FISHEATING CREEK SUB-WATERSHED

FEASIBILITY STUDY

PHASE 1

(Contract No. 4600000912-WO01)

DOCUMENT/DATA SUMMARY REPORT

(draft Final)

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ZFI

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ACRONYMS

BHC	Benzene Hexachloride
BMP	Best Management Practices
BODR	Basis of Design Report
BSIR-STA	Brighton Seminole Indian Reservation Stormwater Treatment Area
C&SF	Central and Southern Florida
CDV	Cattle Dip Vat
CERP	Comprehensive Everglades Restoration Plan
CR	County Road
DBHYDRO	SFWMD Database
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
EMA	Emergent Macrophyte
EPA	Environmental Protection Agency
ES	Endangered Species
F.A.C.	Florida Administrative Code
FCWMA	Fisheating Creek Wildlife Management Area
FAWN	Florida Automated Weather Network
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FWC	Florida Fish and Wildlife Conservation Commission
FWCC	Florida Fish and Wildlife Conservation Commission
GIS	Geographical Information System
GPS	Global Positioning System

IWHRS	Integrated Wildlife Habitat Ranking System
LOPA	Lake Okeechobee Protection Act
LOPP	Lake Okeechobee Protection Plan
LOPP	Lake Okeechobee Protection Plan
LOP2TP	Lake Okeechobee Watershed Phase II Technical Plan
LOW	Lake Okeechobee Watershed
LOWP	Lake Okeechobee Watershed Project
M&E	Metcalf & Eddy | AECOM
M&E Team	Metcalf & Eddy | AECOM and ZFI Engineering
MPMP	Master Project Management Plan
mt	metric ton
NES	Nadic Engineering Services, Inc
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NRHP	National Register of Historical Places
NWI	National Wetland Inventory
OCHP	Office of Cultural and Historical Preservation
PAA	Planning Area Alternatives
PEM	palustrine emergent
PIR	Lake Okeechobee Project Implementation Report
PL-566	Public Law Assessment – 566
ppb	parts per billion (µg/l)
PSS/PFO	palustrine scrub-shrub/forested wetland
QA/QC	Quality Assurance / Quality Control
RASTA	Reservoir Assisted Stormwater Treatment Area
RCRA	US EPA Resource Conservation and Recovery Act

RESTUDY	Central and Southern Florida Project Comprehensive Review Study
RV	recreational vehicle
SAV	Submerged Aquatic Vegetation
SFWMD	South Florida Water Management District
SHCA	Strategic Habitat Conservation Area
SPT	Standard Penetration Test
SR	State Road
SSC	Species of Special Concern
STA	Stormwater Treatment Area
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TS	Threatened Species
UF/IFAS	University of Florida / Institute of Food and Agricultural Sciences
UMAM	Uniform Mitigation Assessment Method
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WIMS	Water Information Management System
WMA	Water Management Area
WOD	Lake Okeechobee Works of the District Basins
ZFI	ZFI Engineering

SBIO	Sampling Stations from Statewide Biological Database
COMET	Compliance & Enforcement Tracking Facilities
ERPpa	Environmental Resource Program's Permitting Application facilities (subset of PA)
HRS	metadata does not state what HRS means
PA	Permit Application Tracking System
PWS	Potable Water System Plants
STCM	metadata does not state what STCM means
STORET	Storage Retrieval sampling stations

SECTION 1 INTRODUCTION

Lake Okeechobee Watershed Construction Project Phase II Technical Plan (LOP2TP) was developed by the South Florida Water Management District (SFWMD) in coordination with the Florida Department of Environmental Protection (FDEP) and Florida Department of Agricultural and Consumer Services (FDACS) as required by the Florida legislature under the Northern Everglades and Estuaries Protection Program. The LOP2TP provided recommendations on how to reduce the phosphorus loading to the Lake Okeechobee to achieve water quality targets for the Lake. The Plan also suggested the evaluation of additional water storage alternatives to improve the Lake's operating levels to more ecologically desirable ranges and to be able to avoid undesirable discharges to the estuaries (SFWMD Scope of Work, 2008).

The above feasibility study recommendations are suggested to be performed at the sub-watershed level. Throughout the Plan nine sub-watersheds were evaluated within the study area including Fisheating Creek (FEC) Sub-watershed. The FEC sub-watershed has been determined as one of the most significant sources of phosphorus loading to Lake Okeechobee among the other sub-watersheds evaluated (SFWMD, 2008).

Based on the recommendations of the Lake Okeechobee Watershed Construction project Phase II Technical Plan, SFWMD has taken the initiative to conduct a more detailed feasibility study to further define the best mix of surface storage and water quality improvement features that are most suitable in FEC sub-watershed; to identify locations for siting these features; and to develop preliminary engineering design and cost estimates for the identified features. This report represents the Phase I of the Fisheating Creek Sub-Watershed Feasibility Study and summarizes conditions of the Study Area.

1.1 Background

The FEC is the only tributary that flows into Lake Okeechobee with its natural flow regime with an average gradient of 0.5 foot per mile. The FEC sub-watershed is located in both Highlands and Glades County. A small area of the sub-watershed on its southwest part is located in Charlotte County. The entire sub-watershed covers approximately an area of 440 square miles (mi^2). The Fisheating Creek, which is about 56 miles, originates in western Highlands County and flows south through Cypress Swamp into the Glades County. The stream turns to east around 1 mile north of County Road (CR) 731 and flows into Lake Okeechobee through the Cowbone Marsh (**Figure 1**) (SFWMD Scope of Work, 2008).

The sub-watershed provides many benefits both to its residents and the natural ecosystem in its surroundings. The northern part of the sub-watershed within the Highlands County limits is mostly utilized for agricultural purposes. Smaller percentage of wetlands and forests are also observed in this part of the area. The southern part of the basin located in Glades County and partly Charlotte County is occupied with forests, conservation areas, wetlands and agricultural land use.

Representatives of the SFWMD, Metcalf & Eddy | AECOM and ZFI Engineering (M&E Team) flew over the Study Area on October 08, 2008. The Cowbone Marsh was visited on October 22, 2008. M&E Team visited the Study Area through October 27 and 29, 2008, including the Florida Ranchlands Environmental Services Project Areas.

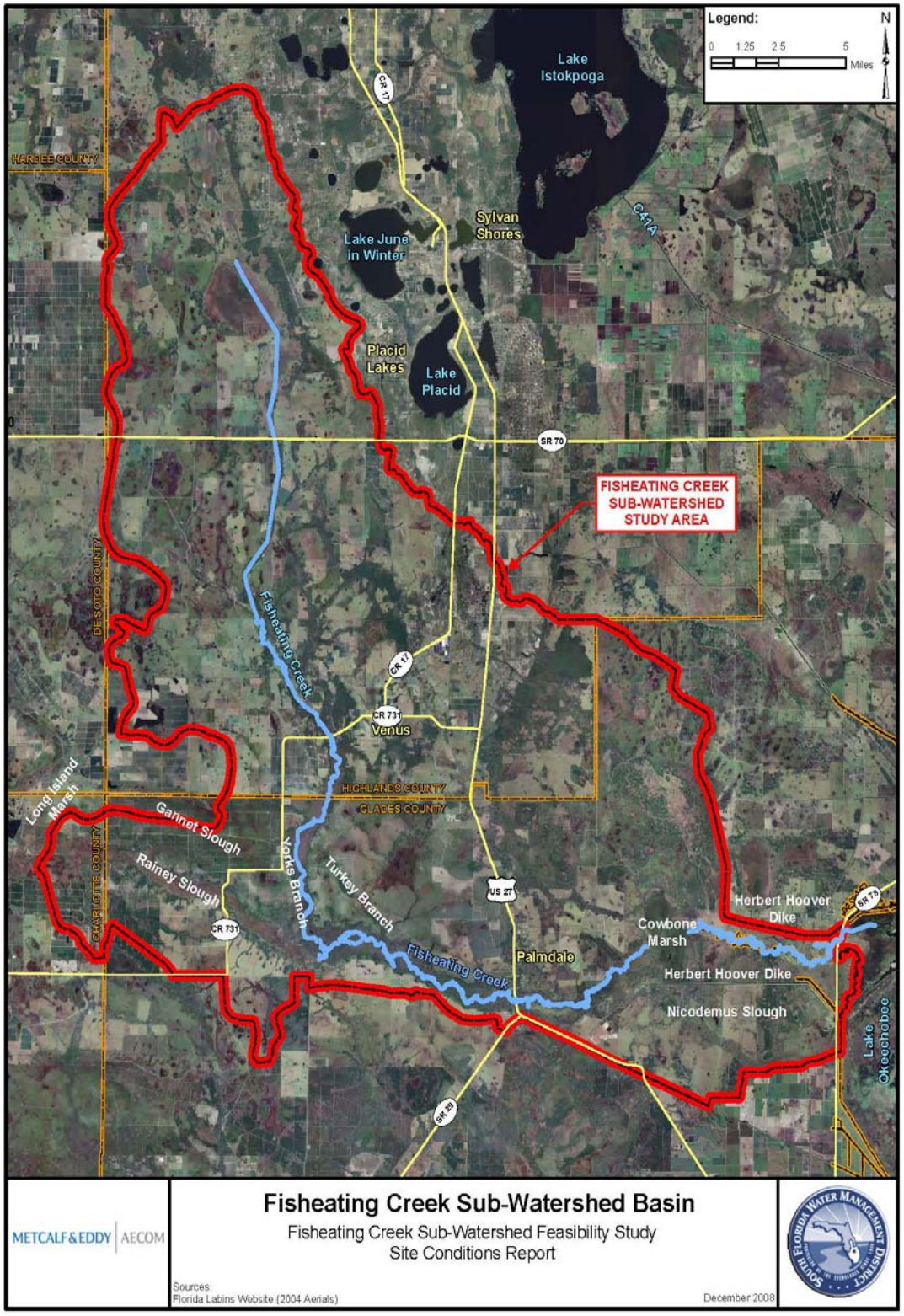

Figure 1. Fisheating Creek Sub-Watershed Study Area

44 **Table 1. Ground Truthed Locations within the Study Area**

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Site Location	Date	Latitude	Longitude
Culvert Discharging to FEC Downstream of Drop Spillway No.1 Structure	Oct 27 2008	27.27513 N	81.47126 W
FEC - US 27 Intersection (Looking NW)	Oct 27 2008	26.93241N	81.31520W
View of Pasture Land from CR 731 (Looking NW)	Oct 27 2008	27.07277N	81.37945W
View of FEC from CR 731 (Looking S)	Oct 27 2008	26.98478N	81.49188W
View of Pasture land from Farabee Road	Oct 27 2008	26.97078N	81.51617W
View of Tasmania Road	Oct 27 2008	26.97690N	81.49090W
View from Intersection of CR 74 and CR 731	Oct 28 2008	26.94492N	81.48886W
Fisheating Wildlife Management Campground Entrance on US 27	Oct 28 2008	26.93930N	81.31952W
View of Private Land Entrance Heading to FEC	Oct 28 2008	26.94574N	81.31789W
View of FEC from Clark Road (Looking N)	Oct 28 2008	27.32236N	81.48840W
Discharge Point of FEC to Lake Okeechobee	Oct 28 2008	26.96220N	81.12110W
Cowbone Marsh	Oct 22 2008	-	-
Lykes Marsh Reservoir	Oct 29 2008	-	-
Buck Island Ranch	Oct 29 2008	-	-

1.2 Purpose and Scope

The main objective of the Fisheating Creek Sub-Watershed Feasibility Study is to prepare a Feasibility Report that will identify the most feasible alternative(s) for the water storage and P-load reduction within the Fisheating Creek Sub-Watershed Study Area. The feasibility report will not only define the most feasible alternatives but also conduct alternative analysis and selection, including preliminary design and cost estimates of identified features in the preferred alternative

This report as a part of the Phase 1 of the Fisheating Creek Sub-Watershed Feasibility Study presents the historic and existing Site Conditions of the Fisheating Creek Sub-Watershed Study Area in order to depict its overall characteristics that are important to provide a through evaluation in development of the Feasibility Report. Therefore climate, land use, topography, geology and soils, hydraulics and hydrology, water quality, land ownership, vegetation, wetlands and floodplains, fish and wildlife, threatened and endangered species, recreational resources, aesthetics, ecological, cultural and archaeological resources, hazardous waste sites, existing utilities as well as the previous studies and reports conducted for the study area are described herein.

SECTION 2 PREVIOUS STUDIES AND REPORTS

This section provides an overall review of existing studies that geographically and hydrologically relate to the Fisheating Creek (FEC) sub-watershed, Lake Okeechobee Basin. Reports that support this review were provided by the SFWMD, counties, and other entities within this water management region. Most existing studies address water resource issues within the Lake Okeechobee Basin and its major sub-watersheds, however, there are limited studies related to the FEC sub-watershed. The hierarchical structure of most of the reviewed reports in this section is shown in **Figure 2**. A list of studies is presented as follows:

- Central and Southern Florida Project Comprehensive Review Study (RESTUDY)
- Master Project Management Plan (MPMP)
- Lake Okeechobee Protection Plan
- Lake Okeechobee Watershed Construction Project – Phase II Technical Plan (LOP2TP)
- Fisheating Creek Alternative Plan Evaluation Document, February 2006
- Fisheating Creek Basin Water Quality Survey, July 26, 2001

2.1 Central and Southern Florida Project Comprehensive Review Study (RESTUDY)

The Central and Southern Florida (C&SF) Project was established during the past 50 years, extending from south of Orlando to the Florida Keys. The authorized purposes of the project included flood control, regional water supply for agricultural and urban areas, prevention of salt water intrusion, water supply to Everglades National Park for the preservation of fish and wildlife, recreation and navigation. The original C&SF Project included some construction work within the FEC sub-watershed. Major improvement work consisted of creating Canal 22 and Structure 69. However, these two structures were withdrawn from the C&SF Project recommendations in 1959 because flood protection in the area could not be economically justified. Since then, the FEC sub-watershed has not been significantly altered by regional level construction projects such as canalization, and impoundment.

The Central and Southern Florida Project Comprehensive Review Study (RESTUDY) was created based on the requirements of the Water Resources Development Act of 1992 and 1996

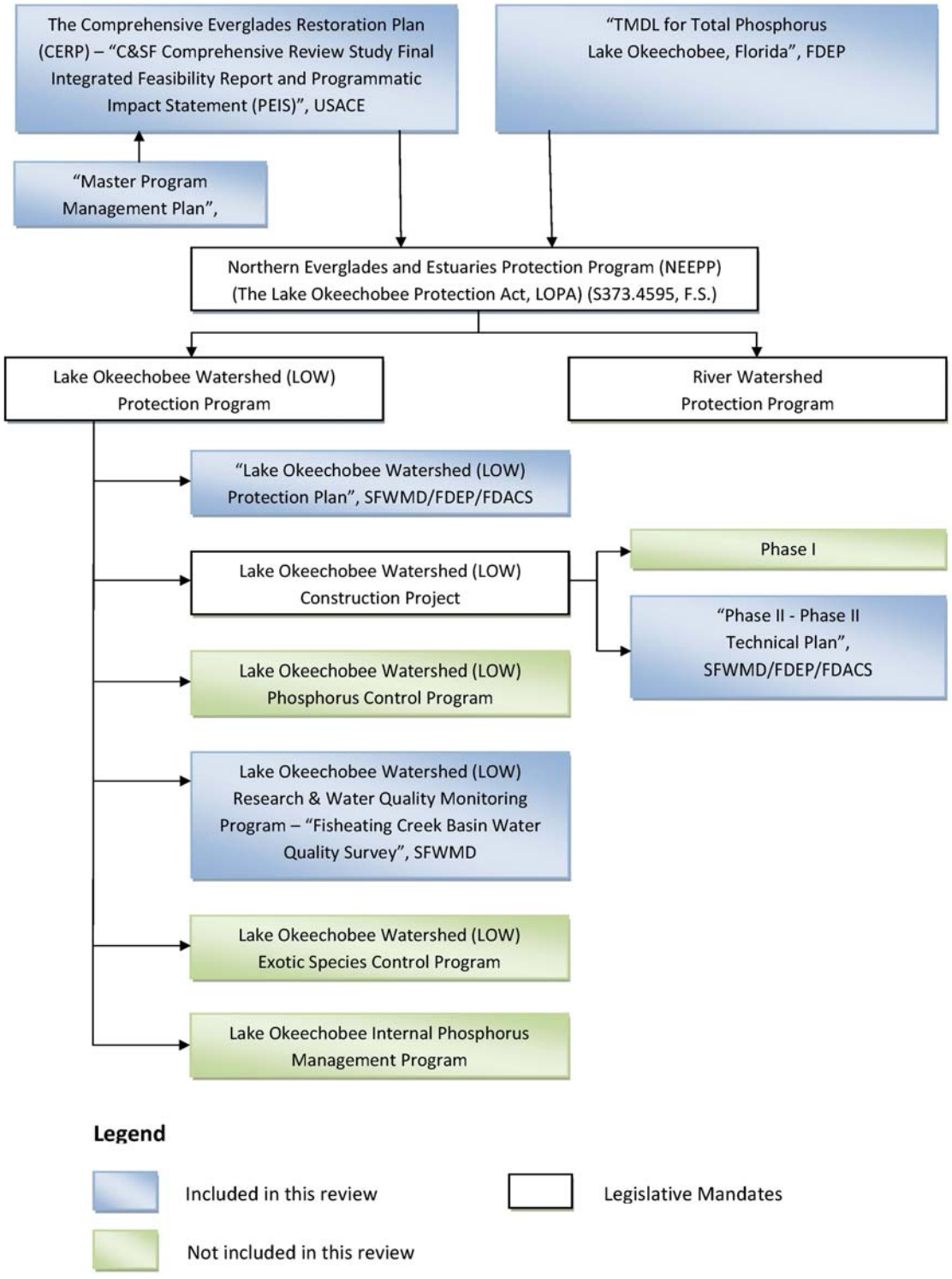

Figure 2. Hierarchy of Relevant Studies Reviewed

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to re-examine the environmental and water resource impacts of the C&SF Project on the Everglades and the C&SF ecosystem. The RESTUDY planned water-related needs such as urban and agricultural water supply requirements and flood protection within the Everglades Ecosystem including the Lake Okeechobee Watershed. The RESTUDY established a set of objectives to achieve falling under general goals of enhancing ecologic values, and enhancing economic values and social well being.

The RESTUDY recognized adverse environmental impacts due to channelization of the Kissimmee River Watershed which occurred under the C&SF Project. A restoration plan was developed to repair the river and its floodplain by increasing water storage in the upper Kissimmee Watershed and physically modifying the lower watershed.

