target" for the COP Water Control Plan that will be used to assess S-331 support operations for 8.5 SMA flood mitigation. The lower limit for "restricted" performance threshold between the yellow and the red line was delineated using historical events within 1.0 standard deviation of the average for all historical events; this threshold represents the "constraint" for the COP Water Control Plan that will be used to determine whether S-333 inflows to the L-29 Canal should be reduced or temporarily discontinued with implementation of the Tamiami Trail Flow Formula, which, if executed, would trigger a requirement for an After-Action Report. Given the limited sample size, available from the historical hydroperiod events, durations beyond the "restricted" performance threshold may not adhere with the historical pre-MWD drainage rates observed for the 8.5 SMA, and water management decisions during the COP should avoid hydroperiod durations which fall within this range. For the acceptable (yellow) and restricted (red) performance thresholds, 67% (24 of 36 events) and 89% (32 of 36 events) of historical observed rainfall and hydro-period events fell above these lines, respectively. During development of the field test operational criteria and COP formulation, operational changes were identified to include additional utilization of S-331 to reduce the necessity for S-357 pump operations, increased pump operations at S-357, and/or consideration of additional operational constraints for inflows to NESRS. Based on the COP hydrologic modeling of the 1983 Base Condition used to assess 8.5 SMA flood mitigation performance (refer to Appendix H, Annex 6 of the COP EIS), the simulated hydroperiod response to rainfall events during water years 2006 (wet year), 2007 (average year), and 2012 (dry year) was observed to match closely with the historical data response for the "acceptable" performance threshold shown in **Figure C.6-4**, and no further adjustments to the previously-established MWD field test hydroperiod duration assessment criteria was warranted.

Based on monitoring, data evaluation, and water management experience during the field tests, the majority of the COP operational criteria for S-357 and S-331 were unchanged from the Increment 2 field test. For S-357, the notable change for COP is the inclusion of operational flexibility to consider lowering the S-357 headwater stage range to a minimum limit of 2.5 to 3.0 feet NGVD and lowering of the S-331 headwater stage range to a minimum limit of 2.8 to 3.5 feet NGVD when the G-3273 stage is greater than 7.5 feet NGVD and the LPG-2 stage trend is not expected to recover in accordance with the 8.5 SMA flood mitigation criteria; these operations may be continued until LPG-2 can be maintained between 6.2 and 6.6 feet NGVD. Based on operational experience, at elevated water levels above 7.5 feet NGVD at G-3273, both S-357 and S-331 pump stations will need to be operated in tandem in order to manage the increased seepage from NESRS and L-31N Canal into 8.5 SMA while providing the required flood mitigation. The operating intent is to transition S-331 to normal operations prior to S-357 returning to normal operations. Similar to the field tests, the COP Water Control Plan also includes the ability for WCA 3A flows to NESRS to be temporarily suspended until water levels in 8.5 SMA (specifically the area west of C-357 Canal)

recede below ground surface elevations, if conditions are experienced when both S-357 and S-331 operate at the lowest canal settings and the 8.5 SMA flood mitigation hydroperiod response criteria are not met.

Concurrent with the development of the COP, operations during the MWD field test were conducted to target hydroperiod durations below the "acceptable" performance threshold for a given periodic rainfall accumulation, to the maximum extent possible given other field test operational considerations. The assessment methodology for 8.5 SMA flood mitigation will continue to be informed by new information collected during the MWD Incremental 2 field test and the COP Adaptive Management and Monitoring Plan and may be periodically revised if warranted by new information. Although not anticipated following implementation of the COP Water Control Plan operations, if observed rainfall and hydroperiod events fall between the "target" (yellow line) and the lower limit of the "constraint" performance threshold for more than one-third of post-COP hydroperiod events (corresponds to the statistics used to delineate the target threshold), this assessment result would provide an indication that further operational changes, such as more pre-emptive lowering of S-331 headwater stages, are needed to ensure achievement of the required 8.5 SMA flood mitigation performance. 8.5 SMA ongoing flood mitigation assessments will be documented within the COP Adaptive Management and Monitoring Plan reports and periodic interagency PDT+ coordination meetings.

