APPENDIX C – G-3273 CONSTRAINT RELAXATION/S-356 FIELD TEST AND S-357N OPERATIONAL STRATEGY MONITORING PLAN

This page intentionally left blank

PART 1 - WATER QUALITY AND HYDROLOGY MONITORING

This page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

This page intentionally left blank

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.

DRI – Desert Research Institute, Groundwater well servicing contractor for Corps.

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 Agiculture 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, ground water, 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

EXECUTIVE SUMMARY

The water quality and hydrology monitoring plan presented here for the proposed G-3273 Constraint Relaxation / S356 Field Test and S-357N Operational Study was developed by an interagency team from SFWMD, USACE, DOI, and FDEP. This proposed study will be referred to here after as the "Increment 1 Test". The proposed water quality monitoring plan will provide data to: (1) assess achievement of phosphorus target for S356 discharges, (2) distinguish water sources for S356 and (3) quantify water quality interactions associated with the test through detailed analysis of chemical and physical parameters. Source attribution and characterization are needed to guide water quality management efforts in the future. The proposed monitoring plans for surface water hydrology and ground water hydrology will provide data to: (1) assess the zone of influence of the S356 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 (pending construction completion), to maintain the surface water and ground water 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 Annex 1 of the monitoring plan.

In developing this plan, 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 G3273 operations constraint during Increment 1 testing. The Increment 1 testing is expected to last up to two years. At the completion of Increment 1 testing, a portion of the additional monitoring proposed in this plan may be carried forward to Increment 2 testing or other operating conditions that may follow. New monitoring stations are preliminarily identified in this plan. As such, this plan incorporates the best information available; however, as the test operations are implemented, this plan may require revision.

Late in the development of this plan, the Increment 1 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 "Annex 1, Increment 1 Monitoring South of S-331" of this plan. This annex is attached to the main body of the monitoring plan.

C.1.1 INTRODUCTION

This document serves as a reference for monitoring water quality and hydrology during the G3273/S356 Increment 1 test (Increment 1 test). The Modified Waters Delivery (MWD) Increment 1 Field Test will be the first increment in a series of three related, sequential efforts that will result in a comprehensive integrated water control plan, referred to as the Combined Operating Plan (COP), for the operation of the water management infrastructure associated with the MWD and C-111 South Dade Projects. Monitoring will be conducted to evaluate Increment 1 performance with regard to operational constraints, restoration goals and regulatory requirements. Specifically, the Increment 1 test is intended to be the first of two test operating periods intended to redistribute flows from WCA-3A into Everglades National Park (ENP) and to eventually allow stages in the L29 Canal to increase up to 8.5 ft NGVD. 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 G3273/S356 area of influence is primarily in the area of the L29 and L31N canals. Increment 1 will also implement a testing protocol to assist in defining operating criteria for the new 8.5 SMA S-357N water control structure following completion of construction. The recommended plan also includes changes to operations at the S197 structure at the southern end of the C-111 canal; however, this plan does not propose additional monitoring locations in the C-111 basin.

The incremental approach to the development of the COP will 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 include conducting field tests for existing structures, developing operating criteria for existing and planned structures, and ultimately updating the WCAs-ENP-SDCS 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 S356 discharges, (2) distinguish water sources for S356 and (3) quantify water quality interactions associated with the test through detailed analysis of chemical and physical parameters. 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 S335, S356, and G211 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 (S335, S336 [replaced with L30MILE0 as surrogate], G211 [replaced with L31NMILE5 as surrogate], and S356) 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. Concentrations for a full suite of ions (Na, Ca, Mg, K, Cl, SO4, 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 5-miles of L31N 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. 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 L29 canal, between the S356 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 will attempt 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.

C.1.2 PROJECT DESCRIPTION

The Increment 1 test is part of the MWD project, which is primarily intended to increase water deliveries from WCA3A to ENP through NESRS for the benefit of natural resources. The Increment 1 test is a small incremental step toward achieving that goal by reducing the number of times S333 discharges are limited by the existing G3273 stage constraint of 6.8 feet NGVD. G3273 lies within eastern ENP, directly west of the 8.5 Square Mile Area (8.5 SMA). The G3273 constraint of 6.8 feet NGVD was originally established as a flood protection measure. A stage of 6.8 feet NGVD at this gage has been used since 1985 as a trigger to cease S333 discharges from flowing south into NESRS as a protective measure for residential areas to the east, particularly the 8.5 SMA. During the Increment 1 test, additional seepage is expected to augment flows in the L31N canal. To ensure that the existing level of flood protection is maintained in the L31N basin, the S356 pump station will be operated to return seepage to the L29 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 (pending construction completion) will be operated to maintain water control levels specified within the 2012 Water Control Plan within the C-357 Canal and the L-31N Canal.

Water deliveries to ENP and NESRS are subject to the water quality limit for total phosphorus (TP) contained 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), calculated using the measured total annual flows from the S12A, S12B, S12C, S12D, and S333 (S333 flows expressed as S333 minus S334) structures that distribute flows from WCA 3A into Shark River Slough. 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 $1{,}061 \times 10^3$ ac-ft per year. Although the effect of the Increment 1 test is largely to redistribute existing flows, with respect to the Appendix A LTL, Increment 1 operations are expected to result in higher flow volumes through the S333 structure, lower flow volumes through the S-334 structure, and moderately lower flow volumes through the S12D

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 has been at or just below the LTL for four of the past seven years, it is possible that Increment 1 test operations will increase the risk of exceeding the LTL limit.
At present, TP concentrations measured at the S356 pump station are not included in the Appendix A calculation. However, in light of this, the Technical Oversight Committee (TOC) is evaluating whether this structure may be incorporated in future Appendix A calculations. The TOC will also continue to evaluate Appendix A compliance during Increment 1. The SFWMD proposed and FDEP will require a water quality assessment methodology to assess Outstanding Florida Waters compliance as part of the FDEP test authorization requirements. The proposed methodology is expected to require that the S356 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. For S356, it is anticipated that the Increment 1 testing is likely to show 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 WCA3B. 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 test will be assessed to discern sources of water pumped by S356.

Water quality monitoring and analyses during Increment 1 testing will be used to help identify potential changes to the operating rules that could increase the probability of water quality compliance for additional flows entering NESRS. A water quality assessment will be evaluated at the S356 pump station in accordance with the FDEP test authorization to conduct Increment 1 testing. Concurrently, compliance with the LTL will be determined in accordance with the Settlement Agreement Appendix A requirements on an annual basis during Increment 1 testing. Both the water quality assessment of S356 and the Appendix A compliance calculations are based on the same annual period of October 1st through September 30th. Given that the Increment 1 testing is proposed to begin in the Spring of 2015, the first year of water quality assessment of the Increment 1 test will contain a partial year with test conditions. The second year of the Increment 1 test will likely include 12 months of test conditions. Because of this, operating plan changes resulting from the S356 water quality assessment, if needed, would be implemented only after the conclusion of the Increment 1 test period (up to two years). During Increment 1 test operations, the Corps does not plan to impose operational constraints for water quality that could restrict or otherwise limit inflows to NESRS.

C.1.3 PRIMARY OBJECTIVES OF WATER QUALITY AND HYDROLOGY MONITORING PLAN

There are six primary objectives of this monitoring plan. Additional objectives are included in Annex 1 of this monitoring plan for the hydrologic monitoring plan components south of S-331.

1) Characterize surface water quality and volume discharged from the S356 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.

2) Identify sources of the S356 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.
3) Support water quality compliance determination for Settlement Agreement and OFW compliance at S356.
4) To determine, to the maximum extent practical, the area of influence of S-356 pump station operations in the Biscayne Aquifer.
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.

C.1.4 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 1 testing proposes the establishment of new monitoring locations; however, in many instances, the existing network of monitoring stations will be utilized to demonstrate the effects of Increment 1 on hydrology and water quality as well as compliance with water quality standards. Authorization to conduct the Increment 1 test will be obtained from the FDEP and this monitoring plan is likely to be included in that authorization by reference. Certain details of the actual authorization required new monitoring may not exactly match the information presented in this plan.

C.1.5 MONITORING COMPONENTS

C.1.5.1 Project Baseline Monitoring

Existing water quality and hydrology data that have been collected in the L29, L30 and L31N basins over the last 10-15 years will serve as the baseline data for the Increment 1 test.

C.1.5.2 Construction Monitoring

Construction of the S356 structure was completed in 2002. No construction phase monitoring is anticipated for Increment 1 testing.

C.1.5.3 Post-Construction Monitoring (Effectiveness Monitoring)

The Increment 1 test will continue for up to two years. At the completion of Increment 1, the water quality and hydrologic monitoring plan will be modified to match the needs of either Increment 2 testing or a refinement of the MWD / C-111 basin Operating Plan.

C.1.5.4 Inventory of Existing Monitoring Networks

C.1.5.4.1 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.1-1** shows a list of the existing hydrologic monitoring locations within the Increment 1 area of interest. Real-time monitoring data for these hydrologic

monitoring locations will be relied on by USACE, SFWMD, and ENP water managers to evaluate implementation of Increment 1 operations relative to the Increment 1 goals, objectives, and constraints, as described in the Operational Strategy (**Appendix A**); reference maps which show these hydrologic monitoring locations are included in **Appendix A** (**FIGURE 2**, **FIGURE 3**, **FIGURE 4**, and **FIGURE 5**), **Appendix C** (**FIGURE C.1-2**, **FIGURE C.1-4**, and **FIGURE C.1-5**), and Annex 1 of **Appendix C** (**FIGURE C.A-1** and **FIGURE C.A-2**). Though not listed in **TABLE C.1-1** because they are outside of the immediate area of interest, the S12x, S9x and S151 also have ongoing hydrologic measurements. Information from these structures could conceivably be used in evaluating the upstream conditions or effects observed during Increment 1 testing.

TABLE C.1-1. GAGES AND SENSORS FOR SURFACE WATER HYDROLOGIC MONITORING DURING THE INCREMENT 1 TEST.

Feature	Parameter	Purpose
S-333	HW, TW, Q	Canal level, flow volume
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-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-332D	HW, TW, Q	Canal level, 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
G-3626	Stage	Depth, duration, recession
G-3627	Stage	Depth, duration, recession
G-3628	Stage	Depth, duration, recession
LPG1	Stage	Depth, duration, recession
LPG2	Stage	Depth, duration, recession
LPG3	Stage	Depth, duration, recession

LPG5	Stage	Depth, duration, recession
Feature	**Parameter**	**Purpose**
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
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	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
S-199	HW, TW, Q	Canal level, flow volume
S-200	HW, TW, Q	Canal level, flow volume

Notes: HW– headwater stage; TW– tailwater stage; Q– discharge (cfs)

Sensors that measure surface water stage and flow 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 S356 are sourced along the L30 and L31N canals. Surface water flow is measured continuously with acoustic Doppler velocity meters (ADVMs) by the USGS or the Miami-Dade Limestone Products Association (MDLPA) at seven locations along the L31N canal. 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. The water quality sampling events will be timed to best match the ADVM velocity data collection

events on L29, until continuous monitoring stations are established. Two other existing ADVM stations are located at mile 0 and mile 2 along the L31N canal. These stations are maintained by the MDLPA, and data are available on request. The MDLPA ADVM stations may be removed at their discretion.

Surface water flow is measured manually by the USGS on a biweekly basis at two locations along the L29 canal at either end of the Tamiami Trail Bridge. Currently there are no permanent ADVM stations in the L29 canal between structures S-333 and S-334. However, the USGS is seeking a permit to establish two permanent ADVM stations along L29 canal for continuous monitoring (personal communication, Mark Dickman, USGS). These data, when available, will be incorporated into the data analysis.

C.1.5.4.2 Surface Water Quality

New water quality monitoring efforts associated with the Increment 1 test are contemplated for the L29 canal, L30 canal, L31N canal, and Northeastern Shark River Slough. **FIGURE C.1-1** through **FIGURE C.1-5** 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") and/or the Everglades Forever Act (TP-rule). **FIGURE C.1-1** 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.1-2** shows the existing structure monitoring locations on the north and eastern boundaries of the ENP, along the L29 levee (S12s, S333, S334, S355A/B, S356) and along the L31N/C-111 levee canal (S332s, S176, S-18C, S-197). **FIGURE C.1-3** shows the existing marsh monitoring locations within WCA-3, and **FIGURE C.1-4** shows the existing marsh monitoring locations within ENP. On these two figures (**C.1-3, C.1-4)**, 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 a monthly and bi-weekly basis. **FIGURE C.1-5** shows existing locations for surface water flow velocity measurements using ADVMs along L31N canal.

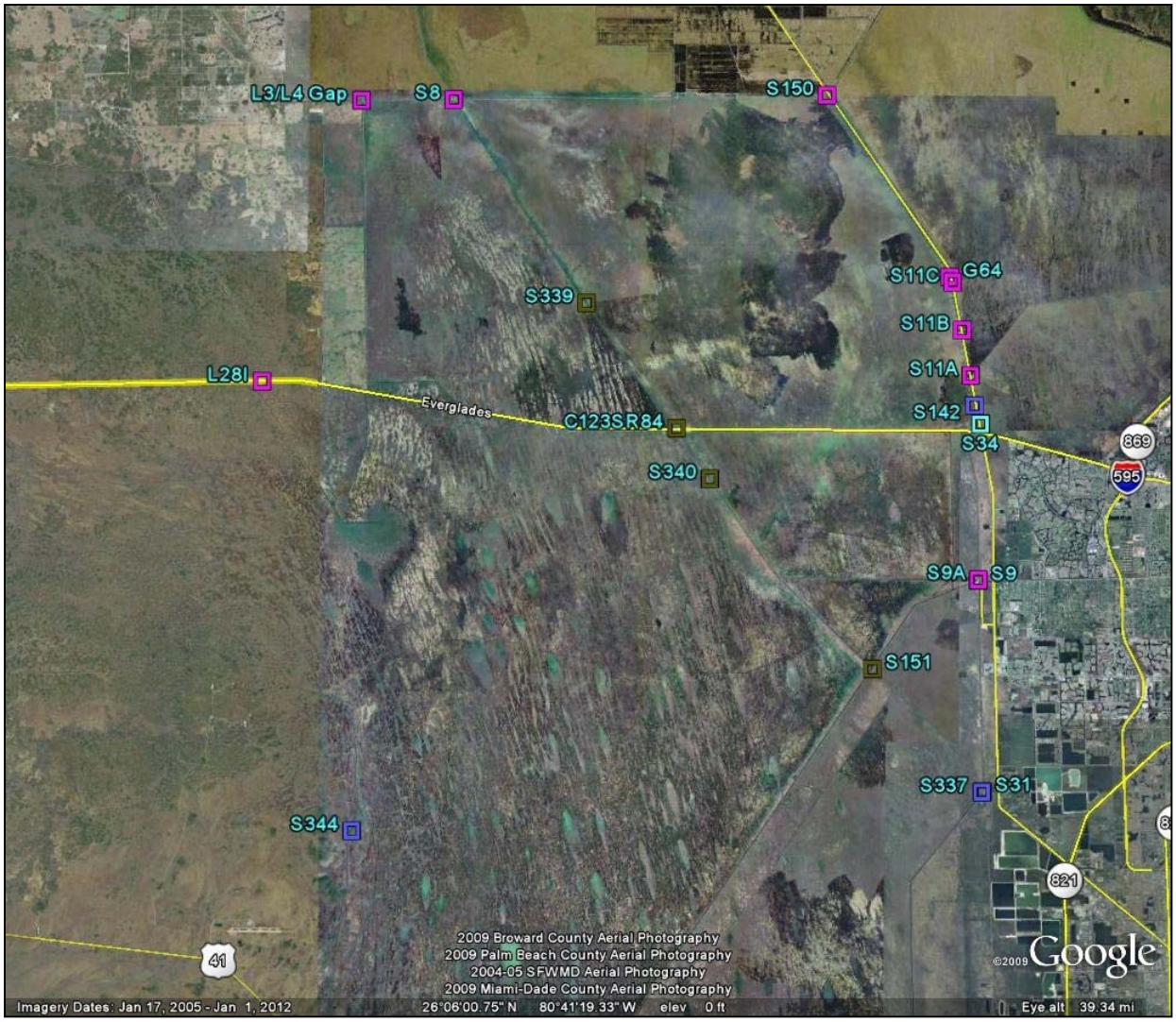


FIGURE C.1-1. EXISTING SURFACE WATER STAGE AND FLOW MONITORING LOCATIONS AT STRUCTURES IN WCA-3A/B

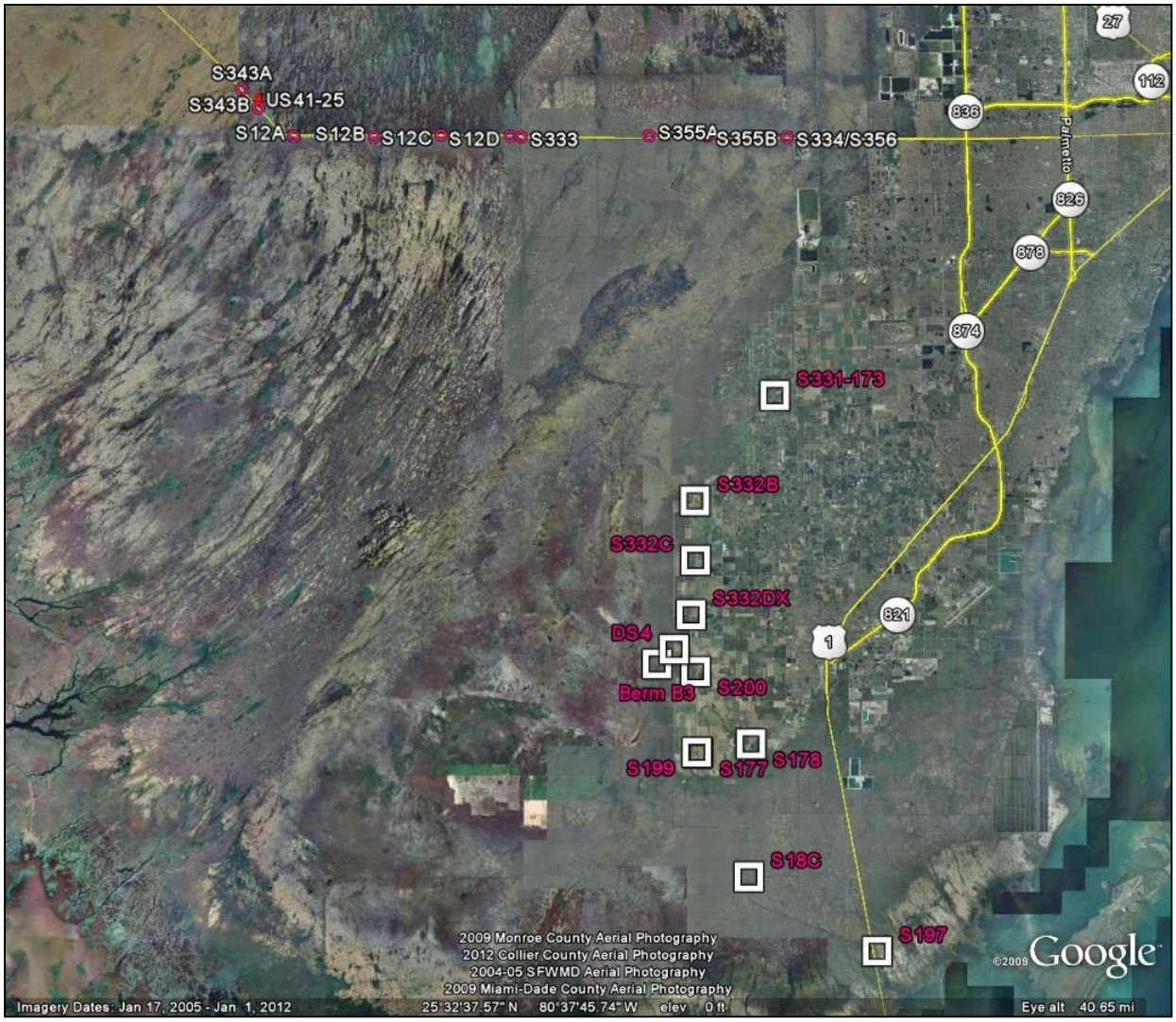


FIGURE C.1-2. EXISTING SURFACE WATER STAGE AND FLOW MONITORING LOCATIONS AT STRUCTURES ALONG THE NORTHERN AND EASTERN BOUNDARY OF ENP

