Please fold out last page to refer to the Figure 1 Map of the Loxahatchee River Watershed Restoration Project and Study area as you read the Report Synopsis.

Table of Contents

List of Tables

List of Figures

1.0 Stage of Planning Process

This is a re-scoping of a Comprehensive Everglades Restoration Plan (CERP) feasibility study originally entitled North Palm Beach County Part 1 and renamed the Loxahatchee River Watershed Restoration Project (LRWRP). The LRWRP Project Delivery Team (PDT) identified a Tentatively Selected Plan (TSP) in August 2010. Subsequent to the selection of the TSP and prior to its approval, a select component of the plan was repurposed to accomplish specific state water quality objectives and it was determined this component would not be available to achieve water quantity, timing, and distribution goals. This resulted in the need to rescope project objectives and identify additional alternatives through the U.S. Army Corps of Engineers (USACE) SMART Planning process. This study will use existing and available science and data to develop an array of project alternatives and select a recommended plan to achieve restoration within the Loxahatchee River Watershed and provide restoration flows to the Loxahatchee River Northwest Fork and estuary.

2.0 Timeline

The following includes the estimated timeframe or schedule for completing the study using tabular format.

Completed Milestones	Date
Design Agreement Between the Department of the Army and The South Florida Water Management District for the Design of Elements of the Comprehensive Plan for the Everglades and South Florida Ecosystem Restoration Project.	12 May 2000

Future Milestones	
3x3x3 Compliance	06 JAN 2015
Alternatives Milestone	17 APR 2015
Tentatively Selected Plan Milestone	01 JUL 2016
Agency Decision Milestone	16 NOV 2017
Division Engineer Transmittal	27 APR 2017
Civil Works Review Board	13 JUL 2017
FEIS filed with EPA	16 AUG 2017
30-Day S&A Review start	17 AUG 2017
Chief of Engineers Report	06 NOV 2017

3.0 Study Authority

On Dec 11, 2000 the Water Resources Development Act of 2000 (WRDA, 2000) was signed into law by the President of the United States (Public Law No. 106-541, of the 106th Congress). Title VI, Section 601 of the Act provides for and guides modifications to the Central and Southern Florida project and describes authorizations specific to the CERP. Section 601(b)(A) "Comprehensive Everglades Restoration Plan Approval" provides authority for CERP.

> (b) Comprehensive Everglades Restoration Plan Approval – (A) IN GENERAL. —Except as modified by this section, the Plan is approved as a framework for modifications and operational changes to the Central and Southern Florida Project that are needed to restore, preserve, and protect the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection. The Plan shall be implemented to ensure the protection of water quality in, the reduction of the loss of fresh water from, and the improvement of the environment of the South Florida ecosystem and to achieve and maintain the benefits to the natural system and human environment described in the Plan, and required pursuant to this section, for as long as the project is authorized.

Section 601(d) "Authorization of Future Projects" provides the authority for the preparation of the Project Implementation Report.

> (1) IN GENERAL- Except for a project authorized by subsection (b) or (c), any project included in the Plan shall require a specific authorization by Congress.
>
> (2) SUBMISSION OF REPORT- Before seeking congressional authorization for a project under paragraph (1), the Secretary shall submit to Congress—
>
> (A) a description of the project; and
>
> (B) a project implementation report for the project prepared in accordance with subsections (f) and (h).

3.1 Additional Study Guidelines

1. <u>SMART Planning and 2014 Water Resources Reform and Development Act (WRRDA) Guidance</u>

In February and March 2012, Major General Walsh issued two planning memoranda on a revised approach to planning studies that emphasized risk-based decision making and early vertical team engagement. These planning memoranda provide the basis for planning modernization efforts, which are a central component of the Civil Works Transformation concepts contained in the WRRDA 2014. The requirements of planning modernization under the Transformation initiative is to complete high quality feasibility studies within shorter timeframes (no more than three years), with lower costs (no more than $3 million), and with concurrent reviews by District, Division, and Headquarters.

2. <u>December 2003 CERP Programmatic Regulations (33 Code of Federal Regulations Section Part 385)</u>

The Programmatic Regulations set guidance specific to CERP project requirements relative to the National Environmental Policy Act, Project Implementation Reports, RECOVER review, and Savings Clause analyses specific to reserving water for the natural system and maintaining water supply and flood control levels that existed in 2000.

3. 16 March 2005 North Palm Beach County Part 1 Feasibility Scoping Meeting Guidance Memoranda

Feasibility Scoping Meeting held with USACE Headquarters, South Atlantic Division, Jacksonville District, South Florida Water Management District, and contractor on the reformulation of the original CERP project components. Guidance was provided on national ecosystem restoration benefits formulation, accounting for flood Damage reduction service constraint and/or ancillary benefits, future without project assumptions, land acquisition, water quality, tradeoffs, mitigation, and other plan formulation issues.

4. 30 July 2009 South Atlantic Division Guidance for CERP land Valuation and Crediting Issues

Issued guidance that the national valuation and crediting policy contained in the Corps Real Estate Handbook (ER 405-1-12) will be used for plan formulation, cost estimation, and crediting, except as to lands acquired utilizing Federal funds under the 1996 Farm Bill or to which WRDA 2000 Section 601 (e)(3)(A) are applicable.

5. 31 August 2009 Headquarters Implementation Guidance for WRDA 2007 Section 2039

Monitoring plans must contain ecosystem restoration success criteria and adaptive management plans must be developed for ecosystem restoration projects.

6. 27 May 2010 South Atlantic Division Requirements for CERP Project Implementation Reports and Other Implementation Documents

Issued guidance specific to management of exotic or native nuisance vegetation; operational testing and monitoring period; project monitoring requirements; and Lands, Easements, and Real Estate requirement determinations, valuation and crediting.

There are also several signed agreements between the USACE and SFWMD specific to CERP projects noted here:

7. May 2000 CERP Design Agreement

USACE and SFWMD executed a CERP design partnership to identify and assign responsibility for the activities to be undertaken associated with the planning, engineering and design of CERP elements. In accordance with this agreement, USACE and SFWMD developed and approved the CERP Master Program Management Plan which provides direction and guidance for cost sharing, construction and operations of the CERP projects including LRWRP.

8. 13 August 2009 CERP Master Agreement

The design agreement was amended by USACE and SFWMD to reflect Section 601(e)(5) of the Water Resources Development Act of 2000 in regard to credits and to reference the Master Agreement to promote uniformity of terms, ease of administration, and efficiency in execution of CERP projects. This agreement sets forth the terms of participation in the construction, operation, maintenance, repair, replacement and rehabilitation of projects under CERP. The Master Agreement criteria will apply to the LRWRP when the project is approved and a project partnership agreement is executed.

4.0 Non-Federal Sponsor

The LRWRP CERP project SMART Planning Study is led by the USACE with the South Florida Water Management District (SFWMD) as non-federal sponsor. USACE and SFWMD have successfully

partnered on several CERP projects. CERP Generation 1 projects include: Indian River Lagoon-South (IRL-S), Site 1, Picayune Strand Restoration Project, and Melaleuca Eradication and Other Exotic Plants. Generation 2 projects include Broward County Water Preserve Areas, Biscayne Bay Coastal Wetlands, C-111 Spreader Canal and Caloosahatchee River West Basin Storage Reservoir. Most recently the agencies collaborated to complete the Project Implementation Report (PIR) for the Central Everglades Planning Project.

5.0 Purpose and Need

Purpose and Need

The renewed purpose of LRWRP is to restore and sustain the overall quantity, quality, timing, and distribution of freshwaters to the federally designated "National Wild and Scenic" Northwest Fork of the Loxahatchee River (NWFLR) for current and future generations. This project also seeks to restore, sustain, and reconnect the area's wetlands and watersheds that form the historic headwaters for the river. These areas include Jonathan Dickinson State Park (JDSP), Pal Mar East/Cypress Creek, Dupuis Wildlife and Environmental Management Areas, J.W. Corbett Wildlife Management Area (WMA), Grassy Waters Preserve (GWP), Loxahatchee Slough, the last remaining riverine cypress stands in Southeast Florida in the Loxahatchee River, and the Loxahatchee River Estuary.

The LRWRP seeks to address these goals by developing alternatives that will capture, store, and redistribute water currently lost to tide; rehydrate headwater natural areas that have been hydrologically impacted by excessive draining and water diversions; reduce peak discharges to the project's estuarine systems; improve timing and distribution of water from the upstream watershed to increase the resiliency of freshwater riverine habitats to future sea-level changes; and reestablish connections among natural areas that have become spatially and/or hydrologically fragmented. If implemented, these actions will help restore more natural water deliveries, promote improved health and functionality of wetland and upland areas, and increase the quantity and quality of habitat available for native wildlife and vegetation.

Background

The NWFLR is one of Florida's two federally designated National Wild and Scenic Rivers and is home to one of the last vestiges of native cypress floodplain swamp in southeast Florida. The river originates in both the Loxahatchee and the Hungryland Sloughs, located south of and west of the LRNWF. The Loxahatchee Slough, once an arm of the Everglades, contained both sawgrass and ridge and slough habitats characteristic of the Greater Everglades. The Central and Southern Florida (C&SF) Project cut off this connection and had unintended consequences of altering hydrology of the Loxahatchee Slough and River (McVoy, et al., 2011). Downstream from these sloughs, the Northwest Fork receives additional input from the other major tributaries of the Loxahatchee River: Cypress Creek/Ranch Colony Canal, Hobe Grove Ditch, and Kitching Creek. A cypress river swamp community historically dominated the floodplain of the Loxahatchee River, with freshwater stream swamps and cypress communities present in the floodplain upstream from river mile 6.5 and dominant within the floodplain above river mile 8.0. Between 1957 and 1958, the C-18 Canal and S-46 Structure, components of the C&SF Project, were constructed, cutting off the NWFLR from its watershed and channelizing the Southwest Fork of the Loxahatchee River. The flood control improvements resulted in reduced flows to the Northwest Fork by diverting freshwater to the Southwest Fork that formerly flowed naturally to the Northwest Fork. The G-92 structure was constructed (in the early 1980's) by the SFWMD to provide a way to divert water from the C-18 to the Northwest Fork, however, altered drainage patterns and lowered groundwater

levels due to canals, roads, and levees in many upper watershed natural areas still limit dry season flows. The stabilization of the Jupiter Inlet further compounded problems resulting from diminished flows by allowing more saltwater movement up the estuary (See **Figure 1** – Map of Project Area for structures, canals, natural areas, and hydrologic basins – Foldout in back of Report Synopsis). Collectively, these changes have promoted the upstream movement of saltwater that has contributed to the substantial mortality of cypress trees and upstream encroachment by mangroves within the lower portions of the river. This freshwater portion of the river closest to tidal influence remains very vulnerable to future sea-level changes that increase salinity effects. Additionally, natural wetlands upstream have degraded structure and function due to altered hydroperiods that have resulted from increased drainage and reduced connectivity.