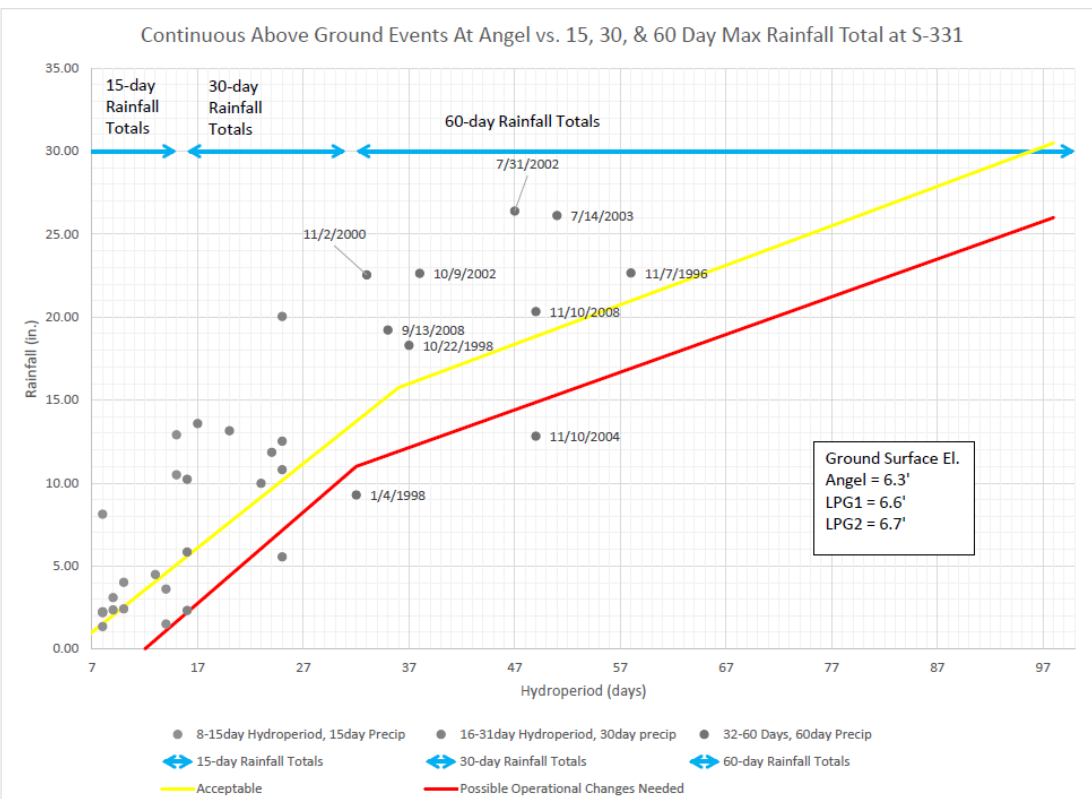


Figure C.6-4. Preliminary hydroperiod target limits for accumulated rainfall totals over 15 days, 30 days, and 60 days.

C.6.3.3 Project Hydro-period Response to Seasonal Rainfall Accumulation

Hydrologic response within the 8.5 SMA throughout the duration of the wet season (May through October) and dry season (November through April) for each water year will additionally be tracked using the hydro-period metrics defined in this section. The cumulative number of consecutive and non-consecutive days with water stages above ground at LPG-1, LPG-2, and LPG-17 will be monitored in response to seasonal accumulations of rainfall, starting from the beginning of the wet (01 May) and dry season (01 November). **Figure C.6-6** (wet season) and **Figure C.6-8** (dry season) were generated from an assessment of historical S-331 seasonal rainfall totals and historical cumulative non-consecutive hydro-periods at Angel's Well. The historical rates of rainfall and cumulative hydro-period accumulations for the historical assessment period from 1991 through June 2009 (prior to initial operation of the MWD 8.5 SMA project), which are shown on **Figure C.6-5** (wet season) and **Figure C.6-7** (dry season) were evaluated to aid with delineation of the performance threshold lines at the beginning of the wet and dry season. Based on operational experience with applying the 8.5 SMA hydroperiod criteria during the MWD incremental field test from 2017-2019, COP flood mitigation monitoring and real-time operations for management of 8.5 SMA continuous inundation events did not require utilization of the historical wet and dry season event analysis shown in these figures, and the seasonal criteria will not be used for real-time water management during COP (the figures are included as a record of the historical data analysis only).