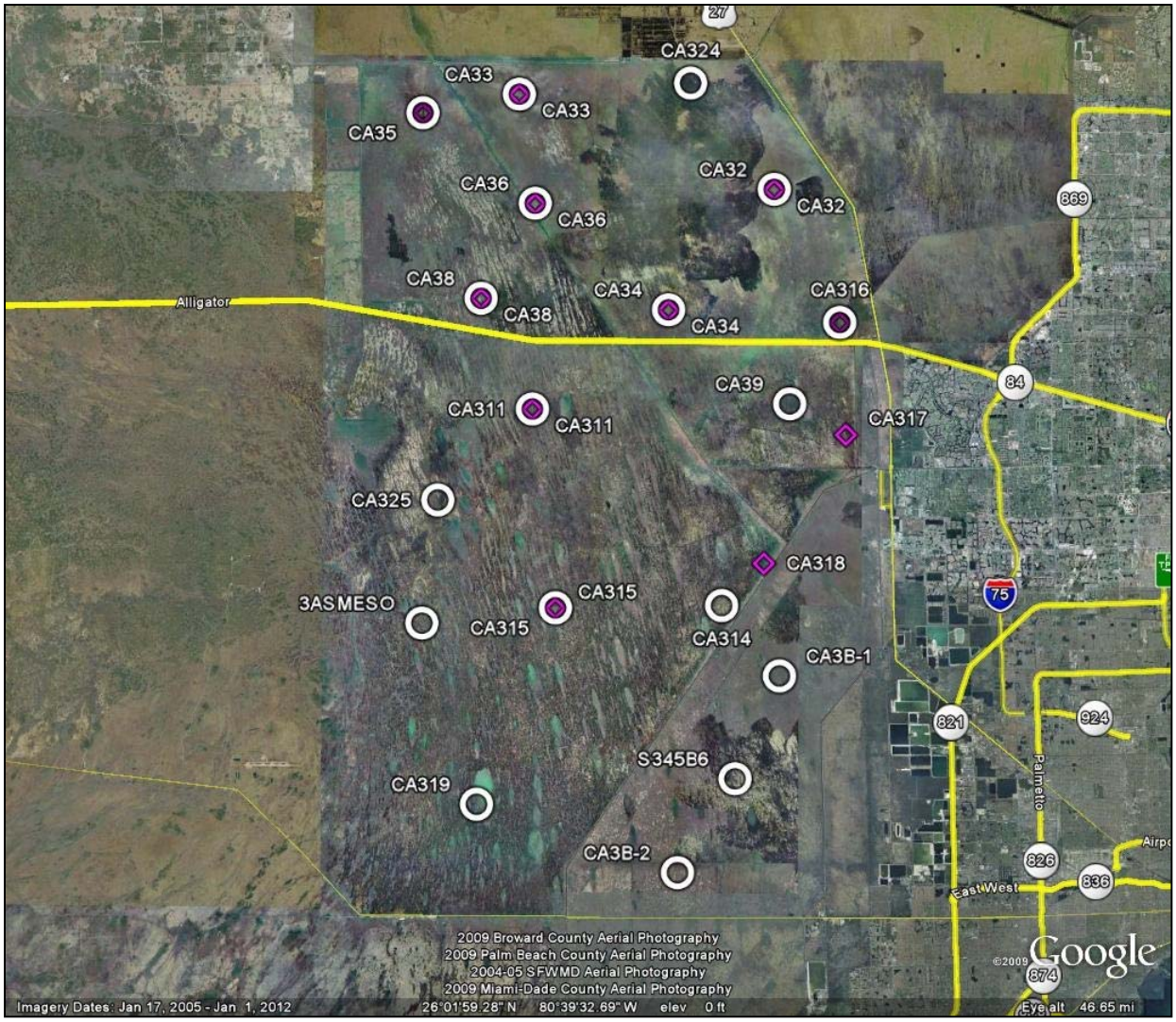


FIGURE C.1-3. EXISTING SURFACE WATER STAGE MONITORING AT MARSH LOCATIONS IN WCA-3A/B

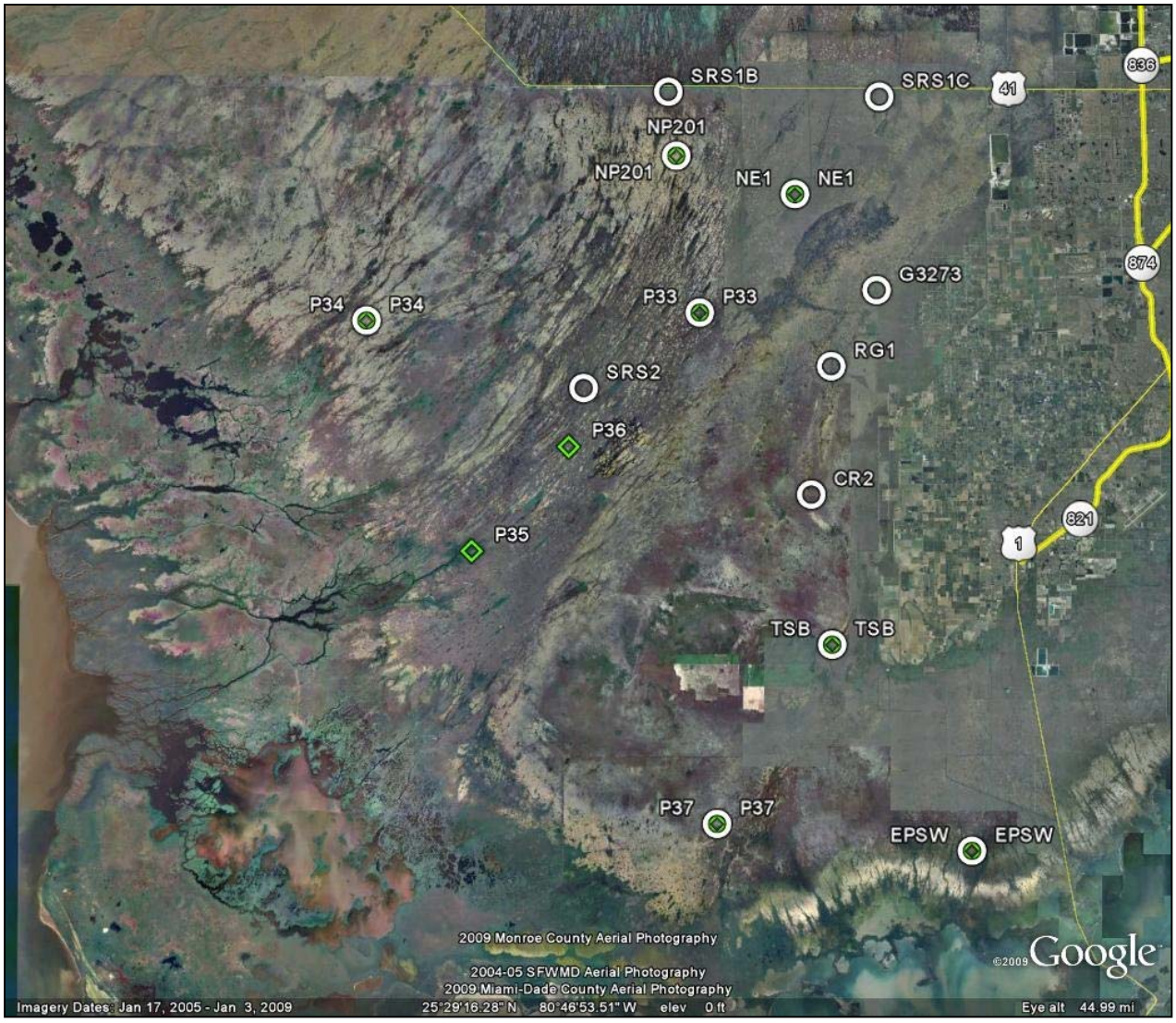


FIGURE C.1-4. EXISTING SURFACE WATER STAGE MONITORING AT MARSH LOCATIONS IN ENP

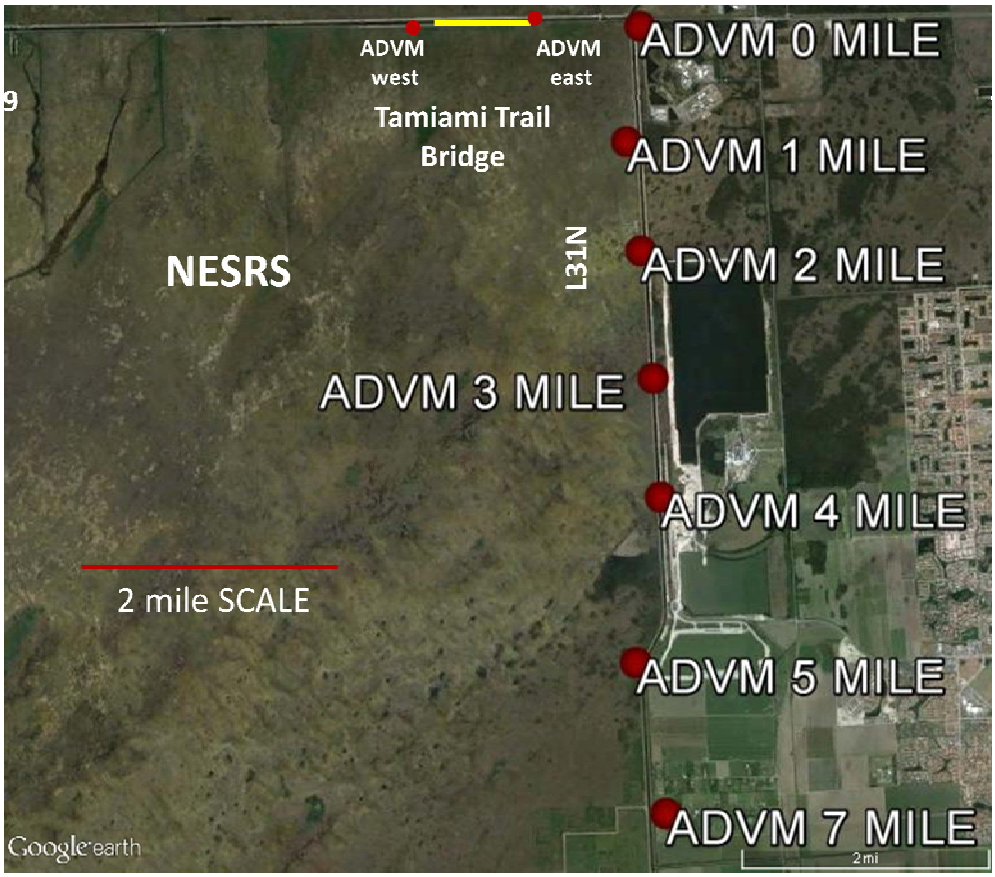


FIGURE C.1-5. EXISTING SURFACE WATER FLOW VELOCITY MONITORING ALONG L29 AND L31N WITH ADVMS

C.1.5.4.3 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

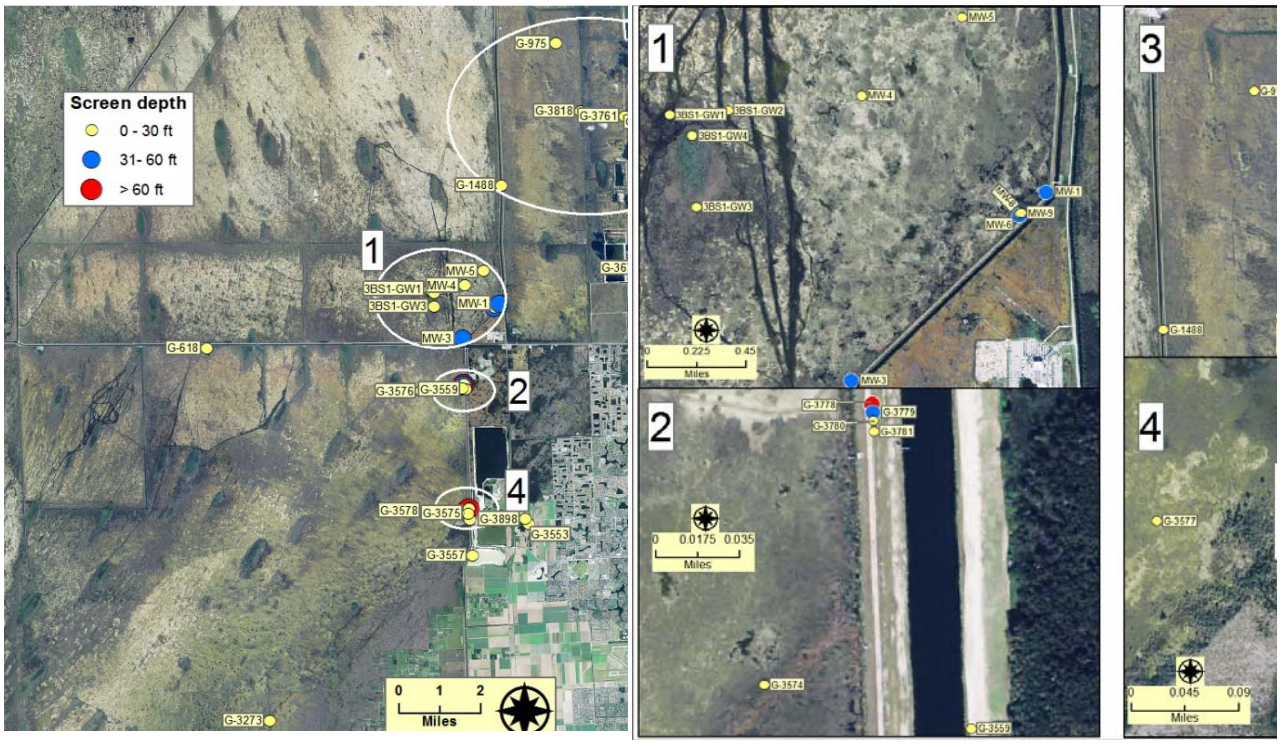


FIGURE C.1-6**.** The result is a comprehensive groundwater monitoring network that will provide detailed data to evaluate effects of S356 pump station operation. **TABLE C.1-2** lists monitoring wells and clusters by location, and the types of data that are measured at each well. All wells listed in **TABLE C.1-2** will be evaluated during the first few months of the Increment 1 test. Hydrologic responses to S356 pumping stresses in surrounding monitoring wells will 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 S356 (for example, in Pennsuco wetlands or the Miami-Dade northwest wellfield). Monitoring wells located along L29, L30, L31N, WCA3B and NESRS will be retained throughout the study.

Groundwater hydrologic monitoring includes groundwater level, flow rate, and flow direction, but not all characteristics are measured at all locations. Hydrologic conditions in WCA3B 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 WCA3B 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 L30 and L31N levees, and on tree islands in southeast WCA-3B (**FIGURE C.1-6-1**). The L30 and L31N monitoring wells are instrumented with heat-pulse flowmeters that measure groundwater flow rate, flow direction, and level. Groundwater characteristics are measured hourly, and data are transmitted through a SCADA system to an off-site receiver at Desert Research Institute (DRI), Reno, NV. Hydrogeologic data are evaluated at DRI for quality control, then packaged and delivered monthly in spreadsheets. Real-time data (with no quality control evaluation) can be viewed on the web portal for the previous two-week period. (http://waterdata.usgs.gov/fl/nwis/current/?type=flow). Most of these wells were

constructed for baseline monitoring in advance of CERP L30 Seepage Management Pilot Project (SMPP) cut-off wall construction. The L30 SMPP project was cancelled in 2010, but data acquisition continued through 30 September 2011. Instrumented monitoring wells were re-engaged in October 2012 to continue baseline groundwater data collection prior to the Increment 1 field test, and also to quantify effects of the test itself. In addition, there are some existing wells between mile 0 and mile 3 along L31N that were constructed by the Miami Dade Limestone Products Association (MDLPA) to evaluate performance of the 2-mile long seepage barrier constructed along L31N levee. These wells may be available for additional data collection during Increment 1 field test.

Of particular importance are those monitoring wells/well clusters that are instrumented with heat-pulse flowmeters and pressure transducers, which measure groundwater flow rate, flow direction and water level (**FIGURES C.1-6-1** and **C.1-6-2).** In the event that S356 pump station field test affects seepage direction and flow rate, data from these wells show the directional and rate changes of groundwater flow from WCA3B and ENP. During the field test, the zone of influence of the S356 pumping stress will be defined by comparison of pre-test data with field test data.

Groundwater monitoring locations can be grouped according to sampling objective, and these groups are shown on

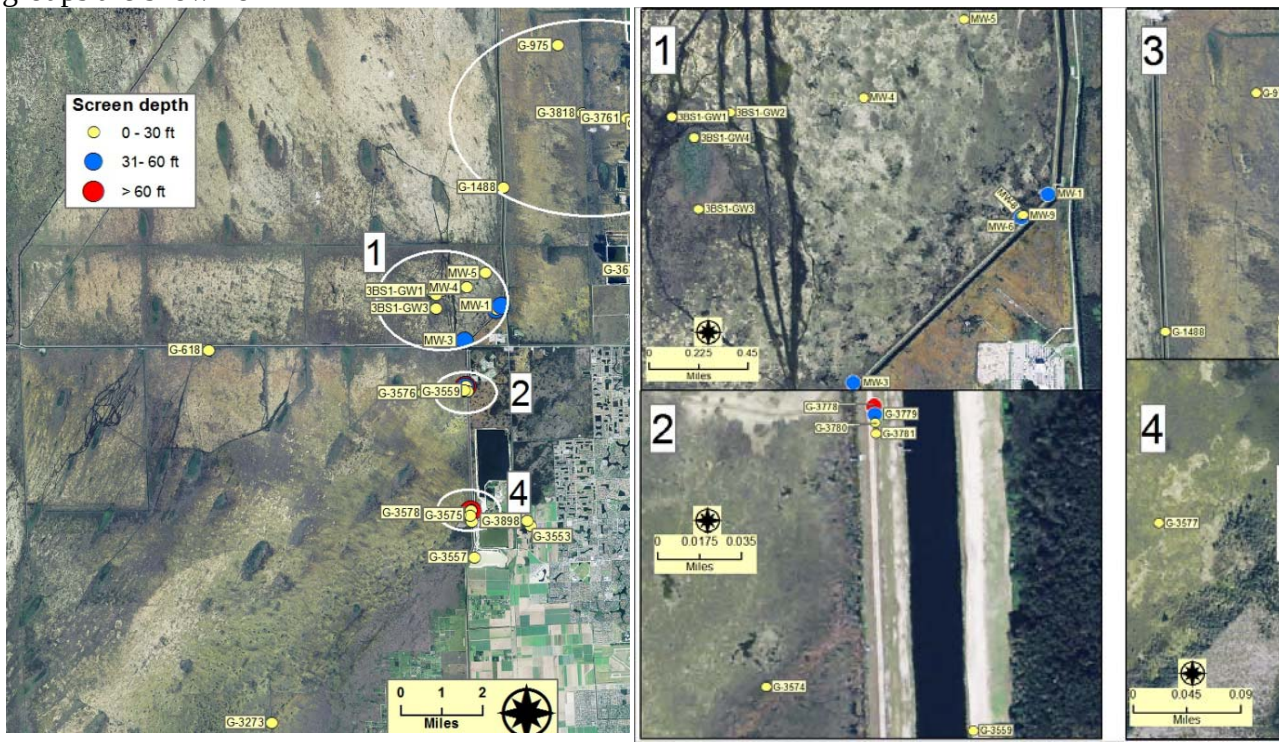


FIGURE C.1-6. Groundwater level and flow data at monitoring locations in WCA-3B and along L30 (**FIGURE C.1.6-1**) will characterize seepage in upgradient and background positions, and also will define the S356 zone of influence north of the pump station. Groundwater level and flow data obtained in northern NESRS and along the northern and southern portions of L31N (**FIGURES C.1.6-2** and **C.1.6-4**, respectively) will characterize seepage in downgradient positions, and also will define the S356 zone of influence south of the pump station. Hydrologic effects of the MDLPA seepage barrier along L31N also will be evaluated from these data.

Groundwater level data obtained near the Miami-Dade Water and Sewer Department (MDWSD) northwest wellfield (**FIGURE C.1.6-3**) 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.1.6-3**), and 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 L30 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 S356 and has five times its pumping capacity. It will not be known whether this mixing effect will occur at S356 until the operational field test is conducted. Water-quality changes observed at S-7 are not directly applicable to the field test proposed in this document.

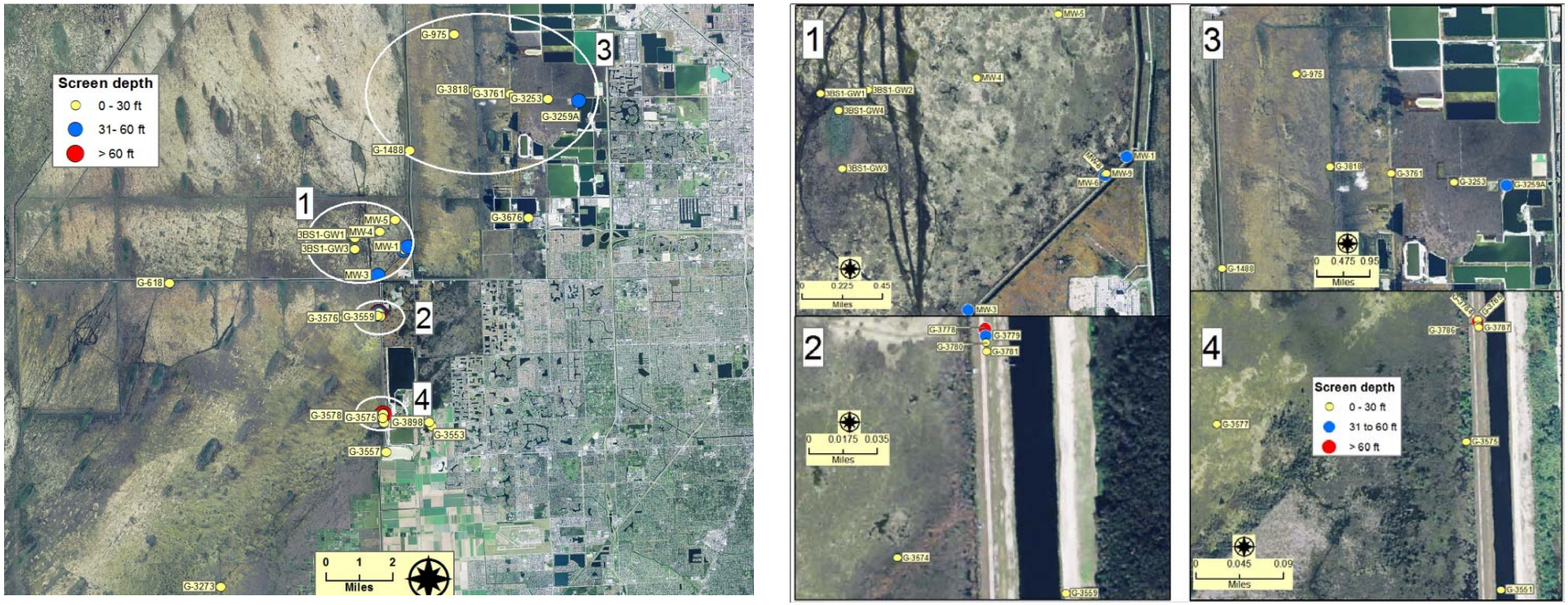


FIGURE C.1-6. EXISTING GROUNDWATER MONITORING WELLS IN THE PROJECT AREA. LEFT, BASE MAP SHOWING ALL WELL LOCATIONS. RIGHT, INSET MAP. C.1.6-1, INSTRUMENTED MONITORING WELLS ALONG L30 AND WCA-3B (TREE ISLAND WELLS); C.1.6-2, APPROXIMATELY 1 MILE SOUTH OF TAMIAMI TRAIL, ALONG L31N BETWEEN ENP AND THE L31N CANAL; C.1.6-2, EAST OF L30 PROXIMAL TO THE MIAMI-DADE WATER AND SEWER DEPARTMENT NORTHWEST WELL FIELD; C.1.6-4, APPROXIMATELY 4 MILES SOUTH OF TAMIAMI TRAIL, ALONG L31N BETWEEN ENP AND THE L31N CANAL.