Figure 1. MAP of Loxahatchee River Watershed Restoration Project Area

5.1 Federal Interest

The Everglades system is the heart of Florida, and sustains the economic and cultural growth of the South Florida region. The LRWRP area represents one of several key sloughs once connected to the Greater Everglades system. The Loxahatchee Slough contains the same unique ridge and slough landscape and tree islands and unique mix of species that supported designating the Everglades as a World Heritage Site. The Loxahatchee River Watershed also includes the federally designated "National Wild and Scenic" Loxahatchee River. In addition, significant Federal resources have already been expended on ecosystem restoration of the Everglades. The LRWRP represents a crucial step towards reviving the Loxahatchee River Watershed and NWFLR in Florida.

The LRWRP is consistent with the aquatic ecosystem restoration mission of USACE to pursue ecosystem restoration (national ecosystem benefits) and is integral to the continued operation and function of the Central and Southern Florida Project to meet multiple objectives. The LRWRP would support the USACE Campaign Plan by delivering reliable, resilient, and sustainable water resource solutions through collaboration with partners and strategic engagement and communication with stakeholders. Additionally, the LRWRP is a primary example of watershed integration, addressing the needs of the south Florida ecosystem while balancing the needs of the overall human environment. As such, the LRWRP is in both the Federal and USACE interest.

The watershed is home to 83 state and federally listed plants and animals (33 federally threatened and endangered species; 20 federally protected migratory bird species; and additional 30 state species of concern). Federally endangered plants within the watershed include the four-petal pawpaw (*Asimina tetramera),* perforate reindeer lichen (*Cladonia perforata)* and Small's milwort (*Polygala smallii)*. The entire Loxahatchee River has been designated by the U.S. Fish and Wildlife Service as a critical habitat for the West Indian manatee (*Trichechus manatus*), which frequents the Loxahatchee River and Estuary. Additional faunal species that are federally listed as endangered include the wood stork (*Mycteria americana*) and the Everglade snail kite (*Rostrhamus sociabilis*). The Eastern indigo snake (*Drymarchon couperi*) and the Florida scrub jay (*Aphelocoma coerulescens*), federally listed as threatened species, are also present within the watershed.

6.0 Study Scope

The LRWRP was initially comprised of six individual components that were outlined in the CERP (CERP; USACE and SFWMD 1999). These components (**Table 1**) were combined into a single project to resolve on-going water resource issues in northern Palm Beach and southern Martin counties.

Table 1. Restudy CER Components Included in Previous Study Effort.

Component	*Element*	*What's involved*	*Purpose*
9.1.8.1 (OPE)	Pal-Mar and J.W. Corbett WMA Hydropattern Restoration	Water control structures, canal modifications and acquisition of 3,000 acres between Pal-Mar and Corbett Provide hydrologic connections between Corbett and 1) Moss 2) C-18 Canal 3) Indian Trails Improvement District (ITID) and 4) L-8 Borrow Canal	Extend the spatial extent of protected natural areas; increase connectivity of hydrology, flora, and fauna between natural areas; improve seasonal timing and distribution of water to improve hydropatterns in drained areas.
9.1.8.2 (K & GGG)	WPAs/L-8 Basin	48,000 acre-feet. Above ground/in ground reservoir Aquifer Storage and Recovery (ASRs) for 50 million gallons per day with pre and post water quality treatment Series of pumps, water control structures and canal capacity improvements in the M canal	Increase water supply availability and flood protection, provide flows to enhance hydroperiods in Loxahatchee Slough, increase base flows to Northwest Fork, reduce high discharges to Lake Worth Lagoon (LWL)
9.1.8.4 (OPE)	Lake Worth Lagoon (LWL) Restoration	Sediment removal and trapping within C-51, sediment removal or trapping within 2.5 mile area downstream of C-51 and LWL	Improve water quality and allow for reestablishment of sea grasses and benthic communities.
9.1.8.6 (X)	C-17 Backpumping and Treatment	Backpumping facilities and Stormwater Treatment Areas (STA) of 2,200 acre feet (550 acres, 4' depth)	Increase water supplies to West Palm Beach Water Catchment Area and Loxahatchee Slough by capturing and storing excess flows discharged to LWL through C-17
9.1.8.7 (Y)	C-51 Backpumping and Treatment	Backpumping facilities and STA of 2,400 acre feet (600 acres, 4' depth)	Increase water supply to West Palm Beach Water Catchment Area and Loxahatchee Slough by capturing and storing excess flows discharged to LWL from C-51

During the course of the previous study effort and identification of a draft TSP, several of these components were screened out. These included component X (C-17 Backpumping and Treatment) and Y (C-51 Backpumping and Treatment). The Pal-Mar J.W. Corbett WMA Hydropattern Restoration (OPE), and the Water Protection Areas/L-8 Basin (K & GGG) are project components that remain. However, the L-8 reservoir has been repurposed to address state water quality issues and is no longer available for LRWRP purposes. In addition, the previous effort did not consider several other CERP components proposed for the LRWRP study area: L-8 and C-51 Basin ASR (Component K), C-51 Regional Groundwater ASR (Component LL), and Palm Beach County Agricultural Reserve Reservoir and ASR (Component VV). This renewed effort will evaluate ASR technology as a potential measure for providing additional water storage within the watershed.

6.1 Study Area

The LRWRP study area is approximately 480,000 acres (753 square miles) and is located in northern Palm Beach County and southern Martin County (Please refer to **Figure 1.** MAP of Loxahatchee River Watershed Restoration Project Area

foldout map at end of report). The study area is characterized as highly urbanized in the eastern portion, and transitions to extensive natural areas to the west and north. The study area is bounded on the north by the C-44 Canal, on the south by the C-51 Canal, on the west by the L-8 Canal and Lake Okeechobee, and on the east by the Loxahatchee River Estuary and Lake Worth Lagoon. The project area includes all of the Loxahatchee River watershed and limited portions of the St. Lucie River watershed.

Central and Southern Florida Project features within the study area include the L-8 Canal, the east and west legs of the C-18 Canal, and the C-51 Canal. Transportation infrastructure within the project area includes the Florida Turnpike and Interstate 95, as well as several major east/west county and state roadways (Indiantown Road [SR 706], PGA Boulevard [SR 708], and Northlake Boulevard). This infrastructure and other development within the watershed have resulted in lowered groundwater levels and altered drainage patterns and flow regimes within the natural and less developed areas.

6.2 Project Area

The Loxahatchee River Watershed drains an area of approximately 240 square miles, much of which is undeveloped sloughs and wetlands. In the upper portion of the watershed, nearly half of the drainage basin is comprised of wetlands. Agricultural and forested uplands in the northern area of the basin comprise one quarter of the watershed. The remaining quarter is developed urban areas (SFWMD, 2006). There are two predominant topographical features within the project area. One topographical feature consists of a ridge along the eastern project boundary referred to as the Atlantic Coastal Ridge. The second predominant topographical feature includes a lower plain, known as the Osceola Plain, which originates at the southern extent of what is now the L-8 Basin and extends north of the project study area. Both of these topographical features played a significant historic role in subtly directing flows to various natural systems. The construction of the L-8 levee and borrow canal essentially severed these areas from the historic Everglades.

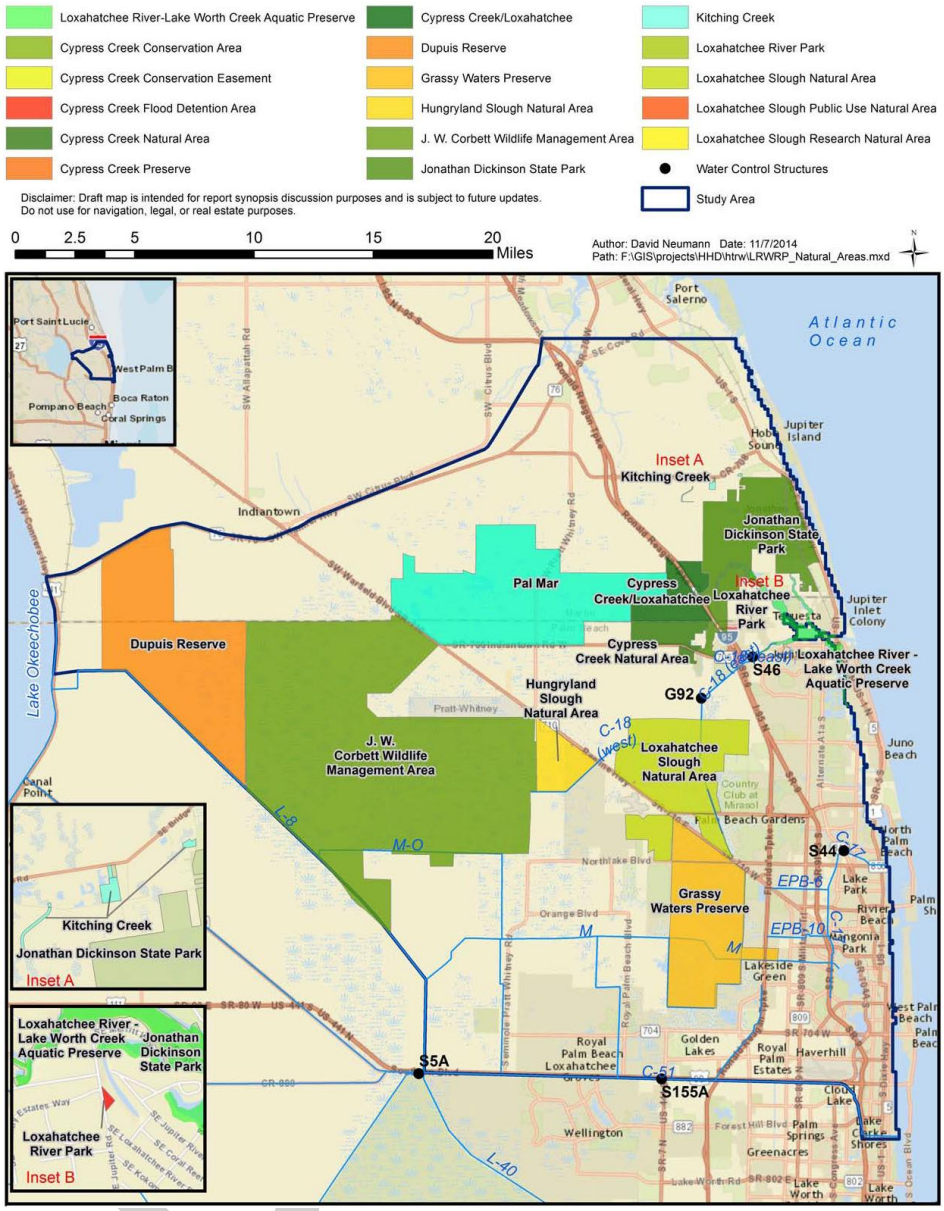
The Atlantic Coastal Ridge comprises broad, low dunes and ridges with elevations typically ranging from 10 to 25 feet National Geodetic Vertical Datum 1929. This ridge area ranges from two to four miles in width from its northern edge within the project study area to its southern edge in Miami. The highest elevation in the project study area, 86 feet, is located within JDSP, along the Atlantic Coastal Ridge. Within the project study area, the Atlantic Coastal Ridge is a relatively continuous topographical feature, with distinct slopes to the southern extent of the Indian River Lagoon and gradually west to the Loxahatchee River Estuary. Just south of the Loxahatchee River Estuary in the area that is north of what is now Donald Ross Road, the ridge is non-descript. Freshwater flows from the western extent of the project study area reached the LWL to the east of the ridge through this low area.