The lower limit for "acceptable" performance thresholds (above the yellow line) shown on **Figure C.6-6** (wet season) and **Figure C.6-8** (dry season) were delineated using historical events within 0.5 standard deviations of the average for all historical events. The lower limit for "restricted" performance threshold (between the yellow and the red line) was delineated using historical events within 1.0 standard deviations of the average for all historical events; given the limited sample size, durations within this range may not adhere with the historical pre-MWD drainage rates observed for the 8.5 SMA, and water management decisions during the field tests and COP should avoid hydroperiod durations which fall within this range. For both the historical wet season events and the historical dry season events, the acceptable (yellow) and restricted (red) performance thresholds, 61% (11 of 18 events) and 89% (16 of 18 events) of historical observed rainfall and hydro-period events fell above these lines, respectively. Concurrent with the development of the COP, operations during the MWD field test were conducted to target hydroperiod durations below the "acceptable" performance threshold for a given periodic rainfall accumulation, to the maximum extent possible given other field test operational considerations.

The inclusion of additional operational flexibility within the COP, as detailed in Section C.6.3.2, are included in the COP Water Control Plan to ensure real-time adherence to the 8.5 SMA flood mitigation hydroperiod response criteria. The Hydro-period Response to Seasonal Rainfall Accumulation will continue to be assessed at the end of each wet and dry season, as conducted throughout the MWD field test duration, to continue to inform the COP Adaptive Management and Monitoring Plan. These seasonal computations will generally not be used to guide real-time water management decisions. 8.5 SMA ongoing flood mitigation assessments will be documented within the COP Adaptive Management and Monitoring Plan reports and periodic interagency PDT+ coordination meetings.

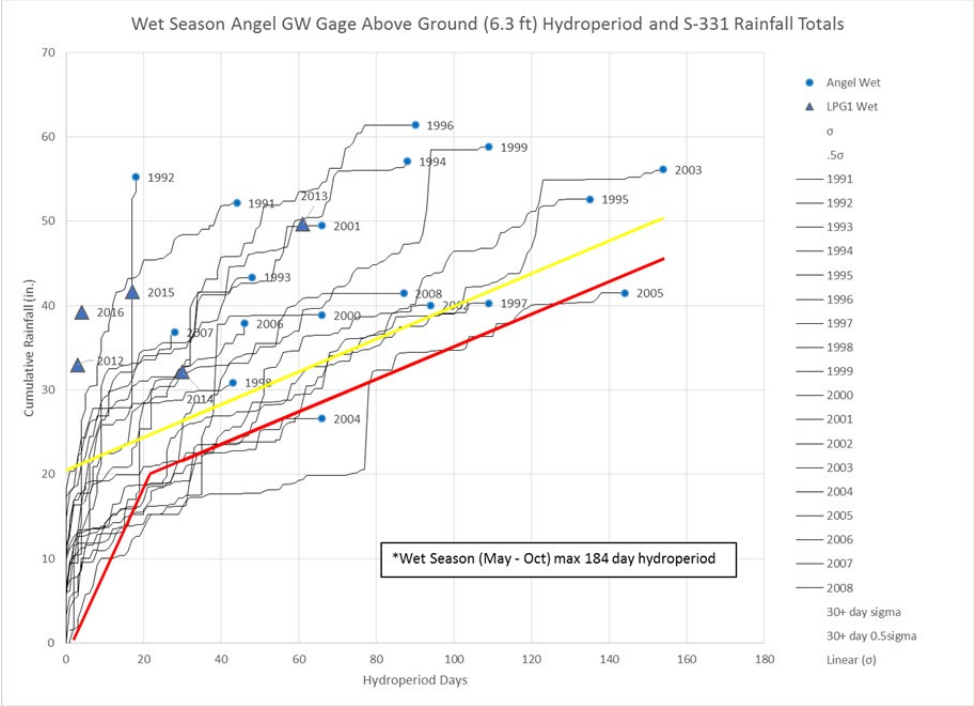


Figure C.6-5. Historical data used to identify preliminary hydroperiod target limits for accumulated wet season rainfall totals.