TABLE C.1-2. HYDROLOGIC CHARACTERISTICS MEASURED IN EXISTING MONITORING WELLS.

Well	Location	Open Interval (ft NGVD29) from land-surface elevation	Casing Construction	Hydrologic Parameters					Access Data (real-time or near-time) and comments
				Real-time GW Level	Real-time GW flow rate	GW flow direc-tion	Specific Conduc tance	Temper - ature	
MW-6	just west of L30 levee in WCA-3B	-31.9 to -33.2	PVC	Yes	Yes	Yes	Yes	Yes	http://l30l31.dri.edu
MW-8	just west of L30 levee in WCA-3B	-13.9 to -15.15	PVC	Yes	Yes	Yes	Yes	Yes	http://l30l31.dri.edu
MW-9	just west of L30 levee in WCA-3B	-5.5 to -6.7	PVC	Yes	Yes	Yes	Yes	Yes	http://l30l31.dri.edu
MW-1	L30 levee at S-335	-40.5 to -42.5	PVC	Yes	Yes	Yes	No	Yes	http://l30l31.dri.edu
MW-3	L30 levee at TT	-40.2 to -42.2	PVC	Yes	Yes	Yes	No	Yes	http://l30l31.dri.edu
MW-4	WCA-3B	-22.45 to -24.45	PVC	Yes	No	No	Yes	Yes	http://l30l31.dri.edu
MW-5	WCA-3B	-24.64 to -26.64	PVC	Yes	No	No	Yes	Yes	http://l30l31.dri.edu
SW-7	Stilling well just west of L30 levee in WCA-3b	Surface water level to +2.1	PVC	Yes	No	No	No	No	http://l30l31.dri.edu
G-3778	L31NN cluster (L31NN-GW1) 1 mi S of TT	-85.7 to -87.7	PVC	Yes	No	No	No	No	http://l30l31.dri.edu and dbhydro search for site name "L31NN"
G-3779	L31NN cluster (L31NN-GW2) 1 mi S of TT	-36.5 to -38.5	PVC	Yes	Yes	Yes	No	No	http://l30l31.dri.edu and dbhydro search for site name "L31NN"
G-3780	L31NN cluster (L31NN-GW3) 1 mi S of TT	-15.7 to -17.7	PVC	Yes	Yes	Yes	No	No	http://l30l31.dri.edu and dbhydro search for site name "L31NN"
G-3781	L31NN cluster (L31NN-GW4) 1 mi S of TT	-0.6 to -2.6	PVC	Yes	Yes	Yes	No	No	http://l30l31.dri.edu and dbhydro search for site name "L31NN"
G-3784	L31NS cluster (L31NSGW1) 4 mi S of TT	-83.1 to -85.1	PVC	Yes	No	No	No	No	dbhydro search for sitename "L31NS"
G-3785	L31NS cluster (L31NSGW2) 4 mi S of TT	-27.2 to -29.2	PVC	Yes	Yes	Yes	No	No	dbhydro search for sitename "L31NS"
G-3786	L31NS cluster (L31NSGW3) 4 mi S of TT	-11.1 to -13.1	PVC	Yes	Yes	Yes	No	No	dbhydro search for sitename "L31NS"

TABLE C.1-2. HYDROLOGIC CHARACTERISTICS MEASURED IN EXISTING MONITORING WELLS- *CONTINUED*.

Well	Location	Open Interval (ft NGVD29) from land-surface elevation	Casing Construction	Hydrologic Parameters					Access Data (real-time or near-time) and comments
				Real-time GW Level	Real-time GW flow rate	GW flow direc-tion	Specific Conducta nce	Temper-ature	
G-3787	L31NS cluster (L31NSGW4) 4 mi S of TT	-1.5 to -3.5	PVC	Yes	Yes	Yes	No	No	dbhydro search for sitename "L31NS"

3BS1-GW1	Dual zone monitor well in WCA-3B tree island north of TT	upper: -8.77 to -9.77 lower: -27.00 to -29.00	PVC	Yes in both intervals	No	No	No	Yes in both intervals	http://l30l31.dri.edu and dbhydro search for site name "3BS%"
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 intervals	No	No	No	Yes in both intervals	http://l30l31.dri.edu and 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 intervals	No	No	No	Yes in both intervals	http://l30l31.dri.edu and 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 intervals	No	No	No	Yes in both intervals	http://l30l31.dri.edu and 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	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	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	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	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255027080245501 and DBHydro
G-3551	4.2 miles S of TT and 100-ft west of L31N canal	-6.7 to -11.7	PVC	Yes	No	No	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	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 L31N Canal	-7.9 to -12.9	PVC	Yes	No	No	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	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 L31N Canal	-5.9 to -10.9	PVC	Yes	No	No	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 L31N Canal	-3.8 to -3.8 ft open end well	PVC	Yes	No	No	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254207080300201&PARAmeter_cd=72020,62611 and DBHydro

TABLE C.1-2. HYDROLOGIC CHARACTERISTICS MEASURED IN EXISTING MONITORING WELLS- *COMPLETED.*

Well	Location	Open Interval (ft NGVD29) from land-surface elevation	Casing Construction	Hydrologic Parameters					Access Data (real-time or near-time) and comments
				Real-time GW Level	Real-time GW flow rate	GW flow direction	Specific Conductance	Temperature	
G-3576	ENP: 1.1 mi south of TT and 1.03 mi west of levee on west side of L31N Canal.	-3.6 to -3.6 ft open-end	PVC	Yes	No	No	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=254442080305201&PA

		well							RAmeter_cd=72020,62611 and DBHydro
G-3574	ENP: 1.06 mi. S of TT on L31N levee	Stilling well - 0.6 ft	PVC	Yes	No	No	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 L31N Canal	-3.8 to -3.8 ft open end well/piezometer	PVC	Yes	No	No	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 L31N Canal.	-3.6 to -3.6 ft (possibly an open-end well/piezometer)	PVC	Yes	No	No	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 L31N canal.	-2.0 to -2.0 ft (possibly an open-end well/piezometer)	PVC	Yes	No	No	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 L31N Canal	0 to 0 ft (possibly an open-end well/piezometer)	PVC	Yes	No	No	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	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	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=255035080255402
G-3818	Latitude 25°50'36.8", Longitude 80°27'04.3" 2.25 mi. due W of G3253/MDWASD NW well field, 5.3 mi N of TT in Pennsuco wetlands	Maximum depth -14.9	PVC	Yes	No	No	No	No	http://waterdata.usgs.gov/fl/nwis/nwismap/?site_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	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	No	No	http://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=254500080360001
G-975	Pennsuco Wetlands: 1.0 mi SW of junction of Pennsuco Canal and Dade/Broward Levee, 5.5 mi SW of Pennsuco, and 7.5 mi N of U.S. Highway 41.	-2.6 to -7.6	Stainless Steel	Yes	No	No	No	No	http://waterdata.usgs.gov/fl/nwis/uv/?site_no=255208080274001&PARAmeter_cd=72020,62611

In July 2012, the MDLPA completed construction of a 2-mile long seepage barrier along the northern terminus of the L31N 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: 2-miles long, 32-inches wide, and 35-ft deep below land surface (to approximately -30 ft NGVD29). The primary objective of this seepage barrier is to reduce groundwater flow rate eastward out of NESRS. This objective is currently under evaluation.

C.1.5.4.4 Groundwater Quality

Biscayne Aquifer water quality has moderate carbonate alkalinity, low chloride, sulfate and total phosphorus concentrations, and low specific conductance values (**FIGURE C.1-7).** 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. Limited groundwater quality data are available on the SFWMD database DBHydro, and the USGS database NWIS. All groundwater quality data in the immediate vicinity of L29, L30, and L31N were obtained from the L31NN monitoring well cluster (**FIGURE C.1-7**). There are no groundwater quality data available for the Bird Drive Recharge Area, or other areas adjacent to the L30 and L31N canals.

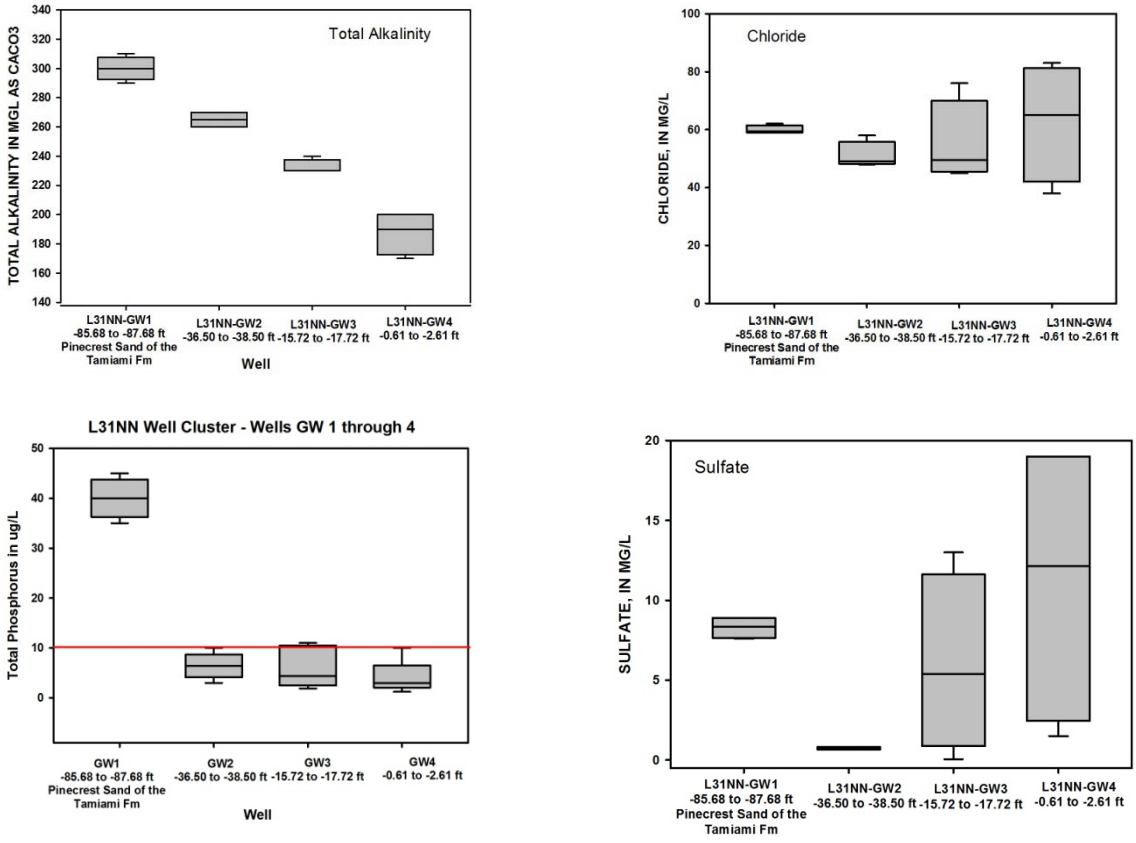


FIGURE C.1-7. BOX DIAGRAMS SHOWING GROUNDWATER QUALITY DATA AT DIFFERENT DEPTHS FROM BISCAYNE AQUIFER MONITORING WELL CLUSTER L31N.

C.1.5.5 Integration of Monitoring Components

New monitoring stations (refer to **Section C.1.7**) 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.1.6 DURATION

This monitoring program is expected to be conducted during the Increment 1 testing period, which is expected to last up to two years. The Increment 1 test is expected to commence in June 2015. At the completion of Increment 1 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. One set of pre-test data will be collected from all stations to define pre-test conditions before the Increment 1 test begins.

C.1.6.1 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 1 test is complete. This 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 Increment 1 test objectives. Decisions to adjust the monitoring plan will be coordinated through the project partners as well as the FDEP.

This Increment 1 monitoring plan was 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 Project will reevaluate monitoring priorities.

C.1.7 NEW 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.1.7.1 Surface Water Hydrology

C.1.7.1.1 Flow Measurements Along L29 and L31N

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 L29 between structures S-333 and S-334. The bi-weekly USGS flow data collection effort will be coordinated with the water quality sampling schedule. These measurements may be supplemented by installation of new ADVM sensors along L29 if resources are available.

C.1.7.1.2 L29 Canal Morphology

Stream channel morphology will be monitored in the L29 Canal immediately downstream of S356 will be made 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 will be defined by two or more surveyed cross-sections located downstream (west) of the S356 pump station, between the outflow and the 1-mile Tamiami Trail bridge.

C.1.7.2 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. 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.1-8** shows physical locations of these stations. **TABLE C.1-3** lists the sample monitoring locations in the vicinity of L29 and L31N. 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.1.7.2.1 New 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: S356 Surface Water Flow and Quality

S356: To characterize the quality and volume of flow discharged at the S356 pump station, weekly surface water quality grab sampling combined with an ADT autosampler for time dependant TP monitoring will be conducted at the S356 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.

TAMBR1, TAMBR4, NE0: Water in the L29 canal between the S-334 structure and S333 is characterized by existing monitoring conducted at the Safari, Glader, Coopertown, and S-355A/B stations shown in **FIGURE C.1-8**. All of these existing stations are located at least 3 miles west of the S356 pump. To characterize the quality of water that enters NESRS in close proximity to the S356 pump, two new L29 monitoring locations are 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 L29 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.

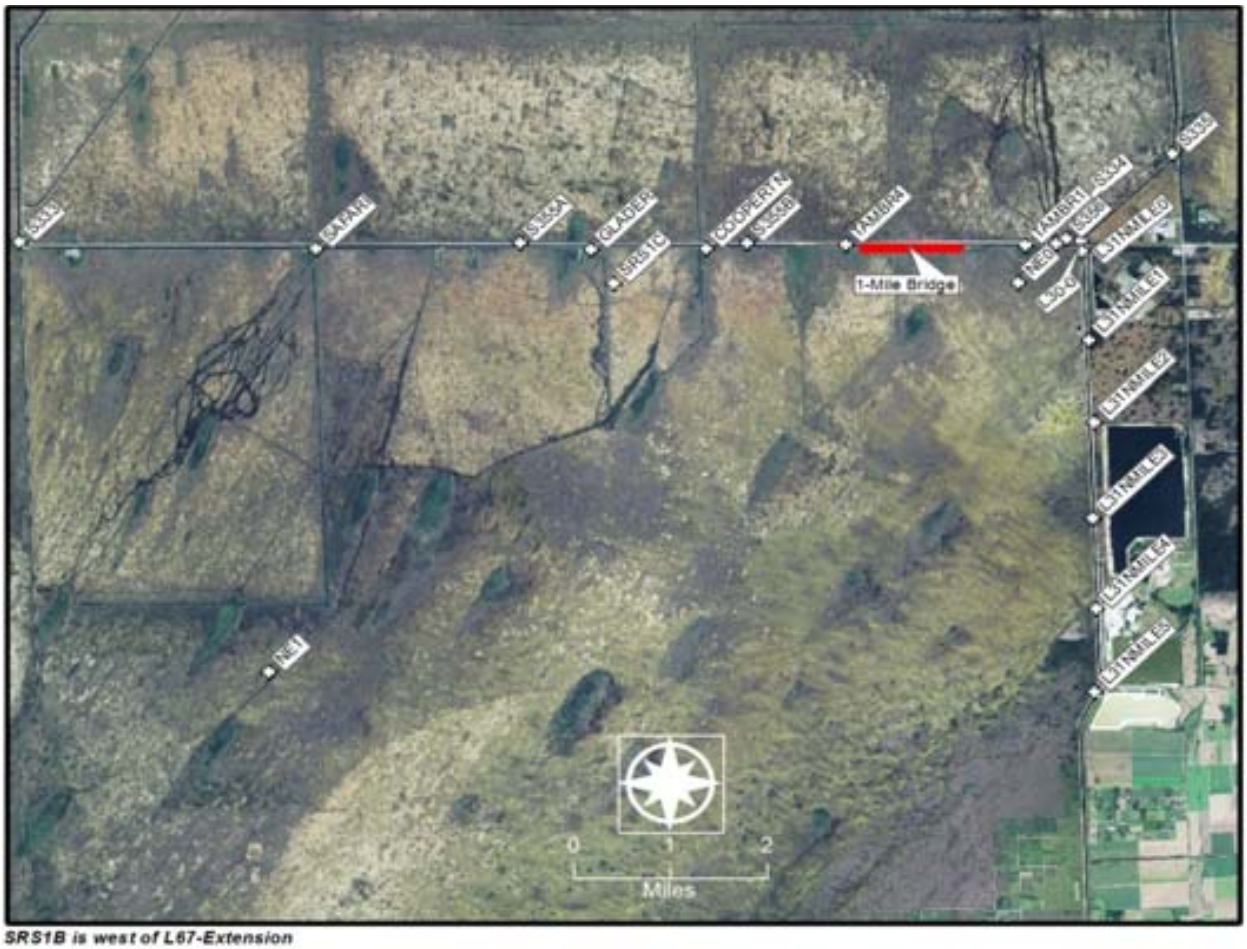
Objective 2: Sources of S356 Flows

L31NMile0, L31NMile1, L31NMile2, L31NMile3, L31NMile4, and L31NMile5: Water pumped at S356 will potentially be sourced from L30 flows, groundwater in the vicinity of the pump, seepage from WCA-3B into L30 canal, and seepage from ENP into the L31N canal. The existing surface water quality monitoring network will be augmented to include two new stations (L31NMile0 and L30Mile0 (surrogate for S336)) at the confluence of the C4, with the L31N and L30 canals, respectively and along the L31N canal (L31NMile1, L31NMile2, L31NMile3, L31NMile4, and L31NMile5). The five new monitoring sites along the L31N 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 S336, S21A, L31NMile7, G211, and S338. 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. (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 S12X, S333, S334, S355A/B structures. The SFWMD has been supplementing the required TP monitoring at these structures by collecting weekly samples at the S12 structures and at the S333 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 S12s to S333.

The collection of flow and TP concentration data at the S356 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 S356 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 Corps and the results will be available in March of the following year.



SRS1B is west of L67-Extension

FIGURE C.1-8. SURFACE WATER QUALITY MONITORING STATION LOCATIONS ALONG TAMIAMI TRAIL.

TABLE C.1-3. PROPOSED SURFACE WATER QUALITY MONITORING FOR G3273/S356 INCREMENT 1 TEST

Station	Location	Water Quality Parameters	Frequency and Sample Type	
			Flowing	Non-Flowing
TAMBR1	L29 north bank, directly across from culvert under US 41; 0.3 mi. west of S-334; a.k.a. FDOT Culvert 59	*TPO_4, OPO_4, 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
TAMBR4	L29 north bank, directly across from culvert under US 41; 2.2 mi, west of S334; a.k.a. Culvert 56	*TPO_4, 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
NE0	NESS marsh site 0.5 km south of FDOT Culvert 59 (TAMBR1)	*TPO_4, 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	L30 canal/L29 juncture NW corner; 25° 45' 41.93" N, 80° 29' 53.70" W	*TPO_4, OPO_4, 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
S355A	Approximately 5.5 mi. west of S356. Tail Water	*TPO_4, 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
S355B	Approximately 3.25 mi. west of S356. Tail Water	*TPO_4, 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	Downstream of culvert south of L29, approximately 8 mi. west of L31N.	*TPO_4, 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	Downstream of culvert south of L29, approximately 5-1/4 mi. west of L31N.	*TPO_4, 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	Downstream of culvert south of L29, approximately 4 mi. west of L31N.	*TPO_4, 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
S333	SE Corner of WCA3A at L29.	*DO, SC, pH, Turb, TSS, NO_x, TKN, OPO_4, TPO_4, Na, K, Ca, Mg, Cl, SO_4, Alk*	Weekly when flowing; otherwise monthly; grab	Monthly grab; collection and analyses by SFWMD
		TPO_4, TKN, NO_x	Time-proportional autosampler: weekly	
S334	On L29 approximately 1/4 mile west of L31N. Head Water.	*TPO_4, 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
S335	On L30 north of L29. Tail Water (and Head Water).	*TPO_4, OPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
S356	On L29 approximately 1/4 mi. west of L31N.	*DO, SC, pH, Turb, TSS, NO_x, TKN, OPO_4, TPO_4, Na, K, Ca, Mg, Cl, SO_4, Alk*	Weekly when flowing; otherwise monthly; grab	Monthly grab; collection and analyses by SFWMD

Station	Location	Water Quality Parameters	Frequency and Sample Type	
			Flowing	Non-Flowing
	NOTE: Autosampler on site.	*TPO_4, TKN, NO_x*	Time-proportional autosampler: weekly	
S197	On C111 approx .15mile east of US 1/C111 juncture: 25° 17' 13.46" N, 80° 26' 29.94" W	*DO, SC, pH, TSS, NO_x, TKN, OPO_4, TPO_4, Na, K, Ca, Mg, Cl, SO_4, TURB, SO4*	Biweekly if flowing	Quarterly Quarterly
L31NMile0	0.06 miles south of the intersection of L29 and L31N – Stage gage; 25° 45' 36.25" N, 80° 29' 53.32" W	*TPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L31NMile1	One mile south of the intersection of L29 and L31N - miles south of the intersection of L29 and L31N – Stage gage; 25° 44' 46.75" N, 80° 29' 51.46" W	*TPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L31NMile2	Two miles south of the intersection of L29 and L31N - miles south of the intersection of L29 and L31N – Stage gage; 25° 43' 54.75" N, 80° 29' 48.72" W	*TPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L31NMile3	Three miles south of the intersection of L29 and L31N - miles south of the intersection of L29 and L31N – Stage gage; 25° 43' 03.32" N, 80° 29' 47.57" W	*TPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L31NMile4	Four miles south of the intersection of L29 and L31N - miles south of the intersection of L29 and L31N – Stage gage; 25° 42' 06.82" N, 80° 29' 45.23" W	*TPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
L31NMile5	Five miles south of the intersection of L29 and L31N – Stage gage; 25° 41' 09.81" N, 80° 29' 50.10" W	*TPO_4, Na, Ca, Mg, K, Cl, SO_4, Alk, SC, DO, pH, SC, T*	Biweekly; grab; collection and analyses by SFWMD	Monthly grab; collection and analyses by SFWMD
NE1	In the Park marsh, 4.67 miles south of the L29 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	In the Park marsh, 0.42 miles south of L29 canal	*TPO_4, DO, pH, SC, T*	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD
SRS1B	In the Park marsh, 0.31 miles south of L29 canal	*TPO_4, DO, pH, SC, T*	Monthly; grab; collection by ENP, and analysis by SFWMD	Monthly; grab; collection by ENP, and analysis by SFWMD

LEGEND		
Color Code	**Description**	**Parameters**
Blue	Station currently being monitored	Red text: added analytes
Green	Proposed station; many stations were previously monitored by SFWMD	
Yellow	Collection by ENP, Analysis by SFWMD	

C.1.7.3 Groundwater Hydrology

All existing groundwater monitoring stations described in **Section C.1.5.4.2** will be included during the initial months of Increment 1 of the S356 pump station field test. Distal well locations may be eliminated (as defined in **Section C.1.5.4.2**) if no response is shown to S356 operation. Only one new groundwater monitoring station is proposed. The proposed station will be a 2-well or 4-well cluster located proximal to the S356 pump station, on the north side of the L29 Canal, and these wells will be instrumented with water level sensors. Construction of this proposed monitoring station is pending availability of resources.