The Osceola Plain is the second predominant topographical feature within the project study area. It consists of a subtle plain located within what is now the Pal-Mar and L-8 Basins. This plain generally originates north of the southern portion of the project study area and east of what is now the L-8 Canal. The plain begins at an elevation of 16 to 20 feet in the southern portion of the L-8 Basin where it

continues north to an elevation of approximately 21 to 25 feet and then 26 feet and greater just north of the northern project study area. Within the plain, there are also slight variations in topography. In some instances, nondescript depressions provide an east to west linear variation in topography. One such depression is located almost exactly where the west leg of the C-18 Canal exists today and provided flows from the eastern extent of the plain, now the L-8 Basin, to the Loxahatchee Slough and ultimately the Northwest and Southwest Forks of the Loxahatchee River.

Key natural areas of the project area include JDSP, Cypress Creek, Pal-Mar, J.W. Corbett WMA, Dupuis Management Area, Loxahatchee Slough and GWP/ Water Catchment Area (**Figure 2**). These key areas are a mosaic of upland and wetland systems comprised of at least nine major habitat types. The seven wetland types include freshwater depression marsh, dome swamp, floodplain swamp, strand swamp, hydric hammock, wet prairie, and hydric flatwood. The two upland types include mesic flatwood and mesic hammock communities. The project area includes the Loxahatchee National Wild and Scenic River and the Loxahatchee Estuary. The Loxahatchee Estuary's Central Embayment is located at the center of three major tributaries: the Northwest Fork, the Southwest Fork and the North Fork.

Figure 2. Map of Natural Areas to be Connected by Loxahatchee River Watershed Project



JDSP is located in the northeast section of the project area within Martin and Palm Beach Counties and is comprised of 11,471 acres. The park contains portions of several branches of the Loxahatchee River and its upstream tributaries (Northwest Fork, upper reaches of the North Fork, Cypress Creek, Moonshine Creek, Hobe Grove Ditch, Wilson's Creek and Kitching Creek).

The NWFLR, one of Florida's two federally designated National Wild and Scenic Rivers, is a natural river channel that originates in the Loxahatchee and Hungryland Sloughs. Downstream from these sloughs, the NWFLR receives additional input from the other major tributaries of the Loxahatchee River: Cypress Creek/Ranch Colony Canal, Hobe Grove Ditch, and Kitching Creek. A cypress river swamp community historically dominated the floodplain of the Loxahatchee River with freshwater stream swamps and Cypress communities present upstream from river mile 6.5 and dominant within the floodplain above river mile 8.0 (See

Figure 3).

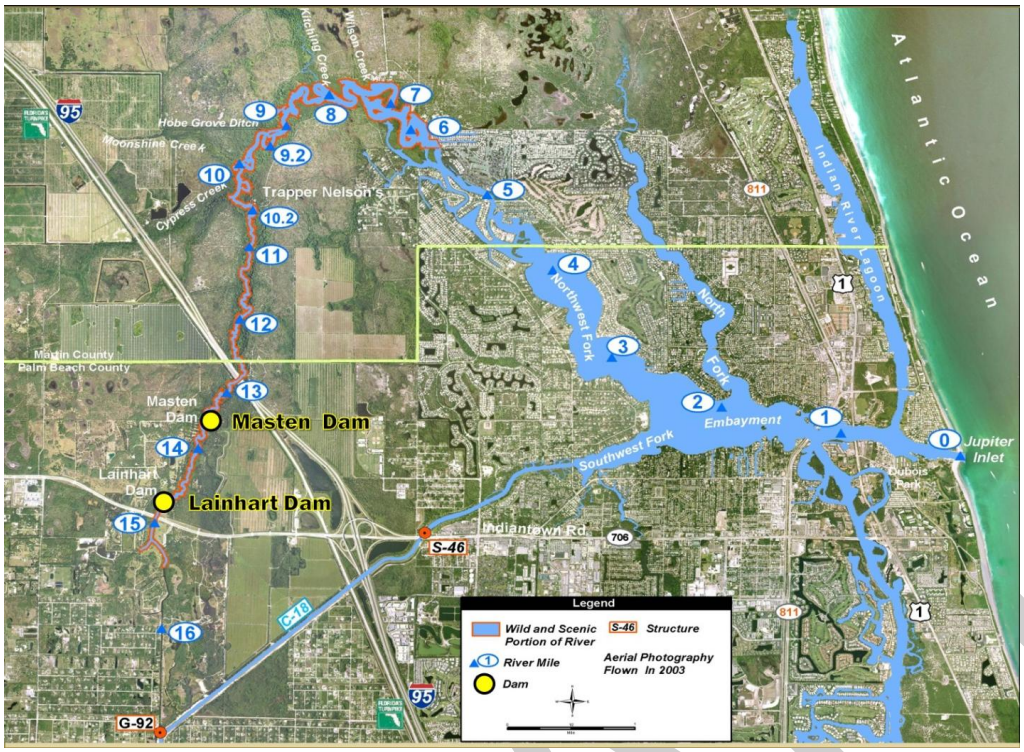


Figure 3. Map of Loxahatchee National Wild and Scenic River, Tributaries, and Estuary

Pal-Mar comprises more than 37,000 acres in southern Martin and northern Palm Beach counties, and forms a linkage between J.W. Corbett WMA and JDSP. Cypress Creek historically drained the Pal-Mar area as well as the Cypress Creek sub-basin and the agricultural areas. Due to the transformation of the historic creek into the Cypress Creek Canal and the diversion of water from the historic creek into the Ranch Colony Canal, flows into the creek have been greatly altered and it is no longer a receiving body of Pal-Mar surface water. Pal-Mar is primarily a natural area and most of western Pal-Mar occurs as wetland/upland communities including depression marsh, wet prairie, dome and strand swamps, pine flatwoods and sloughs. The wetlands and uplands in western Pal-Mar are primarily intact, though several small parcels within Pal-Mar have been developed for agricultural usage. However, the Groves Basin, also known as Pal-Mar East, has undergone significant hydrological changes. More than 90 percent of this area has been converted to agricultural use and most of the historic wetlands in this area, due to overdrainage, have converted to uplands. The loss of these wetlands has further altered the hydrology of Cypress Creek and the NWFLR.

J.W. Corbett WMA encompasses approximately 62,000 acres and is located in the northwest section of the project area. It contains extensive hydric/mesic flatwoods, depression marshes, wet prairies, strand and dome swamps and hydric/mesic hammocks. An intact Everglades sawgrass marsh ecosystem occurs along the southern boundary of J.W. Corbett WMA, and is considered a remnant portion of the Greater Everglades ecosystem.

The Loxahatchee Slough was historically one of the most prominent flow ways in the study area and contained a large portion of the historic headwaters of the Northwest and Southwest Forks of the Loxahatchee River. The 11,000 acre site is the single most ecologically-diverse tract of protected land in

Palm Beach County, including nine distinct community types, the largest of which are comprised of oak hammock and slough habitats (SFWMD 2004). The slough used to extend all the way to what is now Loxahatchee National Wildlife Refuge, but has been cut off by the levees that surround the Refuge and by the C-51 and C-18 canals. These features have altered historic drainage patterns in this area and have allowed for extensive invasions by melaleuca (*Melaleuca quinquenervia*).

The southern half of the historical Loxahatchee Slough has been impounded to form the Grassy Waters Preserve (GWP). The GWP is a managed wetland ecosystem, approximately 12,800 acres (20 square miles), which is owned and operated by the City of West Palm Beach. GWP serves as a surface water catchment, groundwater recharge and storage system for public water supply. GWP is also known as the West Palm Beach Water Catchment Area. The City's management of the GWP as an element of the water supply system has protected and sustained most of this system in a high quality wetland condition. The wetlands within this catchment area include wet prairies (sawgrass and spikerush), sloughs and cypress and other tree islands configured in a remarkably natural mosaic. In general, these wetlands are functioning at very high levels.

The hydrologic conditions in the tributary basins of the Loxahatchee Estuary have been altered by the construction of canals, channelization of natural waterways, drainage and/or impoundment of wetlands, and increased groundwater withdrawals. The construction of the C-18 Canal and the S-46 Discharge Structure has resulted in increased (sometimes excessive) discharges into the estuary. Lack of storage in those tributary basins results in periods of excessive freshwater inflow, followed by periods of insufficient freshwater inflow. The net result is an unnatural oscillation of salinity conditions. Large pulsed releases cause impacts to seagrasses, shellfish populations, and other fish and invertebrate communities residing in the estuary.

7.0 Prior Reports and Existing Water Projects

The following includes general information on prior studies, reports, National Environmental Policy Act documents and species surveys, existing water projects, and other key related activities.