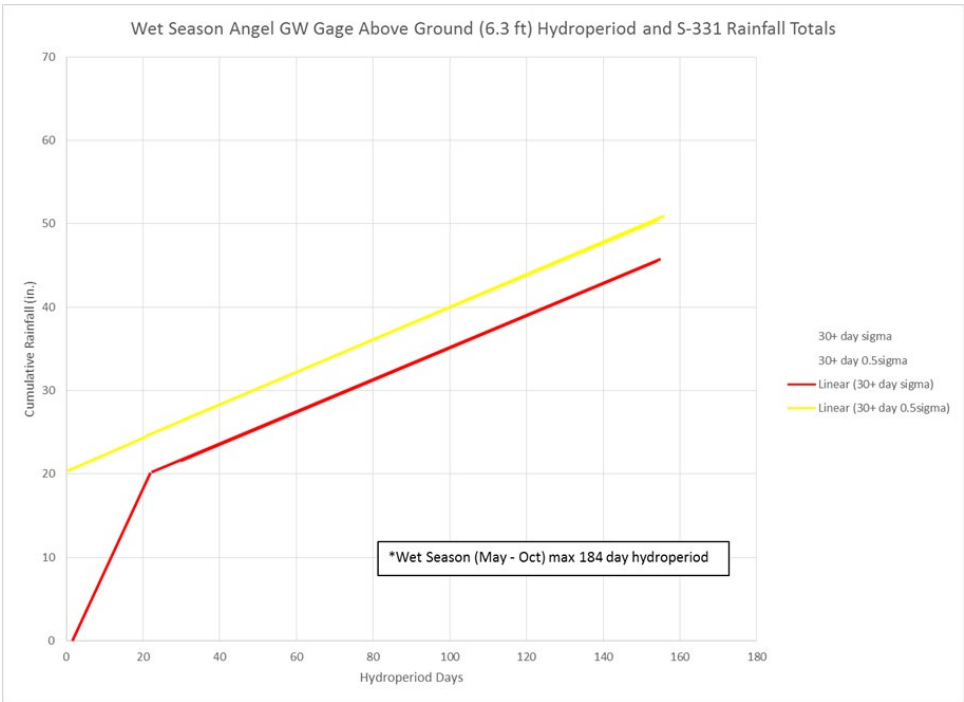


Figure C.6-6. Preliminary hydroperiod target limits for accumulated wet season rainfall totals.

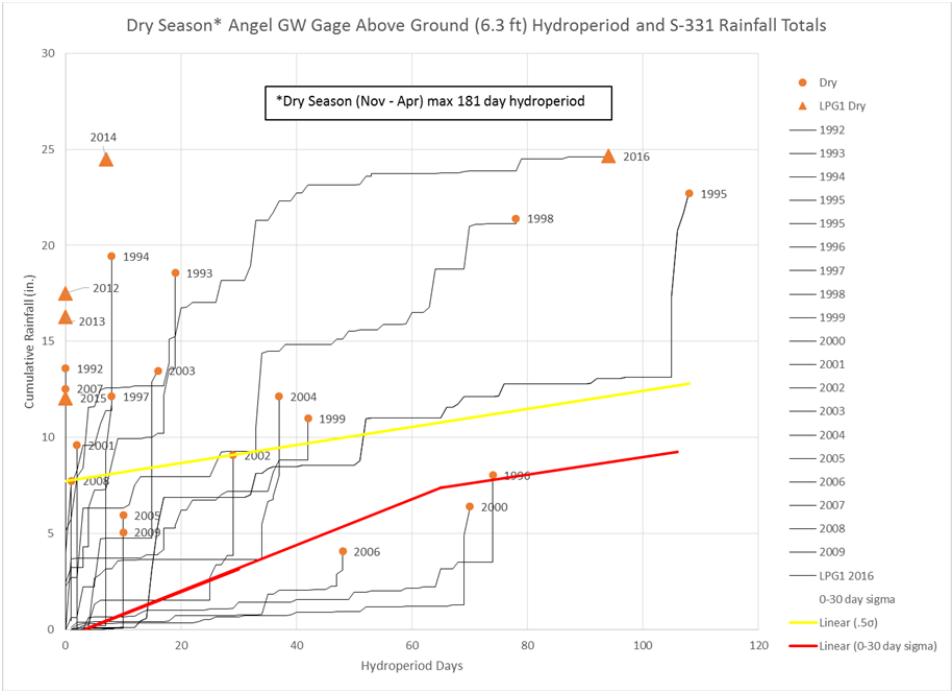


Figure C.6-7. Historical data used to identify preliminary hydroperiod target limits for accumulated dry season rainfall totals.