C.1.7.4 Groundwater Quality

Most of the wells listed in **TABLE C.1-2** are not sampled routinely for groundwater quality, so data that define groundwater quality conditions at various depths in the Biscayne Aquifer are sparse. A groundwater quality monitoring program is proposed in **TABLE C.1-4**, to complement the surface water quality monitoring program. Groundwater samples will be obtained from a sub-set of wells, and will be analyzed for an identical suite of water-quality constituents as the surface water samples. Combined, these data will allow source water characterization of surface and groundwater seepage flows, and characterization of mixing processes between those two water end-members. The final product will be 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 S356 pump station operation.

Groundwater quality monitoring locations are grouped according to sampling objective, with locations shown on

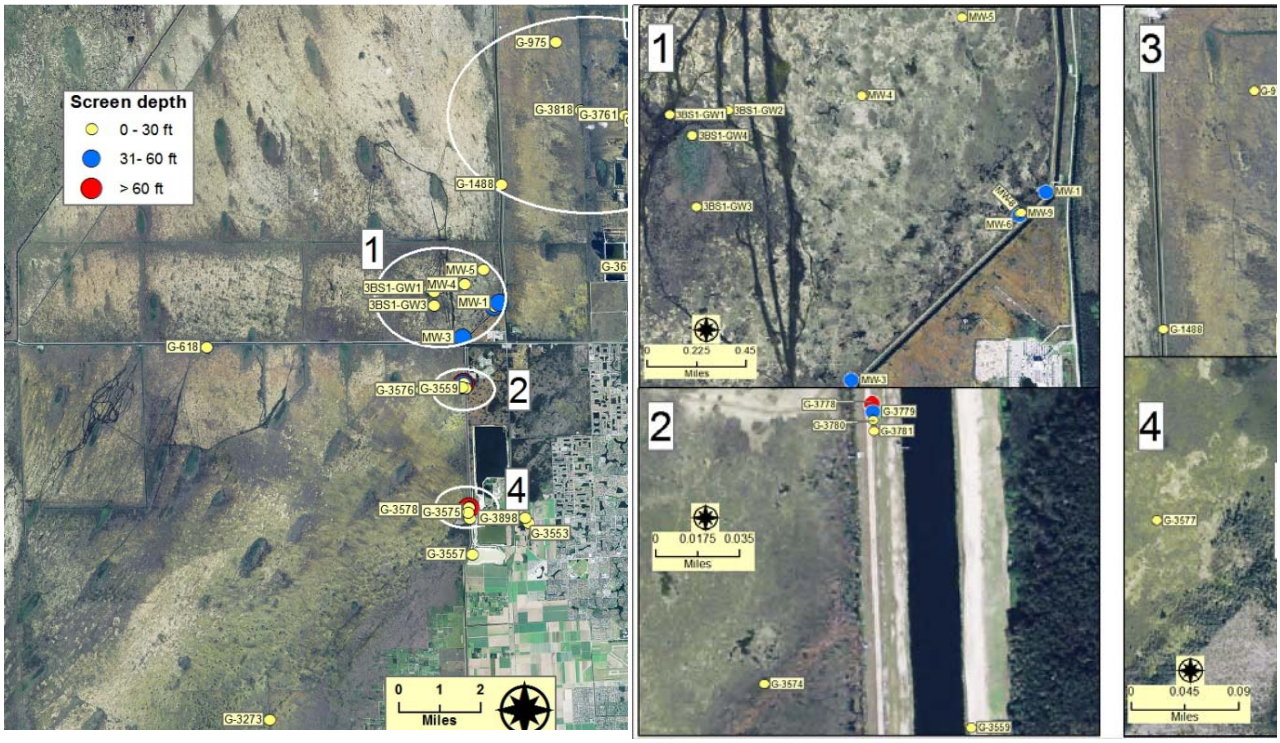


FIGURE C.1-6. Wells sampled for water quality are a subset of the groundwater flow and level monitoring network. All groundwater quality data compiled during the Increment 1 test will be incorporated into the source water characterization and water budget tasks. Groundwater quality

data obtained at monitoring locations in WCA-3B and along L30 **(MW-1 through MW-9; 3BS1-GW3)** will characterize seepage in upgradient and background positions, and also at a tree island. Groundwater level and flow data obtained in northern NESRS and along the northern and southern portions of L31N (all other wells, **TABLE C.1-4**) will characterize seepage in downgradient positions.

Most wells will be sampled quarterly during Increment 1 because groundwater quality changes occur seasonally in the upper Biscayne Aquifer, and over longer time scales in the lower Biscayne Aquifer. A subset of wells will be sampled monthly for at least one year of the Increment 1 test. Data from these wells are the basis for the source water characterization study, which requires a greater number of samples for statistical analysis. The "MDLPA wells" (**TABLE C.1-4**) were constructed on the L31N levee crest west of the seepage barrier. These wells will be sampled monthly unless deleterious water quality effects result from groundwater interactions with the seepage barrier, or that sampling will be detrimental to ongoing groundwater level monitoring. Should these samples show anomalously alkaline pH, or elevated cation concentrations, these wells will be deleted from the monitoring plan.

C.1.7.5 Geographic Location of New Groundwater Monitoring Stations

The exact location of the new groundwater monitoring station has not been determined at this time. After the EA is approved, this monitoring plan will be revised to include the latitude and longitude of each new station.

C.1.7.6 Access and Authority

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.

TABLE C.1-4. GROUNDWATER QUALITY SAMPLING PLAN. WELL LOCATIONS ARE SHOWN IN FIGURE C.1-6.

WELL	Water Quality Parameters	Frequency and Sample Type		Objective
		Flowing	Non Flowing	
MW-6	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
MW-8	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
MW-9	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
MW-1	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
MW-3	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
MW-4	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
MW-5	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
SW-7	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B
3BS1-GW3	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	Background, upgradient WQ in WCA-3B (tree island)
G-3778	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NN cluster;Downgradient flowpath, NESRS and L31N seepage
G-3779	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NN cluster;Downgradient flowpath, NESRS and L31N seepage
G-3780	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NN cluster;Downgradient flowpath, NESRS and L31N seepage
G-3781	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NN cluster;Downgradient flowpath, NESRS and L31N seepage
G-3784	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NS cluster; Downgradient flowpath, NESRS and L31N seepage
G-3785	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NS cluster; Downgradient flowpath, NESRS and L31N seepage
G-3786	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NS cluster; Downgradient flowpath, NESRS and L31N seepage
G-3287	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Quarterly	Baseline sample before Incr 1	L31NS cluster; Downgradient flowpath, NESRS and L31N seepage
G-3551	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly	Baseline sample before Incr 1	L31N 4.2 mi; Downgradient flowpath, NESRS and L31N seepage
G-3553	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly	Baseline sample before Incr 1	Bird Dr. recharge area; Downgradient flowpath, NESRS and L31N seepage
G-3557	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly	Baseline sample before Incr 1	L-31N 5.2 mi; Downgradient flowpath, NESRS and L31N seepage
G-3559	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly	Baseline sample before Incr 1	L-31N 1.0 mi; Downgradient flowpath, NESRS and L31N seepage
G-3575	TPO_4, Na, Ca, Mg, K, Cl, SO4, Alk, DO, SC, T & pH	Monthly	Baseline sample before Incr 1	L31N-4.0m; Downgradient flowpath, NESRS and L31N seepage

C.1.8 PROJECT REPORTING

Reporting for project monitoring conducted to comply with the Settlement Agreement, 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 CERPRA permit requirement. At the completion of each year of Increment 1 testing,

a water quality assessment report and a hydrometeorological report will be prepared by the USACE in conjunction with DOI that summarizes how the test was conducted and how data are interpreted. Specifically, results of the surface water stage, flow velocity, and water-quality sampling programs, and groundwater level, flow velocity, direction, and water quality sampling programs will be interpreted to address objectives defined in **Section C.1.3**.

The reports would be prepared and provided to DEP on an annual basis with a target delivery date of April of each year. The report may be delayed by the Federal Water Year Appendix A report timing. The reporting period would be the federal water year for Appendix A and S356 compliance assessments. Data for the October through December period may be included in the non-regulatory data analysis if this information is available and it makes sense to include it because of ongoing pumping through the end of the wet season. Report preparation will require support and assistance from cooperating agencies such as ENP. The report outline shown below is a first cut draft that incorporates most of the data collected in the monitoring plan. A more detailed analysis and reporting plan will be developed during data acquisition over the first year of monitoring. Ecological reporting may be incorporated into this report or be reported separately. The reporting associated with the C-111 SC project area is discussed in Annex 1.

Report Outline (draft version)

1. Objectives and Methodology of Surface and Groundwater Monitoring
2. Operational Report (stages, structure ops, etc.) (USACE)*
    a. WCA3A Stages
    b. ENP Stages
    c. L29, L30, L31N, C-111 Stages
    d. South Dade Agricultural Area Stages
    e. Structure HW, TW, flows (S12X, S333, S334, S335, S336, G211, S331, S332X, S176, S177, S178, S199, S200, S18C, S197)
3. Appendix A Results (Referenced from SFWMD report) (SFWMD)
4. S356 FWM TP Calculation. (USACE,ENP)
5. Evaluation of effect of Increment 1 on Water Quality Compliance (multi-agency)
6. Source Analysis for S356 Flows (mass balance assessment and water budget)
7. Evaluation of L31N Water Quality (USACE, ENP)
    a. Surface WQ trends when S356 Pumping
    b. Surface WQ trends when S334 Open
    c. Surface WQ trends when S334/S356 closed/off
8. Evaluation of L29 Water Quality (concentration, loads) (USACE)
    a. Surface WQ trends when S356 Pumping
    b. Surface WQ trends when S334 Open
    c. Surface WQ trends when S356/S334 closed/off
9. Evaluation of L30 Water Quality (USACE, ENP)
    a. Surface WQ trends when S356 Pumping
    b. Surface WQ trends when S334 Open

c. Surface WQ trends when S356/S334 closed/off

10. Evaluation of GW (stage, flow direction, WQ) Response to S356 Ops (USACE, ENP)
    a. Response of GW wells in vicinity of WCA and L30
    b. Response of GW wells at S356
    c. Response of GW wells along northern L31N (S-336 to S-331)
    d. Response of GW wells along southern L31N (S-331 to S-176)
    e. Response of GW wells in C-111 Basin
11. Evaluation of Water Quality at NESRS Marsh Stations (ENP)
12. Recommendations for Ongoing Monitoring Efforts (year 1 report) (multi-agency)
13. Recommendations for future operations for water quality and monitoring (year 2 report) (USACE, ENP, SFWMD, DEP)

*****The operational information in the first year report may include only hydrographs and limited interpretation or description of operations. If needed, modifications to Increment 1 water management operations will also be documented following interagency workshops and implementation, including the justification for each modification and consideration of agency and/or stakeholder input. The Operations Team, under the direction of the USACE water managers, will provide a comprehensive Field Test Documentation Report to provide a cumulative summary of monitoring observations, interagency coordination between water managers and the PDT, and hydrometeorological analysis results (refer to Section C.1.8.2.1) after the second year of Increment 1 operations.

C.1.8.1 Frequency

Monitoring results will be reported no less frequently than annually and informal updates may be provided quarterly. Hydrometeorological monitoring information routinely tracked for assessment by USACE, SFWMD, and ENP water managers (refer to **Section C.1.8.2.1**) 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/Environmental/EcosystemRestoration/G3273andS356PumpStationFieldTest.aspx
http://www.saj.usace.army.mil/Missions/CivilWorks/WaterManagement.aspx

C.1.8.2 Content and Format

C.1.8.2.1 Hydrometeorological Analysis and Reporting

The Monitoring Plan contains a list of gages in **TABLE C.1-1** to be used to evaluate Increment 1 water management operations. During the development of field test Operational Strategy (refer to Appendix A of the 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 test and future field test operations, as described below as analysis items A. through J. below. The analyses will complement the overall monitoring plan and evaluate implementation of Increment 1 water management operations relative to its goals, objective and constraints. Field Test 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 Field Test operations relative

to the Increment 1 goals, objectives, and constraints. USACE, SFWMD, and ENP water managers will meet monthly to discuss the collected data and the results of preliminary analyses, as well as system conditions and Field Test operations; additional technical staff from these agencies who are involved in the Increment 1 monitoring and data assessment efforts will also participate in the monthly coordination meetings, as needed. Results from these weekly and monthly coordination meetings, including preliminary recommendations from water managers to incrementally modify the operational strategy (within the covered NEPA EA scope), will be further discussed with the PDT during regularly-scheduled interagency meetings to occur four times per year. PDT meetings will also include updates from the water quality and ecological monitoring sub-teams. Established meetings (e.g., WCA-3 Periodic Scientists Calls) may also support evaluation of the Field Test and/or provide additional forums for periodic updates on the monitoring and assessment results.

If the operational strategy needs to be modified and proposed adjustment are within the NEPA scope, the Increment 1 Field test may be modified. Following each interagency PDT meeting where potential operational adjustments are discussed, the justification for modifications to Increment 1 water management operations will be documented, including consideration of agency and/or stakeholder input provided during each workshop. Upon completion of the Increment 1 Field Test, the cumulative results of these analyses will be summarized for the Field Test Documentation Report.

Preliminary methodologies for water managers to analyze the Increment 1 Field Test and evaluate implementation of Increment 1 operations relative to the Increment 1 goals, objectives, and constraints are listed below in A. through J. These analyses will complement the overall monitoring plan and will be used to assess and evaluate the achievement of several of the stated water management objectives from the Increment 1 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 Increment 1 contribute to flooding within the C-111 basin; and (4) determine whether the Increment 1 operational changes at S-197 are necessary to 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. Modifications to the methodologies for the analyses listed here may be necessary due to data limitations or inconclusive results realized during implementation of Increment 1 and additional analyses may be developed to support review of the Increment 1 performance. The analyses will account for average monthly historic rainfall as measured at available rainfall gages, compared to the average monthly rainfall observed at available rainfall gages during this Field Test. The following analysis items are planned to be tracked on a real-time basis during the Increment 1 Field Test: 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, will be assessed at pre-determined periodic intervals during the Increment 1 Field Test, and this information will be considered prior to any proposed operational adjustments.

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 will review 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 Water Management Section 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: USACE Water Management Section will complete the following analyses to establish Increment 1 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 Water Management Section 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 1 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.

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 Water Management Section 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.

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 canal stage, 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 1 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.

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 Water Management Section 2009 report on 8.5 SMA operational testing (Increment 1 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.

I. Quantify the effects of the S-178 TW 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 1 field test (if data is available) 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 (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-178 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 S-178 trigger criteria during the Increment 1 field test. Assessment by water managers will be integrated with input from the ecological monitoring sub-team.

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 1 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 1 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 1 may provide justification for additional, expanded future testing in either subsequent years of Increment 1 or Increment 2, which would be accompanied by appropriate NEPA analysis and documentation.

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 should be used during Increment 1 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 should be 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.

C.1.8.2.2 Surface and Groundwater Quality Reporting

Short descriptions of each of the key chapters in the annual reports are provided below.

Chapter 1: This will be a short summary of the objectives and methodology of the hydrology and water quality monitoring plan and data analysis.

Chapter 2: This will include a summary of the hydrologic conditions over the reporting period for NESRS, WCA-3B, nearby canals, and operable structures. The first year hydrology report may be limited to data compilation and data graphing and will be used primarily to inform the WQ analysis. The second year report will include more detailed analysis of hydrologic conditions and operations as it pertains to flooding and performance relative to hydrologic targets in the L31N and C111 basins.

Chapter 3: This will include the Settlement Agreement Appendix A compliance evaluation if available at the time that the report is submitted to FDEP. A draft version of this report may be used in place of the final report.

Chapter 4: This will include the S356 OFW compliance evaluation required by the permit authorization. The S356 / S334 flow records, loads, and TP concentrations will be plotted.

Chapter 5: This will include an evaluation of the impact of relaxing G3273 and operating S356 on water quality compliance. S333 Flows and loads attributable to periods when G3273 is relaxed will be segregated from the record to determine what if any impact these flows have on water quality. The Operational conditions that have more or less potential to cause impacts to water quality will be identified.

Chapter 6: This will include the source analysis / mass balance assessment for S356 flows and findings of the water budget exercise. This will incorporate surface and groundwater quality data collected under different operating conditions (pump flow, NESRS stage, L-31N stage, etc) to assess the contributions of groundwater seepage and surface water flow to S356, and flow data collected at ADVM locations and structures.

Chapters 7, 8 and 9: This will include an evaluation of spatial and temporal canal (L29, L30, L31N) water quality coincident with different operating scenarios (S356, S334, S333) as well as different operating conditions (NESRS, WCA-3A, WCA-3B stages). The analysis may include comparison of Increment 1 data against pre-test water quality data. The information from the mass balance assessment will be used to make inferences regarding how changes to groundwater contributions that arise from pump operations may influence canal WQ. Flow patterns along the canals will be used to determine locations where flow enters or exits the canal system under different operating scenarios.

Chapter 10: This will include an evaluation of S356 pump operations on groundwater stage, flow direction and water quality. This will include an analysis of the temporal and spatial effects of pump operations on groundwater and how pump operations may influence seepage rates from WCA-3A and NESRS adjacent to L-31N. The potential for pump operations to influence groundwater in different flow zones within the Biscayne Aquifer will be assessed.

Chapter 11: This chapter will include a summary of the water quality in NESRS with particular emphasis on measurements at the NE0 and NE1 stations. Since the data is collected on a monthly basis, it is recognized that it may be somewhat more difficult to identify effects of S356 pumping on marsh water quality.

Chapter 12: This will be a summary of the monitoring and analysis conducted to date. For the first year report, the focus will be on whether the monitoring efforts are meeting the goals or if some modification in terms of location and frequency of data collection is recommended for the second year of operations. The second year report will include a summary and analysis of all data collected for this monitoring effort. The need for water quality triggers associated with G3273 relaxation will be evaluated in this second year report.

C.1.8.3 Report Recipients and Broader Distribution

The recipients for the monitoring reports include: 1) regulators from the USEPA and FDEP; 2) scientists from local, state, and federal agencies; and 3) non-governmental organization scientists and the general public. Distribution of the reports will be via email and web link.

C.1.8.4 Revisions and Modifications

[This section is reserved for future changes as they are made and should be referenced throughout the document as revisions occur. Sections should be added chronologically. As revisions are made, a note should be added to the corresponding section of the plan.]

C.1.9 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.1.9.1 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.1-5**. 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 1 test is currently scheduled to be conducted by the SFWMD though this is subject to negotiations with the ENP. Any surface water sampling within the Park will be conducted by ENP staff or ENP contractors. The USACE will conduct the groundwater quality sampling and the groundwater flow magnitude and direction monitoring using outside contractors. 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 1. The MDLPA groundwater monitoring is expected to be conducted for the duration of Increment 1 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.1-5. AGENCY ROLES AND RESPONSIBILITIES FOR EACH ACTIVITY

Activities	Number of New Stations / Annual Sampling Events/estimated total number of additional laboratory samples*	Station Registration in DBHYDRO	Field Collection & Lab Reporting	WQ Lab Analysis & Lab Reporting	Analysis and Reporting of Collected Data
1. Ongoing Surface Water Quality Compliance Monitoring			SFWMD	SFWMD	SFWMD**
2. Increment 1 Specific Surface Water Quality Monitoring	10 / 520/~4,500	SFWMD	SFWMD	SFWMD	USACE, ENP
3. Ongoing NESRS Water Quality Monitoring			ENP	SFWMD	USACE, ENP
4. Increment 1 Specific NESRS Water Quality Monitoring	1 / 52/~500	SFWMD	ENP	SFWMD	USACE, ENP
5. Ongoing ADVM Monitoring of Flow in L29 and L31N		SFWMD	USGS	N/A	USACE, ENP
6. Ongoing Groundwater Stage Monitoring			USACE, SFWMD, ENP, MDLPA	N/A	USACE, ENP
7. Increment 1 Specific Groundwater Stage and Flow Monitoring		SFWMD	USACE	N/A	USACE, ENP
8. Increment 1 Specific Groundwater Quality Monitoring	26 / 368/~3,000	SFWMD	USACE	SFWMD	USACE, ENP
9. C-111 Spreader Canal Monitoring / Reporting per PIR & Corps Regulatory Permit **					SFWMD
10. Hydrometeorological Reporting					USACE, ENP

* 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

C.1.9.1.1 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. The USACE will be responsible for compiling and reporting monitoring data during operational team meetings and quarterly PDT meetings. The USACE will assign lead technical responsibilities to Engineering, Planning, and Operations Divisions team members. All agency assignments will be shared with the PDT at the project implementation kickoff team meeting.