1. L-8 Basin General Reevaluation Report (GRR) (2001)

The purpose of the L-8 GRR (USACE 2001) was to develop a regional plan for addressing the water resource problems within the L-8 Basin, as well as outside the basin. The GRR was intended to cover the L-8 Basin and surrounding areas which are affected flows through the basin including the Loxahatchee Slough, the Lake Worth Lagoon, Lake Okeechobee, the City of West Palm Beach WCA (GWP), Water Conservation Area-1, STA-1 East and C-51. It was the intent of the GRR to select a plan that would have operational capability and flexibility to aid in the restoration of the J.W. Corbett WMA, Dupuis Reserve and Loxahatchee Slough, to reduce impacts to the LWL, and to improve flood protection to the L-8 Basin. During the course of the L-8 GRR it became apparent that many of these same project purposes were being evaluated as part of the Restudy, and that the most efficient and effective way to address the water management issues of this area would be to develop solutions through the CERP process. This report provides information to support formulation of problems, opportunities and management measures to address LRWRP objectives.

2. Cypress Creek/Pal-Mar and the Groves Basin Study (2002)

The SFWMD, Martin County, Palm Beach County, the Florida Fish and Wildlife Conservation Commission and the Florida Department of Environmental Protection (FDEP), teamed up to initiate this water

resource study on the Cypress Creek/Pal-Mar and the Groves Basins; two of the seven sub-basins in the Loxahatchee River watershed. These two basins occupy approximately 63 square miles (40,500 acres) in Martin and Palm Beach Counties and provide a significant source of surface water to the NWFLR. The majority of runoff from this basin is through overland flow from west to east and then transitions into the Ranch Colony Canal and Cypress Creek. The eastern portion of the basin has been significantly altered to accommodate agricultural and residential land uses. The primary objective of the study was to develop a set of models representing the hydrologic and hydraulic processes in these basins and to assess historic hydroperiods in the Cypress Creek/Pal-Mar and Groves Basins, flooding and scouring in the canals, the long-term basin-scale water budget and the water quality in the project area. Elements of these models are available for use in the LRWRP formulation of benefits and evaluation of constraints.

3. Northern Palm Beach County Comprehensive Water Management Plan (2002)

During the seven-year period from 1994-2001, the SFWMD and the City of West Palm Beach led a cooperative effort to develop the Northern Palm Beach County Comprehensive Water Management Plan (SFWMD 2002a). The general goals of this effort were to provide adequate present and future water supplies, protect water quality, provide flood protection for urban and agricultural lands and protect and enhance important environmental resources. Specific measures that were developed to achieve these goals included: the impoundment of surface water in the C-51 and L-8 Basins, the linkage of storage areas through existing canal systems and newly constructed pumps and water control structures, the reconnection of historical flows north into the C-18 Basin and the Loxahatchee Slough, augmentation of base flows to the NWFLR. This report provides the background for LRWRP plan formulation for watershed benefits and to evaluate water supply and flood damage reduction risk constraints.

4. The Loxahatchee River Watershed Action Plan (2002)

This action plan published by FDEP outlines a comprehensive assessment of the current condition and needs of the seven major sub-basins of the watershed, which are JDSP/Kitching Creek, Coastal, Estuary, C-18 Canal/J.W. Corbett WMA, Cypress Creek/Pal-Mar, Groves, and Wild and Scenic/Jupiter Farms. The Plan included over 60 proposed environmental projects in areas of educational activities, land management activities, and “turn-dirt” improvement projects. This report provides further information on Loxahatchee River Watershed problems and opportunities, as well as management measures to consider in LRWRP plan formulation.

5. Loxahatchee River Minimum Flow Levels (2002)

Florida law requires the water management districts to develop a priority list and schedule for the establishment of Minimum Flow Levels (MFLs) for surface waters and aquifers within their jurisdiction (Section 373.0421 Florida Statute). This list identified the need to develop an MFL for the Loxahatchee River, which was completed in the SFWMD’s report, “Technical Documentation to Support Development of Minimum Flows and Levels for the Northwest Fork of the Loxahatchee River” (SFWMD 2002b). The MFL criteria developed were for the NWFLR to protect the remaining floodplain swamp community and downstream estuarine resources against significant harm. This document provides information to support project performance measure documentation in combination with any modifications needed to consider sea-level change effects on sustaining the NWFLR.

6. Restoration Plan for the Northwest Fork of the Loxahatchee River (April 2006)

In partnership with the FDEP, Florida Park Service, and the Loxahatchee River District, the SFWMD developed a Restoration Plan for the Northwest Fork of the Loxahatchee River. After an analysis of historic and current flora and fauna communities, the Northwest Fork ecosystem was partitioned into five valued ecosystem components (VEC) including cypress swamp and hydric hammock in the freshwater riverine floodplain, cypress swamp in the tidal floodplain, fish larvae in the oligohaline zone, oysters in the mesohaline zone, and seagrasses in the polyhaline zone downstream. Performance measures for each VEC were developed to relate flow and stage in the floodplain and salinity in the river to the ecological health of the VECs and were used to evaluate the relative biological effects of each restoration flow alternative. It is important to note that one of the goals of these evaluations was to not only restore the river's health, but to ensure in the process that the downstream estuarine communities would not be harmed by increases in freshwater flows. Based on the application of hydrologic and salinity models a preferred restoration flow was identified. This information can be used to support performance measure documentation and benefits methodology for the NWFLR.

7. Addendum to the Restoration Plan for the Northwest Fork of the Loxahatchee River (February 2012)

Since 2006, monitoring efforts recommended by the 2006 Restoration Plan have been conducted that culminated in an Addendum to the Restoration Plan for the NWFLR. This addendum is a compilation of new knowledge gained during the five years subsequent to the release of the 2006 Restoration Plan and focuses on analysis of factors identified in that plan as needing more attention. The new research and monitoring results were organized into six major categories: (1) salinity and stage, (2) floodplain vegetation, (3) floodplain fish and wildlife, (4) estuarine flora and fauna, (5) water quality, and (6) restoration progress. In addition, this addendum evaluates the 2006 flow scenario in light of the results of these monitoring efforts.

8. CERP Project - North Palm Beach County Part 1 Plan Formation

Between 2003 and 2010, the SFWMD the USACE and a multiagency Project Delivery Team (PDT) collaborated on the plan formulation for the North Palm Beach County Part 1 Project, a CERP project that included six (6) of eight (8) components of the Restudy that were located in northern Palm Beach and southern Martin counties. The PDT developed and analyzed a final array of seven (7) alternatives resulting in the identification of a Tentatively Selected Plan. That plan included a 45,000 acre foot storage facility (the L-8 Reservoir) and a collection of management measures that relied on a Flowway based delivery concept to provide restoration flows to the Loxahatchee River and its tributaries, as well as to provide for hydrologic restoration and connectively within the greater Loxahatchee River Watershed. Because the primary storage component included in the TSP was under consideration to be used as a flow equalization basin for addressing water quality concerns in the Everglades Protection Area, the team was asked delay further analysis. Much of the work that was completed to develop the TSP can be updated and utilized to refine alternatives for this renewed study.

9. Restoration Strategies

In 2012, to address water quality concerns associated with existing flows to the Everglades Protection Area (EPA), SFWMD, FDEP and the United States Environmental Protection Agency (USEPA) established a Water Quality Based Effluent Limit (WQBEL) for Total Phosphorus (TP) in Discharges from Everglades STAs to assure that such discharges do not cause or contribute to exceedances of the State of Florida's numeric TP criterion in the EPA. Additionally, a suite of projects that work in conjunction with the Everglades STAs to meet the WQBEL were identified. These projects consist primarily of Flow

Equalization Basins's (FEB), STA expansions and associated infrastructure and conveyance improvements. Design and construction of many of the projects is currently ongoing and the entire suite of projects is scheduled to be completed by 2025. The L-8 Reservoir/FEB, located just north of STA-1E and STA-1W in the Restoration Strategies Eastern Flow path, will provide approximately 45,000 acre feet of storage. The primary purpose of the L-8 Reservoir/FEB is to attenuate peak stormwater flows, temporarily store stormwater runoff and improve inflow delivery rates to STA-1E and STA-1W, thereby providing enhanced operation and phosphorus treatment performance to assist in achieving state water quality standards in the EPA. The L-8 Reservoir/FEB may also be used to assist in maintaining minimum water levels and reducing the frequency of dryout conditions within STA-1E and STA-1W, which will sustain phosphorus treatment performance.

10. Additional Related Projects

The following additional non-CERP projects have either been completed or are currently underway in an effort to improve environmental conditions in the project area: Loxahatchee Slough Restoration (Palm Beach County; Jones Creek Restoration (Palm Beach County); Jupiter Farms Water Quality Improvements (South Indian River Water Control District and SFWMD); Riverbend Park Hydrologic Restoration (Palm Beach County); and Cypress Creek Restoration (Palm Beach County). Additional information on these projects can be found in the Loxahatchee River Preservation Initiative website (LRPI, 2014) and Loxahatchee River Watershed Action Plan (FDEP and SFWMD, 2010).

8.0 Problems/Opportunities

Van Arman et al. (2005) developed a conceptual ecological model for the Loxahatchee watershed that characterized the wetland, riverine, and estuarine components pre-development and how they have been affected by hydrologic alterations, urban and agricultural development, and water management infrastructure and operations. The following information documents the project related problems known to exist currently, many of which are projected to worsen in the future if no action is taken.

8.1 Hydrological/Ecological Problems

1. Altered timing and distribution of headwater base flows to the Northwest Fork of the Loxahatchee River
2. Increased salinity effects on formerly freshwater reaches of the Loxahatchee River
3. Loss of freshwater cypress floodplain adjacent to Loxahatchee River
4. Increased wet season flows to Southwest Fork and Loxahatchee Estuary
5. Degraded natural area structure and function from altered hydrology
6. Conversion of natural areas to agricultural, residential and industrial uses
7. Loss of connectivity and barriers to flow between natural areas, river, and estuary
8. Reduced native floral and faunal populations and diversity
9. Degraded water quality in natural areas

Problems 1, 2, 3 and 4 – Flow to Loxahatchee River, Floodplain, and Estuary

The hydrologic conditions in the tributary basins to the Loxahatchee River and Estuary have been altered by the construction of canals, channelization of natural waterways, drainage and/or impoundment of wetlands, and increased groundwater withdrawals. The construction of the C-18 Canal and the S-46 Discharge Structure in 1957-1958 for flood control purposes have diverted freshwater that flowed

naturally to the Northwest Fork towards the Southwest Fork. This resulted in the over drainage of headwaters from the NWFLR and increased discharges, often excessively, directly into the Loxahatchee Estuary. The channelization of flows in the Cypress Creek Basin has over drained area wetlands and results in large erosive stormwater discharges in Cypress Creek.