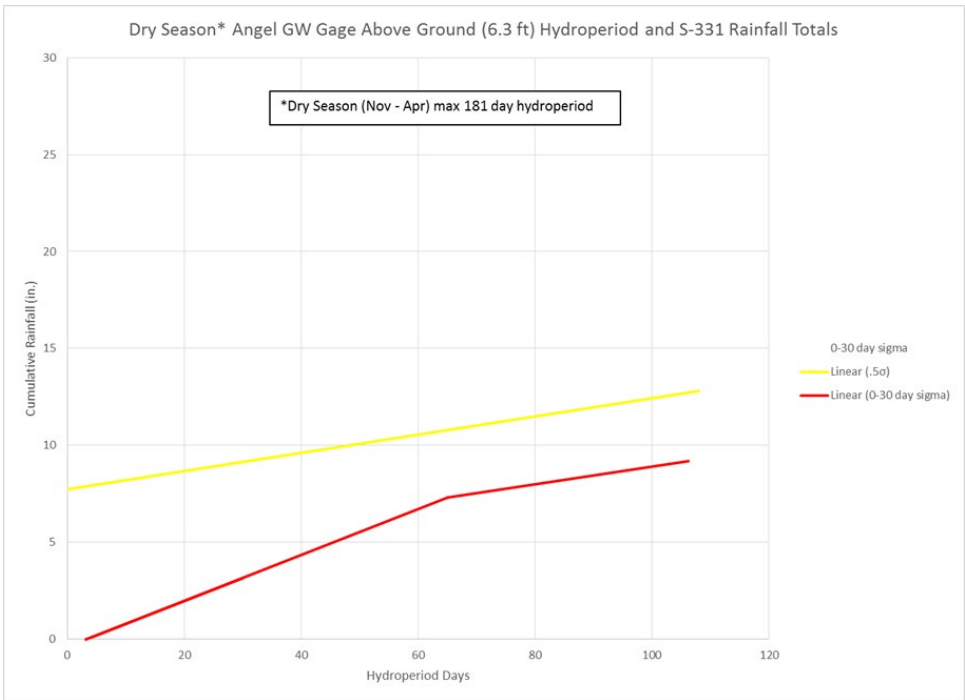


Figure C.6-8. Preliminary hydroperiod target limits for accumulated dry season rainfall totals.

C.6.4 Data Requirements for the COP Water Quality and Hydrology Monitoring Plan

To facilitate real-time tracking and assessments for the 8.5 SMA authorized flood mitigation performance, the information in **Table C.6-2** was previously incorporated into the MWD Increment 2 Hydrometeorologic Monitoring Plan and will be retained for the COP Water Quality and Hydrology Monitoring Plan. The information compiled to support the 8.5 SMA monitoring plan requirements will be evaluated weekly during rainfall periods, with more frequent data assessments conducted if warranted following high-intensity rainfall events.

In addition to the continued monitoring at Angel's Well, LPG-1, and LPG-2, two new 8.5 SMA interior monitoring wells were installed concurrent with Increment 2 field test to supplement the previously available groundwater response data. Sited along a southeasterly transect between LPG-2 and the C-357 Canal (the Canal is located 0.9 miles southeast of LPG-2), LPG-17 is located approximately 0.25 miles southeast of LPG-2, and LPG-16 is located approximately 0.6 miles southeast of LPG-2. The new monitoring locations were fully instrumented and ground-surveyed in September 2019, although the data is not available in real-time (monthly downloads only). The monitoring data from LPG-17 is recorded on a datalogger and manually collected by ENP staff at the beginning of each month. Due to a survey error from the original installation baseline survey, which was first identified in December 2019, the USACE is scheduled to conduct a new elevation survey (wellhead and groundwater elevation) prior to the start of the 2020 wet season or at the earliest opportunity. Following completion of the new survey, the groundwater stage dataset will extend from August 2019 to present, and this information will be used by the USACE to develop correlation trends between LPG-17 and the adjacent groundwater monitoring stations at LPG-2, LPG-16, and the C-357 Canal. With the continued monitoring under the Increment 2 field test and following implementation of the COP (including the AMMP), the USACE will continue to consider adjustments to the flood mitigation criteria at LPG-2, such as using a hydroperiod duration criteria relative to a more representative elevation for this portion of the 8.5 SMA interior mitigation area. If the supplemental monitoring locations result in revisions to the COP Water Quality and Hydrology Monitoring Plan, this information may be incorporated into the Final COP EIS Monitoring Plan, or through the COP Adaptive Management and Monitoring Plan periodic reporting.