C.1.9.1.2 Program Implementation

This monitoring plan is part of a federal-state cost shared project. The USACE has constructed most of the project features. Monitoring efforts will likely be conducted by the SFWMD given its extensive experience conducting on-going environmental monitoring.

C.1.9.1.3 Program and Protocol Review

Review Summary

Monitoring plan shall be reviewed on an annual basis (every 12 months of monitoring) by the S356 WQ/GW subteam to determine if any adjustments are necessary. At the end of the test monitoring period, the subteam shall make a recommendation for the monitoring program that will follow the completion of Increment 1 testing.

- Are the right parameters or indicators being monitored? Can any stations/parameters be eliminated or frequency reduced?
- Are the SOPs appropriate, do they need to be modified, or new SOPs developed?
- Is the project management structure working effectively or are changes in roles and responsibilities required?
- Do the project results demonstrate the verity of conceptual models, restoration hypotheses, and restoration techniques utilized? If not, how will findings be utilized and findings made in monitoring program review?

C.1.10 COST ESTIMATES

Estimated costs are not available at this time.

C.1.11 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.1.12 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 S356 pump station and relaxing the G3273 stage limit at S333. Discussion of decision-criteria is contained within the Increment 1 Test operations plan and environmental assessment decision document.

C.1.12.1 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.1.12.2 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.1.12.3 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.1.12.4 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.1-3** and **TABLE C.1-4** for water quality sampling programs.

C.1.12.5 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.1.13 DATA COLLECTION

C.1.13.1 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.1.13.2 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.1.13.3 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.1.13.4 Quality Control of Samples

C.1.13.4.1 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.1.13.4.2 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.1.13.5 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.1.13.6 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.1.14 DOCUMENTATION

Field records shall be documented in accordance with the procedures specified in the SFWMD FSQM.

C.1.15 QUALITY ASSURANCE AND QUALITY CONTROL

C.1.15.1 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.1.16 DATA ANALYSES 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.1.16.1 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.1.17 ADAPTIVE MANAGEMENT CONSIDERATIONS

This monitoring is proposed for a limited period of time (2-years).

This page intentionally left blank

PART 1 – WATER QUALITY AND HYDROLOGY MONITORING
ANNEX 1
INCREMENT 1 MONITORING SOUTH OF S-331

This page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The main body of Appendix C, Part 1, Water Quality and Hydrology Monitoring Plan for the proposed G3273/S356 Increment 1 test addresses the measurement and assessment of hydrologic and water quality data from stations primarily located north of the S-331 structure on the L-31N canal. This plan was deemed sufficient for alternatives that did not include modification of the operational criteria at structures south of the S-331 pump station. Subsequent to the development of the hydrology and water quality monitoring plan, during the Increment 1 formulation efforts the SFMWD and FDACS recommended consideration of changes to the operational criteria at the S-197 structure. The SFWMD and FDACS proposed changes to the S-197 operational criteria were developed in response to their concerns regarding whether the Increment 1 testing might cause or contribute to flooding of agricultural lands in the lower C-111 basin (south Miami-Dade County). Furthermore, the effects from SFWMD operation of the new CERP C-111 Spreader Canal Western Project on water levels within the agricultural area, if any, have not been determined at this time, pending conclusions from the ongoing SFWMD monitoring and performance evaluations. To address SFWMD and FDACS concerns and also to ensure that sufficient data are collected to determine the effect of Increment 1 on C-111 basin hydrology, additional hydrologic monitoring is required south of the S-331 structure. No additional water quality monitoring south of S-331 is included because the existing water quality monitoring efforts will be sufficient.

The proposed monitoring plans for surface water hydrology and ground water hydrology will provide data to: (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 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.

C.1.1 INTRODUCTION

The main water quality and surface hydrology monitoring plan document for the G3273/S356 Increment 1 test (Appendix C) addresses monitoring required for areas primarily located north of the S-331 station. This annex to Appendix C addresses water quality and hydrologic monitoring in areas south of the S-331 structure that may be affected by the G3273/S356 Increment 1 test. Hydrologic and water quality monitoring is required south of the S-331 structure to assess the impact of Increment 1 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, 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 rely upon the SFWMD to continue monitoring and perform the flood impact analysis required in the C-111 Spreader Canal Western Project Monitoring Appendix found at the following web address:

http://www.saj.usace.army.mil/Missions/Environmental/EcosystemRestoration/G3273andS356PumpStationFieldTest.aspx

The USACE will supplement 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 Increment 1 test will 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.1.2 PROJECT DESCRIPTION

The sole change to the 2012 Water Control Plan for structures located south of the S-331 pump station during Increment 1 testing is 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 is intended to ensure that flood impacts, if any, from Increment 1 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. After the two years of Increment 1 operations, the North Detention Area (Contract 8) features of the C-111 South Dade Project are expected to be installed. This may further alter the hydrologic response of the lower L-31N and C-111 basin to Increment 1 relaxation operations.

The revised operating rules for S-197 include trigger criteria 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 recommended plan also proposes to cap the Level 1 releases to 500 cfs for S-197 gate openings triggered by the S-178 TW stage. 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.

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 1

monitoring plan will incorporate the ongoing SFWMD operations, monitoring, and performance assessments conducted as part of the CERP C-111 Spreader Canal Western Project.

C.1.3 PRIMARY OBJECTIVES OF ANNEX 1 WATER QUALITY AND HYDROLOGY MONITORING PLAN

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 Increment 1 operations contribute to flooding within the C-111 basin.
4) Determine whether the Increment 1 operational changes at S-197 are necessary to 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.

C.1.4 ACTIVE MANDATES AND PERMITS

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. The Increment 1 testing proposes the establishment of several new monitoring locations south of S-331; however, in many instances, the existing network of monitoring stations will be utilized to demonstrate the effects of Increment 1 on hydrology and water quality as well as compliance with water quality standards. Authorization to conduct the Increment 1 test will be obtained from the FDEP and this monitoring plan is likely to be included in that authorization by reference.

C.1.5 MONITORING COMPONENTS

C.1.5.1 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 will serve as the baseline data for the Increment 1 test. Refer to **Section C.1.8.2.1** of **Appendix C** for additional details.

C.1.5.2 Construction Monitoring

No construction phase monitoring is anticipated for Increment 1 testing south of S-331.

C.1.5.3 Post-Construction Monitoring (Effectiveness Monitoring)

The Increment 1 test will continue for up to two years. At the completion of Increment 1, the water quality and hydrologic monitoring plan for south of S-331 will be modified to match the needs of either Increment 2 testing or a refinement of the MWD / C-111 basin Operating Plan.

C.1.5.4 Inventory of Existing Monitoring Networks

C.1.5.4.1 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.A-1** shows a list of the existing hydrologic monitoring locations within area of interest south of the S-331 pump. Reference maps which show these monitoring locations are included in **Figure C.A-1** and **Figure C.A-2**, as well as **Appendix A** (**FIGURE 4** and **FIGURE 5**). Information from these structures could conceivably be used in evaluating the upstream conditions or effects observed during Increment 1 testing.

TABLE C.A-1. GAGES AND SENSORS FOR SURFACE WATER HYDROLOGIC MONITORING DURING THE INCREMENT 1 TEST 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
S-332B	HW, TW, Q	Canal level, flow volume	SFWMD
S-332C	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
RG4	Stage	Southern Detention Area water level	ENP
NTS18	Stage	Southern Detention Area water level	ENP
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	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
C-113 (P-9)**	Stage	Canal level (eastern terminus)	SFWMD
P-8**	Stage	Marsh water level (located between Aerojet and C-111 Canal, between S-177 and S-18C)	SFWMD

Notes: HW– headwater stage; TW– tailwater stage; Q– discharge (cfs)

* Proposed

** Proposed new wells for CERP C-111 Spreader Canal project monitoring (well information may be incorporated into the Increment 1 monitoring, if available).

C.1.5.4.2 Surface Water Quality

No new water quality monitoring efforts are planned for the Increment 1 testing for areas south of the S-331 structure. The Increment 1 testing is not expected to 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.1.5.4.3 Groundwater Hydrology

Several State and Federal agencies have constructed groundwater monitoring wells along the L-31N and C-111 canals. Table C.A.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.A-1** and **FIGURE C.A-2.** The result is a comprehensive groundwater monitoring network that will provide detailed data to evaluate effects of Increment 1 on the lower L-31 basin and C-111 basin.

C.1.5.4.4 Groundwater Quality

No new groundwater quality monitoring efforts are planned for the Increment 1 testing for areas south of the S-331 structure. The Increment 1 testing 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.A-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

Well	Location	Open Interval (ft NGVD29)	Access Data (real-time or near-time) and comments
G-3336	25°20'16.1"N,80°33'56.3"W ENP: 2.6 mi WNW of S-18C	Total Depth -33.5	INACTIVE: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=QS274&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	INACTIVE: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 will be installed by SFWMD contractors, concurrent with Increment 1 field test; well information may be incorporated into the Increment 1 monitoring, if available.
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.A-1. SELECTED REAL-TIME GROUNDWATER MONITORING STATIONS AND STRUCTURES IN THE SOUTHERN L31N BASIN

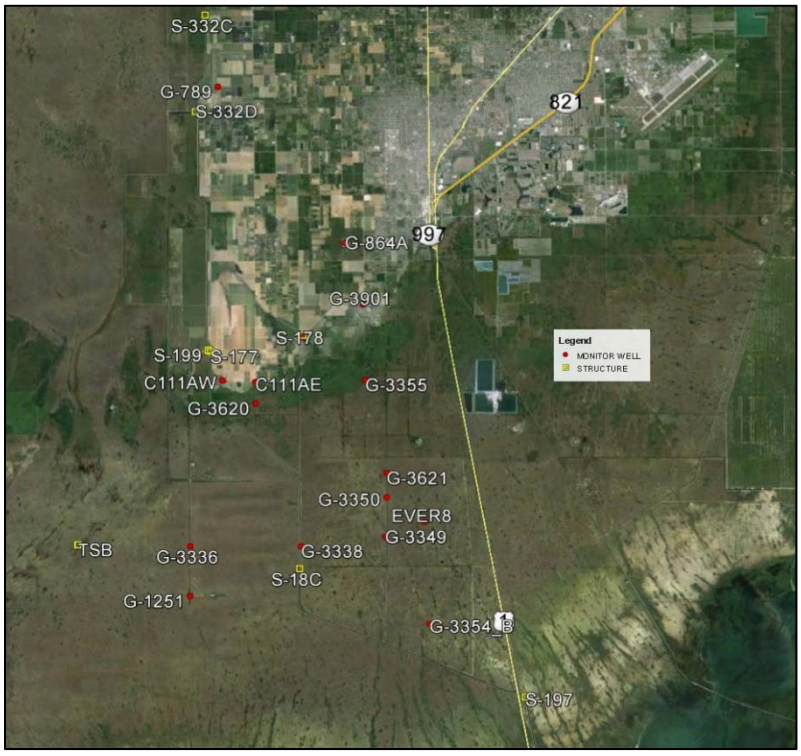


FIGURE C.A-2. SELECTED REAL-TIME GROUNDWATER MONITORING STATIONS AND STRUCTURES IN THE C111 BASIN

C.1.5.5 Integration of Monitoring Components

New monitoring stations (refer to **Section C.1.7**) proposed as part of this project will be 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.1.6 DURATION

This monitoring program is expected to be conducted during the Increment 1 testing period which is expected to last up to two years. The Increment 1 test is expected to commence in May 2015. At the completion of Increment 1 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.

C.1.6.1 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 1 test is complete. This 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 Increment 1 test objectives. Decisions to adjust the monitoring plan will be coordinated through the project partners as well as the FDEP.

This Increment 1 monitoring plan was 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 Project will reevaluate monitoring priorities.

C.1.7 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.1.7.1 Surface Water Hydrology

C.1.7.1.1 Flow Measurements Along L31N and C111 South of the S-331 Structure

The flow measurements taken at the S332X pump stations, S331, S176 are expected to be sufficient to characterize flow conditions in this reach of L-31N. Measurement of flows at the S199, S200, 178, S177, S18C, and S197 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. These measurements may be supplemented by installation of new ADVM sensors along L31N if resources are available.

C.1.7.2 Surface Water Quality Monitoring Plan

No supplemental water quality monitoring below the S-331 structure is included in the plan.

C.1.7.3 Groundwater Hydrology

All existing groundwater monitoring stations described in **Section C.1.5.4.2** will be included in Increment 1 of the S356 pump station field test.

C.1.7.4 Groundwater Quality

No supplemental groundwater quality monitoring is included for areas below the S-331 structure.

C.1.7.5 Access and Authority

New monitoring stations located at water control structures or along the L31N 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.1.8 PROJECT REPORTING

Reporting for monitoring data and assessment of information gathered below the S-331 structure is included within the outline provided in the main surface hydrology and water quality monitoring plan (**Section C.1.8** of **Appendix C**). 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. The SFWMD flood impact analysis will be supplemented by an analysis prepared by the USACE to evaluate the Increment 1 hydrologic impacts to the lower L-31N basin and the C-111 basin. No water quality assessment will be specifically performed to identify Increment 1 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.1.8.1 Frequency

Data will be analyzed during and after Increment 1 as described in this monitoring plan and operational strategy (**Appendix A**). Interagency workshops to facilitate discussion of the Increment 1 performance relative to the achievement of Field Test goals and objectives are planned to be conducted approximately four times per year. Upon completion of the Increment 1 Field Test, the cumulative results of these analyses will be summarized for the Field Test documentation report. Hydrometeorological monitoring information routinely tracked for assessment by USACE, SFWMD, and ENP water managers (refer to **Section C.1.8.2.1** 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
and
http://w3.saj.usace.army.mil/h2o/reports/r-fti1.html

C.1.8.2 Content and Format

These details are provided in the main monitoring report (**Section C.1.8** of **Appendix C**).

C.1.8.2.1 Report Recipients and Broader Distribution

The recipients for the monitoring reports include: 1) regulators from the USEPA and FDEP; 2) scientists from local, state, and federal agencies; and 3) non-governmental organization scientists and the general public. Distribution of the reports will be via email and web link.

C.1.8.3 Revisions and Modifications

[This section is reserved for future changes as they are made and should be referenced throughout the document as revisions occur. Sections should be added chronologically. As revisions are made, a note should be added to the corresponding section of the plan.]

C.1.9 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.1.9.1 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.A-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 1 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.A-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 Corps Regulatory Permit			SFWMD		SFWMD

2. Ongoing C-111 Spreader Canal Monitoring			SFWMD		SFWMD
3. Increment 1 Specific Groundwater Level Monitoring	USACE	SFWMD	USGS	USACE	USACE, ENP

This page intentionally left blank

PART 2 – ECOLOGICAL MONITORING

This page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

C.2.1 FIELD TEST SPECIES MONITORING

The U.S. Army Corps of Engineers (Corps) and South Florida Water Management District (SFWMD) will continue existing hydrologic and species monitoring plans to ensure that the Incidental Take as defined within the U.S. Fish and Wildlife Service (USFWS) 2009 Biological Opinion (BO) on the C-111 Western Spreader Canal Project and the 2010 BO on the Everglades Restoration Transition Plan (ERTP) is not exceeded. In February 2012, the SFWMD completed construction of the C-111 Western Spreader Canal Project as part of its state-expedited program. The SFWMD currently conducts an annual assessment of the project in accordance with Corps permit reporting guidelines (Department of Army Permit SAJ-2005-9856 [IP-AAZ]) and the USFWS 2009 BO (http://www.fws.gov/verobeach/verobeach_olddont_delete/sBiologicalOpinion/index.cfm?method=biologicalopinion.search). In accordance with the Terms and Conditions within the USFWS 2010 BO on the ERTP, the Corps is required to provide an annual assessment of ERTP operations. The annual assessment includes a summary of Periodic Scientist Calls, analysis of incidental take, analysis of ERTP performance measures, and ecological targets and species monitoring. The Incidental Take Statements, Terms and Conditions and Reinitiation Notice are defined in the 2010 ERTP BO (http://www.evergladesplan.org/pm/program_docs/ertp.aspx).

Significant hydrologic changes are not anticipated in regions with threatened and endangered (T&E) species as a result of this field test. All regulatory monitoring requirements included in the 2009 BO on the C-111 Western Spreader Canal Project and 2010 BO on ERTP will continue as stated in those plans. However, the Corps proposes additional monitoring to measure potential hydrologic impacts within Cape Sable Seaside Sparrow (CSSS) subpopulations and critical habitat units (*i.e.* CSSS-F/Unit 5, CSSS-E/Unit 4, CSSS-C/Unit 2) and wood stork colonies (*i.e.* Tamiami Trail West [TT-West], Tamiami Trail East [TT-East], Tamiami Trail East 2 [TT-East 2], and Grossman Ridge West) located along Tamiami Trail and within North East Shark River Slough. Additional monitoring is being proposed to measure potential direct effects of the field test within these locations. ERTP Periodic Scientists Calls will continue to be conducted throughout the G-3273 Constraint Relaxation and S-356 Field Test and S-357N Operational Strategy to ensure wildlife recommendations are considered during the water management decision process. Appropriate operational modifications of the field test will be implemented if deemed appropriate.

Presently, the known distribution of the CSSS occupies two areas of marl prairie east and west of Shark River Slough in the Everglades region (within Everglades National Park [ENP] and Big Cypress National Preserve) and the edge of Taylor Slough in the Southern Glades Wildlife and Environmental Area in Miami-Dade County. **FIGURE C.2-1** illustrates the current location of CSSS sub-populations A-F and CSSS designated critical habitat.

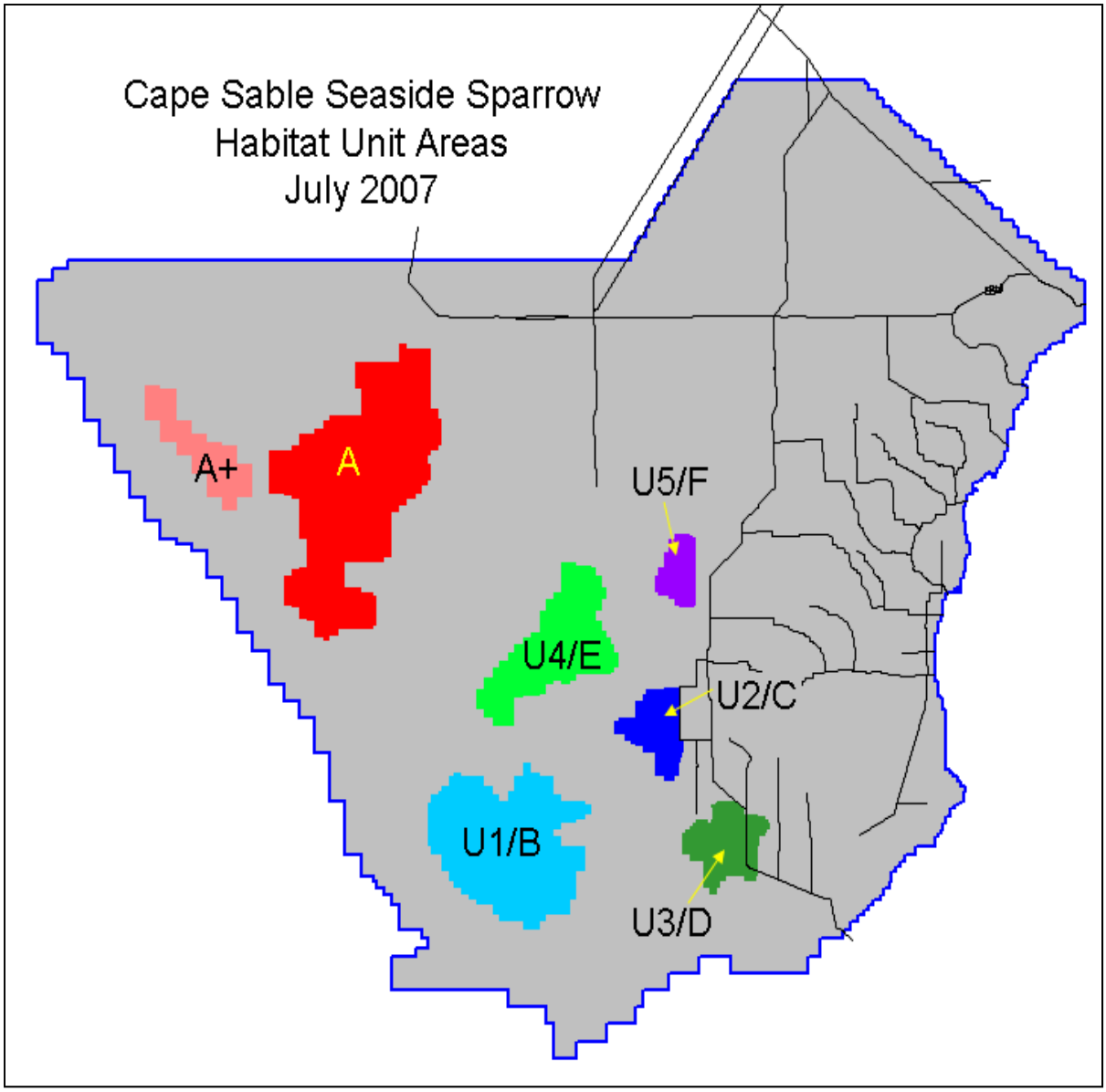


FIGURE C.2-1. CAPE SABLE SEASIDE SPARROW SUBPOPULATIONS (A-F) AND DESIGNATED CRITICALHABITAT UNITS (U1-U5)

The Corps will monitor existing hydrological gages listed in **TABLE C.2-1** and **TABLE C.2-2.** These tables are provided as example illustrations of the type of data that will be analyzed in a post field-test assessment of hydrology within the CSSS-subpopulations. The goal of this assessment will be to determine if correlations exist between operation of S-356 and relaxation of the G-3273 stage constraint, with marsh water level conditions in CSSS habitat during both the wet and dry seasons. CSSS-D will continue to be monitored, as it is currently, under the C-111 Western Spreader Canal Project authorization and that data will also be analyzed after the field test.

a. Dry nesting days at related gages within CSSS-E, CSSS-F, and CSSS-C between March 1 and July 15.

b. Annual hydroperiod or number of days water is above ground surface during the water year.