The watershed north to Lake Okeechobee, including the FEC sub-watershed, was considered as a sub-area in the C&SF project. The RESTUDY characterized overall watershed conditions that existed in the south Florida ecosystem prior to drainage and development activities. Prior to drainage, the north region of Lake Okeechobee was characterized by a complex wetland system, as the dominant woody species being oaks. All landscape in the FEC sub-watershed used to be interconnected with ecotones with slight topographic gradients. The Fisheating Creek is the only gravity driven free flow creek drains into the lake's littoral zone in the west. Interconnected landscapes are now dominated by pine flatlands, pine rocklands, tropical hardwood hammocks, and xeric hammocks.

Nowadays, Lake Okeechobee water levels are regulated by a multifaceted system of pumps, spillways and locks. Fisheating Creek is the only uncontrolled tributary to Lake Okeechobee. The creek flows through vast prairies and flatlands and discharges freely to the broad littoral zone of Lake Okeechobee at the northwest corner. Water level of the creek is controlled downstream by the lake's control structures.

Surface water draining and agricultural land use are described as the major activities impacting the water quality in Lake Okeechobee. Total phosphorus concentrations in Lake Okeechobee were as low as 50 ppb in the late 1960's and early. Currently total phosphorus concentrations in the lake have been measured in the range of 100 ppb and above. The FEC sub-watershed was described as a pollutant source contributing a significant phosphorus load to the lake in the RESTUDY report.

Restoration plan for Lake Okeechobee water quality improvement focused on the vast contribution of phosphorus from the Kissimmee River and Taylor Creek/Nubbin Slough sub-watersheds. The area was characterized in the RESTUDY report as highly productive agricultural regions and rapidly growing urban areas. However, when compared with other major sub-watersheds of the region, FEC's hydrology and land uses have endured the least human impact, containing many natural, undeveloped areas suitable for preservation. Land uses within FEC sub-watershed are dominated by agricultural practices such as cattle grazing and dairy and citrus farming but also have a large percentage of forested lands and wetlands.

The major water quality problems in the FEC sub-watershed are elevated nutrient levels expressed as chlorophyll a and low dissolved oxygen (DO). Elevated nutrient levels can most likely be attributed to agriculture activities; but low DO may be caused by either agricultural nutrient loading or natural occurrences in the swamp water. Within the FEC sub-watershed, there is one wastewater treatment facility discharging treated flow to groundwater and one permitted landfill. Irrigation/discharge canals and pumping operations throughout the watershed collect contaminated surface runoff and discharges into the creek.

The RESTUDY formulated and developed a comprehensive restoration plan that includes a set of sixty-eight (68) construction projects covering the entire study area. According to the plan, 49 construction projects, including 5 construction pilot projects and 44 construction projects, should be completed before 2010. Within the Kissimmee River region where the FEC sub-watershed is located, the RESTUDY identified six (6) projects including four (4) construction projects for water quality improvement and two projects to improve the operation of water management practices. However, no project has been proposed to restore the FEC Ecosystem in the FEC sub-watershed. It should be noted that although RESTUDY depicts it different, the FEC Study Area for this project does not associate with the Kissimmee River Region or the Sub-Watershed.

2.2 Master Project Management Plan

The purpose of this Master Program Management Plan (MPMP) was to describe the framework and process to be used by the U.S. Army Corps of Engineers (USACE) and the SFWMD for managing and monitoring the implementation of the Comprehensive Everglades Restoration Plan (CERP).

The MPMP specified the large regional scope of CERP management and control framework, including program level management and coordination, program management and control requirements, program activities and project activities.

No detailed information regarding planning, assessment and engineering related to the FEC sub-watershed were included in this report.

2.3 Lake Okeechobee Protection Plan

In 2000, the Florida legislature passed the Lake Okeechobee Protection Act (LOPA) in Section 373.4595, Florida Statutes (F.S.), which requires state water quality standards to be achieved no later than January 1, 2015 (Section 373.4595(4)(c)(3), F.S., 2000). LOPA also requires the coordinating agencies to work together to address total phophorus loading and exotic species control. LOPA was amended by the legislature in 2007 to include the St. Lucie and Caloosahatchee River Watershed Protection Program, and was renamed the

Northern Everglades and Estuaries Protection Program (NEEPP) (Section 373.4595, F.S., 2007). As specified by LOPA, the SFWMD, FDEP, and FDACS submitted the Lake Okeechobee Protection Plan (LOPP) to the Florida legislature in January 2004 (SFWMD et al., 2004). The LOPA requires that the protection plan be reevaluated every three years to determine if further TP load reductions are needed to achieve the TMDL. A three-year reevaluation report was submitted to the legislature in March 2007 (SFWMD et al., 2007). In April 2007, the Florida legislature substantially expanded the LOPA to include protection and restoration of the Lake Okeechobee Watershed and the Caloosahatchee and St. Lucie rivers watersheds and estuaries. At the same time, the legislature also extended the Save Our Everglades Trust Fund for 10 years, providing a dedicated state funding source for the restoration through 2020. As noted before, the newly expanded program was named as the Northern Everglades and Estuaries Protection Program (NEEPP) (Section 373.4595, F.S., 2007). Consequently, the Lake Okeechobee and Estuary Recovery (LOER) Plan, announced by the former Governor Bush in October 2005, was migrated into this program.

The Lake Okeechobee Protection Plan (LOPP) (2004) identified alternative plans, schedules and costs to meet the total phosphorus TMDL requirement. To achieve the goal of restoration and protection of Lake Okeechobee, the LOPP proposed an integrated management strategy which combines different levels of the phosphorous source control efforts, including Best Management Practices (BMPs) at the parcel level; projects of source control and flow attenuation at the sub-basin and regional level; and remediation within the lake.

The preferred phosphorous source control and flow attenuation plan was formulated in the LOPP by considering a number of assumptions related to regional hydrology, lake functions, performance of projects/BMPs on phosphorous reduction, water storage volumes in various land uses, time lag effects, and overall schedule and funding. This study recognized uncertainties introduced by the study assumptions, and applied conservative estimates to formulate the Plan.

The LOPP's study area includes the entire Lake Okeechobee Watershed that contributes surface water flow and phosphorous load to the Lake Okeechobee. LOPP consists of nine sub-watersheds: Eastern Lake Okeechobee, Lake Istokpoga, Northern Lake Okeechobee (including FEC, Taylor Creek/Nubbin Slough, Lower Kissimmee and Indian Prairie basins), Southern Lake Okeechobee (EAA basins), Upper Kissimmee and Western Lake Okeechobee. The FEC area lies within the Northern Lake Okeechobee sub-watershed.

The LOPP suggested using treatment alternatives for those sub-watersheds of low flow but high phosphorous concentration, while using storage alternatives for those sub-watersheds of high flow but low phosphorous concentration. Within each sub-watershed, different water control and treatment facilities may be used interactively. Combinations of treatment alternatives and storage increase alternatives were specially investigated to develop effective solutions for phosphorous reduction and flow attenuation.

The Lake Okeechobee total phosphorous TMDL of 140 mt (metric tons) was adopted by the State in May 2001 (Chapter 62-304.700, F.A.C.). To describe the recent water quality conditions within the study area, LOPP defined the baseline condition using the monitored total phosphorous data (load and concentration) collected spatially within the watershed during the period from 1991 to 2000. The LOPP listed FEC and Nicodemus Slough as separate drainage basins which contribute inflows and P-loads to Lake Okeechobee. The data analysis results are shown in Table .

Table 2 . Contribution of Inflows and P Loads from FEC and Nicodemus Slough to LO (LOPP) (1991 – 2000)

Basin Name	Watershed Area (acre)	Average Annual Discharge (acre-ft)	Average Annual P Loads (mt)
Fisheating Creek	289,366	200,766	40.97
Nicodemus Slough	25,641	3,371	0.25
Lake Okeechobee. Total	3,451,086	2,246,336	433.09
	(%)	(%)	(%)
FEC / Lake Okeechobee	8.38	8.94	9.46
Nicodemus. Slough / Lake Okeechobee	1.00	0.002	0.06

The LOPP identified the FEC to be a problematic sub-watershed requiring restoration efforts and recommended the use of local projects within the sub-watershed; such as owner implemented BMPs, funded cost-share BMPs, and cost-share BMPs, in order to achieve phosphorous source control objectives. No regional level projects within the FEC sub-watershed were suggested by LOPP.

In addition to the current watershed activities that define restoration measures of owner-implemented BMPs, funded BMPs, other phosphorous reduction projects, and regional public works projects; the LOPP developed two future implementation alternatives. Alternative I consisted of typical cost-share BMPs that require future funding, other regional projects, and the Lake Okeechobee Watershed Project (LOWP). Alternative II consisted of all items of Alternative I plus Additional Agricultural Practices which are activities that are implemented in addition to the typical cost-share BMPs (e.g., edge of farm chemical treatment, or modifying the internal work of a farm to achieve nutrient balance on individual parcels) (SWFWMD, 2004). Based on the evaluation criteria, public comments and SFWMD Governing Board Directions, Alternative I was selected as the preferred plan. The components of the preferred plan included implementation of current activities, execution of typical cost-share BMPs that require future funding, and construction of regional projects and the LOWP. Alternative II was not considered as preferred plan due to its large capital investment and high operation & maintenance cost.

Both Alternatives I and II assume regional projects will be designed to address the remaining load reduction necessary to meet the TMDL once the State implements components that fall outside of the scope of the LOWP. Excluding the LOWP, the total

phosphorous load reductions estimated from the implementation of Alternatives I and II are 60% and 72%, respectively, of the total reduction needed to meet the TMDL. Alternative I assumes a greater P-load reduction from the regional treatment facilities in the LOWP as compared to Alternative II. Alternative II has more reductions associated with source control from the implementation of Additional Agricultural Practices.

Most phosphorous source control activities within the FEC sub-watershed are owner-implemented BMPs without cost sharing for agriculture lands. There is one funded cost-share BMP project through the South Control Grand Program located at Lazy Ranch. The FEC sub-watershed has not identified future cost-sharing projects or Regional Public Works projects.

2.4 Lake Okeechobee Watershed Construction Project – Phase II Technical Plan

The Phase II Technical Plan (LOP2TP) was prepared by SFWMD, FDEP and Florida Department of Agriculture and Consumer Services (FDACS) to assess the technical issues and developed/evaluated solutions of water quality, quantity, and water distribution within the northern Everglades region. To develop a set of preferred construction projects, the up-to-date available land use information, flow data and water quality data were used to identify existing flows and phosphorus loads from the lake's northern watersheds. A review of current programs and projects was performed in order to identify potential constraints for the proposed new development and to ensure compatibility with all ongoing and/or planned initiatives and legal mandates.

The Lake Okeechobee watershed studied in the LOP2TP encompasses a drainage area of over 3.5 million acres, spanning ten counties in Florida, and is dominated by agricultural land uses. Based on hydrologic and geographic boundaries, the watershed is generally delineated into nine sub-watersheds. The LOP2TP focused on the northern sub-watersheds to Lake Okeechobee that contributes most surface water flow and phosphorus load to the Lake. This includes lands that drain by gravity (controlled or uncontrolled) to the lake, as well as areas that are drained by pumps into the lake. The distinct tributary systems to the lake include the Kissimmee River Valley, Lake Istokpoga-Indian Prairie/Harney Pond, Fisheating Creek, and Taylor Creek/Nubbin Slough. Only Fisheating Creek flows into the Lake by uncontrolled gravity flow; other inflows are controlled by gravity-fed or pump-driven water control structures.

The FEC sub-watershed drains into the Lake Okeechobee from the west side naturally as an uncontrolled stream flow. The creek starts in western Highlands County and flows south through Cypress Swamp and into Glades County. Water leaves the creek channel from central Glades County, and flows east through Cowbone Marsh into Lake Okeechobee. More than 60,000 acres of land adjacent to the lower reaches of the creek is covered under

a State controlled conservation easement. The State plans to acquire additional lands for conservation in the area. Major land use in the upper reaches of Fisheating Creek is agriculture, such as cattle farming, tree plantations, and citrus growth. These land uses are the main contribution to water quality conditions in the creek. LOP2TP recognized various types of BMPs under LOPP were planned and under implementation, and recommended to continue the BMP implementation for water quality reduction. No additional structures were recommended in the sub-catchment.

The LOP2TP developed a set of four alternatives that would increase water storage and reduce phosphorus loading to the lake. Alternative 1 characterizes the TP load reduction and storage that would be provided by the Level 1 and Level 2 MMs (Management Measures). It also includes certain Level 3 and Level 4 MMs. Alternative 1 was used as a base for other alternatives. Alternative 2 was intended to maximize storage capacity in the LOW. Alternative 3 was intended to maximize TP load reduction in the LOW. Alternative 4 was intended to optimize storage capacity and reduce TP loads in the study area. Alternative 4 which consist of integrating the optimal combination of storage increase and phosphorus load reduction to achieve the desirable average phosphorus load reduction and storage capacity increase was considered the basis for the preferred Construction Plan.

The LOP2TP identified that "the Indian Prairie, Taylor Creek/Nubbin Slough and Fisheating Creek sub-watershed contribute disproportionately high phosphorus loads to the Lake Okeechobee relative to their flow contributions". In the 1991 – 2005 period of record, for example, the average annual total phosphorus concentration of FEC was 199 ppb, much higher than the average annual total phosphorous concentration value of the upper Kissimmee sub-watershed (78 ppb) and the lower Kissimmee sub-watershed (166 ppb). During the same period, the average annual total phosphorus loading from FEC was approximately 55 mt as indicated in **Table 3**. The LOP2TP requires additional water quality measures to be applied for these three sub-watersheds to control the phosphorus loadings to the Lake.

Table 3. Summary of Average Annual Flows and TP Loads to LOP2TP (1991-2005)

Sub-Watershed	Area (acre)	Aver. Annual Discharge (ac-ft)	Average Annual P Load (mt)	Average Annual P Concentration (ppb)
Total LOW	3,451,087	2,558,279	514	163
Fisheating Creek	315,007	224,368	55	199
	(%)	(%)	(%)	(%)
Comparison FEC vs. LOW	9.1	8.8	10.7	122

The FEC sub-watershed, including the Nicodemus Slough area discharging to the Lake through Culvert 5, covers 9.01% of the total Lake Okeechobee Watershed, and contributes 8.8% of annual flow to the Lake. However, the FEC sub-watershed contributes 10.7% of averaged annual total phosphorus load to the Lake. The phosphorus concentration is considerably higher than the averaged Annual P concentration within LOW.

In 2001, the FDEP established a TMDL for phosphorus loads to the Lake Okeechobee as 140 mt including 35 mt of total phosphorous loading estimated for atmospheric deposition. The FDEP TMDL requirement calls for significant reduction of total phosphorous load to Lake Okeechobee from the entire LOW including the FEC sub-watershed. As indicated in the LOPP, most phosphorous control projects within FEC sub-watershed are owner-implemented BMPs. Only one fund-matching BMP project, but no regional phosphorous control project is located within the FEC sub-watershed.

The target total phosphorous reduction for the FEC sub-watershed is projected to be 38 mt, or reducing the current 55 mt to 16 mt, as established by the LOP2TP. The current level of LOPP project implementation will generate a reduction of 15 mt of total phosphorus from FEC to the Lake Okeechobee. This reduction is not enough to achieve the TMDL goal established for this sub-watershed. Other improvement projects beyond the scope of LOPP will need to be implemented.

The LOP2TP established a set of additional projects and grouped those projects into four alternatives and requested that the combined effect of all LOP2TP projects reach the water quality goal for Lake Okeechobee Restoration. Alternative 4 was selected by the LOP2TP as the Preferred Plan. This plan targeted the overall cost effective function of total phosphorous reduction and flow attenuation to the Lake Okeechobee. It was created as a cost-effective hybrid between Alternative Plans 2 and 3 and would reach the required total phosphorous load reduction from FEC by only building necessary storage capacity within the subwatershed. Additional projects to be implemented within the FEC sub-watershed would include:

- FEC Reservoir Assisted Stormwater Treatment Area (RASTA) I would provide 39,000 ac-ft of storage capacity in the upper reaches of the FEC Sub-watershed. It consists of a 9,000 acre. 1-ft deep STA, and a 3,000 acre, 10-ft deep reservoir. This RASTA would reduce total phosphorous loads by approximately 28-29 mt.

- FEC RASTA II would provide 15,000 ac-ft of storage capacity in the lower reaches of the FEC sub-watershed. It consisted of a 1,350 acre, 12-ft deep reservoir and a 450 acre STA. This RASTA would reduce TP loads by approximately 2-3 mt

- Nicodemus Slough RASTA – This proposed feature would provide approximately 168,000 ac-ft of storage capacity and reduce TP loads by up to 33 mt in the lower reaches of the Fisheating Creek Sub-watershed. The RASTA complex consists of a 6,500 acre STA coupled with an 11,000 acre, 16-ft deep reservoir. Because of its

proximity to the Lake Okeechobee, it could also be used to store and treat lake waters, if necessary

2.5 Fisheating Creek Alternative Plan Evaluation Document, February 2006

This document was prepared by the SFWMD, assisted by HDR Engineering Inc, to be incorporated to the Lake Okeechobee Project Implementation Report (PIR). This document includes results and recommendations from six planning steps that were undertaken on the Fisheating Creek (FEC) Planning Area Alternatives (PAA) in order to improve the water quality and better management of Lake Okeechobee water levels and releases to the estuaries. These six planning steps consisted of identifying problems and opportunities, inventory and forecast, formulation of alternative plans, evaluation alternative plans, comparing alternative plans, and selecting a plan.

According to this document, reservoirs were considered the preferred option for water storage, and Stormwater Treatment Areas (STAs) were the preferred option for phosphorus loading reduction within the FEC sub-watershed. A combination of both, called Reservoir Assisted Stormwater Treatment Areas (RASTA's) could also be effective when storage and water quality improvement would be required.

Two areas within the FEC sub-watershed and a 21,000 acre parcel located in the Nicodemus Slough area were identified to be potentially suitable to this study. These two areas within the FEC sub-watershed were located upstream of the creek and preliminary assessments indicated that a significant change in flow patterns could occur; therefore, these two areas were eliminated from further studies.

The Nicodemus Slough area was recommended as the preferred site for further consideration, even though it is not located within the FEC, it could still be used to store and treat water from the FEC sub-watershed. The following configurations were selected for future studies:

- FEC PAA1: 6,300 acres STA, consisting of 75% Emergent Macrophyte (EMA) and 25% of Submerged Aquatic Vegetation (SAV). Estimated reduction of approximately 40 mt of phosphorus.

- FEC PAA 2: 6,300 acres STA, consisting of 100% Emergent Macrophyte's. Estimated reduction of approximately 20 to 25 mt of phosphorus.

2.6 Fisheating Creek Basin Water Quality Survey, July 2001

This document was prepared by Paul Ritter, from the SFWMD Okeechobee Service Center, to provide an overview of the FEC sub-watershed, focusing on the Total Phosphorus concentrations. Soil information, Lake Okeechobee Works of the District Basins (WOD) Compliance Monitoring Sites, Land Use Map, and Historical Total Phosphorus Concentration Annual Average from 1973 to 2001 were included in this document.