C.6.5 Periodic Updates to 8.5 SMA Assessment Methodology

The 8.5 SMA monitoring and assessment plan will be periodically reviewed throughout the duration of the COP and may be periodically revised if warranted by new information. 8.5 SMA ongoing flood mitigation assessments will be documented within the COP Adaptive Management and Monitoring Plan reports and periodic interagency PDT+ coordination meetings.

Table C.6-2. Additional 8.5 SMA monitoring and data collection requirements. Table shows real-time monitoring information required for 8.5 SMA Flood Mitigation Assessment. Data is expected to be used to assess conditions weekly with more frequent reporting in response to significant rainfall events (>2.5 inches).

Date of reporting xx-xx-2016	Rainfall (inches) S-331	Rainfall (inches) NEXRAD	Reces-sion Rate Angel's Well (inches/ day)	Reces-sion Rate LPG-1 (inches/ day)	Reces-sion Rate LPG-2 (inches/ day)	Ante-cedent Stage Angel's Well (ft. NGVD)	Ante-cedent Stage LPG-1 (ft. NGVD)	Ante-cedent Stage LPG-2 (ft. NGVD)	Hydro-period Duration Angel's Well (day)	Hydro-period Duration LPG-1 (day)	Hydro-period Duration LPG-2 (day)
3-day event total	X	X	X	X	X	X	X	X	--	--	--
7-day event total	X	X	X	X	X	X	X	X	--	--	--
Last 15 days	X	X	--	--	--	--	--	--	X	X	X
Last 30 days	X	X	--	--	--	--	--	--	X	X	X
Last 60 days	X	X	--	--	--	--	--	--	X	X	X
Water Year (May-April)	X	X	--	--	--	--	--	--	X	X	X

C.7 Cultural Resources Monitoring Plan

Effects to cultural resources within WCA 3 and ENP resulting from the COP have been determined as not adverse based on the analysis conducted under the Everglades Restoration Transition Plan (ERTP) Programmatic Agreement (PA), current analysis of anticipated water elevations, and controls established through this monitoring plan. As discussed in the EIS, the Preferred Alternative is not anticipated to create any conditions that would be considered adverse in their effects to significant historic properties. It is anticipated that the relative increases in water depth within ENP are minor and should not inundate any known archeological sites beyond that which is typical throughout the year. Additionally, any decreases in water depth within WCA 3 would also be slight and should not over dry any known archeological sites beyond that which is typical throughout the year. However, cultural resources monitoring tools established under the ERTP Final Environmental Impact Statement and the associated ERTP PA will be utilized to understand how the COP performs in relation to relative water depth located adjacent to known archeological resources and tree islands within ENP and WCA 3. Conditions and stipulations applied within the ERTP PA will not be applied during the COP operational strategy as the PA has been finalized and there are no anticipated impacts to cultural resources. Active monitoring will occur utilizing the Everglades Depth and Elevation Network (EDEN) to better understand potential effects to cultural resources for future operational plans that propose adding to the existing water budget and determine whether conditions significantly vary from those established within the current EA (http://sofia.usgs.gov/eden/water_level_percentiles_map.php).

Monitoring will allow a better understanding and insight into how water spreads south throughout Northeast Shark River Slough (NESRS) after being discharged into ENP. Monitoring will also provide a better understanding of the zone of influence of water as it flows across the cultural landscape. Finally, the monitoring efforts will provide valuable information to better understand the response of archaeological deposits to changes in water elevation for future operational plans (i.e. the Central Everglades Planning Project).

The EDEN monitoring will compile water elevation data associated with known archeological sites within ENP and WCA 3. There are 394 tree islands that are monitored through EDEN, 112 of which contain previously identified cultural resources (for protection of these resources their names and locations will not be listed). Based on previous monitoring efforts and detailed background research, there are 38 tree islands that have not been seasonally inundated during the period of record (1965-2005) and will be actively monitored (**Table C.7-1**). If conditions arise as a result of the COP where water levels may approach overtopping these sites, an assessment will be conducted by the USACE to determine the cause of the high water levels. The purpose of the analysis will be to examine the root cause or complexity of the issue and help understand the cause; if it is rainfall induced, related to operations, or a combination of both. If the cause is determined to be a result of USACE operations and will result in prolonged inundation, the USACE may initiate consultation with interested parties, including the State Historic Preservation Officer, the appropriate Tribal Historic Preservation Officer(s), and the appropriate interested Tribes.