Gages will be analyzed for CSSS-E, CSSS-F, and CSSS-C using elevations obtained through EDEN.

TABLE C.2-1. DATES THAT WATER DEPTHS WERE BELOW GROUND SURFACE ELEVATION AT RELATED CSSS SUBPOPULATION GAGES DURING THE CSSS NESTING WINDOW OF MARCH 1 AND JULY 15. DATA TO BE POPULATED POST-FIELD TEST.

Sub-Population	Gages	Start Date (depth below ground surface elevation)	End Date (depth below ground surface elevation)	Number of Consecutive Days Dry	Number of Consecutive Days Dry (March 1 to July 15)
E	NP-206, , CR3, A13, NP62, NP44				
F	RG1, RG2, RG3				
C	E112, R3110, NTS10, NTS1, NTS18, NTS14				

TABLE C.2-2. NUMBER OF DAYS WATER IS ABOVE GROUND SURFACE DURING THE WATER YEAR AT RELATED CSSS SUBPOPULATION GAGES. DATA TO BE POPULATED POST-FIELD TEST.

Sub-Population	Gages	Annual Hydroperiod (depth above ground surface elevation)
E	NP-206, CR3, A13, NP62, NP44	
F	RG1, RG2, RG3	
C	E112, R3110, NTS10, NTS1, NTS18, NTS14	

Wood storks are known to forage in a 360-degree radius of 30 km (18.6 statute miles) from an active colony. The optimal water depth for wood storks is 14-15 centimeters (cm) with suboptimal dry water depths ranging from -9 to 4 cm and suboptimal wet water depths ranging from 26 to 40 cm. Hydrologic monitoring for wood stork colonies and foraging habitat located within the field test area will be monitored as usual via systematic reconnaissance flights and hydrologic monitoring at individual gauges throughout the system (or with EDEN). Periodic Scientist Calls will continue to evaluate real-time nesting and hydrologic conditions in order to

prevent or reduce the likelihood that abrupt changes in field test operations will have a negative impact on the colonies.

All hydrologic data will be assessed post-field test to determine how various operational changes affected system hydrology, including water depths, duration and recession rates.

TABLE C.2-3 lists wood stork colonies with core foraging areas (CFA) that may be affected by the field test. Colony locations are depicted in **FIGURE C.2-2.**

TABLE C.2-3. WOOD STORK COLONIES WITH CFAS THAT MAY BE AFFECTED BY THE FIELD TEST.

COLONY	COUNTY	LAST ACTIVE	2011 NESTING PAIRS	LATITUDE	LONGITUDE
Tamiami Trail East	Miami-Dade	2010		25.758	-80.508
Tamiami Trail East 2	Miami-Dade	2010		25.760	-80.508
Tamiami Trail West	Miami-Dade	2011	500	25.760	-80.545
Grossman Ridge West	Miami-Dade	2011		25.636	-80.653

Data were obtained from 2013 Interim Wading Bird provided by Peter Frederick in accordance with ERTP BO Monitoring.

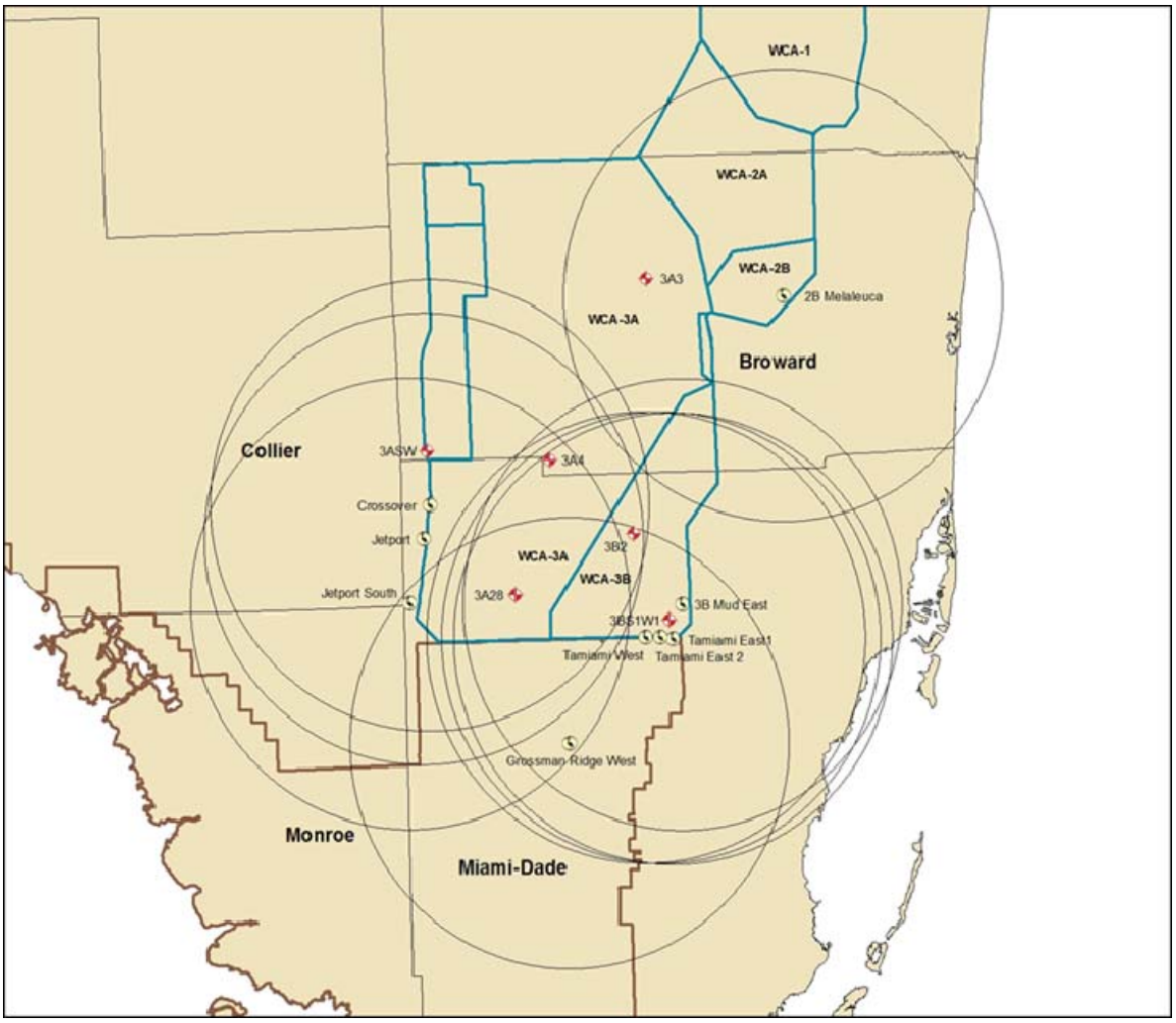


FIGURE C.2. LOCATION OF WOOD STORK COLONIES TT-WEST, TT-EAST, TT-EAST 2, AND GROSSMAN RIDGE WEST

The Corps will monitor existing hydrological gages listed in **TABLE C.2-4** to measure wood stork foraging water depths within wood stork colonies TT-West, TT-East, TT-East 2, and Grossman Ridge West as defined below:

a. Water depths (5-25 cm) within the Core Foraging Area (18.6 mile radius, CFA) of any active wood stork colony

Gages will be analyzed for wood stork CFA water depths using elevations obtained through EDEN.

TABLE C.2-4. LIST OF GAGES THAT OCCUR WITHIN THE CFA OF THE IDENTIFIED WOOD STORK COLONIES FOR THE FIELD TEST.

COLONY	GAGE								
	3A4	3A28	3B2	3BS1W1	NE-1	NP-203	NP-205	NP-206
Tamiami East	X	X	X	X	X	X	X		X
Tamiami East 2	X	X	X	X	X	X	X		X
Tamiami West (NESRS)	X	X	X	X	X	X	X		X
Grossman Ridge West		X	X	X	X	X	X	X	X

The wood stork analysis will utilize daily stage data for the gages listed in **TABLE C.2-4** in feet NGVD29. Water depths will be obtained by subtracting the average ground elevations (obtained from EDEN and converted to NGVD29) from the daily stage in feet NGVD29. Water depths will then be converted to centimeters by multiplying values by 30.48 (30.48 cm = 1 foot). These water depths, now in centimeters, will then be used to graph daily foraging depths in Microsoft Excel. On these graphs, the red-yellow-green light method will be used to illustrate water depths. **TABLE C.5** illustrates the values that will be used for the red-yellow-green light method.

TABLE C.2-5. FORAGING WATER DEPTHS IN CENTIMETERS USING THE RED-YELLOW-GREEN LIGHT METHOD (RED=UNDESIRABLE/UNAVAILABLE, YELLOW = SUBOPTIMAL AND GREEN = OPTIMAL).

Water Depth (centimeters)
< -0.3 ft
-0.3 to 0.13 ft
0.16 to 0.82 cm
0.85 to 1.31 cm
> 1.31 cm

The Corps will also monitor existing hydrological gages listed in **TABLE C.4** to observe recession rates within wood stork colonies TT-West, TT-East, TT-East 2, and Grossman Ridge West as defined below:

b. Recession rates (optimal range of 0.06 to 0.07 feet per week), from January 1 to June 1.

TABLE C.2-6 is provided as an example illustration of the type of data to be presented.

TABLE C.2-6. OBSERVED WEEKLY RECESSION RATE FROM JANUARY 1 THROUGH JUNE 1, 2011 BASED UPON GAGES LOCATED WITHIN EACH CFA AS DEFINED IN TABLE C.2-4. DATA TO BE POPULATED POST-FIELD TEST.

Week Ending	Recession Rate (feet per week)

Note: Recession rate numbers will be highlighted to correspond to FWS Multi Species Transition Strategy stoplight key below

FWS MSTS Recession Rate (feet per week)
< 0.17
> 0.07 but ≤ 0.17
Preferred 0.06-0.07
≥ -0.05 but < 0.06
< -0.05

The USFWS requested a comparison of flows through the S-12 structures (S-12 A, B, C, and D) during G-3273 consultation per correspondence dated February 2nd, 2014 (**Appendix D**). A comparison of flows through these structures with the project compared to the flows that would have occurred if the project were not operating was recommended. As requested, the Corps will provide as part of the monitoring and assessment of project data a comparison of the S-12 structures. The assessment will be limited to the duration of the project and provided to USFWS on an annual basis. The methodology used to track S-12 flows is provided below.

C.2.2 ECOLOGICAL MONITORING TO BE PERFORMED BY EVERGLADES NATIONAL PARK

ENP will conduct additional monitoring of resources within NESRS during the field test as part of a greater effort to assess restoration success within the project area as a result of the Modified Water Deliveries (MWD) Project. A description of the monitoring is provided in Annex 1 (*Modified Water Deliveries to Everglades National Park: Draft Ecological Monitoring in Support of G-3273 Constraint Relaxation and S-356 Field Tests, Water Control Plan Development, and Long-term Assessment*). The monitoring program will include vegetation, water quality (*i.e.* surface water, floc, soil, and periphyton) and fish and invertebrates components. The monitoring will be conducted through a scope of work between ENP and Florida International University. Measurements will be made downstream of Tamiami Trail within NESRS and east of the L-67 Extension during the field test. Ecological sampling conducted by ENP during the field test will provide baseline data for future planning efforts of the MWD Project, as well as assess short term ecological effects of the field test. Sampling frequency will be dependent upon the component being measured and will occur during the wet or dry season, or at both times of the year. Collected data will not be used to inform operational modifications during the field test. Water quality data will not be used for the regulatory purposes of evaluating compliance with current water quality standards. Water quality monitoring to be performed by the Corps for purposes of compliance is provided in Part 1 of Appendix C. Data collection is currently planned for 2014 and 2015. Reporting of the monitoring data will be under the purview of ENP.

C.2.3 COASTAL SALINITY MONITORING

The Corps will monitor existing salinity gages in Joe Bay, Long Sound, Manatee Bay, and Barnes Sound to measure potential hydrologic impacts associated with operational criteria

included within the field test for S-197. Continuous measurements of salinity will be recorded at four stations within Joe Bay, Long Sound, Manatee Bay and Barnes Sound. The locations of these monitoring sites are shown in
FIGURE C.2-3. These sites are part of ENP's Marine Monitoring Network. Data for these sites resides on DBHydro and/or will be provided by ENP staff. Salinity and temperature data is recorded every 15 minutes at each of these locations. An analysis of daily average salinity concentrations will be performed following the field test to assess potential effects of additional freshwater flows through S-197 as a result of the field test.

Biscayne National Park also maintains several sites within Manatee Bay and Barnes Sound (**FIGURE C.2-4**). These sites (i.e. BISC 00; BISC 01; BISC 04; BISC 05; BISC 06) are currently not remotely operated. Salinity and temperature data will also be assessed at these locations, if available, post field-test.

FIGURE C.2-3. FIELD TEST SALINITY MONITORING STATIONS – ENP MARINE MONITORING NETWORK (ENP JB, ENPLS, MBTS AND TPTS)

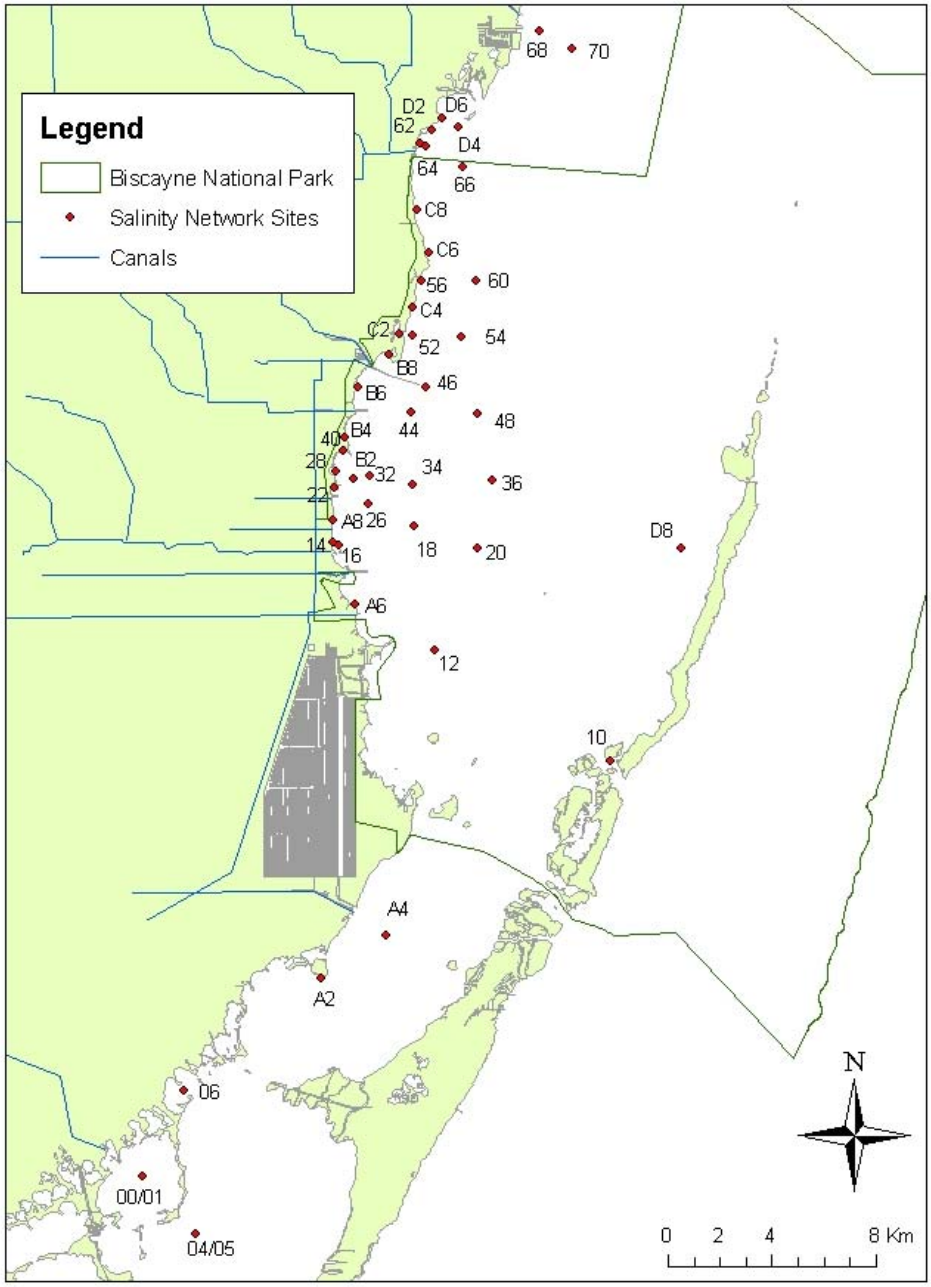


FIGURE C.2-4. FIELD TEST SALINITY MONITORING STATIONS – BISCAYNE NATIONAL PARK (PERTINENT SALINITY MONITORING STATIONS INCLUDE BISC 00; BISC 01; BISC 04; BISC 05; BISC 06)

C.2.4 ADDITIONAL COASTAL SALINITY MONITORING PROPOSED BY THE SFWMD

A suite of downstream monitoring stations will be installed by the SFWMD to supplement the ability of the existing network to capture the eco-hydrologic response of an S-197 opening. During the field test, salinity data from continuous benthic salinity and temperature monitoring

probes will be manually downloaded every three months. Salinity and temperature readings will be taken every 30 minutes. Two or three probes would be distributed along a salinity gradient from S-197 to the saline waters of Barnes Sound. Exact locations are still a matter of discussion. Potential locations of these continuous monitoring probes are shown on **FIGURE C.2-5** as stars. Currently existing salinity monitoring stations in Manatee and Barnes Sound will be utilized as well as the two to three new probes associated with this field test monitoring design. These data will assess the hydrologic impacts of S-197 releases on downstream salinities relative to mixing from Barnes Sound and through the culverts under US Highway 1.

A second, event-driven, flow-through spatial salinity mapping unit called the Dataflow, built and maintained by the SFWMD (ESA Section), would be used to track the resulting freshwater plume during releases from S-197 and would assess the spatial and ecological reach of this plume. SFWMD will conduct deployment of the surface water quality mapping unit known as Dataflow, if S-197 is operated as part of the field test and the structure remains open for more than 3 days. A spatial analysis (*i.e.* kriging) of the Dataflow output will be used to estimate freshwater plume dynamics in Barnes Sound and evaluate the potential for ecological impacts, both positive and negative. A report will be written by the SFWMD, summarizing the analysis and findings. If this report concludes that Manatee Bay may be harmed by continuing the low-volume releases from S-197, further modeling will be performed to identify the relative contribution of S-197 releases on salinity changes within Manatee Bay to inform any modification process for the proposed S-197 operation plan.

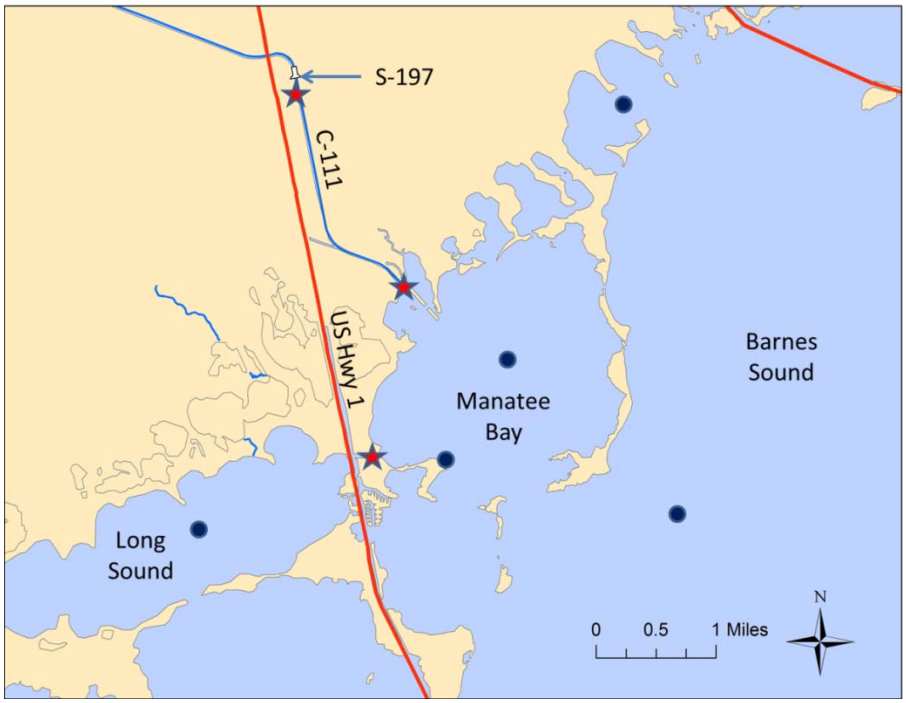


FIGURE C.2-5. MAP OF S-197 DOWNSTREAM AREA WITH CURRENT SALINITY STATIONS MARKED WITH DARK BLUE CIRCLES AND 3 POTENTIAL LOCATIONS WITH RED STARS. THE PLAN CALLS FOR 2-3 NEW STATIONS SELECTED FROM THE POTENTIAL LOCATIONS. STATION LOCATIONS IN MAP ARE APPROXIMATE.