High phosphorus concentration locations were identified and further study was recommended. The Total Phosphorus concentration was above 500 ppb in the upper and lower reaches of the creek.

The following areas were recommended for further studies due to the high phosphorus concentrations:

- Platt Branch Creek
- Upstream of culverts at Farabee Rd and Hwy 731
- Headwaters of Gopher Slough at Site 69
- Headwaters of Gator Slough (under Hwy 27)
- East of FEC and north of Hwy 70.

It should be noted that, while the FEC Basin Water Quality Survey report included the historical monitoring data from 1973, the mentioned 500 ppb total phosphorus concentration was based on a one (1) day snap shot and was not flow weighted. Steffany Gornak from SFWMD Okeechobee Field Station, mentioned that the purpose of these surveys were to provide information on areas of concern not to provide a precise phosphorus concentration from a particular area.

SECTION 3 ON-GOING STUDIES IN THE WATERSHED

The Lake Okeechobee Interim Water Storage Assessment (LOIWSA), together with the LOP2TP, is the follow-up investigation of publicly owned parcels, identified by the SFWMD, for potential water storage within Lake Okeechobee watershed. The purpose of the LOIWSA is to assess the potential for interim water storage and develop cost estimates for the interior water storage strategies at each of these sites. Interim water storage facilities (i.e. temporary ditch blocks, minor berming, and minimal earthwork) are being considered as enhancement of long-term stormwater treatment areas planned at some of the investigated sites. In addition, the LOISWA also considers the potential for wetlands restoration, and options for the diversion of water to sites with temporary pump facilities.

Three sites were identified in Fisheating Creek sub-watershed in the Lake Okeechobee Interim Water Storage Report. These sites were designated as FEC East 1, FEC East 3, and Fisheating Creek. The Fisheating creek site was categorized as a priority site for further investigation for purposes of the report. Below is a table describing the different parameters at each site.

Table 4. Parameters for identified sites within Fisheating Creek Watershed in the LOIWSA.

Site	Total Site Area (acres)	Total Wetlands (acres)	% poor	% fair	% good	Land Use	Total Upland (acres)
FEC East 1	5.1	1.6	100	0	0	vacant	3.5
FEC East 3	25.9	25.7	100	0	0	vacant	0
Fisheating Creek	608.2	83.9	12	28	0	vacant	519.4

Site	Total Surface Water (acres)	Initial Estimate of Effective Water storage Capacity (acre-ft)	Maximum water storage capacity (acre-ft)	Diversion potential
FEC East 1	-----	3	5	Rim Canal
FEC East 3	0.2	0	25	Rim Canal
Fisheating Creek	4.9	578	578	Fisheating Creek

(Source: SFWMD, LOIWSA, 2008d)

One of the seven priority sites in the study was a fallow agriculture field in Fisheating Creek, bordered by Banana Grove Road and SR 78. This site identified as Fisheating Creek in **Table 4**, contained poor quality wetlands and was used as a low quality pasture for cattle. The site investigation showed that drainage to the site was limited to the site footprint, but that there was potential to divert water to the site from Fisheating creek, which lies immediately north. The LOISWA explains the hydrology and hydraulics of Fisheating Creek

based on gages located in Lakeport and Palmdale. The study showed that the stage in Fisheating Creek is mainly controlled by the elevation in Lake Okeechobee. Over a fifteen year period, 1991-2008, the stage exceeded the proposed interim water storage site average elevation less than 20 percent of the time. Based on the data, the design objectives were to create pocket wetlands by using creek waters reaching the site during flood events. An evaluation of alternatives was completed to divert water to the site by gravity during flood events and contain water on-site. Results of the evaluation identified a maximum of 50 acres for wetlands restoration and diversion of water from Fisheating Creek, by manually controlled gates during extreme flood events.

A Florida Ranchlands Environmental Service Project is currently being conducted at the Payne Ranch. The Payne's Josephine Road Ranch Water Management Alternative is to retain both on-site and off-site stormwater runoff within a 466 acre site of improved pasture surrounded by a dike (FRESP June 2008). This project involves operating six water control structures and monitoring water quality from five on-site wells. Initial modeling by Florida Ranchlands is also being conducted.

It should be noted that Florida Ranchlands has seven more sites within the Northern Everglades for a similar study.

SECTION 4 HISTORICAL CONDITIONS

According to the Florida Fish and Wildlife Conservation Commission (FWC), the time of the first settlement which took place along the banks of the FEC goes back to between 1000 and 500 BC. The Creek's name comes from the Creek Thlothlopopka-hatchee which means "the creek where fish are eaten." Belle Glad People who are known as the early inhabitants of the area are the first residents known to build mound and other earthworks. They survived by netting fish, harvesting turtles, snakes and alligators. In addition to its use as a food and water source, the creek was also used for transportation by means of canoe since it was possible to travel to Lake Okeechobee and other settlements on both of its east and west (FWC, 2008). Fort Center site, an archaeological site in the Fisheating Creek Sub-Watershed Study Area, includes over at least 2000 year old mounds, ponds, circular ditches and linear embankments. **Figure 3** shows a painting of the Fort Center (FWC, 2008).

The Fort Center Site is listed in the National Register of Historic Places. It is noted that the site had residents at the time of the arrival of European's in the 16th and 17th centuries. However, no evidence of agricultural use of the land was found for this time period through the archaeological researches.

Based on the information found on FWC website, it was very hard to travel on the creek due to its twisted shape and changing width according to the descriptions of a US Navy officer traveled on the creek in 1842. **Figure 4** depicts residents traveling on FEC with a canoe (FWC, 2008). According to the observations of another US Navy office from 1855, the Fort Center area then was too hot, full of mosquitoes and snakes. It is also written on the website that as a result of research conducted for five areas for the US Government in 1881, 37 families used to live in 22 campsites in five areas and one of these areas was Fisheating Creek. This shows the FEC area was not highly populated at that time.

Figure 3. A Historical View of Fort Center

Figure 4. Residents Traveling on Fisheating Creek, 1842

Above historical information represents mostly the southern part of the Study Area within Glades County. Based on the data available only historical knowledge about the northern part of the Area in Highland County pertains to two (2) man made structures located in the Public Law Assessment – 566 (PL-566) Area. These structures, named as Check Dam No.1 and Drop Spillway No.1, were built for flood prevention and agricultural water management purposes (HSDH, 1957).

Figure 5 and **Figure 6** show the aerial view of these structures on the FEC Study Area.

SECTION 5 EXISTING CONDITIONS

5.1 Site Overview

The Fisheating Creek Sub-watershed Study Area is mostly covered with pasture lands through which canals are discharging to the Fisheating Creek. Fisheating Creek (FEC) originates in Highlands County, and flows south through the Glades County. From Glades County it turns to the east about one mile north of the CR 74. The creek flows to the east until it drains to the Lake Okeechobee through Cowbone Marsh.

Existing conditions within the Study Area were observed through site visits in addition to literature research. A fly-over on the Study Area took place on October 08, 2008 with the representatives of the SFWMD. A three (3) day site visit through October 27 and 29, 2008 was also conducted by Metcalf & Eddy (M&E) and ZFI Engineering representatives. This section presents the site visit observations along with the site pictures. The Global Positioning System (GPS) locations of the sites visited are also presented for some of the areas along with their pictures taken during these visits.

Almost all of the Study Area is owned by private landowners. Therefore, site visits were mostly conducted on the publicly accessible areas. The Public Law Assessment – 566 (PL-566) structures (Check Dam No.1 and Drop Spillway No.1) were accessed via special permission obtained from the landowners by FDACS and SFWMD representatives. **Figure 5** and **Figure 6** show the aerial view of these two structures on the FEC. These two (2) structures located on the northern part of the creek within the PL-566 area were built for flood prevention and agricultural water management purposes (HSDH, 1957). The surroundings of the PL-566 area was observed to be occupied mostly with pasture lands and cattle ranches. Many culverts were observed around these structures (**Figure 8** and **Figure 9**). Although pasture lands and cattle ranches were observed to be very dominant in the area, dense cypress swamp were also observed around the creek in the southern watershed where it intersects with US 27 and SR 731 **(Figures 11** and **12)**. **Figure 15** shows a view of a pasture land on CR 731 located about 3 miles west of the US 27. **Figure 16** shows a view of Fisheating Creek passing under the CR 731. There are several sloughs located at the southern parts of the Study Area. Views of the Rainey Slough from the CR 731 is shown on **Figure 17** and **Figure 18**. **Figure 21** shows a view of the Tasmania road. **Figure 24** and **Figure 25** show pictures of Fisheating Wildlife Management Area entrance through the Campground located at Palmdale, FL. **Figure 30** shows the discharge point of FEC to the Lake Okeechobee.

Representatives of SFWMD and M&E Team attended to a site visit on October 22, 2008 to Cowbone Marsh. **Figures 31** through **36** show pictures from this site visit.

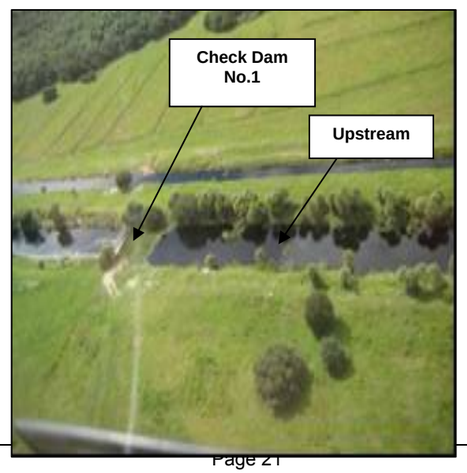

Figure 5. PL-566 Check Dam No.1 Structure on FEC (Looking W)

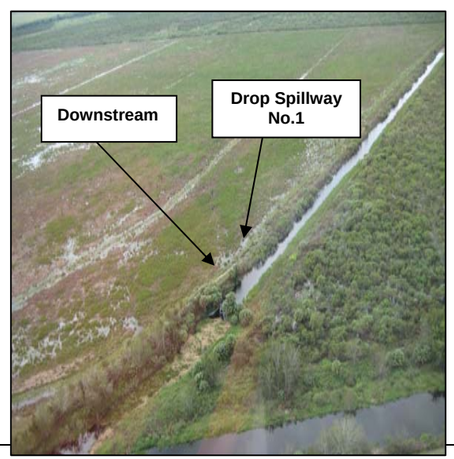

Figure 6. PL-566 Drop Spillway No.1 Structure on FEC (Looking SW)

Figure 7. A View of Check Dam No.1 Structure from Downstream

Figure 8. Culvert Located at the Downstream of Check Dam No1 (27.27513 N, 81.47126 W)

Figure 9. A Culvert Discharging to FEC at the Downstream of Drop Spillway No.1 Structure (27.27513 N, 81.47126 W)

Figure 10. Wetland in the Vicinity of Drop Spillway No.1 (27.27758 N, 81.47368 W)

Figure 11. FEC – US 27 Intersection (Looking SE)

Figure 12. FEC – CR 731 Intersection (Looking South)

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Figure 13. FEC – US 27 Intersection (Looking NW) (26.93241N, 81.31520W)

Figure 14. FEC – US 27 Intersection (Looking NE)

Figure 15. A View of a Pasture Land from CR 731 (27.07277N, 81.37945W) (Looking N)

Figure 16. A View of FEC from CR 731 (Looking S) (26.98478N, 81.49188W)

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Figure 17. Rainey Slough from Tasmania Road (Looking SW)

Figure 18. Rainey Slough (Looking W)

Figure 19. Pasture Land View on FEC (26.97610N, 81.51333W)

Figure 20. A View of Tree Line on Pasture from Farabee Road (26.97078N, 81.51617W)

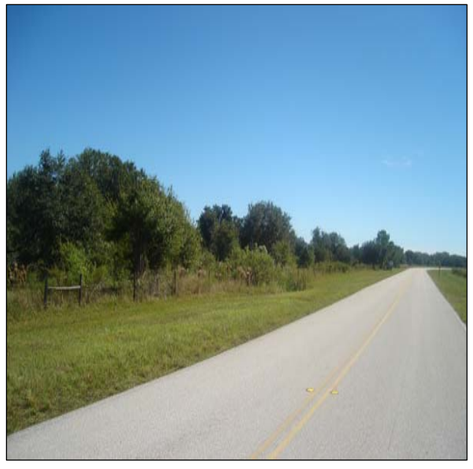


Figure 21. A View of Tasmania Road (26.97690N, 81.49090W)

Figure 22. A View from Intersection of CR 74 and CR 731 (26.94492N, 81.48886W)

Figure 23. A View of Cattle on the Study Area (26.94116 N, 81.37667 W)

Figure 24. Fisheating Wildlife Management Campground Entrance on US 27 (26.93930 N, 81.31952 W)

Figure 25. FWMA - Fisheating Creek Campground

Figure 26. Another View from the Study Area (26.99999 N, 81.45618 W)

Figure 27. A View of a Private Land Entrance Heading to the FEC (26.94574 N, 81.31789 W)

Figure 28. FEC Basin from CR 731 (Looking SW)

Figure 29. A View of FEC from Clark Road (27.32236 N, 81.48840 W) (Looking N)

Figure 30. Discharge Point of FEC to the Lake Okeechobee (26.96220 N, 81.12110 W)

Figure 31. Cowbone Marsh (1)

Figure 32. Cowbone Marsh (2)

Figure 33. Cowbone Marsh (3)

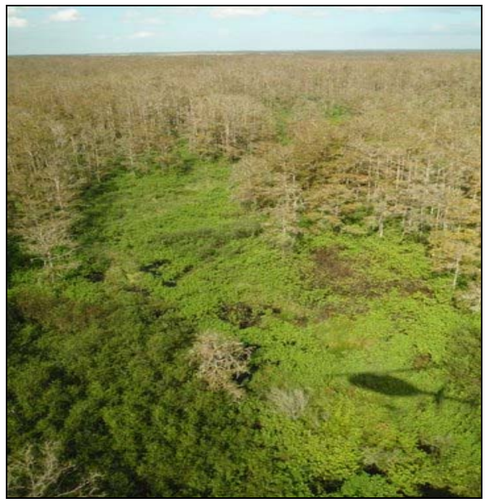


Figure 34. Cowbone Marsh (4)

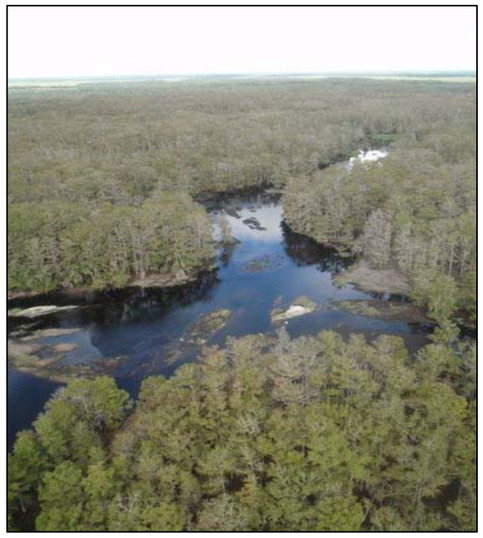


Figure 35. Cowbone Marsh (5)

Figure 36. Cowbone Marsh (6)

Figure 37 and **Figure 38** show pictures from the Florida Ranchlands Environmental Services Project Areas site visit which took place on October 29, 2008.

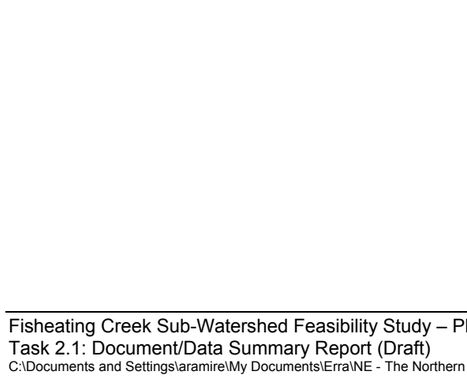


Figure 37. Lykes Marsh Reservoir

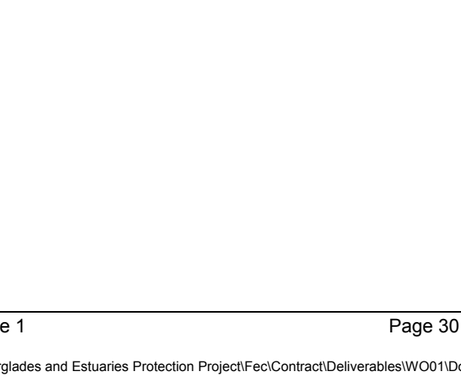
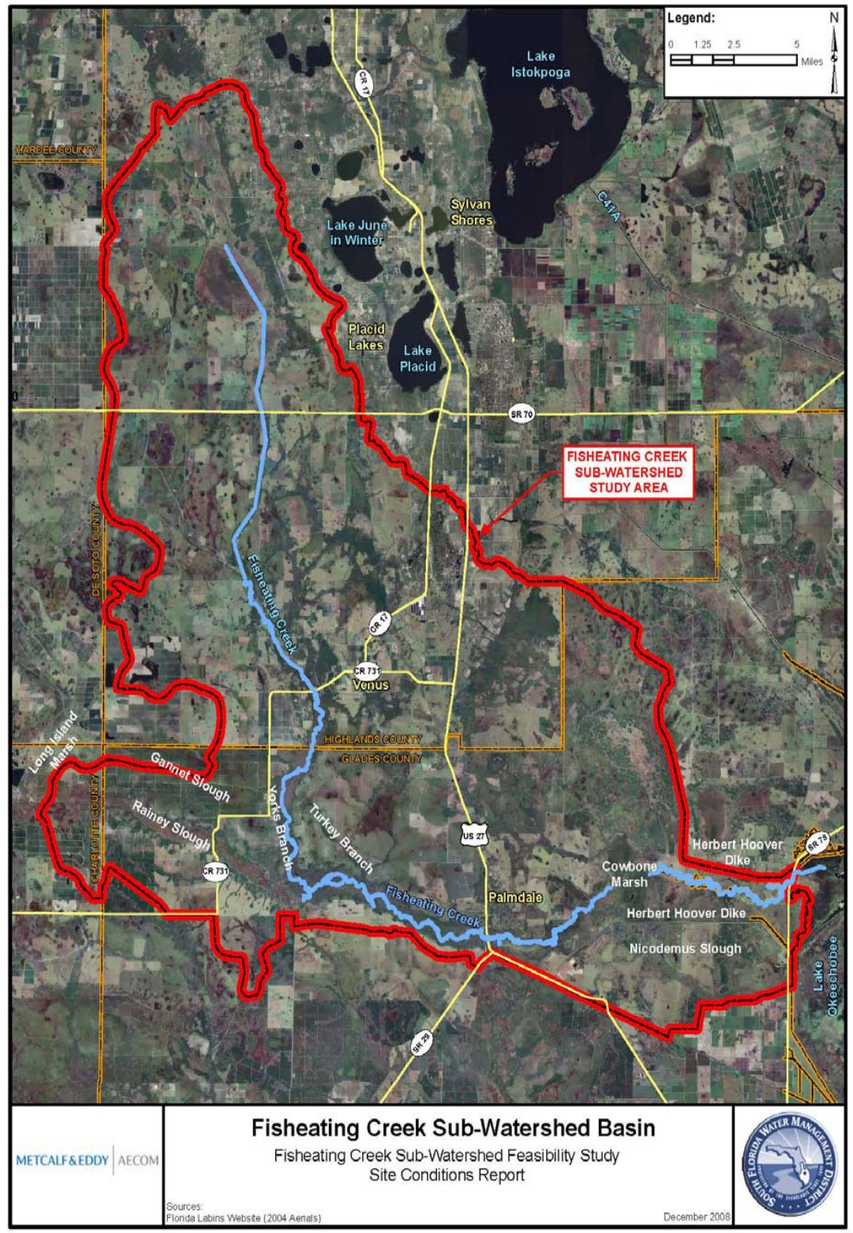


Figure 38. Buck Island Ranch

Figure 39 shows the approximate location of the FEC Sub-watershed Study Area on an aerial map along with some of its important details.