Table C.7-1. Tree islands monitored during the COP.

Tree Island	Latitude	Longitude	Basin	Maximum Ground Elevation[1]	Observed Maximum Water Elevation [1,2]	Date of Observed Maximum Water Elevation[2]
3A_28_19	25.77774	-80.83052	WCA 3A	10.515	10.24017734	1/5/1995
3A_6_9	26.02087	-80.77037	WCA 3A	10.928	10.71050849	11/2/1999
3B_13_1	25.93758	-80.53088	WCA 3B	9.705	7.868379308	10/16/1999
3B_13_3	25.90325	-80.54317	WCA 3B	8.743	8.04814967	10/16/1999
3B_15_2	25.89322	-80.50021	WCA 3B	9.331	7.883805803	10/16/1999
3B_21_1	25.83408	-80.53783	WCA 3B	9.183	7.769557122	10/16/1999
3B_21_8	25.86764	-80.49196	WCA 3B	8.757	7.852057209	10/16/1999
3B_25_1	25.77899	-80.50983	WCA 3B	8.921	7.743753348	10/16/1999
3B_30_1	25.76608	-80.58155	WCA 3B	8.32	8.005511667	10/16/1999
Black	25.61089	-80.68831	ENP	7.398	6.563759851	10/16/1999
Chekika	25.74496	-80.65728	ENP	8.343	7.270777445	10/16/1999
Grossman	25.61582	-80.58348	ENP	7.126	6.484809635	10/16/1999
Gumbo	25.63052	-80.74102	ENP	6.755	6.586604481	10/16/1999
Irongrape	25.64599	-80.66475	ENP	7.664	6.964816196	10/16/1999
Manatee	25.49811	-80.81532	ENP	3.904	3.483169285	10/17/1999
Mosquito	25.35641	-80.79853	ENP	2.927	1.989011189	6/10/1997
Panther	25.57347	-80.75916	ENP	5.869	5.540908854	10/16/1999
Satin	25.65968	-80.7559	ENP	7.208	7.188733419	10/16/1999
SS-05	25.58843	-80.70951	ENP	6.654	6.193871385	10/16/1999
SS-06	25.5713	-80.7275	ENP	6.198	5.789324242	10/16/1999
SS-07	25.5358	-80.76325	ENP	5.167	4.900295027	10/16/1999
SS-23	25.50675	-80.84813	ENP	3.241	3.049819676	10/17/1999
SS-27	25.52224	-80.82604	ENP	4.121	3.676932377	10/16/1999
SS-34	25.54734	-80.80133	ENP	5.039	4.557857363	10/16/1999
SS-36	25.55208	-80.81542	ENP	4.534	4.48964587	10/16/1999
SS-37INT	25.55344	-80.81595	ENP	4.685	4.48964587	10/16/1999
SS-38	25.5816	-80.80611	ENP	5.62	5.120357503	10/16/1999
SS-48	25.62063	-80.77404	ENP	6.306	6.22874683	10/16/1999
SS-50	25.64302	-80.75232	ENP	6.972	6.835538008	10/16/1999
SS-52	25.62935	-80.7186	ENP	7.238	6.717086652	10/16/1999

Tree Island	Latitude	Longitude	Basin	Maximum Ground Elevation[1]	Observed Maximum Water Elevation [1,2]	Date of Observed Maximum Water Elevation[2]
SS-63	25.68253	-80.70717	ENP	7.927	7.72216877	10/18/1995
SS-69	25.73301	-80.6423	ENP	9.075	7.207007921	10/16/1999

[1] feet NAVD88
[2] Observed during the Period of Record

Data obtained from the COP will be utilized to compare the period of performance to identify a similar rainfall cycle and compare changes in water elevation on known archeological resources. A comparison will also be performed against the previous water level analysis conducted as part of the EA for the ERTP planned deviations (i.e., Increment 1.1/1.2 and Increment 2) operational strategy so that a better understanding of the variation can also be developed. Periodic Scientists Calls will continue to be conducted throughout COP to ensure cultural resource issues are considered during the water management decision process.