C.2.5 ROLES AND RESPONSIBILITIES

Roles and responsibilities for Part 2 (Ecological Monitoring) of the G-3273 constraint Relaxation/S-356 Field Test and S-357N Operational Strategy Monitoring Plan are described above and summarized in **TABLE C.2-7** below.

TABLE C.2-7. ROLES AND RESPONSIBILITIES ECOLOGICAL MONITORING

Agency	Monitoring Conducted	Frequency of Reporting	Referenced Section of Monitoring Plan
Corps	Propose field test hydrological species monitoring to measure potential hydrologic impacts within CSSS subpopulations and wood stork colonies located adjacent to Tamiami Trail and within NESRS.	Assessment provided on annual basis.	Section C.2.1
Corps and SFWMD	Existing hydrologic and species monitoring plans as defined within the FWS 2009 BO for C-111 Western Spreader Canal Project (Purview of SFWMD) and 2010 BO for ERTP (Purview of Corps).	Frequency dictated by BO	Section C.2.1
Corps	Comparison of flows through the S-12 structures (S-12A, S-12B, S-12C, S-12D). Comparison will be made with the project versus what would have occurred if the project were not operating as recommended.	Assessment provided on annual basis.	Section C.2.1
ENP	Conduct additional monitoring of resources within NESRS (vegetation, water quality, fish and invertebrates etc.) as part of greater effort to assess restoration success as result of MWD.	Assessment provided on annual basis.	Section C.2.2 and Annex 1
Corps	Monitor existing salinity gages to measure potential	Assessment provided on	Section C.2.3

Agency	Monitoring Conducted	Frequency of Reporting	Referenced Section of Monitoring Plan
	hydrologic impacts associated with operational criteria for S-197	annual basis.	
SFWMD	Installation of additional gages to monitor salinity changes associated with operational criteria for S-197. . Includes potential deployment of Dataflow.	Assessment provided on annual basis.	Section C.2.4

Effects of Increment 1 G-3273/S-356 Field Test on S-12 Discharges

S-12 Discharges under Increment 1 (observed) will be compared to estimated S-12 Discharges under the prior 2012 Water Control Plan (ERTP). The comparison methodology described below will be periodically reviewed during the Increment 1 field test, and the methodology may be revised by USACE following coordination with USFWS, if needed.

Observed S-12 discharges will be manually adjusted to estimate S-12 discharges if operations remained under the 2012 WCP, based on the following general equation (equation variables are defined below):

[Increment 1 Changes to Discharges from S-12s] = [S-12s] $_{INCREMENT1}$ - [S-12s] $_{ERTP}$ **(EQUATION 1)** (positive value for Increment 1 increases; negative value for Increment 1 reduction)

[S-12s] $_{ERTP}$ = [S-12s] $_{INCREMENT1}$ + [Additional S-333] $_{INCREMENT1}$ - [Reduced Column 2] $_{INCREMENT1}$ **(EQUATION 2)**

Variables: [S-12s] $_{ERTP}$ = Estimated 2012 WCP (ERTP) S-12 Discharges

[S-12s] $_{INCREMENT1}$ = Observed S-12 Discharges under Increment 1

[Additional S-333] $_{INCREMENT1}$ = Increment 1 S-333 Discharges when G-3273 > 6.8 feet NGVD and S-334 is closed (WCA 3A Rainfall Plan > 0)

NOTE: [Additional S-333] $_{INCREMENT1}$ = 0 if all gates at available S-12 structures are fully open (2012 WCP and Increment 1 are equally limited by S-12 capacity)

[Reduced Column 2] $_{INCREMENT1}$ = [2012 WCP Column 2] $_{ESTIMATED}$ - [Increment 1 Column 2] $_{OBSERVED}$ **(EQUATION 3)**

[2012 WCP Column 2] $_{ESTIMATED}$ = Estimated S-333/S-334 Column 2 discharge rate for 2012 WCP operations (refer to Figure 1)

[Increment 1 Column 2] $_{OBSERVED}$ = Observed S-334 Column 2 discharge rate under Increment 1 (Limited to conditions with WCA 3A stage > Increment 1 Action Line and S-356 is off)

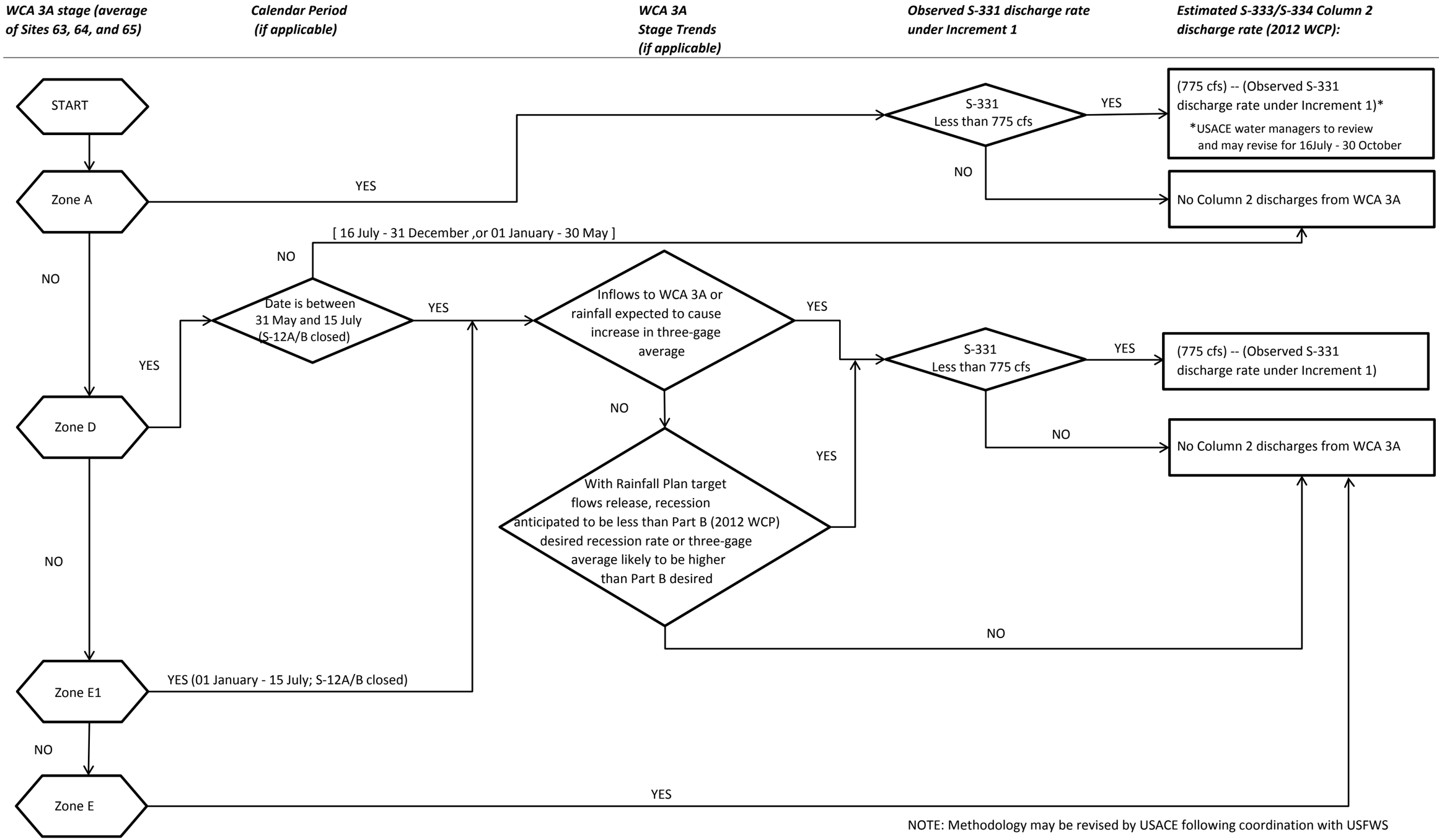
Computations for estimated S-12 discharges will be computed weekly, based on initial WCA 3A stage (consistent with Rainfall Plan), G-3273 stage level, average weekly S-331 discharge rate under Increment 1, and estimated average weekly S-333/S-334 Column 2 discharge rate (2012 WCP).

Computations for Equations 1, 2 and 3 require the following observed daily parameter values: G-3273 stage level; S-333 discharge rate; S-334 discharge rate; S-12A, S-12B, S-12C, and S-12D discharge rates;
Estimation of 2012 WCP Column 2 discharges (from Figure 1) requires the following observed weekly parameter values: S-331 discharge rate; WCA 3A three-gage average stage; WCA 3A inflow projections; WCA 3A Rainfall Plan discharge targets; and WCA 3A ascension or recession rate projections.

The following list of assumptions are required with use of the Equations 1, 2 and 3 above:

1. Maximum operating stage for the L-29 Canal would be maintained at 7.5 feet NGVD for the 2012 WCP and Increment 1;
2. WCA 3A weekly stage levels are assumed unchanged by the Increment 1 field test (long-term effects of Increment 1 operations are expected to result in increased releases from WCA 3A to NESRS, offset by decreased releases from WCA 3A to the SDCS);
3. S-12 observed discharges are assumed equivalent to S-12 estimated discharges when G-3273 <= 6.8 feet NGVD;
4. S-333 discharges from WCA 3A to NESRS would be discontinued for the 2012 WCP when G-3273 > 6.8 feet NGVD, so that observed S-12 discharges during this condition are only adjusted to account for increased use of Column 2 operations at S-333/S-334 under the 2012 WCP;
5. Additional discharge capacity is available from the available S-12 structures (e.g. accounting for seasonal closure periods for S-12A and S-12B) to potentially discharge the observed Increment 1 S-333 discharges when G-3273 > 6.8 feet NGVD, except under the condition where all gates at the available S-12 structures are fully open;
6. Additional discharges from the available S-12 structures (above observed Increment 1 discharges) would be desirable by ENP, including under conditions which require greater than 55 percent of the Rainfall Plan target flows to be released through the S-12s;
7. Under the 2012 WCP, assume Column 2 operations at S-333/S-334 would be constrained to not exceed two (2) pump units at S-331, or approximately 775 cfs (use Increment 1 observed S-331 pump discharges for Figure 1 estimation).
8. Historical use of Column 2 discharges to manage WCA-3A high water conditions (stages within Zone A) outside of the S-12A closure period of 01 Nov. - 15 July has been assessed on a case-by-case basis by USACE and SFWMD water managers. USACE water managers will review weekly estimates generated using Figure 1 when WCA 3A stage is in Zone A between 16 July - 30 October, and weekly estimated values may either be reduced or set to zero (may not be increased) based on consideration of the current WCA 3A storage accounting "discharge deficit" (accounting methodology implemented by USACE and SFWMD in 2014) and an assessment of system-wide conditions including WCA 3A and South Dade County; recommended revisions will be documented with supporting rationale.

Figure 1: Flow Chart to Estimate S-333/S-334 Column 2 discharges for 2012 WCP operations



PART 2 – ECOLOGICAL MONITORING
ANNEX 1

This page intentionally left blank

Modified Water Deliveries to Everglades National Park: Ecological Monitoring in Support of G-3273 Constraint Relaxation and S-356 Field Tests, Water Control Plan Development, and Long-term Assessment

Ecological Monitoring Overview, Goals, and Objectives

An ecological monitoring plan is proposed here with two fundamental purposes. First, proposed monitoring will assess the effects of two Incremental Field Tests, which will inform development of the Comprehensive Operating Plan (COP) that incorporates constructed features of the MWD and C-111 South Dade Projects into the WCAs-ENP-SDCS Water Control Plan. Second, this monitoring will build a pre-project "baseline" for assessing the long-term effects of MWD operations, eventually including Tamiami Trail Next Steps (TTNS) features. The Incremental Tests entail G-3273 constraint relaxation and operation of S-356 the new 8.5 Square Mile Area structure S-357N for seepage control tests either with L-29 at a limit of 7.5 feet NGVD in Increment 1 or 8.5 feet NGVD in Increment 2. This monitoring plan includes a proposal to establish a new set of short (about 1 km) transects at the northern boundary of Shark River Slough (SRS), starting at the Tamiami Canal (L-29) and ending downstream in the slough. The primary purpose of these transects is to assess the fate and effects of nutrients previously imported to northern SRS from the L-29 canal (legacy nutrients) and any new nutrients imported with future operations. The plan also includes sampling of previously sampled sites across a broad domain of the northern SRS landscape to assess long-term ecological responses.

The overarching goal of this proposed monitoring is to document and understand restoration successes and problems, contributing scientific information for adaptive management of northern Shark River Slough.

Short-term monitoring plan objectives during Incremental Tests 1 and 2 are as follows.

- Quantify and assess effects of the Incremental Tests on:
  - Nutrient inputs, legacy accumulations, and nutrient transport into un-impacted marshes;
  - Ecosystem restoration indicators, including hydropatterns, periphyton, soil condition, plant community structure and biomass, fish and invertebrate prey base for wading birds, wading bird (especially wood stork) nesting, and alligator abundance, condition, and nesting.
  - Threatened and endangered species, including Cape Sable Seaside Sparrow sub-populations, snail kites, and wood storks.
- Provide ecological information supporting water control plan development (per Incremental Test 3) and implementation.
- Improve "baseline" documentation and understanding for long-term assessment of MWD and TTNS.

Long-term objectives for assessing MWD and TTNS implementation include:

- Quantify and assess project ecological effects as for the Incremental Tests;
- Quantify changing spatial patterns of plant community composition and distribution from fine-scale vegetation maps;

- Assess influence of shifting source of SRS water eastward;
- Assess influence of sheetflow versus point source water inputs (compare bridges, culverts, S-12s);
- Assess influence of sheetflow and barrier removal on exotic invasive species.

Ecological Monitoring Design Strategy and Description

This proposal for scientific support of MWD operational testing and subsequent operational planning has been based on consideration of the design and results of existing Everglades-wide monitoring programs (within the Comprehensive Everglades Restoration Plan, CERP), as well as other past and current project-specific monitoring efforts. Criteria for inclusion of monitoring elements for any new MWD funding were:

- *Relevance to the MWD project*, with the ability to provide information to assess project success and support management decision-making for future operations
- C*ost efficiency of any new monitoring*, maximizing the use of all relevant data from other ongoing and past monitoring efforts, identifying data gaps (regarding sampling locations or measurements) and filling these gaps by using a similar sampling design and similar methods to those of other efforts. When possible, include sampling stations with a history of data collection to maximize the statistical power of any change analysis.
- Include *measurements required to address key project constraints*, particularly documenting and understanding the status of water quality conditions and threatened and endangered species.
- Include *measurements necessary to quantitatively document how effectively the project furthers Shark River Slough restoration,* with monitoring focused on the northern slough (NSRS) to assess responses.
- Use of well-established ecological indicators (especially those in Brandt et al. 2012) to assess and communicate how changes in indicators were influenced by project operation.

The proposed design will include a set of three sampling approaches to gain ecological insights at three spatial scales: 1) short **transects** near the L-29 canal to assess the fate and effects of nutrients with altered patterns of flow from the canal; 2) a set of broadly distributed **Sentinel sites** across the SRS landscape to assess responses of ecological indicators (reflecting changing hydrology, nutrients, habitat, and food webs) to the incremental tests and MWD implementation; and 3) regional **vegetation mapping from satellite imagery** (plant community composition and cover) to assess long-term changes in the spatial patterns of Everglades' structure. Each of these approaches will include sites and areas that are located not only in the zone of project influence, but also in reference areas away from this influence, enabling Before-and-After Control-Impact Paired Series (BACIPS) analysis of time series data.

Note that the monitoring design described below entails assumptions regarding the availability of funds and the timing and duration of the Incremental Test series, as well as of subsequent TTNS construction and MWD operations. Changes in the spatial coverage, frequency, or sampling parameters may be necessary in order to adapt to budgetary or programmatic changes.

Near-canal transects will start at the L-29 canal, approximately following flow paths for about 1 km (Figure 1 and Figure 2), to quantify changes in the sharp phosphorus enrichment gradients that exists at current and historic canal culverts. Each transect will have either 6 sample sites (for transects starting in enriched, woody vegetation halos) or 8 sample sites (for transects starting at marsh sites adjacent to the L-29 canal with no culvert or halo). The additional points through the latter transects will be closely spaced near the L-29 canal in order to detect the movement of any new nutrient enrichment front. Each transect's orientation will be decided based on initial estimates of flow direction in the marsh. Two transects will be downstream of existing culverts closest to S-356. Three will be downstream of the 1 mile bridge, recently constructed under the MWD Project, with one starting at the site of a culvert that was removed during bridge construction and two others starting at points away from past culverts, with no history of sustained water input from the canal. Two reference transects will be to the west, east of the L-67 extension and south of the future site of TTNS 2.6 mile bridge (within the future SRS flow-way), with one transect starting at the location of a current culvert and another starting away from any culvert. The latter two transects serve as short-term reference sites (until TTNS implementation) and will also serve to provide pre-project (baseline) information for subsequent TTNS assessment. Sampling along these transects will enable assessment of changes in the distribution of nutrients along existing and future nutrient enrichment gradients, the input of any new nutrient associated with changing operations, and associated ecological response patterns. The first sampling of the NCT sites is expected to be in the spring of 2015. Additional sites west of the L-67 extension will need to be established in the future to enable long-term assessment of decreasing flows through the S-12s, but are not currently proposed in this plan.

Broad, landscape-scale Sentinel sites (fixed stations) will be distributed across the northern SRS marsh (Figure 1) to assess changes of ecological indicators (Table 1) across SRS ecological zones in response to MWD Incremental Tests and future implementation. Site locations were previously sampled several times in 2006-2008 and in 2012 (Gaiser et al. 2009, Gaiser et al. 2013) and are distributed to assess the effects of changing water flow patterns. Currently, proposed sites are east of the L-67 extension and will enable ecological assessment of Incremental Test flow, including the assessment of differential ecological responses to culvert flow versus sheetflow under the 1 mile bridge. The design will concurrently improve the baseline for TTNS assessment of the future 2.6 mile bridge. Initial sampling of the sentinel sites under this plan is expected to be in the late wet season of 2015. Additional sites west of the L-67 extension will need to be established in the future to enable long-term assessment of decreasing flows through the S-12s (not currently proposed in this plan).

Figure 1. Map of ecological sampling network, including both Landscape Sentinel Sites and Near-Canal Transect sites. The sites of the existing 1-mile bridge and planned 2.6 mile bridge are shown, with proposed near-canal transects (approximately 1 km long) in the flow-way of each bridge, as well as downstream of the two most easterly culverts. Sample sites in short-hydroperiod marshes along the eastern boundary of Shark River Slough are included because hydrologic and ecological change may be most evident at the Slough edge.

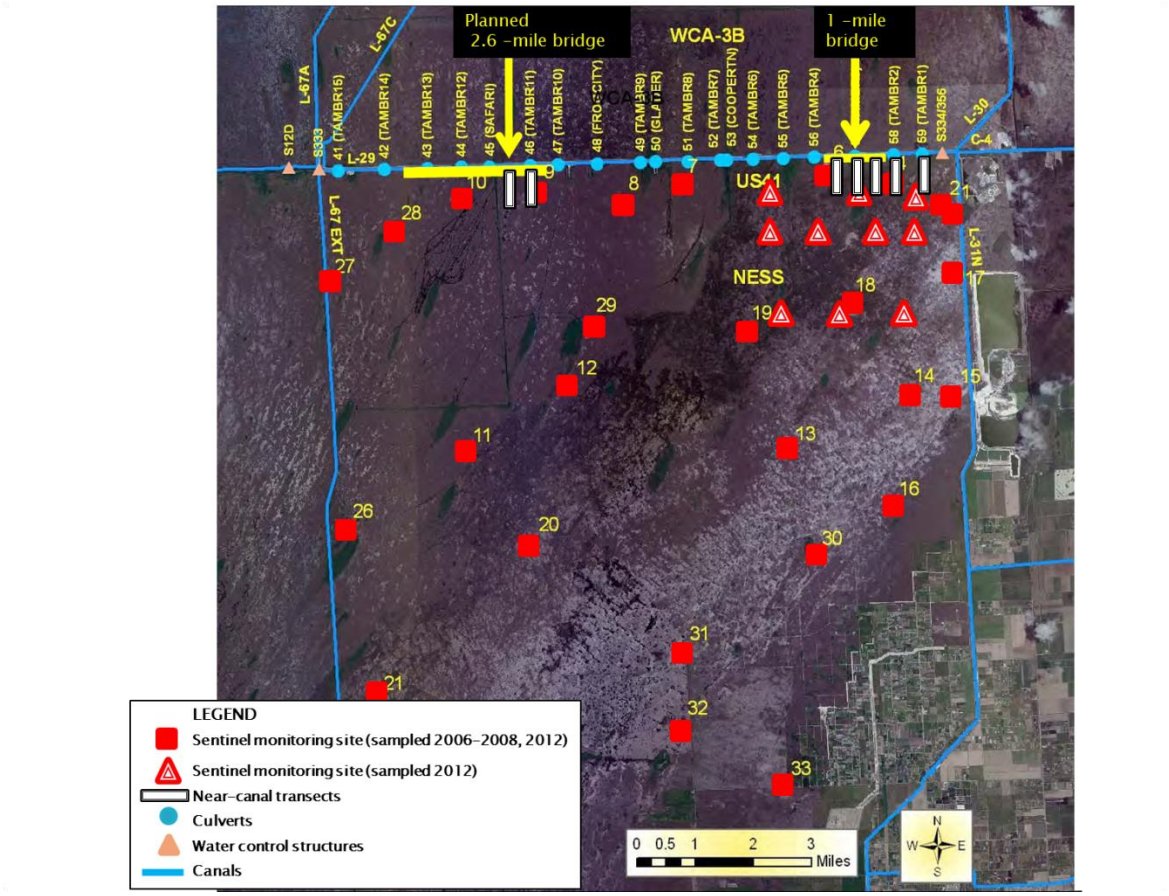


Figure 2. Conceptual diagram of Near-Canal Transect from the L-29, through a halo of enriched soil with dense woody vegetation (depicted as "inner zone"; enriched marsh grass area depicted as "outer zone"), to the downstream un-enriched marsh. Each transect is intended to follow the local primary flow path; the direction at a given site may differ from that in this figure or Figure 1.