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574 **Figure 39. Fisheating Creek Sub-Watershed Basin Aerial View**

5.1.1 Fisheating Creek (FEC)

The Fisheating Creek (FEC) flows into Lake Okeechobee by gravity through a broad littoral swamp in the northwest direction. Among all inflow canals to the lake, the FEC is the only uncontrolled, gravity driven free-flow creek. The creek starts at the Highlands Hammock swamp in western Highlands County and flows south through the Cypress Swamp and into Glades County. Water leaves the creek channel from central Glades County, and flows east through the Cowbone Marsh into Lake Okeechobee.

To the North of State Road 70, the creek is a regular open channel, developing from a confined open channel to a swamp water course with dendritic tributaries between State Road 70 (SR 70) and County Road 731 (CR 731). The creek becomes a wide cypress swamp with a broad floodplain flowing south towards CR 731. Since 1982, the maximum water level recorded at the United States Geological Survey (USGS) Palmdale station (USGS Station 02256500 / South Florida Water Management District (SFWMD) Station FISHP (DBKEY 00088)) is 8.24 feet NGVD (SFWMD, 2004) and the minimum water level recorded was -0.45 feet NGVD (SFWMD, 2008c) (Datum of gage: 27.19 feet NGVD). Landscapes over interconnected swamp, wetlands and water course are dominated by pine flatlands, pine rocklands, tropical hardwood hammocks, and xeric hammocks. The creek lies within the FEC sub-watershed, and the main stream course flows into the boundary of Lake Okeechobee under the State Road 78 (SR 78) Bridge.

5.1.2 Fisheating Creek Sub-Watershed Study Area

The SFWMD Basin Atlas (Guardo, 1992 with 2004 SFWMD updates) was used to specify the boundary of the Study Area. The Basin Atlas was derived from ongoing field investigations and other updates of watershed boundaries. In general, boundaries of the Study Area specified in the Basin Atlas have been accepted as the “best” boundary delineations unless there is compelling evidence from other sources to modify the boundaries. It is our understanding that this sub-watershed network is from the Basin Atlas, which was initialized in 1992, and continuously evolved to cover more and more areas as defined by the District. Although SFMWD Basin Atlas depicts it different, FEC Study Area for this project does not associate with the Kissimmee River Region or the Sub-Watershed.

The Study Area extends from west-central Highlands County southward into the Glades County, and runs eastward to connect the northwest boundary of Lake Okeechobee. The Study Area for this report includes the FEC Sub-watershed and Nicodemus Slough which is not currently in the FEC basin. The FEC sub-watershed covers about 440 square miles (mi^2) of area and the Nicodemus Slough covers 27 mi^2 of area.

The FEC sub-watershed and Nicodemus Slough are surrounded by the adjacent sub-watersheds of Josephine Creek, C-41, L-61E, L-61W, L-41, L-42, C-19, Meander Ditch, Upper Citrus Center, Upper Linden Pen Marsh, Upper Cypress Branch, Jacks Branch, Cow Slough SWF, Gannet Slough and Prairie Creek (**Figure 48**). The southeast end of the FEC sub-watershed connects with the littoral zone of the Lake Okeechobee. The sub-watershed may receive inflow from the Highlands Hammock state forest at its northern-most end, and possibly from other creeks, ditches and wetland water courses. The surface water drainage system of the sub-watershed may also receive groundwater recharge from the Lake Wales Ridge area. Surface water connections between the FEC sub-watershed and other surrounding sub-watersheds need to be further identified during this study.

5.1.3 Sub-Watershed Settings

Agricultural, natural forest and wetlands are predominant landscapes within the FEC sub-watershed. The combined agricultural and ranch land uses occupy 58 percent of land within the sub-watershed; and the combined forest, swamp and wetlands cover nearly 40 percent of the total land within the sub-watershed. The dominant agricultural land uses include cattle grazing, dairy farming and citrus growth. Urban and commercial developments are minimal within the sub-watershed. No industry or commercial land uses are found within the sub-watershed.

More than 60,000 acres of land around the lower reaches of the creek are protected under a State controlled conservation easement. The rural undisturbed natural lands are adequate for wildlife habitat protection, restoration and natural conservation. The State plans to acquire additional lands for conservation in the area. (SFWMD, 2008)

The hydrologic system of the FEC sub-watershed forms a part of the interconnected Kissimmee River ecosystem, which lies at the northern end of the Everglades Ecosystem. Historically, water from both the Kissimmee River tributary system and the Fisheating Creek meandered slowly into Lake Okeechobee. Construction of the Herbert Hoover Dike around Lake Okeechobee and channelization within the upper and lower Kissimmee River basins significantly altered the surface water resources and drainage hydrology in the region north to Lake Okeechobee.

However, the hydrologic system of the FEC sub-watershed has endured the least human impact. The sub-watershed is quite rural comparing with other south-central Florida regions. In the early stages of the Central and Southern Florida (C&SF) Project development, some regional water improvement work, including construction of Canal 22 and Structure 69, was planned within the FEC sub-watershed. However, these two structures were withdrawn from the C&SF Project in 1959 as flood protection in the area could not be economically justified. Since then, the FEC sub-watershed has not received any regional flood control and ecosystem restoration modifications. Only local channelization and drainage network have been implemented in the northern section of the sub-watershed along with agricultural land development.

The water quality of the FEC has been adversely affected by agricultural activities in the upper reaches of the creek. Phosphorous loadings from non-point sources associated with cattle farming, dairy production, tree and vegetation plantation, and citrus growth directly result in degradation of the creek water quality and consequently increase the eutrophication rate in the Lake Okeechobee. Long term and extensive water quality monitoring results for the Kissimmee River region indicate that the FEC sub-watershed is a pollutant source contributing significant phosphorus loads to Lake Okeechobee (FDEP, 2004). In the Florida Department of Environmental Protection (FDEP) 1998 303(d) list of impaired water bodies in Florida (FDEP, 1998), approximately 25 water bodies/segments were identified as impaired surface water bodies in the Central and South Florida regions. Excessive nutrients, low levels of dissolved oxygen, and high concentrations of iron and chlorides, as well as coliform bacteria are being discharged into the Lake Okeechobee through the FEC.

Regional planning on the Lake Okeechobee water quality improvement and the Everglades Ecosystem restoration has been focused on the vast contribution of phosphorus from the Kissimmee River and the Taylor Creek/Nubbin Slough sub-watersheds. These areas are characterized as highly productive agricultural regions and rapidly growing urban areas. Currently water quality improvement Best Management Practices (BMPs) within the FEC sub-watershed are limited to owner self- funded agricultural BMPs and grant funded BMPs. In recent planning studies, two regional Reservoir Associated Stormwater Treatment Areas (RASTAs) have been evaluated and planned within the FEC sub-watershed (Lake Okeechobee Protection Plan (LOPP), 2004 and SFWMD 2008).

5.2 Climate

The climate in the proximity of the Fisheating Creek Sub-Watershed Study Area is presented in this section. Temperature and precipitation information was obtained from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) which has several meteorological stations in Florida (NCDC, 2004). Rainfall and evapotranspiration data at the Palmdale Station was obtained from SFWMD DBHYDRO.

5.2.1 Temperature and Precipitation

The climate in South Florida is subtropical and humid. The summers are long, humid, and warm, and the winters are mild with temperatures rarely below freezing. The warmest months are July and August, and January and February are the coolest months.

Climate information was obtained from two National Climatic Data Stations – Moore Haven Lock 1 Station and Archbold Bio Station. In addition, rainfall data was also obtained from the Hicoria Romp 14 station through the Water Management Information System (WIMS) maintained by SWFWMD, and Palmdale station maintained by the Florida Automated Weather Network (FAWN). Moore Haven Lock 1 Station, Palmdale station are located in Glades County and Archbold Bio Station and the Hicoria Romp Station are located in Highlands County as indicated in **Figure 40.**

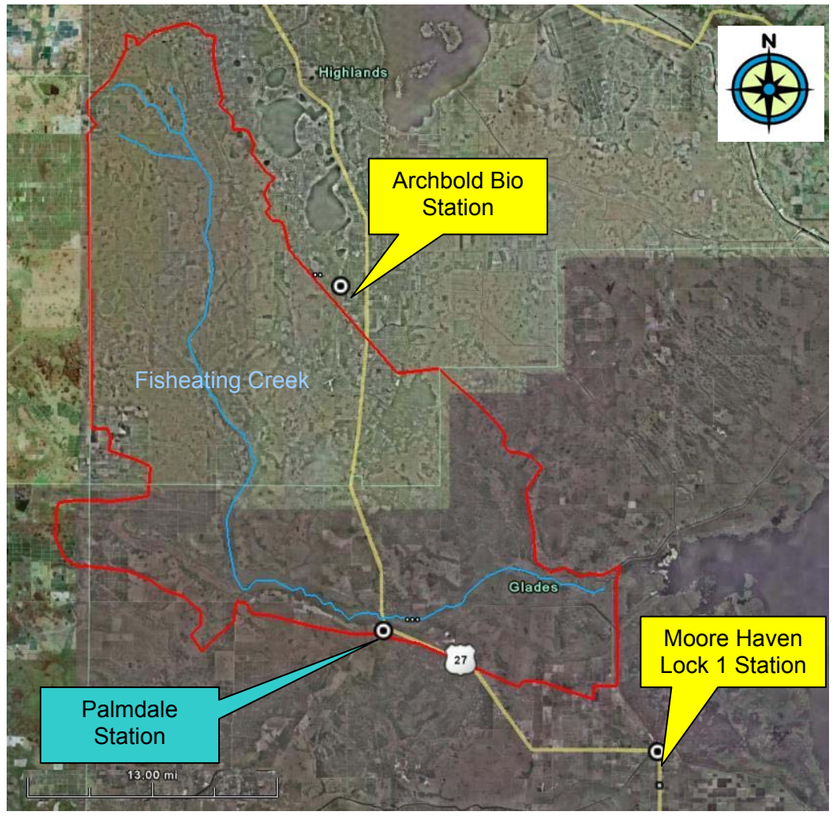

Figure 40. Temperature and Precipitation Stations Location Map

The daily maximum temperatures in the project areas range between 74 ºF and 94 ºF. Average temperatures are in the low 70's ºF, ranging from about 60ºF in midwinter to about 82ºF in summer. The daily minimum temperatures range between 46 ºF and 73 ºF. Maximum, mean, and minimum temperatures for 1971-2000 at Moore Haven Lock 1 Station and Archbold Bio Station are listed in Error! Reference source not found..

There are two distinct periods of rainfall in South Florida, wet season and dry season. The wettest months occur during June through September. November, December, January, and February typically have the lowest rainfall. Annual and seasonal rainfalls, however, vary from year to year and may have major contributions from tropical storms and hurricanes in some years. Annual precipitation from 1971 to 2000 averages 46 inches at the Moore Haven Lock 1 Station and 51 inches at the Archbold Bio Station. According to the rainfall monitoring data from Archbold Biological Station the average annual rainfall was approximately 51 inches between years 1981-1993. Evapotranspiration rates are high in South Florida and may equal or exceed precipitation rates. Mean monthly precipitation values over varying time periods at Moore Haven Lock 1 Station, Archbold Bio Station, the Hicoria Romp 14 station, and Palmdale station are listed in

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Table 5. Moore Haven and Archbold Temperatures (1971 to 2000)

Month	Max Temp (ºF)		Mean Temp (ºF)		Min Temp (ºF)	
	Moore Haven, FL	Archbold, FL	Moore Haven, FL	Archbold, FL	Moore Haven, FL	Archbold, FL
Jan	73.6	74.8	62.7	60.4	51.7	46.0
Feb	75.1	76.8	63.8	61.6	52.4	46.4
March	79.2	81.5	67.9	66.0	56.6	50.5
April	83.0	85.7	71.8	69.5	60.5	53.2
May	87.5	90.4	76.7	75.1	65.8	59.8
June	90.0	92.6	80.4	79.2	70.8	65.8
July	91.1	93.7	81.6	80.5	72.1	67.2
Aug	90.5	93.5	81.6	80.6	72.6	67.7
Sept	88.7	91.6	80.5	79.2	72.2	66.8
Oct	84.4	87.1	75.7	73.8	67.0	60.5
Nov	79.4	81.4	70.0	68.1	60.6	54.7
Dec	74.8	76.0	64.5	62.4	54.1	48.7
Annual	**83.1**	**85.4**	**73.1**	**71.4**	**63**	**57.3**

(Source: NCDC, 2004)

Table 6. Moore Haven, Archbold, Hicoria and Palmdale Precipitation

Month	Mean Precipitation (inches)				
	Moore Haven, FL (1971-2000)	Archbold, FL (1971-2000)	Archbold, FL (1931-2008)	Hicoria (2000-2008)	Palmdale (2004-2008)
Jan	2.04	2.32	1.96	1.06	0.75
Feb	2.05	2.38	2.43	1.97	2.71
Mar	2.93	3.25	3.07	2.02	2.76
Apr	2.35	2.33	2.41	2.78	2.33
May	3.7	3.98	3.87	3.02	2.29
Jun	6.98	7.74	8.42	8.76	8.13
Jul	6.67	7.66	8.48	7.68	7.62
Aug	6.8	7.42	8.01	9.32	9.73
Sep	6.42	6.5	7.55	6.71	4.83
Oct	2.95	3	3.79	2.23	3.33
Nov	1.91	2.07	1.75	1.34	1.31
Dec	1.64	1.95	1.74	1.86	1.35
Annual	**46.44**	**50.6**	**53.49**	**48.75**	**47.14**

Sources: (NCDC, 2004; FAWN, 2009; WMIS, 2009)

5.2.2 Rainfall versus Evapotranspiration

Average evaporation and rainfall for 1980-1984 at SFWMD Station Palmdale located at the intersection of Fisheating Creek with US 27 **(Figure 40)** are listed in Error! Reference source not found.. Evaporation is close to the "potential evapotranspiration", which is the evapotranspiration that would occur from vegetated land surface if water were fully available. Evapotranspiration from vegetated land surfaces depends on meteorological conditions, the water availability and the type of vegetation. For this study, it was assumed that the evaporation was the same as the evapotranspiration.

The data in Error! Reference source not found. show that, on an annual basis, evapotranspiration is greater than rainfall. Both rainfall and evaporation, however, exhibit large seasonal fluctuations. These fluctuations tend to be similar, with higher rainfall and evapotranspiration from May to September. An important factor is that both evapotranspiration and more significantly rainfall vary from year to year.

Table 7. Lake Okeechobee Evapotranspiration and Rainfall

Month	Palmdale Evaporation (inches)	Rainfall (inches)	Net Removal (inches)
January	3.38	2.48	0.90
February	4.10	5.02	-0.92
March	5.87	4.54	1.33
April	5.57	3.32	2.25
May	6.97	6.14	0.83
June	10.28	8.40	1.88
July	8.89	8.78	0.11
August	8.52	6.82	1.70
September	6.62	6.88	-0.26
October	4.60	2.84	1.76
November	4.57	2.86	1.71
December	2.35	1.74	0.61
Total	**71.72**	**59.82**	**11.90**

(Source: SFWMD, 2008c)

According to the 2007 South Florida Environmental report, the annual average rainfall on the entire SWFWD region is 52.8 Inches (Ali and Abtew, 1999). The SWFWD region encompasses a much larger area than the FEC project boundary and the areal rainfall statistics were based on data from 1900-1995. As seen in Table 5, the average annual rainfall at the Palmdale station from 1980-1984 exceeded the average by 7.02 inches.

5.3 Land Use

The current land use distribution within the FEC sub-watershed is shown in **Figure 41**. Land use data applied in the assessment was obtained from the SFWMD's GIS database (SFWMD GIS Data Catalog). The boundary delineation of the FEC sub-watershed was taken from the SFWMD's Basin Atlas (SFWMD, 2004). Land uses within the sub-watershed are grouped into 8 main categories and over 50 more detailed sub-categories, some of which are shown in Table 9, among which the agriculture, rangeland, forest land and wetlands occupy more than 96 percent of the total land. The total land within the FEC Sub-watershed is approximately 440 square miles.

From 1984 to 2006, more than 72 square miles (46,080 acres) of rangelands, which by definition represents unimproved grass land with native vegetation, were converted to agricultural land use for farming, citrus growth and cattle production.. This conversion of land use resulted in a significant increase on phosphorous loading to the creek.

Most farmland is distributed in the upper portion of the sub-watershed within Highlands County. Some agricultural land is also located around the downstream end of the FEC. Most state forest conservation, wetlands, and undeveloped ranch land are located in the lower portion of the sub-watershed within Glades County. Agricultural land uses indicate the distribution and intensity of non-point source pollution within the sub-watershed.

The detailed categories in Table 9, show that in 2006 cropland and pastureland made up 37.9% of the land. A significant contribution to land use is also the upland forests. Upland Coniferous Forest and Upland Hardwood Forests combine to contribute 16.3% and an additional 5.9% is contributed by Tree plantations (Table 9, Figure 41).

A majority of wetlands within the area are vegetated non-forested wetlands and Wetland Hardwood Forests contributing to 13.10% and 5.10% of the landuse, respectively (TableX, Figure X). Besides the creek water course and wetlands, the sub-watershed contains a limited area of surface water bodies. Water bodies contribute 0.3% of land use, and they include isolated lakes and agricultural ponds (**Table 9, Figure 41**).

In the past 20 years, land use for urban development within the FEC sub-watershed varied from 1.3% in 1988 to 1.4% in 2006. Scattered urban developments with a low suburban population density are found at the north end and the central portion of the sub-watershed. However, urban town and residential build-ups have been established around Lake Placid and Placid Lakes over the highland of the Lake Wales Ridge (in the Josephine Sub-watershed according to the SFWMD's Basin Atlas, 2004). The Ridge is highly vulnerable to leaching of surface runoff contaminated by chemicals such as pesticides and fertilizers received from the urban development across the sub-watershed boundary. The sandy soils on the Ridge are well drained therefore surface water and groundwater resources within the FEC sub-watershed may be affected by the urban development over the Ridge.