These alterations have adversely affected both the Loxahatchee River and Estuary and produced insufficient base freshwater flows to these resources during the dry season. Insufficient base flows to the NWFLR have resulted in extensive changes to the riparian river vegetation. This, coupled with the influence of the Jupiter Inlet, has enabled the influx of saline waters into what were formerly freshwater river reaches. As a result, cypress and other freshwater vegetation intolerant of elevated saline conditions have been replaced by invading mangroves and other estuarine plant communities. Sea-level rise will continue to convert freshwater habitat to estuarine habitat without dry season flows to increase system resilience to climate change effects.

The lack of storage in the tributary basins results in periods of excessive freshwater inflow to the Loxahatchee Estuary in the wet season, impacting seagrasses, shellfish populations, and other fish and invertebrate communities residing in the Estuary. Large pulses of freshwater followed by periods of insufficient freshwater inflow result in an unnatural salinity oscillation, further degrading ecological communities requiring stable salinity regimes. Collectively, these changes have promoted the upstream movement of saltwater that has contributed to the substantial mortality of cypress trees and upstream encroachment by mangroves within the lower portions of the river.

<u>Problems 5 and 6: Degraded freshwater wetland structure and function and conversion to other land uses</u>

To achieve environmental improvement within these freshwater wetland systems, a combination of storage and conveyance modifications will be required. Modifications and/or inter-basin connections might offer opportunities to achieve substantial environmental restoration. Further opportunities might exist for achieving regional environmental restoration and enhancements by improving hydrologic connections between the Pal-Mar/Cypress Creek Basin and the Loxahatchee River. These connections would help rehydrate tributary wetlands and supplement off-peak or dry season flow to the Loxahatchee River. In addition, restoration of agricultural lands to wetlands will help provide natural storage of water and increase base flows to tributaries of the Loxahatchee River, as well as increase natural area extent. Agricultural lands can also contain agricultural chemicals that need to be addressed as part of any restoration effort.

<u>Problems 7 and 8: Loss of connectivity, barriers to flow, and reduced native floral and faunal populations and diversity</u>

Environmental functions in the project area can be preserved through improved surface water structures, operational protocols, and measures that reduce fragmentation resulting in improved vegetation and hydrology and enhanced habitat for wildlife, as well as recreational opportunities. Habitat fragmentation is only expected to worsen in the future with increased development pressure.

Restoration of hydroperiods in the Loxahatchee Slough and Cypress Creek/Pal-Mar/Groves basin wetlands that are too dry will help reestablish foraging and nesting grounds for the federally endangered snail kite, wading birds and other wetland dependent species. In addition, the Moss Property has been separated by canals and impounded in locations that prevent the sheet flow of surface water, resulting in conditions that are drier than pre-development.

The historic connection between GWP and the downstream remnants of the Loxahatchee Slough and River have been impacted by existing roadways and channelization. This fragmentation disrupts the natural hydrological connection between GWP and the Loxahatchee Slough thus limiting the amount of freshwater that can be sent downstream to the Loxahatchee River. Reduced freshwater flows cause salinity imbalances in the River and reduce the potential extent of additional viable snail kite habitat in GWP.

Problem 9: Degraded water quality in Grassy Waters Preserve

Grassy Water Preserve (GWP) consists of a 19 square mile wetland water catchment area that is the predominant remnant headwaters of the Loxahatchee Slough and "Wild and Scenic" Loxahatchee River. The wetlands within this catchment area include wet prairies (sawgrass and spike rush), sloughs, and cypress and other tree islands configured in a natural mosaic. While there are areas of degradation in GWP, it provides foraging and nesting habitat for the federally endangered snail kite. When necessary the City of West Palm Beach supplements their water supply with water from Lake Okeechobee. Lake Okeechobee water is high in nutrient concentrations and as a result of routing this water through the M-Canal, the fringes of Grassy Waters Preserve have experienced vegetative changes consistent with the effects of degraded water quality. These alterations to wetland vegetation have potentially affected suitable breeding habitat for apple snails, the food source for endangered snail kites.

8.2 Opportunities

There are opportunities to include recreation-related features to increase recreational access and use of the natural lands in the project area. All recreational features would be compatible with ecological restoration.

In addition to addressing aquatic ecosystem restoration problems, opportunities may occur to improve water supply and flood damage risk reduction. WRDA 2000 and the Programmatic Regulations require CERP projects to not reduce the availability of water supply and level of service for flood protection. However, improvements to water supply and level of service for flood damage risk reduction may occur as a result of ecosystem restoration planning and will be captured as ancillary benefits. Opportunities exist to capture excess water to reduce water supply restrictions in the Northern Palm Beach County Service Area. The Ranch Colony and the Links developments located in southern Martin County, and the Indian Trail Improvement District in the L-8 Basin experience flooding during heavy rainfall events. Opportunity exists to reduce frequency of flooding events by keeping more water in the natural areas for restoration purposes.

9.0 Planning Goals/Objectives/Constraints

9.1 Goals

The overall goal of LRWRP is to restore and sustain the overall quantity, quality, timing, and distribution of freshwaters to the federally designated "National Wild and Scenic" Northwest Fork of the Loxahatchee River (NWFLR) for current and future generations. This project also seeks to restore, sustain, and reconnect the area's wetlands and watersheds that form the historic headwaters for the river and flows and salinity conditions in the Loxahatchee River Estuary.

9.2 Planning Objectives

Based on the project area problems and opportunities, project planning objectives are:

1. Restore wet and dry season flows of water to the National Wild and Scenic Northwest Fork of the Loxahatchee River and the river floodplain.

   Objective to be measured by the ability to meet floodplain inundation targets and salinity envelop targets in the Northwest Fork of the Loxahatchee River. Additional data and model calibration is needed to ensure performance measure is sensitive to detect meaningful change in this high priority (National Wild and Scenic River designation) area of the system.

2. Restore oysters, seagrass and other estuarine communities in the Loxahatchee River Estuary by reducing excess wet season high flows to Loxahatchee River Estuary through South Fork at the coastal control structure S-46

   Estuary salinity benefits will be measured based on the percent reduction in frequency and duration of S-46 structure peak flow discharges that relate to salinity threshold criteria for seagrasses.

3. Increase natural area extent of wetlands

   Objective will also calculate additional acres of natural areas added that achieve restored hydrologic regimes of the primary wetland habitats that were once found on the agricultural lands, based on literature review data and GIS analysis. Hazardous, Toxic, and Radioactive Waste existing site information and need for additional survey information will need to be considered in dealing with some agricultural chemicals and whether additional measures are needed to restore the agricultural lands.

4. Restore connections between Corbett Wildlife Management Area, Pal-Mar/Cypress Creek basin, Loxahatchee Slough, Grass Waters Preserve and Loxahatchee River to improve hydrology, sheetflow, hydroperiods, natural storage, and vegetation communities

   Objective to be measured by the increase in connectivity between natural areas compared to the total maximum score achievable. Project will rely on prior project plan formulation information, site collection and areal mapping on possible reconnection opportunities and importance of connection related to historic connections, natural area priorities, supports other objectives (e.g., fish and wildlife population movement).

5. Restore native plant and animal species abundance and diversity in Loxahatchee River watershed natural areas, river, and estuary

   Improvements to Loxahatchee River Watershed natural area hydrology regimes will be measured by achieving appropriate depth, duration, and frequency stage targets. Desired targets are based on prior project plan formulation literature data and model output for predevelopment conditions or existing conditions in unimpacted areas for

each major wetland plant community. Natural area sites will be revisited to update existing conditions for those locations, if they have a high probability of having experience change since 2004 (original baseline site assessment).

In addition to habitat units, best professional judgment based on literature review and model output will be used based on restored area's likelihood of improving fish and wildlife species life-history characteristics.

6. Reduce water quality degradation risk associated with increasing basin flow deliveries to Loxahatchee River

   Water quality degradation risk will be evaluated based on nitrogen, phosphorus non-degradation criteria at long-term sampling stations and comparing to model output to document any ancillary benefit improvements.

7. Increase recreational opportunities at restored natural areas

The LRWRP project planning goals and objectives are consistent with those identified in Table 5-1 Goals and Objectives for the CS&F Restudy (1999) which are:

<u>Goal 1 - Enhance Ecological Values</u>

1. Increase the total spatial extent of natural areas
2. Improve habitat and functional quality
3. Improve native plant and animal species abundance and diversity

<u>Goal 2 - Enhance Economic Values and Social Well Being</u>

4. Increase availability of fresh water (agricultural/municipal and industrial)
5. Reduce flood damages (agricultural/urban)
6. Provide recreational opportunities
7. Protect cultural and archeological resources and values

9.3 Planning Constraints

1. Comply with all Federal, state and local laws, regulations and policies.
2. Maintain levels of service for flood protection to agricultural and urban lands (Savings Clause [Section 601 (h)(5)(B) of WRDA 2000]).
3. Maintain levels of water supply service for legal users (Savings Clause [Section 601 (h)(5)(A) of WRDA 2000]).
4. Minimize impacts to cultural, historical and archaeological resources.
5. Minimize adverse socioeconomic impacts on the local and regional economies.
6. Avoid, minimize, or provide compensatory mitigation for any impacts to pre-existing compensatory mitigation sites within the project area under Section 404 of the Clean Water Act.

10.0 Inventory and Forecast

USACE planning guidance (Engineering Regulation 1105-2-100) requires inventorying the current or existing conditions baseline (ECB) and then projecting the future without (FWO) project conditions of the study area. The ECB conditions are described with respect to hydrology, geology, ecosystem types and conditions, flora and fauna, water management infrastructure and operational criteria, built environment, land use and land change conditions, and governance areas. The ECB is used to describe the effects of the preferred future with alternative plans on trust resources as part of various Federal and State laws to ensure the project avoids, minimizes, and/or mitigates impacts from the project. The base year for the period of analysis for the LRWRP is 2022. The base year assumes an unconstrained implementation timeline in which LRWRP will be authorized, designed, and constructed.

The ECB conditions are then projected out 50 years to identify the FWO to compare to future with project conditions of the same time frame for determining ecosystem restoration benefits. Even if project structures last more than 100 years, there is too much inherent uncertainty to reliably forecast conditions and impacts beyond 100 years. The FWO project condition describes projects, land use and land changes, and environmental condition trajectories that are assumed to be in place if none of the study's alternative plans are implemented. The FWO project condition is the same as the alternative of "no action" that is required to be considered by the Federal regulations implementing the NEPA and other environmental analyses. By incorporating a 50-year period of analysis to reflect beneficial and adverse effects of the project through time, the period of analysis for the FWO and with project alternative plans will end in the year 2072. Sea-level change analysis will consider the effects of this project out to 100 years (2122) per USACE Engineering Technical Letter 1100-2-1 under various sea-level rise scenarios to incorporate adaptation measures into plan formulation that ensure robust and resilient project performance in light of future climate change effects.