C.8 References

Beerens, J.M., E.G. Noonburg, and D.E. Gawlik. 2015. Linking dynamic habitat selection with wading bird foraging distributions across resource gradients. PLoS ONE 10(6):e0128182.

Beerens JM. Development, evaluation, and application of spatio-temporal wading bird foraging models to guide Everglades restoration. Ph.D. Dissertation, Florida Atlantic University. 2014,

CERP RECOVER. 2014. Comprehensive Everglades Restoration Plan 2014 System Status Report. Comprehensive Everglades Restoration Plan Restoration Coordination and Verification Program Technical Report. August 2014. URL: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/8694

CERP RECOVER. 2019. 2019 Everglades System Status Report: Assessment period of 2012-2017. Comprehensive Everglades Restoration Plan Restoration Coordination and Verification Program Technical Report. URL: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/11519

Cook, M.I. (ed.). 2018. South Florida Wading Bird Report, Volume 23. South Florida Water Management District, West Palm Beach, FL

Dessu, S.B., R.M. Price, T.G. Troxler and J.S. Kominoski. 2018. Effects of sea-level rise and freshwater management on long-term water levels and water quality in the Florida Coastal Everglades. Journal of Environmental Management 211:165-176.

Fitterman, D.V., Deszcz, M.1998. Helicopter EM Mapping of Saltwater Intrusion in Everglades National Park, Florida. Exploration Geophysics29:1-2, 240-243, DOI: 10.1071/EG998240

Gann, D., J. Richards, and J. Sadle. 2015. Establishing vegetation trends in Northeast Shark River Slough – Everglades National Park using WorldView-2 and Landsat Thematic Mapper remotely sensed data. Everglades National Park. Task Agreement # P11A50510. Report to National Park Service. 50 pgs

Gann, D., J. Richards, and B. Harris. 2018. Vegetation change along ENP Boundary Areas of Northeast Shark River Slough Between 2010/13 and 2016/17. Task Agreement # P17AC01023. Report to National Park Service. 62 pgs.

Hohner, S. M. and Dreschel, T. W. (2015). Everglades peats: Using historical and recent data to estimate predrainage and current volumes, masses and carbon contents. Mires and Peat. 16(1):1–15.

Park-Said, W. and C. Brown. 2013. Hydrologic Simulation of the Predrainage Greater Everglades Using the Natural System Regional Simulation Model v3.5.2. South Florida Water Management District Water Resources Division. 606 pgs (including appendices).

Price, R.M., P.K. Swart and J.W. Fourqurean, 2006. Coastal groundwater discharge – an additional source of phosphorus in the oligotrophic wetlands of the Everglades. Hydrobiologia. 569:23-36.

Price, R. M., G. Skrzypek, P.F. Grierson, P. K. Swart, and J. W. Fourqurean. 2012. Marine and Freshwater Research. 63:952-966.

Smith, S.M., D.E. Gawlik, K. Rutchey, G. E. Crozier, and S. Gray. 2003. Assessing drought-related ecological risk in the Florida Everglades. Journal of Environmental Management. 68:355-366.

Stewart, M.A., Bhatt, T.N., Fennema, R.J., Fitterman, D.V. 2002. The Road to Flamingo: An Evaluation of Flow Pattern Alterations and Salinity Intrusion in the Lower Glades, Everglades National Park, U.S. Department of the Interior, U.S. Geological Survey.

United States Army Corps of Engineers (USACE). 2009. Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) – Monitoring Ecosystem Restoration. U.S. Army Corps of Engineers Memorandum CECW-PB. August 31, 2009. URL: https://usace.contentdm.oclc.org/digital/collection/p16021coll11/id/2925/

Water Resources Development Act (WRDA). 2007. Public Law 110-114-Nov8 2007, Sections 2031.b.3.E and 2039. URL: https://www.congress.gov/110/plaws/publ114/PLAW-110publ114.pdf.

Zucker, M., Woods, J., Smith, D. 2010. Sediment Transport and Saline Intrusion on Cape Sable, Everglades National Park, Florida. Conference Paper. Proceedings of the Joint Federal Interagency Conference 2010: Hydrology and Sedimentation for a Changing Future: Existing and Emerging Issues: Las Vegas, NV, June 27-July 1, 2010.

This page intentionally left blank