Error! Not a valid bookmark self-reference.Figure 41: Land Use Condition for Fisheating Creek (2006)

689 **Table 8: Land Use Distribution**

Land Use Categories	1988	1995	1999	2004	2006
AGRICULTURE	39.1%	41.3%	59.8%	54.3%	44.5%
BARREN LAND	0.1%	0.0%	0.1%	0.2%	0.1%
RANGELAND	19.9%	10.3%	4.9%	3.6%	9.0%
TRANSPORTATION, COMMUNICATION AND UTILITIES	N/A	0.2%	0.2%	0.2%	0.3%
UPLAND FORESTS	16.8%	23.5%	14.0%	15.6%	20.7%
URBAN AND BUILT-UP	1.3%	0.8%	0.5%	0.7%	1.4%
WATER	0.1%	0.4%	0.3%	0.5%	0.3%
WETLANDS	22.7%	23.5%	20.1%	25.0%	23.6%

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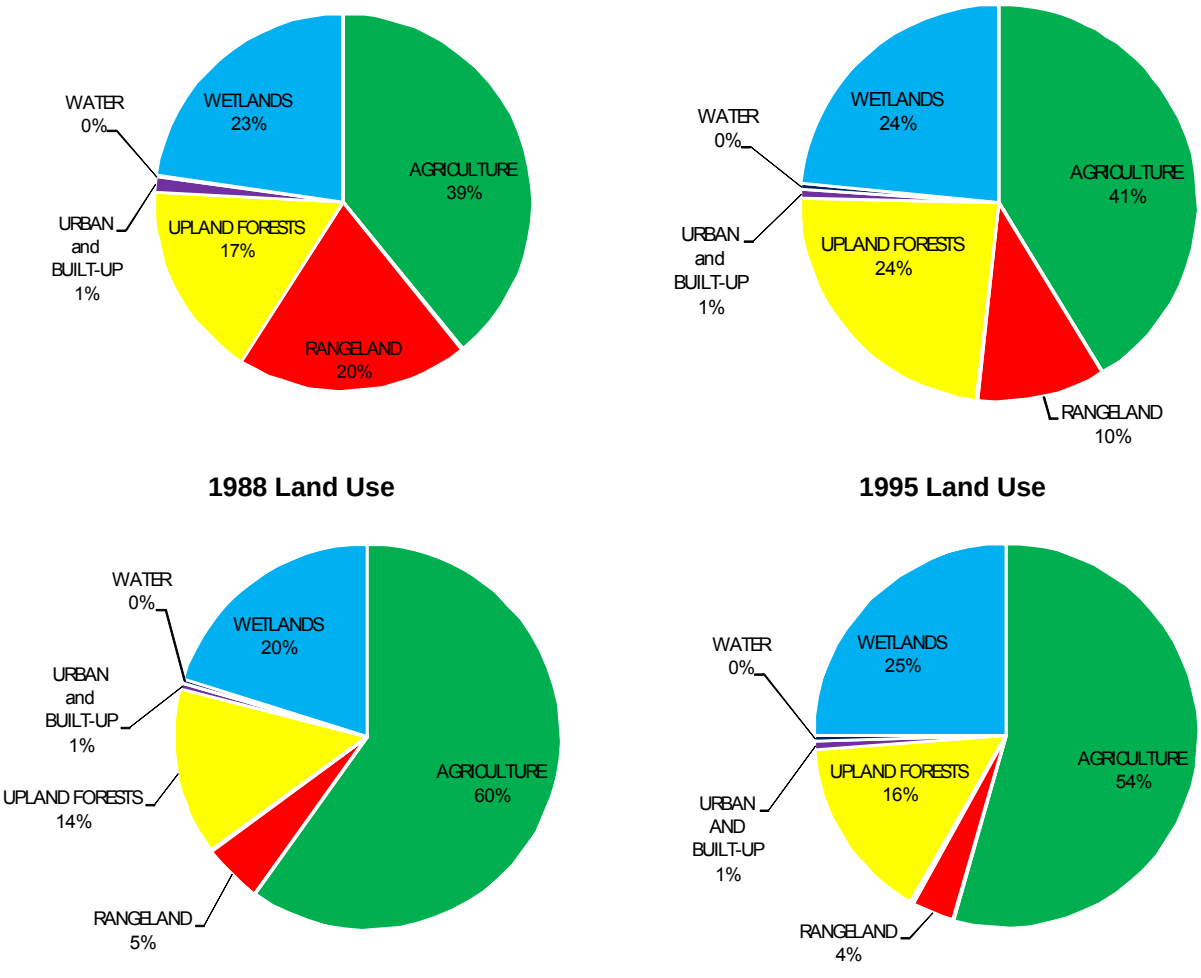

(Source: SFWMD 1988, 1995, 1999, 2004)

Figure 42. Land Use Categories, Distributions and Variations (1988-2004)

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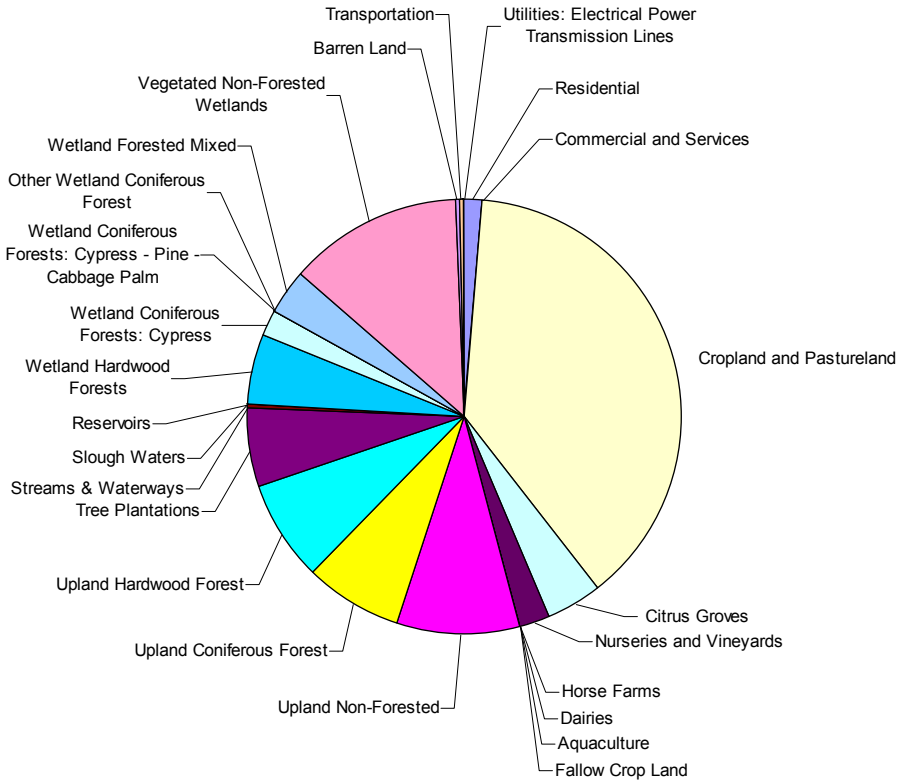
Table 9: Land Use Distribution – 2006 data

Code	Category	% of Total
1100 1200 1300	Residential	1.4%
1400	Commercial and Services	0.0%
1900	Open Land	0.0%
2100	Cropland and Pastureland	37.9%
2210	Citrus Groves	4.3%
2400	Nurseries and Vineyards	0.0%
2510	Horse Farms	2.1%
2520	Dairies	0.0%
2540	Aquaculture	0.0%
2610	Fallow Crop Land	0.0%
3100 3200 3300	Upland Non-Forested	0.2%
4100	Upland coniferous Forest	9.0%
4200	Upland Hardwood Forest	7.3%
4400	Tree Plantations	7.6%
5100	Streams & Waterways	5.9%
5300	Reservoirs	0.2%
5600	Slough Waters	0.1%
6100	Wetland Hardwood Forests	0.0%
6210	Wetland Coniferous Forests	5.1%
6220 6219	Other Coniferous Forest	1.9%
6240	Wetland Coniferous Forests: Cypress - Pine - Cabbage Palm	0.1%
6300	Wetland Forested Mixed	0.1%
6400	Vegetated Non-Forested Wetlands	3.2%
7000	Barren Land	13.1%
8100	Transportation	0.1%
8320	Utilities: Electrical Power Transmission Lines	0.3%
	Total	**100.0%**



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704 **Figure 43: Land Use Categories, Distributions and Variations** (2006)

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5.4 Geology and Soils

5.4.1 Surficial Soil Survey Mapping

The predominant surficial soil types in Fisheating Creek Sub-watershed basin are Immokalee sand, Myakka fine sand, Basinger fine sand and Valkaria fine sand, among others (**Figure 44**).

Table 10 shows all of the soil types with their relevant distribution areas on the Fisheating Creek Sub-watershed Study Area. Soil types determined in the sub-watershed mainly fall under the hydrologic groups B/D (77.92%) and D(15.52%). The rest of the soil in the sub-watershed classified under group A (2.08%), B (0.07%) and C (4.14%) (NRCS-USDA 2006, 2007) (**Figure 45**).

Hydrologic Soil Group A have a high rate of water transmission. They have a low runoff potential when completely wet. This group of soils consist of deep, well drained to excessively drained sands or gravelly sands. Group B soils have a moderate rate of water transmission. When they are thoroughly wet they have moderate infiltration capacity. This group of soil mainly consists of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. Group C soils have a slow infiltration capacity even when they are thoroughly wet. Therefore, they have a slow rate of water transmission, with a layer that slows down the downward movement of water or soils of moderately fine texture or fine texture. Group D soils mainly consist of clays that have a high shrink-swell potential, high water table, a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow infiltration and water transmission rate. Group B/D soil shows that the parts of the area covered with drained soil falls under the Group B while the undrained parts of area soil falls under the Group D (NRCS-USDA, 2006, 2007). It should be noted that 77.92% of the Fisheating Sub-watershed basin falls under this group.

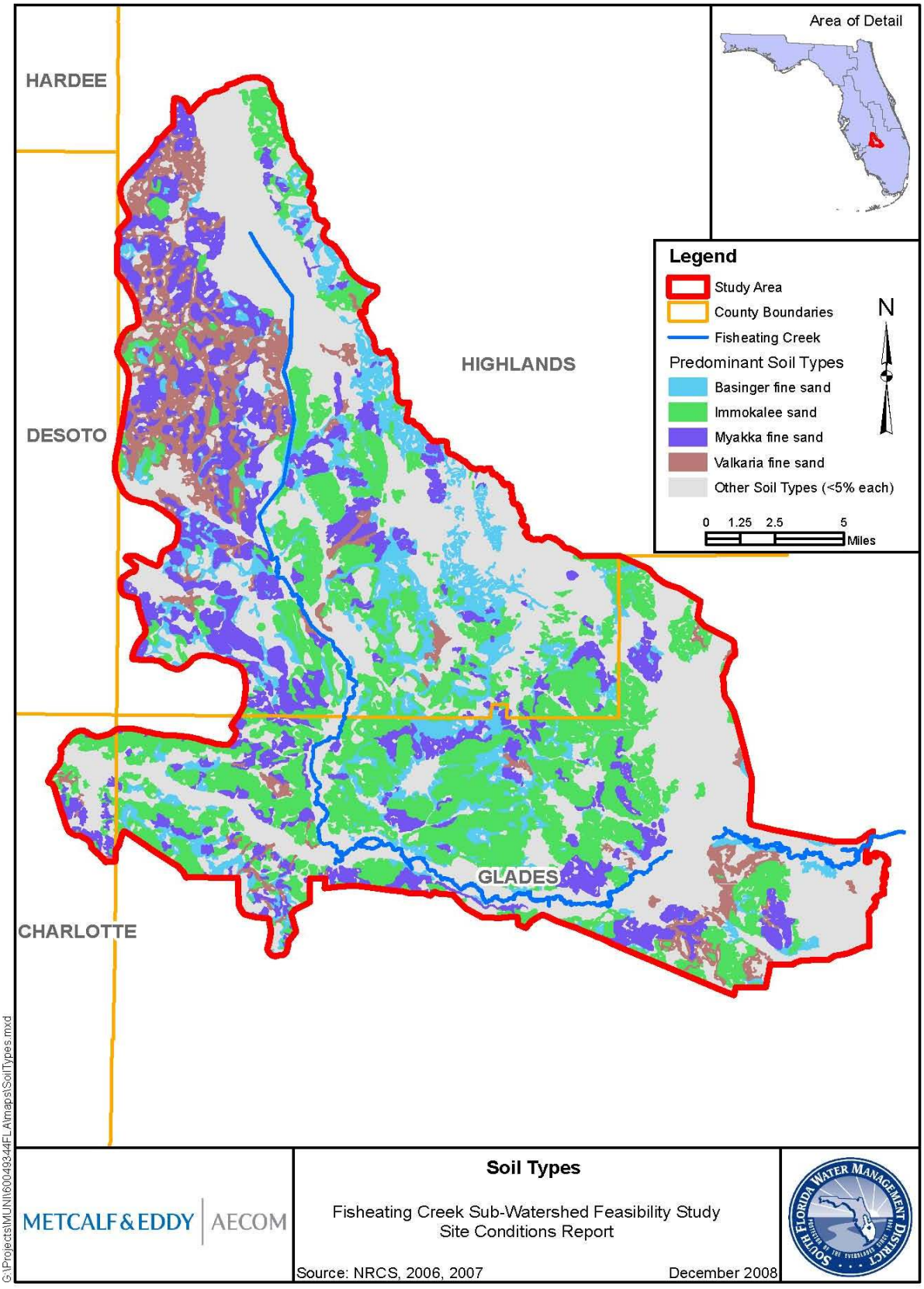
The soil type in the sub-watershed is also classified according to its hydric property. Hydric soils are defined as soils that are formed under conditions of saturation, flooding, or ponding long enough during the growth season to develop anaerobic conditions in the upper part of the soil. It is reported that soils formed under such conditions would support the growth and reproduction of the hydrophtic vegetation. Use of hydric soils along with the published soils survey series is extremely useful for land use planning. However, an on-site test is always required to determine the extent of the hydric soils on a specific site via field identification of the presence of one or more of the hydric soil indicators (FDEP, 2008d) . Such property may be a useful criterion in determination of a wetland area. In general, wetland soils are supposed to be in muck, peat etc. However, loam, clay and sandy soils could be used as wetland soils if it is known that they are frequently saturated or inundated (MDEQ, 2008).

742 **Table 10. Fisheating Creek Sub-Watershed Study Area Surficial Soil Distribution**

Soil Type	Hydrologic Group	Hydric	Area (Acre)	% of Total Area
Anclote sand, depressional	D	All hydric	126	0.04
Anclote-Basinger fine sand, frequently flooded	D	All hydric	2118	0.70
Archbold sand, 0 to 5 percent slopes	A	Not hydric	1289	0.43
Arents, very steep	A	Not hydric	520	0.17
Astatula sand, 0 to 8 percent slopes	A	Not hydric	1078	0.36
Astor fine sand, depressional	B/D	All hydric	4346	1.44
Basinger fine sand	B/D	Partially hydric	30209	9.99
Basinger fine sand, depressional	D	All hydric	6812	2.25
Basinger, St. Johns, and Placid soils	B/D	Partially hydric	8283	2.74
Boca fine sand	B/D	Partially hydric	657	0.22
Bradenton fine sand	B/D	All hydric	1724	0.57
Brighton muck	B/D	All hydric	230	0.08
Chobee fine sandy loam, depressional	D	All hydric	474	0.16
Chobee loamy fine sand, depressional	D	All hydric	106	0.04
Daytona sand	B	Partially hydric	24	0.01
Daytona sand, 0 to 5 percent slopes	B	Not hydric	193	0.06
Duette sand, 0 to 5 percent slopes	A	Not hydric	159	0.05
EauGallie fine sand	B/D	Not hydric	3212	1.06
EauGallie sand	D	Partially hydric	106	0.04
Felda fine sand	B/D	All hydric	9538	3.16
Felda fine sand, depressional	D	All hydric	745	0.25
Floridana fine sand, depressional	D	All hydric	6159	2.04
Floridana sand, depressional	D	All hydric	994	0.33
Floridana, Astor, and Felda soils, frequently flooded	D	All hydric	13910	4.60
Ft. Drum fine sand	C	Partially hydric	1057	0.35
Gator muck	D	All hydric	4143	1.37
Gator muck, depressional	D	All hydric	1222	0.40
Hallandale fine sand	B/D	Partially hydric	55	0.02
Hallandale fine sand, slough	B/D	All hydric	7	0.00
Hallandale-Pople complex	B/D	Partially hydric	423	0.14
Hicoria mucky sand, depressional	D	All hydric	2846	0.94
Hontoon muck	B/D	All hydric	114	0.04
Immokalee fine sand	B/D	Not hydric	55	0.02
Immokalee sand	B/D	Partially hydric	70728	23.40
Kaliga muck	B/D	All hydric	2672	0.88
Malabar fine sand	B/D	All hydric	5338	1.77

Malabar fine sand, depressional	D	All hydric	17	0.01
Soil Type	**Hydrologic Group**	**Hydric**	**Area (Acre)**	**% of Total Area**
Malabar fine sand, high	B/D	Partially hydric	3537	1.17
Malabar sand, depressional	D	All hydric	1208	0.40
Myakka fine sand	B/D	Partially hydric	42433	14.04
Myakka fine sand, depressional	D	Partially hydric	154	0.05
Okeelanta muck, depressional	B/D	All hydric	3926	1.30
Oldsmar fine sand	B/D	Not hydric	1115	0.37
Oldsmar sand	B/D	Not hydric	2054	0.68
Orsino sand, 0 to 5 percent slopes	A	Not hydric	423	0.14
Paola sand, 0 to 8 percent slopes	A	Not hydric	1707	0.56
Pineda fine sand	B/D	All hydric	3116	1.03
Pineda fine sand, depressional	D	All hydric	44	0.01
Pineda sand	B/D	All hydric	3465	1.15
Placid fine sand, depressional	D	All hydric	4990	1.65
Pomello fine sand	C	Not hydric	3108	1.03
Pomello sand, 0 to 5 percent slopes	C	Not hydric	1634	0.54
Pople fine sand	B/D	Partially hydric	5339	1.77
Punta fine sand	B/D	Not hydric	155	0.05
Samsula muck	B/D	All hydric	1814	0.60
Samsula muck, depressional	D	All hydric	0.93	0.00
Sanibel muck	B/D	All hydric	486	0.16
Sanibel muck, depressional	D	All hydric	660	0.22
Satellite fine sand	C	Partially hydric	15	0.01
Satellite sand	C	Partially hydric	6696	2.214
Smyrna fine sand	B/D	Partially hydric	4042	1.34
Smyrna sand	B/D	Partially hydric	6825	2.26
St. Lucie sand, 0 to 8 percent slopes	A	Not hydric	1074	0.36
Tavares sand, 0 to 5 percent slopes	A	Not hydric	52	0.02
Tequesta muck	B/D	All hydric	1026	0.34
Terra Ceia muck, drained	B/D	All hydric	9	0.00
Valkaria fine sand	B/D	All hydric	18434	6.1
Valkaria fine sand, depressional	D	All hydric	13	0.00
Wabasso sand	B/D	Partially hydric	170	0.056
Water		-	827	0.27
Winder sand, depressional	D	Partially hydric	54	0.02