The typical period of analysis for the CERP studies differs from traditional studies because of the programmatic requirement to calculate system-wide benefits. In order to accurately predict system needs and project operations for the entire system, all CERP projects have utilized the same ending date for the period of analysis as the most current version of the plan (i.e. the April 1999 "Final Integrated Feasibility Report and Programmatic Environmental Impact Statement" used 2050). Based on the assumptions used for future forecasting, there is little reason to believe that hydrologic conditions in the LRWRP would be substantially different between 2050 and 2072.

The following sections describe existing conditions and in some cases potential future conditions for either the study area or project area depending on how the prior project documents assessed the conditions. The study areas is 753 square miles that incorporates all basins and natural areas surrounding the potential project foot print and project areas is around 240 square miles that contains natural areas that could be potentially affected by the project.

<u>Geology, Topography and Soils</u>

Geology - For the Loxahatchee River Watershed Restoration Project (LRWRP) project area, the geologic focus is on the surficial aquifer system (SAS). The SAS is a non-artesian shallow aquifer that ranges in thickness from 0 to as much as 300 feet below the land surface and is the source for most water supply wells in the project area. Hydraulic conductivity and transmissivity are key hydrogeologic characteristics that reflect the relative ability of water to move through subsurface materials. Areas with low SAS conductivity and transmissivity are more likely to be useful for surface water detention and retention whereas areas that reflect high permeability would result in high rates of water percolation into the

groundwater rather than surface storage. In the LRWRP project area, both of these characteristics are extremely variable, ranging over several orders of magnitude in different areas.

Topography - The SFWMD Geographic Information System's 5-Foot Contour Topographic Coverage reveals two predominant topographical features that have helped shape the project area's ecosystems. The first feature is the Atlantic Costal Ridge, a relatively steep, narrow ridge located along the eastern extent of the project's boundaries. The project area's highest elevations occur along this ridge which borders the east coast and extends throughout the greater part of the eastern boundary. The second main topographic feature is a broad, yet subtle ridge located throughout western portions of the project area. The western ridge consists of gentle slopes that direct surface water to the south, east and west to ultimate receiving waters. Both ridges extend beyond the project's boundaries.

Soils - Data from the Natural Resource Conservation Service (NRCS) were used to identify the hydrologic soil types present within the project area. The NRCS has classified hydrologic soil groups based on their drainage characteristics. Soil groups A (drained sand and gravel with low runoff potential), B (moderately coarse soils with moderate infiltration rates), C (finer soils with low infiltration rates), and D (chiefly clay soils with high runoff potential) are all present within the project area (**Figure 4**).

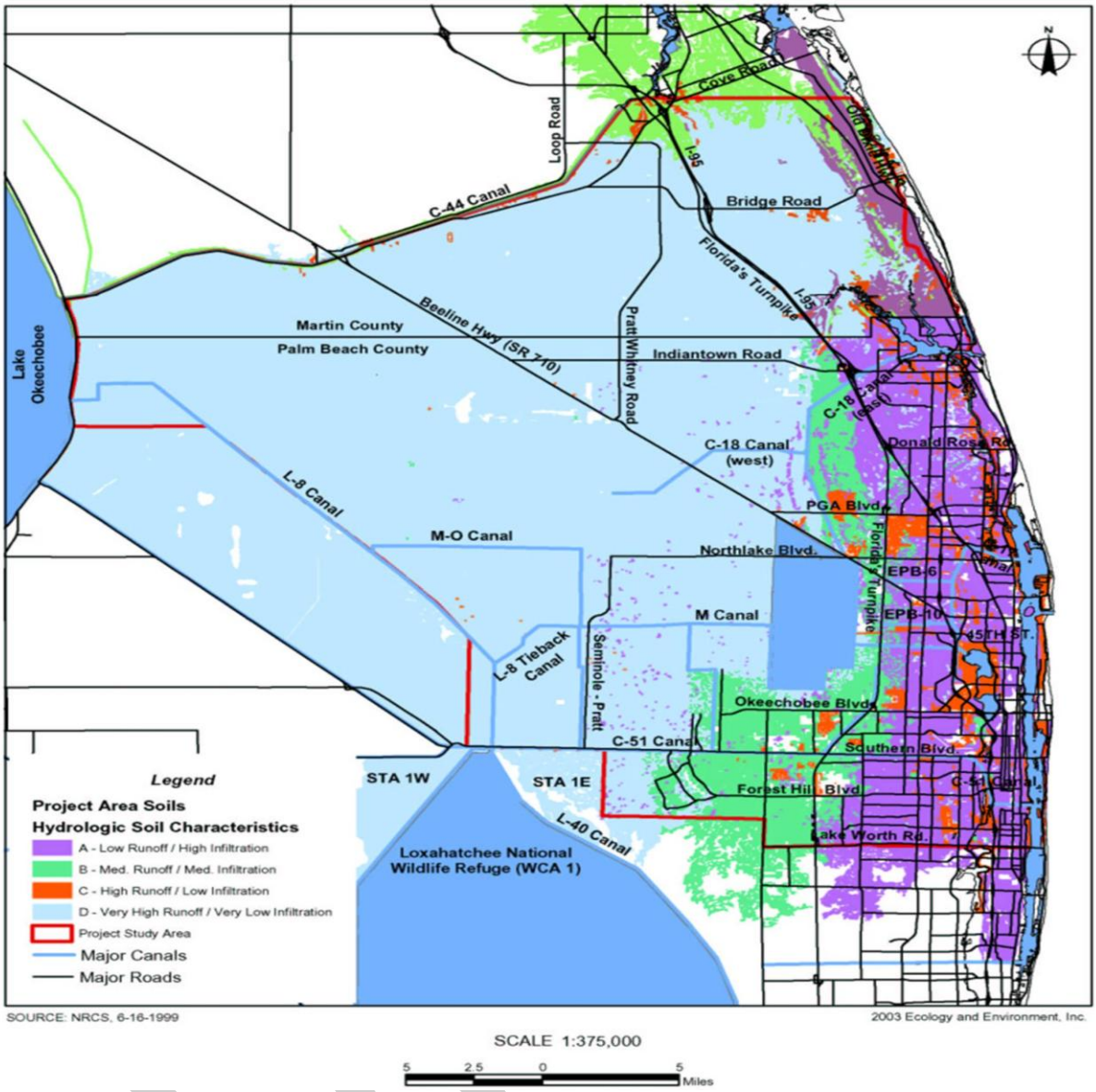


Figure 4. Hydrologic soil characteristics within the project area.

Hydrology

The management of surface water is generally conceived on a watershed level and in the project area, three watersheds have been delineated: the St. Lucie River Watershed, the Loxahatchee River Watershed, and the Lake Worth Lagoon Watershed (**Figure 5**). Within the St. Lucie Watershed, some portions of the C-44 Basin and the south St. Lucie Basin are within the project area. All of the Loxahatchee River Watershed is within the project area and includes the following basins: Kitching Creek, the Grove, Cypress Creek/Pal-Mar, Wild & Scenic River/Jupiter Farms, Loxahatchee Estuary, and the C-18/J.W. Corbett WMA. The L-8 Basin, C-17 Basin, the GWP Basin, and the C-51 Basin are part of the Lake Worth Lagoon Watershed. The primary focuses of the LRWRP project are the Loxahatchee River and the LWL watersheds.

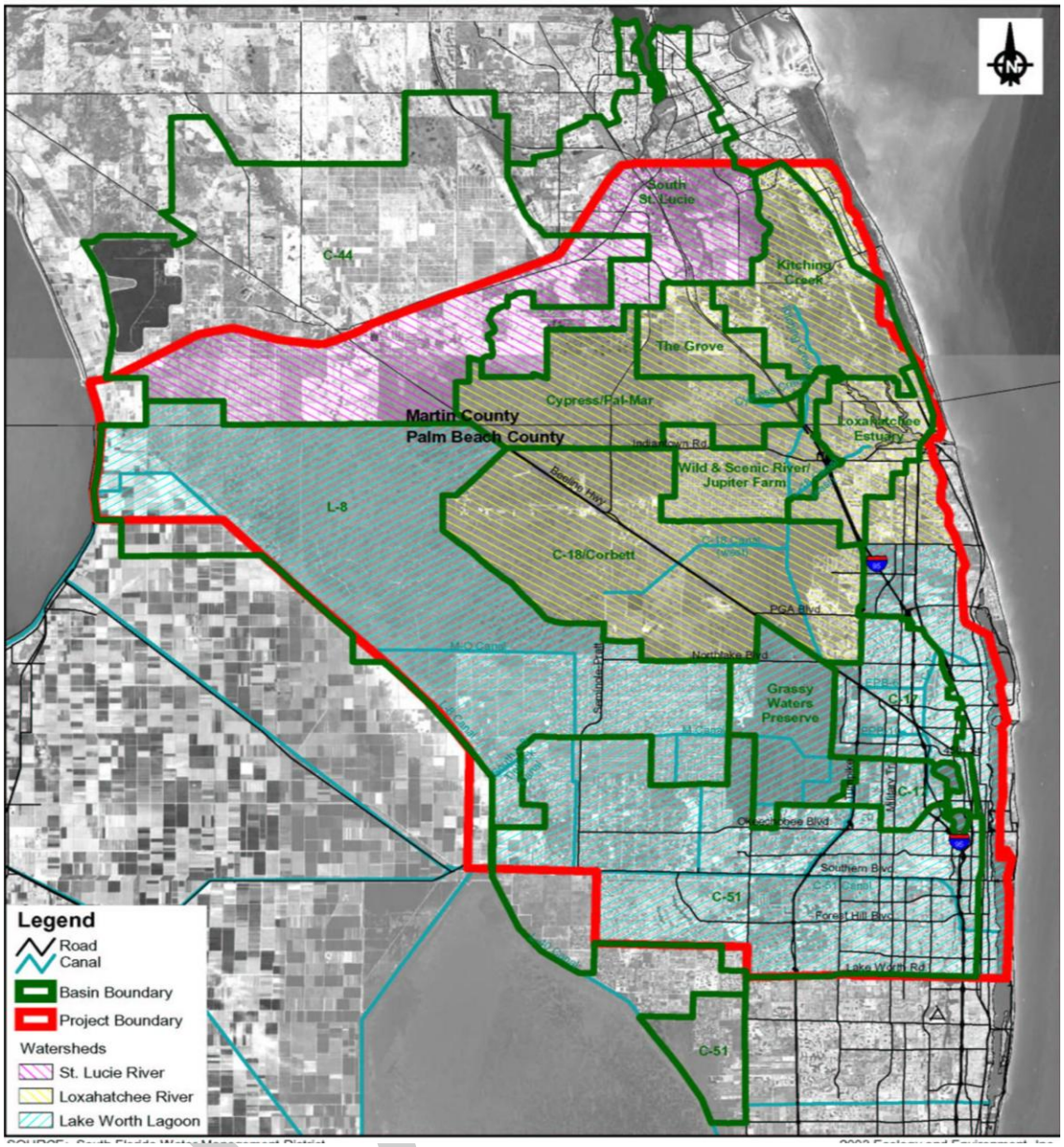


Figure 5. Map of Hydrologic Basins, Major Watersheds, and Barriers to Flow (Roads and Canals)