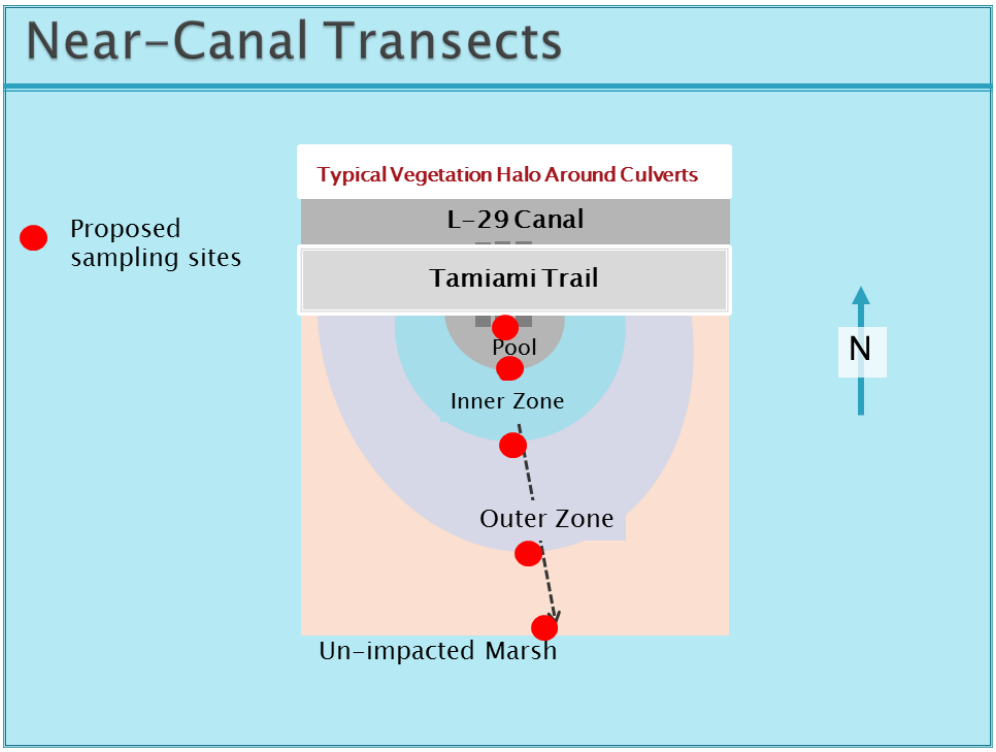


Table 1. Ecological indicators for assessment of responses with MWD Incremental Tests and implementation. Response rate intervals coincide with these approximate time scales: rapid, 1-3 years; moderate, 3-6 years; slow, 6-12 years; very slow, > 12 years. Monitoring frequency is twice per year for Near Canal Transects (NCT), annual for sentinel sites, and every 3 years for vegetation mapping.

INDICATOR CATEGORY	INDICATOR	RESPONSE RATE	MONITORING ELEMENT
Water Quality and Biogeochemistry	Periphyton nutrients	Rapid	NCT, Sentinel sites
	Flocculent nutrients	Rapid	NCT, Sentinel sites
	Plant tissue nutrients	moderate	NCT, some Sentinel sites
	Surface soil nutrients	moderate	NCT, Sentinel sites
	Subsurface soil nutrients	Slow	NCT, Sentinel sites
	Plant community structure (cattails)	moderate-slow	Vegetation mapping from remote sensing
	Soil oxidation risk (moisture, organic matter)	rapid-moderate	Sentinel sites
	Peat soil and elevation gain or loss (soil accretion, elevation change)*	Slow-very slow except potential rapid loss with fire	Select Sentinel sites
	Net soil carbon and nutrient gain or loss (net ecosystem production)*	rapid-moderate	Select Sentinel sites
Habitat and Landscape Structure	Slough vegetation species and distribution	moderate	Vegetation mapping from remote sensing
	Tree island abundance and area	Slow	Vegetation mapping from remote sensing
	Ridge and slough structure: landscape diversity*	very slow	Vegetation mapping from remote sensing, Sentinel sites
	Invasive plant distribution and area	rapid-moderate	Vegetation mapping from remote sensing
Food Web Structure	Periphyton species and biomass*	Rapid	NCT, Sentinel sites
	Small fish and invertebrate prey base: species abundance and distribution	Rapid	Sentinel sites
	Exotic animal species: number of new species, distribution, abundance**	rapid-slow	Sentinel sites for fish & invertebrates; other fauna from non-MWD programs
	Wading bird nesting success and relative species abundance**	moderate	Aerial surveys (non-MWD, NPS and RECOVER programs)
	Alligator nesting success and body condition*	moderate - slow	Aerial & transect surveys (NPS and former-RECOVER programs)
Threatened & Endangered Species	See separate monitoring plan section. Wood Stork included in Wading Bird indicator above.		

*Proposed indicators to be measured after first incremental field test as practical

**MWD indicator measurements fully or mostly funded and implemented by non-MWD programs

Changes in the distribution and spatial patterns of plant community types and the amount of cover will be assessed from vegetation maps. These will be derived from WorldView 2 (WV2) satellite imagery of northeastern SRS from the L-31N to the L-67 extension and L-29 canal to about 16 km south of the canal. Mapping the area west of L-67 is needed to assess effects of decreased flow through the S-12 structures (not proposed in this plan). WV2 images have a 2x2 meter resolution, providing sufficient detail for a minimum mapping unit of 16 m^2 and the capability of documenting fine-scale patterns of community change.

Field Sampling and Analysis

This monitoring program focuses on two major drivers of ecological change: hydrology and water quality. For each of the three sampling approaches proposed here (Near-Canal Transects (NCT), Landscape Sentinel Sites, and Vegetation Mapping), understanding the influence of the testing and full implementation of SRS restoration projects requires documentation of changing hydrologic conditions, nutrient availability, and associated biotic responses. Given the need to assess both small and large spatial scales while minimizing monitoring costs, this monitoring plan proposes infrequent sampling, with responses primarily assessed from measurements of changing biotic structure (e.g. species composition, abundance, biomass, plant cover), rather than changes in biotic process rates (e.g. productivity). For the NCTs, sites will be sampled twice per year (wet and dry seasons), while Landscape Sentinel sites will be sampled only annually in the late wet season for most ecological indicators. Spatial patterns of the landscape's plant community are expected to change slowly; vegetation mapping is proposed to be done every three years for the next decade to assess MWD and TTNS implementation. However, documentation of field site plant species distribution for developing algorithms for image interpretation, as well as ground-truth evaluations of vegetation maps, will be conducted annually.

Hydrologic sampling and analysis. Hydrologic data will largely be derived from the existing hydrologic monitoring network. However, understanding causes of ecological changes at a given site depend upon knowing the history of hydrologic conditions at specific sites, away from hydrostations. The Everglades Depth Estimation Network (EDEN) model can be used to provide spatial estimates for the vicinity of each sample site, but given the topographic variability, commonly does not accurately estimate site specific conditions. To address this need for accurate, site specific hydrologic data, portable and inexpensive pressure-transducer data-loggers (e.g. Hobo recorders) will be deployed for varying periods of time at each monitoring site to correlate local water depths with EDEN estimates. After a wide range of depth conditions are measured and local variance from EDEN is calculated, it is expected that EDEN estimates will suffice for future analysis. Some long site-specific depth recording will be needed to validate this expectation.

Before establishment of the NCT sites, flow directions will be estimated either with tracers, flow meters or a combination of both. As much as practical, transect orientation will follow local flow-paths between the L-29 canal and downstream marshes.

Water quality and biogeochemistry sampling and analysis. Collection of data on nutrient concentrations and other biogeochemical components is included in the ecological monitoring network in order to understand ecosystem responses and not to assess regulatory compliance. Nevertheless, understanding of the fate of legacy nutrients and any new nutrient inputs along the NCT not only will increase understanding of biogeochemical and ecological relationships, but also inform future regulatory considerations. Changes in nutrient availability primary will be assessed from changes in the nutrient content of periphyton, flocculent particles (or "floc", defined as low density, mobile particles that are commonly detrital organic matter) on the soil surface, consolidated surficial (0 to 2 cm deep) soil, deeper (2 to 10 cm) soil, and leaves of dominant plant species (Table 2). Surface water samples also will be analyzed for nutrients and other water quality parameters, but the proposed infrequent sampling is incapable of assessing the rapid changes of nutrients and other constituent of wetland waters; these measurements are only to provide concurrent surface water concentrations that can be compared to the slower changing concentrations in the solid materials listed above. The time scale of expected responses for these indicators of nutrient enrichment and availability is shown in Table 1.

Table 2. Water quality and biogeochemistry components of the ecological monitoring network, listing types of materials to be sampled and parameters to be analyzed from these materials. Near-Canal Transect (NCT) sites are to be sampled twice per year and Landscape Sentinel Sites sampled once per year. A subset of Sentinel sites will also be sampled during the dry season for more intensive soil analysis. Only water samples will be taken at the first NCT site adjacent to the L-29 canal, which is either adjacent to the canal bank or a culvert outlet. Nutrients in vegetation will be measured at all NCT sites, but only a subset of Sentinel sites. For each site, triplicate samples of floc, soil, periphyton, and plant tissues will be collected and analyzed. Depending on within-site variance, these three samples may each be composed of a set of composited samples.

Sampled Material	**Water Quality and Biogeochemical Parameters**
Water grab	TP, TN, DIN, DOC, pH, dissolved oxygen, specific conductance, major ions, temperature, water depth (site-specific calibration of EDEN output)
Flocculent surface soil	TP, TN, TC, loss on ignition, % water, bulk density
Surface Soil (0-2 cm)	TP, TN, TC, loss on ignition, % water, bulk density
Sub-surface soil (2-10 cm)	TP, TN, TC, loss on ignition, % water, bulk density
Periphyton	TP, TN, TC, biomass (dry, ash free dry weight, chlorophyll *a*)
Plant tissue (leaves)	TP, TN, TC

TP = Total Phosphorus; TN=Total Nitrogen; DIN=Dissolved Inorganic Nitrogen; DOC=Dissolved Organic Carbon; TC=Total Carbon

This monitoring plan includes special emphasis on soil conditions and dynamics. Soil water saturation or moisture, molecular oxygen availability, compactness, and nutrient and organic matter content are strong determinants of vegetative habitat quality, productivity, food webs, and changing land elevation. Historic drainage of Everglades caused the loss of peat soils via fire and microbial decomposition, decreasing soil quality and subsiding land elevation. This flattened the landscape, decreased productivity, and made the Everglades more vulnerable to sea-level rise. With MWD implementation, soil conditions are expected to improve, increasing the spatial extent of soil hydration and the rate and quantity of peat soil accretion with carbon and nutrient sequestration, also resulting in increased land surface elevation. These ecosystem services have high value, increasing ecosystem resilience in response to stressors (e.g. nutrient loading and saltwater intrusion with sea level rise) and increasing landscape diversity and food web productivity. To assess changes in these system-level attributes , this monitoring plan calls for measurements of changing soil conditions across SRS, with biannual measurements at NCT sites and annual monitoring at Sentinel sites (Table 2), along with measurements of changing net material (carbon, nutrients) accumulation or loss and elevation changes at a subset of Sentinel sites (location to be determined). Given the importance of soil drying, this subset of Sentinel sites will be monitored during the dry season to calibrate and validate expected soil hydrologic conditions estimated from EDEN.

These sites will also be candidates for estimates of annual soil elevation change (via measurements of changing soil depth with soil elevation tables and marker horizons) and associated estimates of net carbon and nutrient sequestration or release. These are integrative indicators of the state of SRS (Table 1). Estimates of net annual ecosystem production (NEP, the net accumulation or loss of carbon in the wetland) are proposed to be made at a set of four sites, using eddy covariance tower methodology (Barr et al. 2012). This methodology has been researched and established as means to provide rapid and spatially integrated estimates of large wetland areas (about one km^2 area per tower). An array of automated instruments on the tower continuously measures atmospheric CO_2 and other parameters, enabling daily estimates of NEP, as well as evapotranspiration (ET). We propose to deploy towers at four sentinel sites to assess changing NEP and ET patterns downstream of Tamiami Trail bridge flow-ways (for the 1 mile and 2.6 mile bridge areas) and away from the direct influence of these flow-ways. Note that this emphasis on assessing net soil and carbon response to MWD matches adaptive management plans included in the Project Implementation Report of the Central Everglades Planning Project . As with other elements of this MWD monitoring plan, information and knowledge gained in the coming decade will form a solid foundation for planning, implementation, and assessment of future projects.

Habitat sampling and analysis. Another major component of the ecological monitoring network is focused on documenting and understanding how Everglades habitats respond to MWD testing and implementation, as well as TTNS and CERP. Wetland habitat quality is primarily a product of plant community structure. With improved distribution, timing, and quantity of inflow to SRS via MWD, slough hydropatterns are expected to shift toward a restored state with an eastward expansion of vegetation typical of the central slough (dominance of spikerush (*Eleocharis elongata*), white water lily (*Nymphaea odorata*) and bladderwort (*Utricularia sp.*)), along with the stabilization and initial recovery of SRS tree islands and remnant ridge and slough landscape patterns. Among this suite of ecological

indicators (Table 1), slough vegetation is expected to be respond most quickly to MWD implementation. Changes in the distribution and density of invasive species, including native cattails (*Typha domingensis*) and exotic species (e.g. Old World climbing vine, *Lygodium microphyllum*) also will be monitored via vegetation mapping, as well as via field site observations across SRS.

Changes in habitat will be assessed from the analysis of vegetation cover maps that are derived from WorldView2 (WV2) satellite imagery. With its high resolution (2x2m), changing patterns of plant community structure (dominant species classification and cover area) are readily detectible (Richards and Gann section of Gaiser et al. 2013. Algorithms have been developed relating the spectral images of wetland cover with field observation of plant morphological categories, species, and plant density. Based on post-classification accuracy (ground-truth) assessments, classification accuracy exceeds 80%. Approximately 10 ground-truth sites, representing the range of hydrologic and plant communities existing in northern SRS will be surveyed approximately concurrent with image acquisition. Each of these sites will have intensive sampling, with 6 transects, each 150 m long, radiating from a central site point to assess mapping accuracy at the resolution of the maps (16 m^2 minimum mapping unit). Less intensive ground-truth information will be derived from plant survey plots at a subset of Sentinel sites. Finally, helicopter-borne photography of ground-truth sites or sites of immediate interest (e.g. possible expansion of woody vegetation and cattails along the near-canal transects) can be used for rapid data acquisition and more frequent data as needed. This entire effort will be closely coordinated with RECOVER system-wide monitoring and mapping of Everglades plant communities.

Food web sampling and analysis. Food web structure will be characterized at the Sentinel sites during the wet season. This proposed MWD monitoring effort will focus on quantifying the biomass , density, and species composition of small fish and invertebrates that compose the main prey base for wading birds, while utilizing data on wading bird and alligator populations derived from NPS and RECOVER monitoring programs. MWD monitoring will also include measurements of periphyton species composition at a subset of Sentinel sites primarily in order to assess food quality at the base of the food web, and secondarily to buttress interpretation of water quality patterns.

At each site, sampling of fish and invertebrates will be conducted using a combination of 1 m^2 throw-traps and drift-fence traps. The former provides prey base density, biomass, and species information, while the latter provides additional information regarding directional movement of these fauna within the marsh. Directional information enables assessment of the effects of changing MWD hydrologic connectivity and flow on animal dispersal and the propagation of food web influences downstream.

The prey base indicator listed in Table 1 is composed of 14 community metrics, quantifying the abundance and biomass of both the community as a whole, as well as of individual indicator species (Bluefin Killifish, Flagfish, Everglades Crayfish, and Slough Crayfish). Furthermore, data from this monitoring element includes non-native fish and invertebrate species identity, abundance, biomass, distribution, and dispersal direction. With this information, the rate of new species introductions, population growth, and spatial extent can be estimated and the effects of restoration on the status of such invasive exotics can be assessed. All results from this monitoring element can be merged with more spatially extensive RECOVER system-wide data sets and ENP-supported C-111 (IOP) Project data

sets, both of which are collected using the same methodology. Before implementation of any MWD monitoring, there will be an analysis of all programs' site distribution to eliminate redundancy and maximize cost effectiveness.

Assessment of higher trophic levels will depend mostly on monitoring from other programs, especially fundamental ENP natural resource programs and RECOVER. Most importantly, the effects of MWD on wading birds and alligators will be assessed (Table 1). Given the wide-spatial range of these fauna, any changes within the domain of MWD influence needs to consider broader-scale influences and population changes. In northern SRS, key metrics for wading birds will be nesting success, the timing of nesting initiation, and the relative abundance of species with differing foraging strategies (wood storks and white ibis relative to great egret nests, reflecting the restoration status of the trophic web). Similarly, monitoring of alligator nesting success and body condition in the area will indicate MWD on the health of this keystone species. The use of MWD funding for provision of data necessary for assessment of these higher trophic level indicators will be considered only if data from other programs prove insufficient.

Reporting

Reporting of the ecological monitoring results will be under the purview of ENP. Reports summarizing information will be produced on an annual basis by ENP staff. This will include provision of reports produced by cooperators and associated data. A comprehensive report will be produced following Incremental Test 2 and also at subsequent times as appropriate.

References

Barr, J.G., V. Engel, T.J. Smith, and J.D. Fuentes. 2012. Hurricane disturbance and recovery of energy balance, CO2 fluxes and canopy structure in a mangrove forest of the Florida Everglades. Agricultural and Forest Meteorology 153:54– 66

Brandt, L.A., J. Boyer, J. Browder, M. Cherkiss, R.F. Doren, P. Frederick, E. Gaiser, D. Gawlik, S. Geiger, K.Hart, B. Jeffery, C. Kelble, J. Layne, J. Lorenz, C. Madden, F. J. Mazzotti, P. Ortner, M. Parker, M. Roblee, L. Rodgers, A. Rodusky, D. Rudnick, B. Sharfstein, J. Trexler, A. Volety, 2012. System-wide Indicators for Everglades Restoration. 2012 Report. Unpublished Technical Report. 90 pp. http://issuu.com/evergladesrestoration/docs/2012_system_wide_ecological_indicat?e=8031892/10201041

Gaiser, E.E., L.J. Scinto, J.C. Trexler, D. Johnson and F. Tobias. 2009. Developing ecosystem response indicators to hydrologic and nutrient modifications in northeast Shark River Slough, Everglades National Park. Final Report to Everglades National Park, Cooperative Agreement H5297-05-0099

Gaiser, E.E., J. Richards, J.C. Trexler, L.J. Scinto, D. Gann, A. Saha, J. Bransky, and A. Bramburger. D. Johnson and F. Tobias. 2013. Ecological effects of the Modified Water Deliveries and the Comprehensive Everglades Restoration Plan in Northeast Shark River Slough, Everglades National Park. Progress Report to Everglades National Park, Cooperative Agreement H000-10-5040

This page intentionally left blank

PART 3 – CULTURAL RESOURCE MONITORING

This page intentionally left blank

C.3.1 CULTURAL RESOURCE MONITORING

The duration of effects to cultural resources within Everglades National Park (ENP) resulting from the G-3273/S-356 Field Test and S-357N Operational Strategy are not adverse due to the short time span of the test, analysis of anticipated water levels, and controls established through this monitoring plan. They also do not fall under the current Everglades Restoration Transition Plan (ERTP) Programmatic Agreement monitoring plan as they are a deviation and per the agreement subject to separate considerations under the National Historic Preservation Act. As discussed in **Section 4.20** of the Environmental Assessment (EA), the Preferred Alternative is not anticipated to create any conditions that would be considered adverse in their effects to significant historic properties. In addition, it is anticipated that the relative increase in water depth within ENP is minor and should not inundate any known archeological sites beyond that which is typical throughout the year. Therefore, cultural resources monitoring tools established under the ERTP Final Environmental Impact Statement and the associated ERTP Programmatic Agreement will be utilized to understand how the field test performs in relation to relative water depth located adjacent to known archeological resources and tree islands within ENP. Conditions and stipulations applied within the ERTP Programmatic Agreement will not be applied during the G-3273/S-356 Field Test and S-357N Operational Strategy as there are no anticipated impacts to cultural resources. However, active monitoring will occur utilizing the Everglades Depth and Elevation Network (EDEN) to determine whether conditions significantly vary from those established within the EA and conditions set forth below. (http://sofia.usgs.gov/eden/water_level_percentiles_map.php).

The monitoring efforts will allow a better understanding of potential effects of the additional water discharged into ENP and how the water spreads south throughout Northeast Shark River Slough (NESRS). They will also provide a better understanding of the zone of influence of water across the cultural landscape. Finally, the monitoring efforts will provide valuable information to better understand effects of water on cultural resources for future planned field test increments and the completed Modified Water Deliveries (MWD) to ENP Project.

The EDEN monitoring will compile water elevation data associated with known archeological sites within ENP. Finally, there are three sites that are currently monitored that contain human remains, as identified by the State of Florida Division of Historical Resources (for protection of these resources their names and locations will not be listed), that will be actively monitored. If conditions arise as a result of the test where water levels may approach overtopping these sites, an assessment will be conducted by the Corps to determine the cause of the high water levels and consultation with interested parties will ensue. The purpose of the analysis will be to examine the root cause or complexity of the issue and help understand what is the cause if it is rainfall induced, related to operations, or a combination of both. In addition, the monitoring will also serve to meet a U.S. Army Corps of Engineers requirement for archeological monitoring within MWD.

Upon completion of the test, data obtained from the field test 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 G-3273/S-356 Field Test and S-357N Operational Strategy so that a better understanding of the variation can also be developed. ERTP

Periodic Scientists Calls will continue to be conducted throughout the G-3273/S-356 Field Test and S-357N Operational Strategy to ensure cultural resource issues are considered during the water management decision process.

C.3.2 Monitoring Report

Information gained during monitoring of G-3273/S-356 Field Test and S-357N Operational Strategy will be included in a separate report.