743 (Source: NRCS-USDA 2006,2007)



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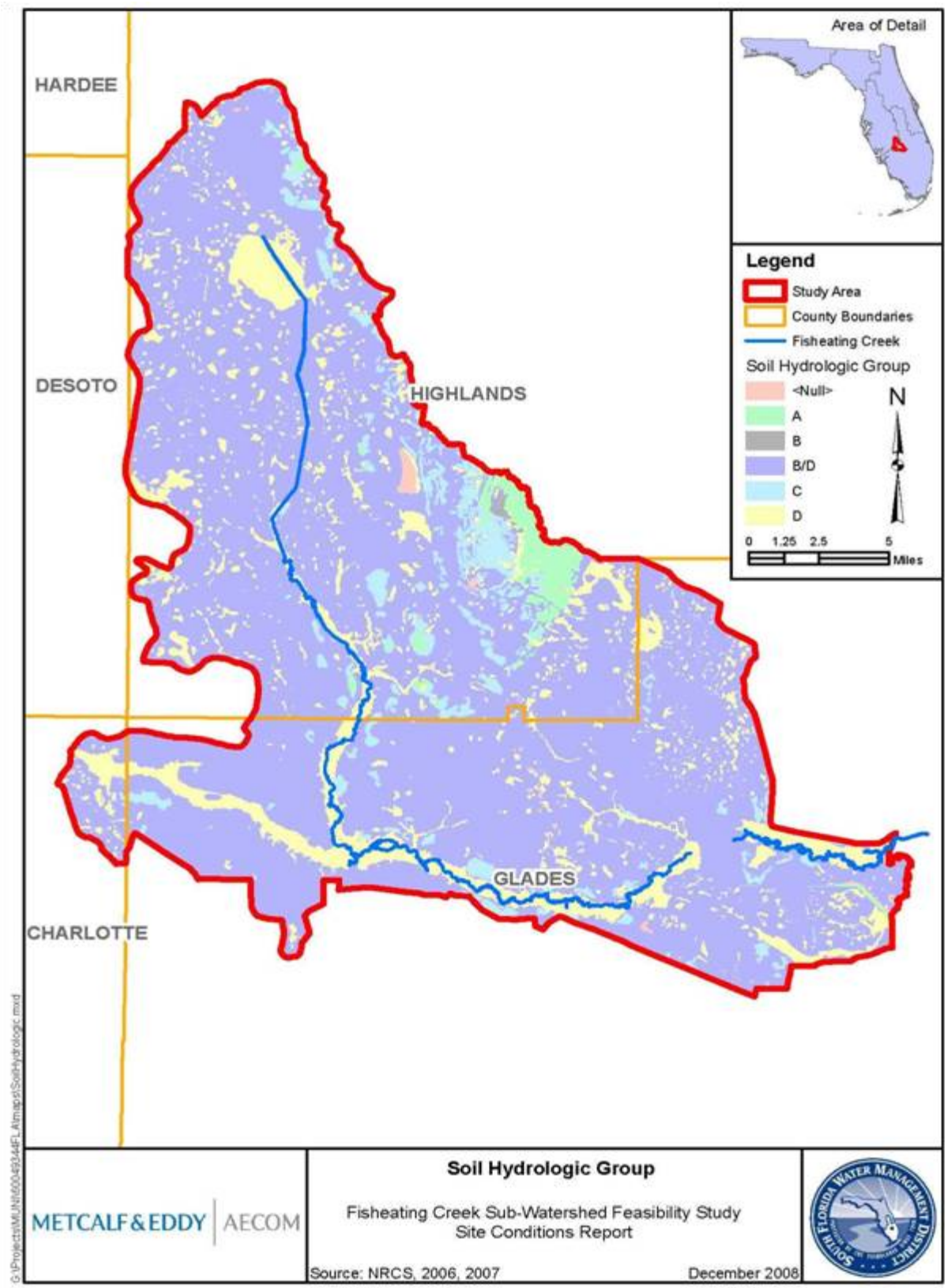
745 **Figure 44. Soil Types in the Fisheating Creek Sub-Watershed Study Area**



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747 **Figure 45. Hydrologic Soil Groups in the FEC Sub-Watershed Study Area**

5.4.2 Subsurface Investigation

Investigation conducted for the subsurface properties did not reveal any information for the Fisheating Creek Sub-watershed basin area. However, information for the study area was located for the vicinity of Nicodemus Slough area (USACE, 1982). The purpose of the geotechnical study was to identify the subsurface materials and determine their characteristics as they relate to engineering construction (USACE, 1982). According to the results of the study, sand is the predominant material in the project area together with lesser amounts of clay, silt, and shells. Local pockets of muck are present at ground surface. A 6-foot thick layer of limestone was found at one boring at elevation -2.1 feet NGVD, approximately 22.5 feet deep. Error! Reference source not found. lists the geotechnical findings at these five core borings drilled in 1955. **Figure 46** shows the geotechnical study boundary for the Nicodemus Slough area.

Table 11. Core Borings Stratigraphy (1955)

Boring No.	Elevation (ft NAVD)	Material Description
1	+20.7 to +18.2	SP-SM-SAND, slgt silty, org, fine
	+18.2 to +10.7	SP-SAND, fine. (+15.7 to +14.7 very shelly and +14.7 to +10.7 shelly, few consol. frags.)
	+10.7 to -0.1	SP-SC-SAND, slgt clayey, very fine, shelly
	-0.1 to -2.8	SP-SAND, very fine (-1.7 to -2.8 very shelly)
	-2.8 to -4.8	SC-SAND, clayey
	-4.8 to -9.3	SP-SAND, shelly, fine SW above -5.3
2	+19.3 to +15.3	SM-SAND, silty, very org, fine
	+15.3 to +12.3	SP-SM-SAND, slgt silty, fine
	+12.3 to -1.2	SP-SAND, clean above +3.3, fine
	-1.2 to -3.2	SP-SC-SAND, slgt clayey
	-3.2 to -8.2	SP-SAND, fn/med, few silt lens
	-8.2 to -10.7	SP-SM-SAND, slgt silty, fn/md
3	+21.6 to +21.1	SP-SM-SAND, slgt silty, fine, org
	+21.1 to +14.6	SP-SAND, fine slgt org.
	+14.6 to +13.1	SP-SM-SAND, slgt silty, org.
	+13.1 to +9.6	SP-SAND, clean, fine

Boring No.	Elevation (ft NAVD)	Material Description
	+9.6 to -0.9	SC-SAND, clayey, fine, shelly (+1.6 to -0.9 very clayey)
	-0.9 to -2.1	LIMESTONE, hard
	-2.1 to -7.0	LIMESTONE, med-hard
	-7.0 to -8.4	SP-SAND, 10% consol.
4	+19.6 to +13.6	SP-SM-SAND, slgt silty, very org. above +19.1
	+13.6 to +9.1	SP-SAND, shelly, clean, to +11.7 (+11.7 to +9.1 some slgt silty lenses, no shell)
	+9.1 to +1.6	SP-SC-SAND, slgt clayey, 50% small consol. frags
	+1.6 to -0.4	SC-SAND, very clayey, very fine, few shelly lenses
	-0.4 to -5.4	CL-CLAY, sandy
	-5.4 to -10.4	SC-SAND, very clayey, shelly
5	+19.5 to +17.0	SP-SM-SAND, slgt silty, fine
	+17.0 to -0.5	SP-SAND, shelly, fine (+13.5 to -0.5 clean, slgt shelly)
	-0.5 to -5.5	SP-SC-SAND, slgt clayey
	-5.5 to -10.5	CL-CLAY, shelly few thin lenses of consol. shell

(Source: USACE, 1982)

5.4.3 Other Relevant Geotechnical Studies

Aquaflorida Project, Highlands County, Ardaman & Associates, Inc.

A report entitled “Subsurface Exploration and Geotechnical Engineering Evaluation”, for the “Aquaflorida” Lake Okeechobee Water Quality Improvement Project, Highlands County, Florida, prepared by Ardaman & Associates, Inc. (Ardaman), dated as January 13, 2003, was provided by Lykes Bros Inc. This report pertains to an area located approximately 17 miles away from the center of the Fisheating Creek Sub-watershed basin (**Figure 46**). The soil information was considered appropriate for this phase of the project.

Ardaman evaluated the subsurface conditions for supporting 8 to 10 feet high earthen levee construction and water distribution structures. A total of 91 Standard Penetration Test (SPT) borings were performed to depths between 15 and 100 feet below the existing ground surface in the period between July 31, 2002 and October 26, 2002. Moreover, a total of 19 permanent 2-

inch diameter monitoring wells were installed at selected locations throughout the site followed by 19 field permeability tests performed at varying depths in the installed wells. The measured hydraulic conductivities varied from 0.057 ft/day to 6.520 ft/day with an average of 1.47 ft/day. Based on the tests results, the soils throughout the site consist of clean, slightly silty, slightly clayey to clayey fine sands from the existing ground surface to depths of about 35 to 50 feet, followed by slightly sandy, low to medium plasticity clays to high plasticity clays reaching depths of 85 to 95 feet, in turn followed by clean fine sands to slightly clayey fine sands reaching the termination depths of the deepest borings. The groundwater was generally encountered above 3 feet. This geotechnical study recommended levees to be constructed in some parts of the site using slightly silty sands borrowed from within the property without removing the encountered surficial organics or the use of synthetic reinforcement, provided that a staged construction technique consisting of 3 to 4 lifts is used. In other parts of the site, levees can be constructed using well compacted 18-inch lifts of slightly silty sands borrowed from within the property, with only conventional clearing operations prior to the start of the filling.

The soils of this study were considered adequate to support a pump station construction on a conventional mat or raft foundation, with a bearing pressure of 2,500 pounds per square foot (psf) or less.

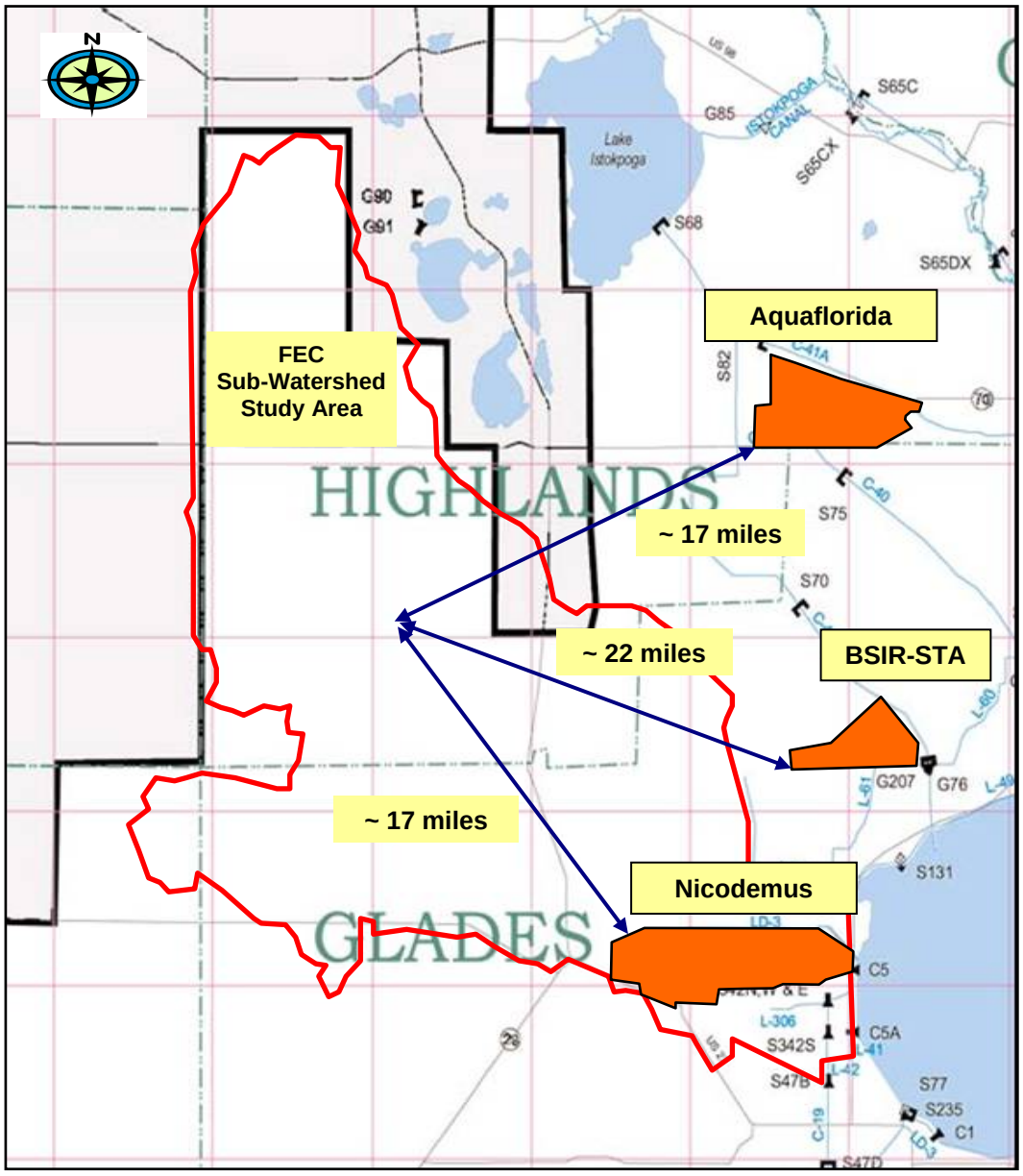
BSIR-STA Project, Glades County, Nadic Engineering Services, Inc.

A report entitled “Preliminary Geotechnical Report”, for the Brighton Seminole Indian Reservation Stormwater Treatment Area (BSIR-STA) Project, Glades County, Florida, prepared by Nadic Engineering Services, Inc. (NES), dated as September 21, 2007, was provided by the SFWMD. This report pertains to an area located approximately 22.25 miles away from the center of the Fisheating Creek Sub-watershed basin (**Figure 46**). The soil information was considered appropriate for this phase of the project.

NES evaluated the subsurface conditions for the design and construction of stormwater treatment areas (STAs) and water control structures. A total of 35 Standard Penetration Test (SPT) borings were performed to depths of about 25 feet below the existing ground surface in the period between January 02, 2007 and March 08, 2007. The borings generally encountered fine sand with varying amount of silt and occasionally clay and trace shell from the existing ground surface to a depth of about seven feet follow by fine sand with silt and trace shells to abundant shells to boring termination depths of about 25 feet below existing grade. Isolated 5-foot layer of clayey sand was encountered in 5 borings at depths between 7 and 17 feet below existing grade. Limestone layer approximately 5-foot thick was encountered in 2 borings at a depth of about 13 feet below existing grade. The near surface sandy soils are generally very loose to medium dense with isolated very dense soils. Below a depth of about 10 feet, the

encountered soils are generally medium dense to very dense. The groundwater was generally encountered from about 2.5 to 6.5 feet, at approximate +14 to +17.5 feet NGVD.

This geotechnical study stated that embankment construction materials can be generated from on-site excavations, except in isolated areas where highly compressible organic soils and peat are present at the ground surface. These excavations may take the form of seepage collection canal(s) as well as several borrow sites from within the property.



(Source: SFWMD, 2005)

Figure 46. Geotechnical Study Site Locations Map

The soils of this study were considered suitable to support a pump station and other structures construction on a variety of foundation types, including shallow foundations, driven piles or drilled shafts, with a bearing pressure of 3,000 pounds per square foot (psf) for dead load plus live loads.

5.5 Topography

Topography map of the FEC Sub-watershed Study Area is shown on **Figure 47** with 5 ft contours (FGDL, 1997). The northwestern portion of the sub-watershed is bounded by the south extension of the Lake Wales Ridge. The topography of the sub-watershed slopes gradually from about 85 feet NGVD in the northwest section to about 20 feet NGVD in the southeast section as identified in the 5-feet topographic map. A bend of low-lying wetland near the southern boundary of the sub-watershed forms the swamp water course of the creek.

5.6 Existing Watershed Hydrology

5.6.1Data Resources

The applied hydrological data is collected from the SFWMD's DBHYDRO database. Hydrologic datasets include:

- Rainfall data monitored at 2 rain stations (ARCHBO & VENUS_R) within the sub-watershed
- Flow and stage data collected at the SFWMD's FISHP station (USGS Station 02256500)
- Groundwater data collected at two monitoring wells south of the sub-watershed
- Water quality data monitored at multiple stations. Total phosphorous concentration data measured at Station FECSR78 is used in this report to estimate the total phosphorous loads.

Locations of the above measurement stations are shown in **Figure 48**, and available data periods at those stations are listed in **Error! Reference source not found.**. Within the 440 square mile study area, there exists only one active SFWMD flow and stage monitoring station, two active rainfall monitoring stations, and no active groundwater monitoring wells. The flow data measured at the US 27 bridge (SFWMD Station FISHP / USGS Station 02256500) is

registered in the DBHYDRO database with a Preferred DBKey (DBKey 15627), indicating that raw data collected at this station has gone through the required QA/QC process. The stage data recorder located at the same station is owned by USGS and therefore is named as "unknown" in DBHYDRO. Both rainfall and groundwater well data are raw data.

In order to assess the recent hydrologic conditions in the FEC, datasets of rainfall, flow/stage, and groundwater level and water quality data for the period of January 1991 - October 2008 were extracted from available data recorded at the above stations. The extracted datasets during this period were examined for data quality in terms of missing measurements, abnormal spikes, recording consistency, and data error flags. The data quality is generally satisfactory.

Table 12. Available Data Periods

Dbkey	Station	Data Type	Freq	Stat	Recorder	Agency	Start Date	End Date
15627	FISHP	Flow	Day	Mean	PREF	WMD	1/1/72	6/30/08
00088	FISHP	STG	Day	Mean	Unknown	USGS	1/5/31	5/11/08
06205	ARCHBO	Rain	Day	SUM	OMD	WMD	1/8/91	11/10/08
VN418	VENUS_R	Rain	Day	SUM	NRG	WMD	10/1/07	3/01/08
	CRS02NM	GrdW						
	MUSE W	GrdW						

Although all data recording frequencies are daily, monthly data (maximum, minimum, monthly cumulative values and monthly averaged values) are used to support the hydrologic assessment.