Biological Resources and Natural Communities

Of the 753 square miles that are included in the study area, approximately 357 (47%) square miles consist of natural communities. Project area ecosystems can be grouped into three broad categories: 1) freshwater wetlands and other aquatic ecosystems, 2) estuarine ecosystems, and 3) upland ecosystems. This classification system is adapted from the Florida Natural Areas Inventory and the Florida Department of Natural Resources (FDNR; 1990) and represents the major plant communities (**Table 2**) found in the project area.

Table 2. Acreage and relative coverage of major plant communities within the project area.

Natural Community Type	Acreage	Relative Coverage (%)
Pine Flatwood [1]	93,943	41.0
Dry Prairie [2]	151	0.1
Sandhill [3]	338	0.1
Scrub [4]	1,185	0.5
Hammock [5]	4,028	1.8
Freshwater Marsh [6]	49,578	21.7
Inland Pond and Slough	9,125	4.0
Wet Prairie [7]	30,677	13.4
Strand Swamp [8]	23,065	10.1
Floodplain Swamp [9]	1,090	0.5
Other Swamps [10]	10,399	4.5
Mangrove Swamp	737	0.3
Exotic/Invasive [11]	4,331	1.9
Total Acreage	**228,647**	**100.0**

Source: FLUCCS, SFWMD 2000 Land Cover Data. Notes: 1 Pine flatwoods with melaleuca; 2 Palmetto prairies; 3 Pine-mesic oaks & xeric oaks; 4 Coastal scrub, longleaf pine-xeric oak and sand pine; 5 Temperate, tropical, mixed & upland hardwoods, live oaks, cabbage palms, & sand live oaks; 6 Freshwater, sawgrass & cattail marshes; 7 Wet prairies with pine; 8 Cypress, cypress with melaleuca & cypress with wet prairie; 9 Lake and river swamps; 10Bay swamps, mixed wetland hardwood, mixed wetland shrub, tree islands and wetland forest mix; 11Brazilian pepper, melaleuca, willows & Australian Pine

There are a wide variety of wetlands including wet flatwoods, hydric hammocks, several different types of freshwater marshes and swamps (**Figure 6**). More than half of the wetlands in Florida have been lost due to drainage and filling (Myers and Ewel 1990) mostly during the last 50-60 years. Wetland habitats are the most impacted areas within the project area both in area and numbers. A wetland assessment study conducted within the Pal-Mar/Cypress Creek and the Groves Basins reported a substantial net loss in total wetland acreage ranging from 25 to 90 percent within the selected project study areas, based on photo-interpretation of 1940 and 2000 aerial photographs (Wan, Y., et al., 2014).

Figure 6. Project area depressional marsh (top left), freshwater marsh (top right), freshwater slough (bottom left) and floodplain swamp (bottom right).

Each area is in various conditions of ecosystem structure and function that were assessed back in 2004. Some areas are highly degraded and not much remains of a functioning wetland. Other areas have certain problem areas, or could become worse in the future due to demands for public water supply, water quality, and sea-level change. For example, the Lower Loxahatchee River has seen Cypress stands change into mangroves (See **Figure 7** and **Figure 8**).

Figure 7. Dead cypress and thriving mangroves on the lower Loxahatchee River.

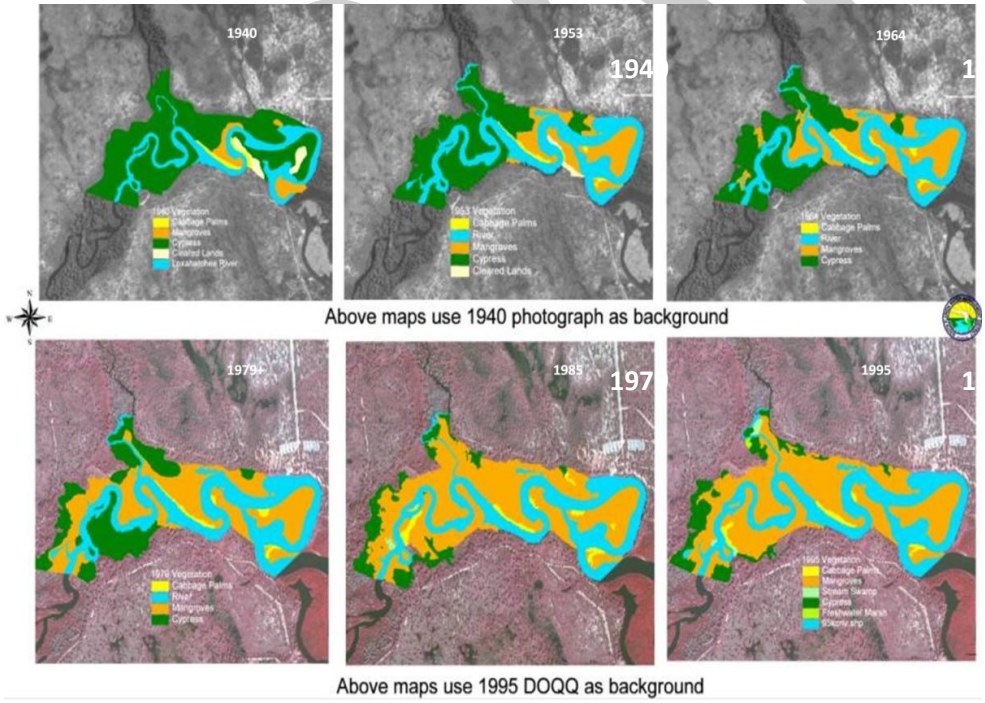


Figure 8. Comparison of the vegetation changes due to both man made and sea-level rise salinity increases between 1940 and 1995 along the Loxahatchee River between River Miles 6.6 and 8.9. The predominant vegetation in 1940 consisted of cypress (green) and has been replaced by mangroves (orange)

Natural areas in the watershed have also been impacted due to canals draining wetlands and barriers preventing sheetflow. J.W. Corbett WMA, Loxahatchee Slough, Pal Mar/Cypress Creek have all experienced lowering of water levels and hydroperiods that shaped the vegetation and landscape communities in these natural areas. Example photos of impacted and more intact sites in J.W. Corbett WMA can be seen in **Figure 9**.

Figure 9. Photographs of J.W. Corbett Wildlife Management Area impacted site to left and more intact site to right.

Estuary

Seagrasses and mangroves are now prevalent in the Loxahatchee Estuary, often replacing oligohaline habitat types that are important nursery areas for coastal fish species. In the Loxahatchee Estuary, seagrass populations are concentrated along the shorelines and areas of vegetative growth are not as extensive and diverse as those in the Intracoastal Waterway segments (Ridler et al., 2003). Dent (2000) stated that salinity in the Loxahatchee River "experiences significant shifts" due to freshwater inflow from the watershed, discharges through control structures, and tidal influence of ocean waters entering the Estuary through the Jupiter Inlet. However, it appears that salinity levels typically rebound quickly and while expansions and contractions of the beds have occurred over time, the core seagrass beds have persisted. Currently, there are 737 acres of mangrove communities in the project area consisting of three species: red mangrove (*Rhizophora mangle*), white mangrove (*Laguncularia racemosa*), and black mangrove (*Avicennia germinans*)

Fish and Wildlife

Small species of fish are present in the Loxahatchee River Watershed and provide a prey-base for a number of large fish, birds, reptiles, and mammals. Fish abundance, distribution and diversity are affected by season, salinity, and habitat availability (Hedgepeth et al., 2001). In the Loxahatchee River, the upstream area (above river mile 9) is characterized by freshwater species and the lower portion (from the Inlet to river mile 5) is characterized by marine and estuarine species. Over 267 species of fish have been known to frequent the estuary, the most abundant fishes in the Loxahatchee Estuary include striped anchovy (*Anchoa hepsetus*), bay anchovy (*Anchoa mitchilli*), Spotfin mojarra (*Eucinostomus argenteus*), silver jenny (*Eucinostomus gula*), and spot (*Leiostomus xanthurus*). Recently conducted surveys showed a rich diversity of wildlife, especially in freshwater marshes. Some wildlife species that

are particularly dependent on freshwater marshes include the least bittern (*Ixobrychus exilis*), green heron (*Butorides virescens*), white ibis (*Eudocimus albus*), limpkin (*Aramus guarauna*), boat-tailed grackle (*Quiscalus major*), pig frog (*Rana grylio*), green treefrog (*Hyla cinerea*), swamp snake (*Seminatrix pygaea*), American alligator (*Alligator mississippiensis*), Florida water rat (*Neofiber alleni*), and marsh rabbit (*Sylvilagus palustris*) (Kushlan 1990). However, while species diversity in the project area remains high, there are several species whose numbers have substantially declined, likely in part to altered hydrology, degradation of some waters and a reduction of wetland area as a result of development.