The distance between FISHP and FECSR78 is about 12 miles. The distance between USGS02255600 and FE36382811 is about 5 miles. These stations are shown in **Figure 48**.

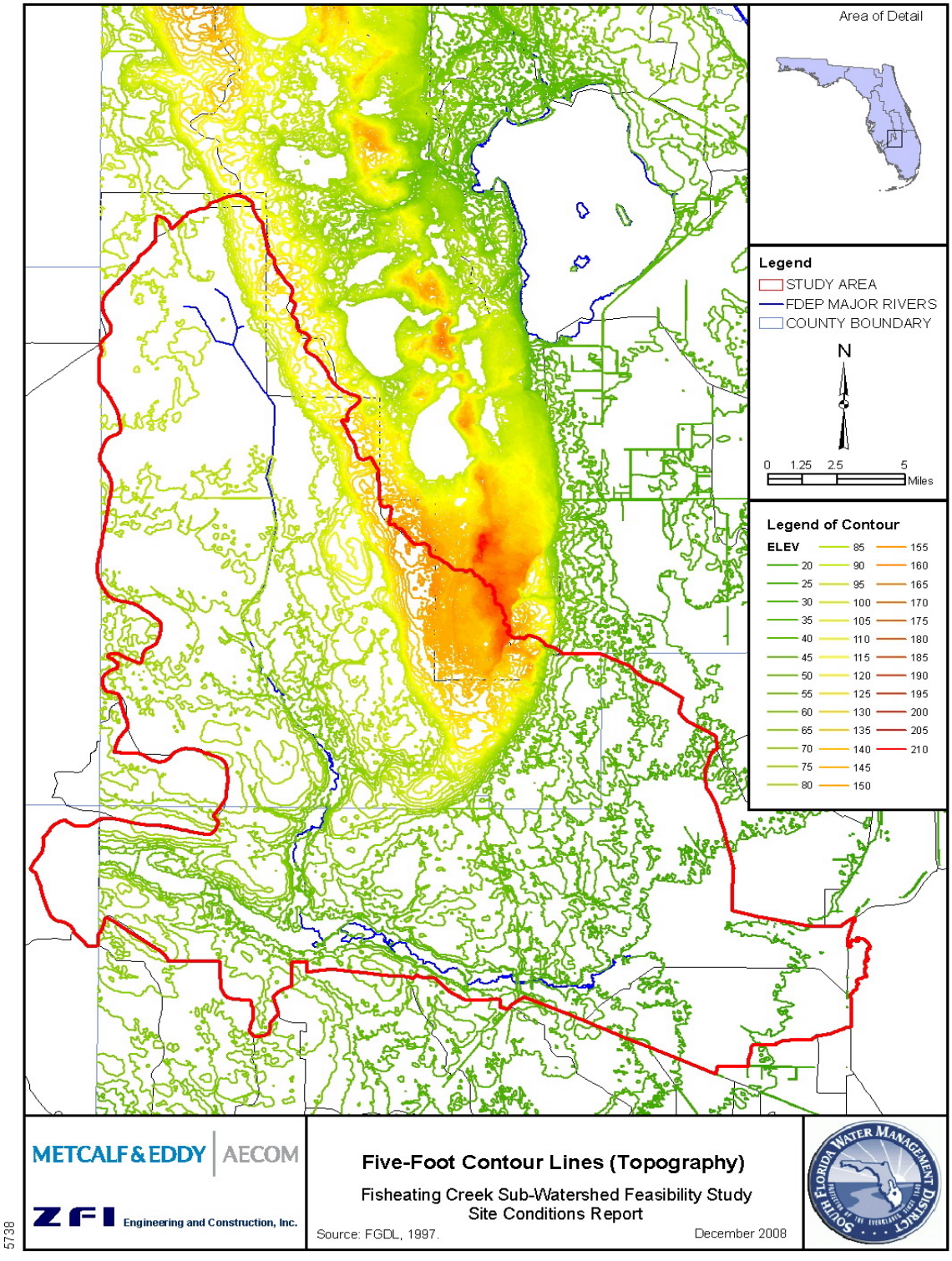


Figure 47. Five-Foot Contour Lines (Topography)

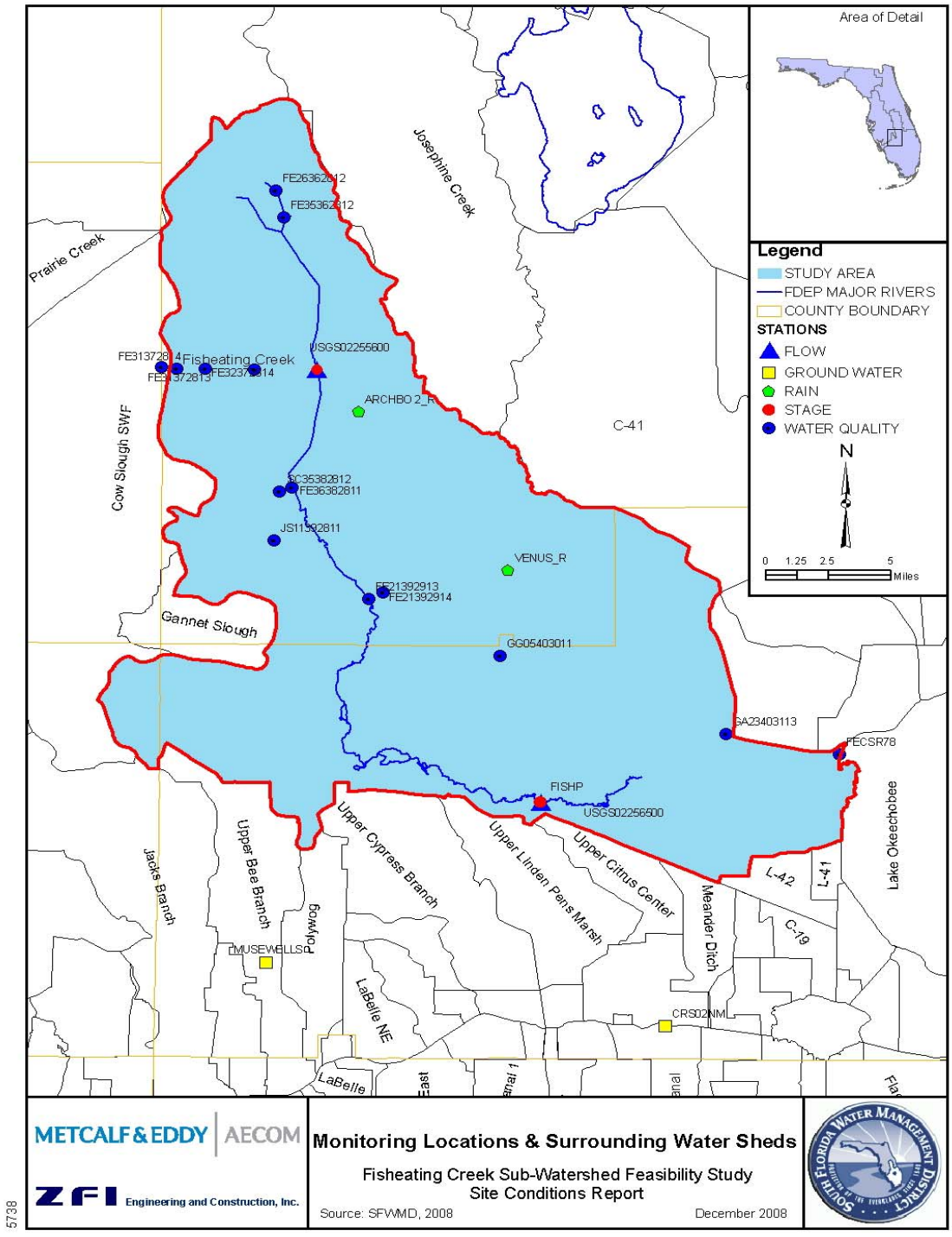


Figure 48. Monitoring Locations & Surrounding Watersheds

5.6.2 Hydrological Characteristics

Rainfall

The general rainfall distribution for the Study Area is assessed using the annually averaged monthly rainfall for the period from 1991 to 2008. The monthly averaged rainfall volumes of a specified month are extracted from all years of the data period, and are averaged to generate the annually averaged rainfall data for the specified month. The result, as shown in, demonstrates a typical central Florida rainfall distribution pattern: the dry season lasts from November to April; the rainy season ranges from June to September; and the transition months between the dry and wet seasons are May and October. In average, more than 40% of annual precipitation is generated during rainy season months.

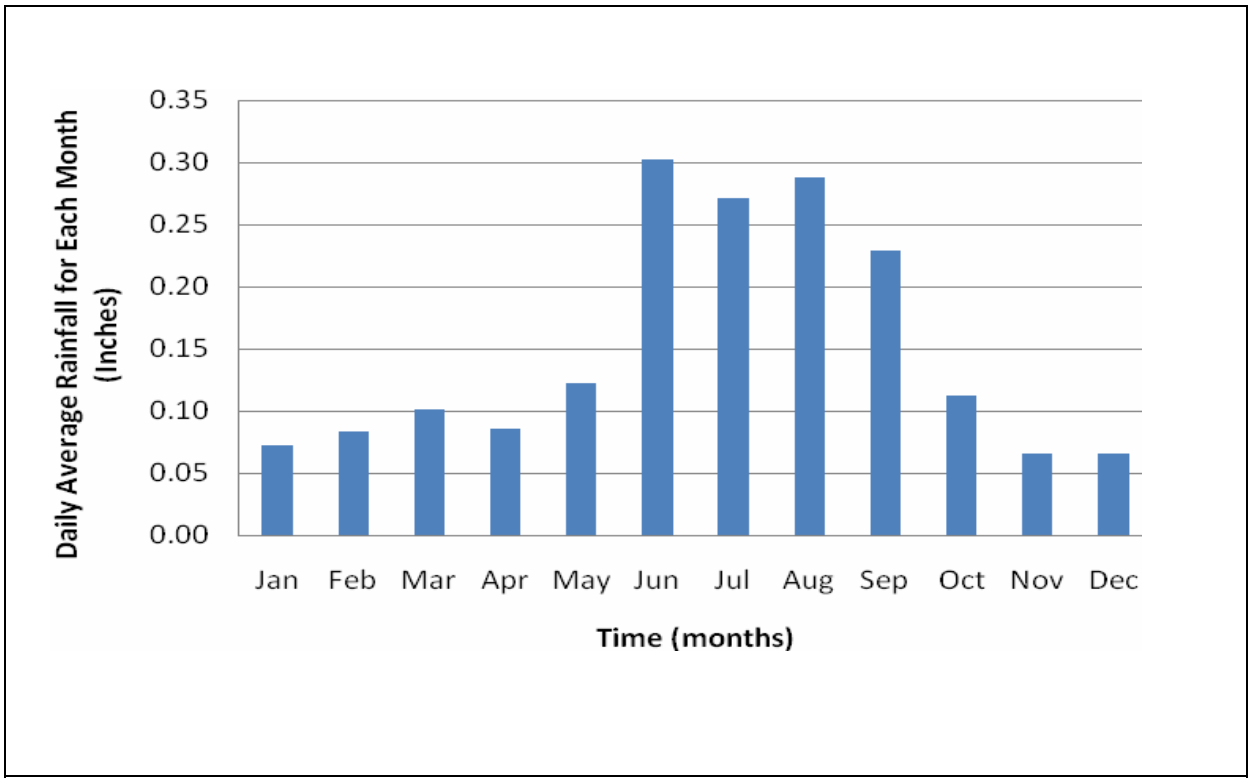


Figure 49. Annually Averaged Monthly Rainfall (SFWMD DBHYDRO (DBKey 16604) 1991-2008)

Stage

Figure 50 shows the monthly averaged creek water level recorded at the SFWMD FISHP station from Year 1991 to Year 2008. The stage data depicted a strong seasonal variation pattern during summer/autumn months. During most years, the creek water level was observed to reach its peak value during July and August. Water level was observed to gradually decrease from October through March and reach an annual low during April or May.

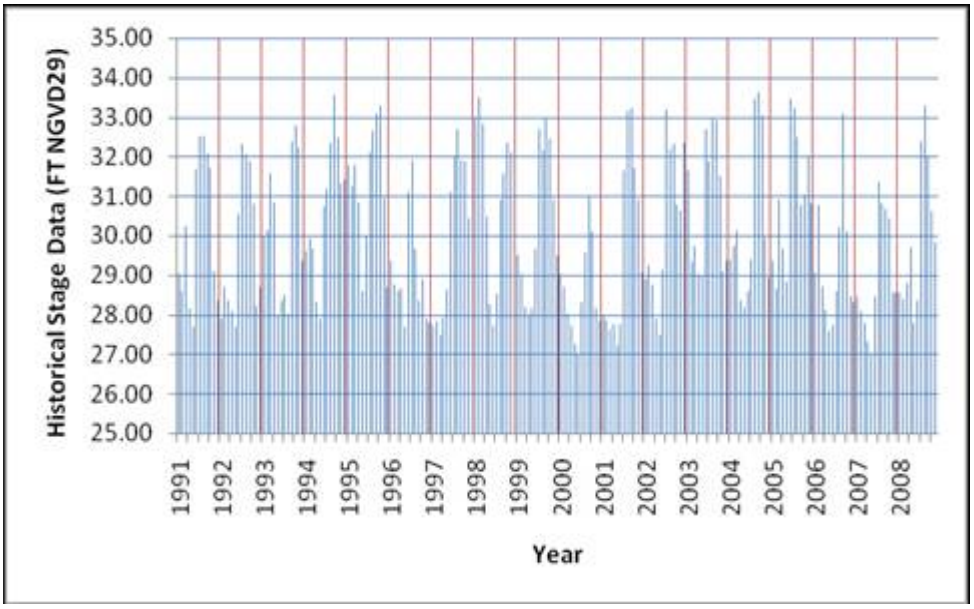


Figure 50. Monthly Averaged Stage Data Measured at FISHP Station (SFWMD DBHYDRO (DBKey 00088) 1991-2008)

The patterns of water levels in the creek were observed to be inconsistent from year to year. Water levels in winter/spring months for some years (e.g., years 1993, 1995, 1998 and 2003) were significantly higher than the winter/spring water levels in other years (e.g. years 1997, 2001 and 2007). Swamps and wetlands near the southern boundary of the sub-watershed play an important role of controlling water level and its temporal variation along the creek water course. Analysis of the relationship between FEC rainfall and stage indicates a well-correlated response during its ascending process, but poor correlation in the stage recession process. Hydrologic characteristics of wetlands, such as duration/frequency of hydro-periods and level of inundation affect the water level fluctuation of the FEC.

The FEC reached its extreme low water level stage in June 2000, May 2001 and May 2007. Given the datum of Station FISHP to be 27.19 feet NGVD, the monthly averaged water levels at

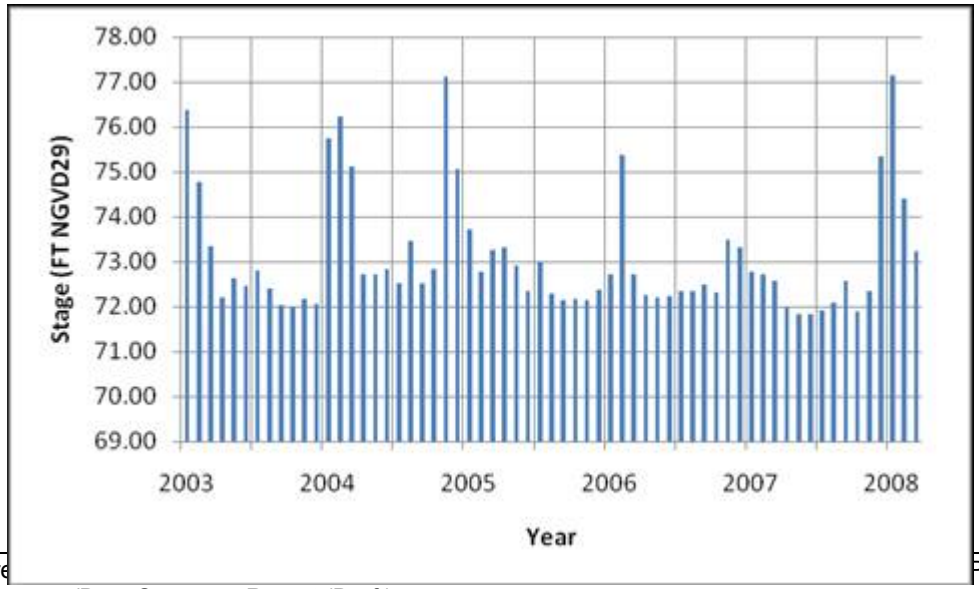
the monitoring station were 27.02 feet NGVD, or 0.17 feet below the datum, in June 2000; 27.22 feet NGVD in May 2001; and 27.00 feet NGVD in May 2007. The occurrence of the FEC's 2007 drought is consistent with that of the Lake Okeechobee drought as water levels of both water bodies reached their extreme lows in the same year. Year 2007 was a historically dry year in the whole Central and South Florida region. The two recorded low water level stages of FEC (2000 and 2001) also corresponded to extreme low water levels in Lake Okeechobee for the same calendar years.

High stage values at FISHP will result in flooding over the low-lying area. At stage elevation of 33 feet NGVD, a large swamp area downstream to FISHP (including Nicodemus Slough Area) will be flooded as shown in **Figure 52.** The topographic map indicates that the upstream section of the FEC sub-watershed is not as susceptible to flooding as the southern section of the sub-watershed.

Stage measurement at the USGS stage and flow monitoring station USGS 02255600 is plotted in **Figure 51**. The station, located at the intersect of the FEC and SR 70, is operated by the USGS. The monitoring data have not been stored in the District DBHYDRO.

The seasonal variation pattern of stage can be observed from the plot although the data span is limited. The averaged stage level in 2007 is considerably lower than comparing with other years, indicating the drought year occurred over the whole sub-watershed. Weak correlations of stage variation between the upstream monitoring station and the downstream FISHP can be observed by comparing the magnitude of stage variations. The wetlands marshes in downstream reaches of the FEC may attenuate high flows and prolong water level variation.