The Loxahatchee Estuary is home to several species of oysters, the most prevalent of which tends to be the American or Eastern oyster (*Crassostrea virginica*). Like seagrasses, oysters are sensitive to changes in salinity. Juvenile oysters can experience mortality in less than a week depending on the severity of the drop in salinity, and though adults can withstand lowered salinities for longer periods, mortality is known to occur when conditions persist for approximately one month. The Loxahatchee Estuary has experienced a recent increase in oyster populations and distribution

10.1 Fish and Wildlife Resources Considerations

There are current changes underway to the surface and groundwater hydrology that are likely to further degrade and alter plant communities. For example, over the past 50 years many of the wetland areas have not been provided suitable quantities of water or, in some instances, have been inundated with too much water. This change in hydrology has led to the spread of exotic and native nuisance species and the transitioning of vegetative communities from those characterized by some wetland dominated species to those that thrive in drier soil conditions. Significant vegetative changes are expected to continue taking place along the nationally designated "Wild and Scenic" Loxahatchee River. Altered hydrologic regimes and reduced flows to the River have resulted in saline waters moving into areas that were historically freshwater. As a result, there is an ongoing transition of the historic cypress swamp to a mangrove-dominated monoculture that is expected to continue in the FWO Project condition. In many instances thriving mangroves are very desirable. In this case, however, the transition is an indication of the extent to which hydrologic alterations have affected the upstream environment. Sea level rise has contributed to these salinity changes and accelerating sea-level rise will likely further compound this problem by increasing the range of tidal influence to the Loxahatchee River.

The project area's uplands are expected to face continued pressure as population levels increase and development moves west. The total upland forested and rangeland acreage is projected to decline by more than 40 percent (SFWMD, 2010). The decline in habitat area will negatively impact native plant and animal species many of them that are state and federally listed threatened and endangered species. The entire Loxahatchee River has been designated by the U.S. Fish and Wildlife Service as a critical habitat for the West Indian Manatee. In addition, fifty two (52) federal and state listed species (23 animals and 29 plants) are found within the federally designated National Wild and Scenic portion of the NW Fork of the Loxahatchee River. Those species that have a federal designation include the wood stork, Eastern indigo snake, the Everglade snail kite, and American alligator. Additional federal and state listed species are found within the watershed, including Florida scrub jay, red-cockaded woodpecker, four-petal paw paw and perforate reindeer lichen, bringing the total listed species to 83.

Negative impacts on population levels of listed species are expected in the FWO project condition as a result of continued habitat loss, degradation and fragmentation. Many animal species depend on wetlands for their life cycle. Declining total wetland quality, spatial extent and connectivity within the project boundary over the course of the planning horizon is expected to diminish as a result of reduced hydroperiods. This is expected to negatively impact certain listed species, as well as numerous native

plants and animals. For example, the federally endangered snail kite forages in wet prairies and marshes almost exclusively for a single species of aquatic apple snail which it typically captures at the surface of shallow, open wetlands. Within the project area these wetlands occur mainly as isolated depression marshes interspersed throughout pine flatwoods. Female apple snails crawl out of the water onto plant stems and lay eggs that after a couple of weeks hatch as juvenile snails, which then drop from the stems to the water below. The behavior of adult female snails and the survival of the apple snail eggs are both dependent on water levels, the latter of which are particularly susceptible to declining water levels and dry-outs. The hydrologic regime of the marsh can, therefore, have a major influence on the population dynamics of the snail kite by determining the availability of their primary food source.

Salinity and sediment water quality parameters for downstream receiving waters are expected to decline in the FWO project condition. For the NWFLR, the freshwater and saltwater mixing zone will likely advance further upstream and continue to alter once freshwater dominated communities unless adequate base flows are maintained. The water quality within the Loxahatchee River Estuary is likely to be somewhat degraded from what occurs today as the cumulative effects of irregular and damaging large releases of freshwater through the S-46 Control Structure will continue to degrade benthic communities, further impairing a system already under stress. In addition, water supply releases from Lake Okeechobee run through GW Preserve and have resulted in increased nutrient levels along the M canals resulting in the spread of native nuisance vegetation into previously high functioning wildlife habitat.

As population levels are expected to increase in the FWO project condition the biggest future threat is the expected western urban expansion. As former wetlands and open agricultural lands are transformed for residential and industrial use, increased fragmentation of hydrologic conditions and habitats have the potential to adversely affect several threatened and endangered species. Likewise, concerns exist that continued hydrologic alteration of freshwater flows delivered to the Loxahatchee Estuary will continue to contribute to changes in the distribution, composition and abundance of submerged aquatic plants and/or a reduction in water quality.

Exotic and invasive species within the project area include Brazilian pepper (*Schinus terebinthifolius*), melaleuca (*Melaleuca quinquenervia*), downy rose myrtle (*Rhodomyrtus tomentosa*) and old world climbing fern (*Lygodium microphyllum*). These species are particularly problematic in locations where the water table has been lowered and natural communities have been disturbed. With anticipated further hydrologic impacts and reductions in wetland hydroperiods it is expected that additional infestation may occur.

10.2 Cultural Resources

The Florida Master Site File data from the Florida Division of Historical Resources lists 38 nationally registered sites, 114 archaeological sites, 18 historical resource groups, 7 cemeteries, 13 bridges, and 6,751 standing structures, within the project area. Most of the 38 National Register of Historic Places listed sites are located along the Lake Worth Lagoon in the study area. The majority of the Florida Master Site File archaeological sites are found in the central to western side of the project area, many of which are prehistoric campsites and middens. There are a significant number of sites concentrated on the west side of the Loxahatchee River, along the Loxahatchee Slough and in the C-51 basin.

11.0 Key Uncertainties

Risk and uncertainty associated with reaching key decision points as part of this planning effort have been initially characterized in the project's risk register (refer to Annex/Appendix X) Risk and uncertainty inherent to achieving project goals and objectives and remaining within constraints will be addressed as part of the adaptive management and monitoring plan required by USACE implementing guidance for Section 2039 of WRDA 2007 and CERP Guidance Memorandum 56. The project risk register includes options to reduce uncertainty in order to better understand the level of risk or how to reduce risk. In addition, the project adaptive management plan will identify adaptive management strategies to reduce uncertainties and improve the level of information needed to adjust project implementation, if needed, to increase the LRWRP success.

12.0 Formulating Alternative Plans

The plan formulation framework for this study will utilize an analytical screening process to develop alternative plans based on existing information from prior plan formulation efforts identified in Section 7, particularly the North Palm Beach County Part 1 study and more recent State of Florida Water Quality Restoration Strategies project. The strategy involves the formulation of interdependent management measures and components that serve to meet the LRWRP goals and objectives, while avoiding constraints listed in section 9.0.

12.1 Management Measures

The planning project will identify and utilize cost effective and appropriate management measures, scales and combinations of feature types to improve the quantity, quality, timing, and distribution of water dedicated and managed for the natural system. These management measures and combination of feature types will likely include:

1. *Spreader Canal* – Shallow canals to distribute and improve water delivery.
2. *Pump Stations* - New Pump Stations to distribute and improve water delivery
3. *Backfill or plugging of canals* – Internal drainage and routing features in the system would be plugged, partially or completely backfilled to improve surface water distribution and eliminate drainage.
4. *Removal of levees and berms* – Levees or berms would be degraded or removed to allow water to sheetflow freely.
5. *Bridges and Culverts* – Structures to be used to allow water flows through existing barriers in the systems
6. *Storage Features* - Shallow, intermediate and deep water reservoirs, flow equalization basins and aquifer storage and recovery for capturing, holding and delivering both normal and peak flows and discharging when water required.
7. *Operational Changes* – Adjustments to operational criteria to improve timing and distribution of flow.
8. *Non-Structural Solutions* – Management measures that can address project goals and objectives without physical structural modifications to the managed/natural system. For example, leasing and/or purchasing land acquisition rights to maintain undeveloped natural areas adaptation zones above high tide to promote ecosystem adaptations to climate change.

9. *Vegetation Management Measures* – Measures to control invasive/exotic species, promote restoration of native species, and/or improved habitat structure and function (e.g., vegetation removal, treatment, fire, plantings).

12.2 Screening of Measures

Screening criteria will be established and utilized to evaluate and select measures. Probable screening criteria are listed below:

1. Operational flexibility
2. Environmental effects
3. Public health and safety
4. Constructability
5. Land use/availability
6. Evapotranspiration losses
7. Recreation effects
8. Maintenance (Vegetation and exotic removal)
9. Excessive costs
10. Cultural resources

12.3 Final Array of Alternative Plans

To be determined in the near future

13.0 Evaluation and Comparison of Array of Alternative Plans

To be determined in future planning steps

14.0 Identifying a Tentatively Selected Plan (and ultimately Recommended Plan)

To be determined in future planning steps

14.1 Systems / Watershed Context

14.2 Environmental Operating Principles

15.0 Key Social and Environmental Factors

To be determined in future planning steps

15.1 Stakeholder Perspectives and Differences.

15.2 Environmental Compliance.

Plan formulation and project design and implementation will comply with all applicable environmental laws and regulations including, but not limited to: Coastal Zone Management Act, National

Environmental Policy Act, Endangered Species Act, Fish and Wildlife coordination Act, Clean Water Act, Magnuson Stevens Fisheries Conservation and Management Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, and National Historic Preservation Act.

16.0 Costs and Benefits

To be developed included by SAD upon transmittal of Final Report to HQ.

16.1 Project Costs

16.2 Equivalent Annual Costs and Benefits.

16.3 Cost Sharing.

17.0 Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R)

To be developed in future planning steps and decision milestones

18.0 Review

Revise process will be outlined in the Review Plan to be developed and coordinated in conjunction with the Alternatives Milestone.

18.1 Quality Assurance and Agency Technical Review

To be developed in future planning steps and decision milestones

18.2 State and Agency Review

To be inserted by HQUSACE after the S&A Review ends.

18.3 Certification of Peer and Legal Review

18.4 Policy Compliance Review

To be inserted by HQUSACE when the Documentation of Review Findings are completed.

19.0 Acronyms

ASR	Aquifer Storage and Recovery
C&SF	Central and Southern Florida Project
CERP	Comprehensive Everglades Restoration Plan
ECB	Existing Conditions Baseline
EPA	Everglades Protection Area
FDEP	Florida Department of Environmental Protection
FEB	Flow Equilization Basin
FWO	Future Without Project
GWP	Grassy Waters Preserve
IRL-S	Indian River Lagoon South
JDSP	Jonathan Dickinson State Park
LWL	Lake Worth Lagoon
LRWRP	Loxahatchee River Watershed Restoration Project
NWFLR	Northwest Fork of Loxahatchee River
NRCS	Natural Resources Conservation Service
PDT	Project Delivery Team
PIR	Project Implementation Report
RECOVER	REstoration COordination VERification
SFWMD	South Florida Water Management District
SMART	Specific, Measurable, Attainable, Risk Informed, Timely
STA	Stormwater Treatment Area
TP	Total Phosphorus
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WQBEL	Water Quality Based Effluent Limit
WRRDA	Water Resources Reform and Development Act

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