Figure 51. Monthly Averaged Stage Data Measured at USGS02255600 (USGS, 2008)



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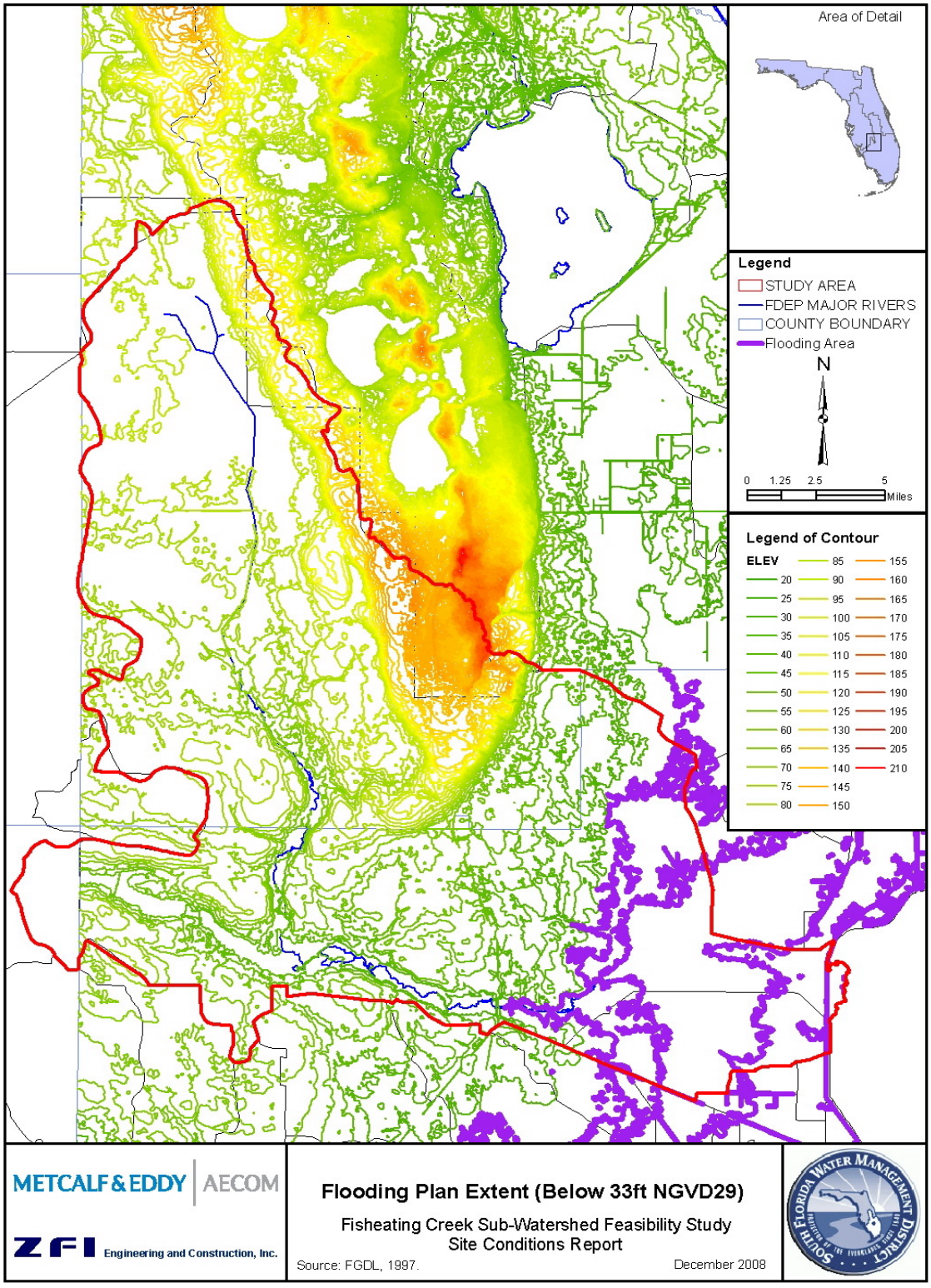

Figure 52. Flooding Plan Extent

Flow

The monthly averaged flow rate recorded at FISHP station is plotted in **Figure 53**. During many winter/spring months, water flow along the FEC was low and undetected. However, in January, February, and March of 1998, high flows occurred together with abnormally high stage levels. During this winter/spring period, a series of heavy rain events were recorded within the FEC sub-watershed. The maximum event rainfall volume during this period ranged from 2.21 inches to 3.25 inches, which is considered to be high precipitation in Central Florida during winter/spring months.

Year 2000 and Year 2007 were two drought years for the FEC sub-watershed. Both monthly flow distribution and the cumulative total water volume reached an extreme low. Flow and stage distributions are consistent in these two years.

The monthly averaged flow rate recorded at USGS02255600 is plotted in **Figure 54**. Although the flow data indicates that all recorded heavy runoff events occurred in wet season months (in 2005 and 2008), meaningful seasonality of flow variation is not depicted due to the length of data period and drought years of 2006 and 2007.

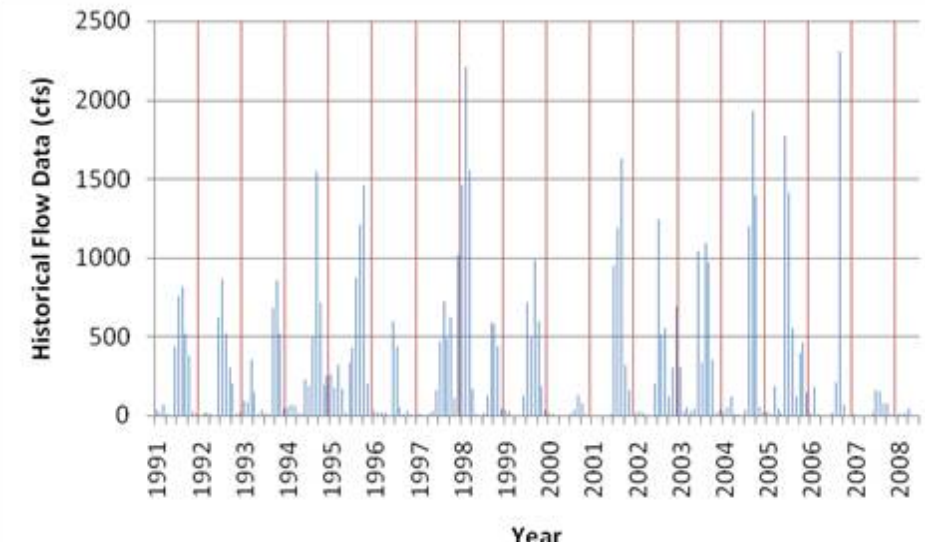

Figure 53. Monthly Averaged Flow Data Measured at FISHP Station (SFWMD DBHYDRO (DBKey 15627) 1991-2008)

Also because of the length of data span, correlation of flow rates between the USGS 02255600 station and the FISHP station cannot be clearly observed. In 2005, the maximum monthly average flow rate recorded at the USGS station was 500cfs, which is approximately one-third of flow rate recorded at FISHP (1750cfs) in the same month. However, the maximum flow at the

USGS 02255600 recorded in 2006 (200cfs) is less than one-tenth of the maximum flow recorded at FISHP (2300 cfs).

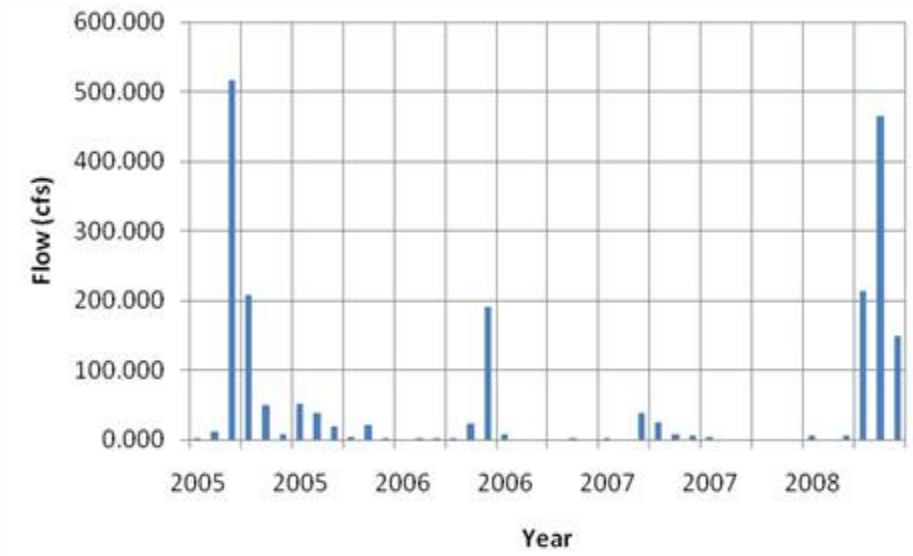

Figure 54. Monthly Averaged Flow Rate Recorded at the USGS02255600 Station (USGS, 2008)

Groundwater

The aquifer systems underneath the FEC sub-watershed consist of surficial, intermediate, and Floridan aquifers.

The thickness of surficial aquifers in the region is generally less than 100 feet. Surface water and groundwater interactions may happen in the surficial aquifers where groundwater continuously moves along the hydraulic gradient from areas of recharge to places of discharge. Surficial aquifers are recharged locally, and the water-table fluctuates in response to drought or rainfall. Affected by highlands of Lake Wales Ridge and broad wetlands marshes, surface drainage conditions such as canal base-flow and surface water retention of the FEC sub-watershed may be influenced considerably by groundwater movement in surficial aquifers. In the northern section of the sub-watershed, groundwater recharge from the Lake Wales Ridge would affect the canal base-flow and agriculture water use; while in the southern section, groundwater flow and water table fluctuation control wetland hydrology such as duration, frequency, and extent of inundation.

The Floridan aquifer is a portion of the principal artesian aquifer which covers the southeast United States and extends into Florida. Groundwater in the Floridan aquifer is contained under

pressure by a confining bed of impermeable sediments. When the water pressure is high enough, the groundwater breaks to the surface and forms spring flows. Although fresh water from the Floridan aquifer supplies water needs to numerous towns and rural communities, deep wells in Floridan aquifer are not found in the FEC sub-watershed in the study area. Most wells used for agricultural irrigation are shallow wells in the surficial aquifer.

Intermediate aquifers are comprised of limestone beds and lie between the surficial and Floridan aquifers. Approximately 10 % of fresh water is stored in intermediate aquifers.

A groundwater monitoring network has not been established in the FEC sub-watershed. For other water supply and groundwater quality studies, the SFWMD and other state and municipal agencies have established a number of groundwater wells in the Lake Wales Ridge area and in other surrounding sub-watersheds. Groundwater level series collected at 3 stations (CRS02 NW (DBKey L7449), Musewells (DBKey15239 and 15240)) located south of the FEC sub-watershed, are plotted in **Figure 55**, and demonstrate groundwater variation in areas close to the sub-watershed. **Figure 48** shows the location of these stations.

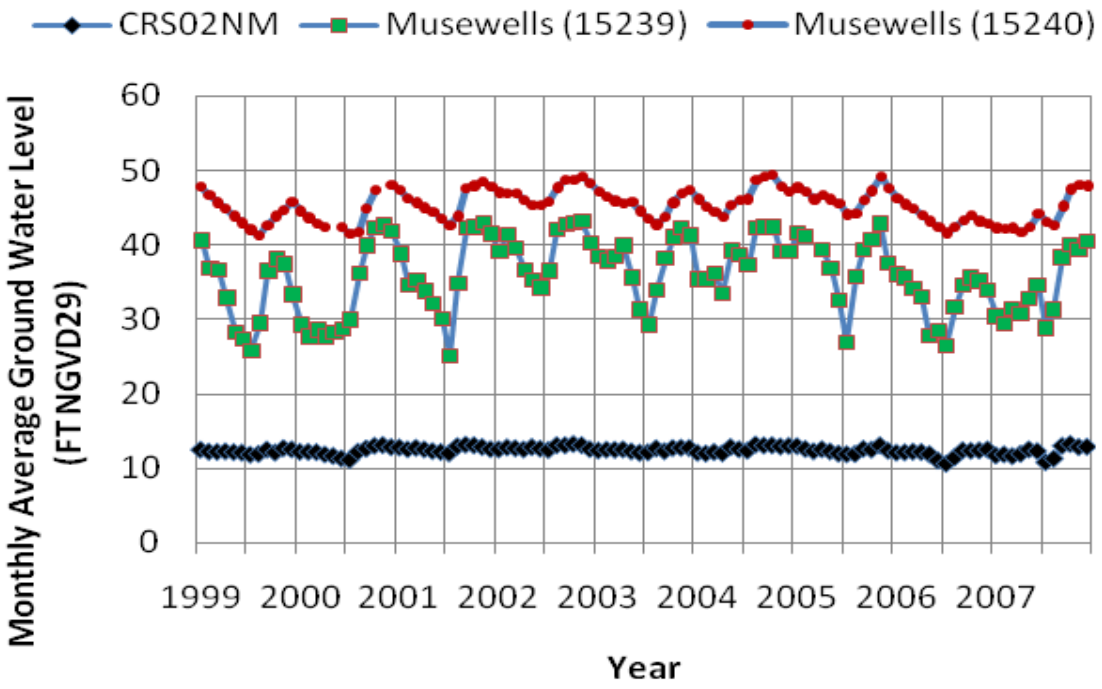

Figure 55. Monthly Average Groundwater Levels Recorded at Monitoring Wells South to the Sub-Watershed

The three monthly averaged groundwater level series show consistent fluctuation patterns, but with different magnitudes depending on well locations. In most years, groundwater levels dropped to their annual low in the months of June to July while reaching their annual high in August to October. The groundwater level variation recorded at the Musewells Station may represent the agricultural water supply pattern, as both wells are located in agriculture land. Groundwater pumping for irrigation in dry-season months and surface recharge due to rainfall in wet season resulted in water table fluctuations.

Similar water table variation patterns may occur over the agricultural areas of the FEC sub-watershed. However, the groundwater resources in the northern portion of the FEC sub-watershed may also be affected by surficial aquifer recharge from the Lake Wales Ridge. Groundwater levels over wetlands, swamps and forest lands in the southern portion of the sub-watershed are most likely different from areas containing Musewells Station. Further groundwater analysis within the FEC sub-watershed would require the installation of both deep and shallow monitoring wells at different FEC sub-watershed locations.

5.6.3 Water Quality Analysis

The Lake Okeechobee total phosphorous total maximum daily load (TMDL) of 140 mt was adopted by the State of Florida in May 2001 (Chapter 62-304.700, F.A.C.). In 2002, the annual measured phosphorous load to Lake Okeechobee was 543 mt. The five-year moving average phosphorous load monitored from 1998 to 2002 was 554 mt, which exceeded the Lake Okeechobee TMDL by 414 mt. This five-year moving average included the lowest measured historical load (169 mt in 2000), due to the worst drought in recent history; and the largest measured load in the past decade (780 mt in 1998) during a very wet year. The water quality data applied for the above analysis in the Lake Okeechobee Protection Plan (LOPP) is an aggregate dataset comprised of multi-point spatial data to present the regional water quality conditions.

The Study Area (FEC sub-watershed and Nicodemus Slough) is listed as problematic source of total phosphorous to Lake Okeechobee. As summarized in the LOPP using water quality data collected from 1991 to 2000, the FEC contributes approximately 9.4% of the Total P load received by the Lake (**Error! Reference source not found.**).

Table 13. Contribution of Inflows and P Loads from FEC and Nicodemus Slough to the Lake Okeechobee (LOPP) Period of Record of Data (1991 – 2000)

Basin Name	Watershed Area (acre)	Average Annual Discharge (acre-ft)	Ave. Annual P Load (mt)
Fisheating Creek	289,366	200,766	40.97
Nicodemus Slough	25,641	3,371	0.25
Lake Okeechobee Total	3,451,086	2,246,336	433.09
FEC / Lake Okeechobee %	8.38%	8.94%	9.46%
Nicodemus Slough / Lake Okeechobee %	1.00%	0.002	0.06%

Error! Reference source not found. shows the averaged annual P loads (40.97 mt for Fisheating Creek 0.25 mt for Nicodemus Slough) under the baseline conditions (year 1991-2000) of LOPP. The base period is determined to present the historical conditions right before the start of LOPA in 2000 (LOPP, FDEP, 2004). These averaged annual P loads do not represent the annual variation of the P loads which may be much higher than the averaged annual loads. For example, P loads of the dry year of 2000 (less than 5 mt) are significantly different from the wet year of 2001 (about 100 mt) due to the variation of surface runoffs. For the restoration and planning purpose, consideration of P loads of individual years would be more important than averaged annual P loads over a period of multiple years as rainfall and evapotranspiration in the region shows fluctuations from year to year.

Phosphorous loads of a sub-watershed are usually estimated by flow measurements and water quality sampling data taken at the outlet structure of that sub-watershed. At most major structures discharging to Lake Okeechobee and at selected tributary flow/stage monitoring stations, the SFWMD has installed integrated water quality monitoring systems and flow meters. However, a water quality monitoring station has not been installed at the hydrologic station FISHP where both flow and stage values are recorded. The estimate of total phosphorous loads from the FEC sub-watershed to Lake Okeechobee is herein developed by using water quality data monitored at the creek's outlet, at the SFWMD's Station FECSR78. The annual total phosphorous loads are provided in **Figure 56**. P Loads are estimated using the FISHP flow data and the FECSR78 water quality data.

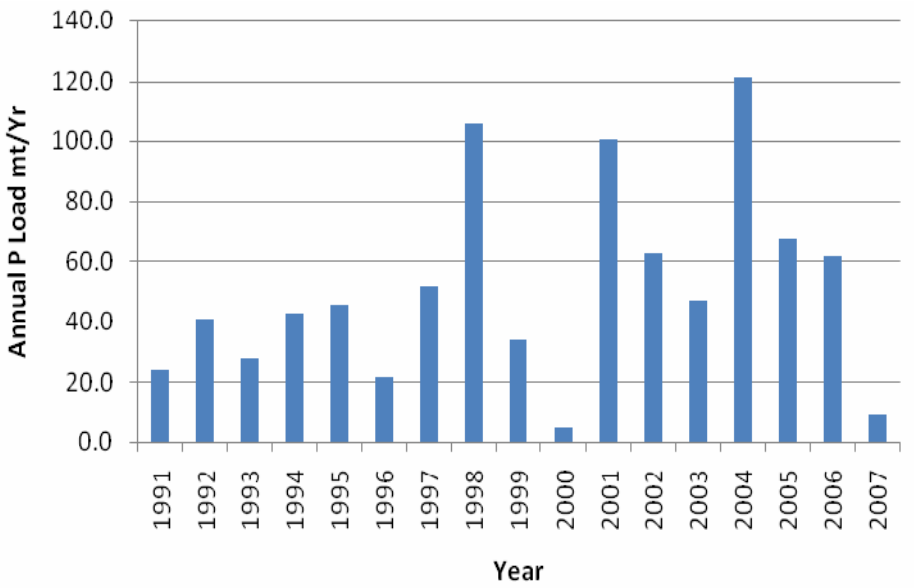

Figure 56. Annual Total Phosphorous Loads from the FEC Sub-Watershed to Lake Okeechobee (SFWMD DBHYDRO (Station FECSR78 and FISHP) 1991-2007)

The phosphorous loads from the FEC sub-watershed are correlated with the discharge flow rates. Low levels of phosphorous loads occurred in drought years 2000 and 2007, while high levels of phosphorous loads happened in wet years of 1998 and 2004. Phosphorous loads in the sub-watershed are primarily generated at non-point sources due to agricultural land uses. Surface water runoff and agricultural discharge are major means of phosphorous load generation.

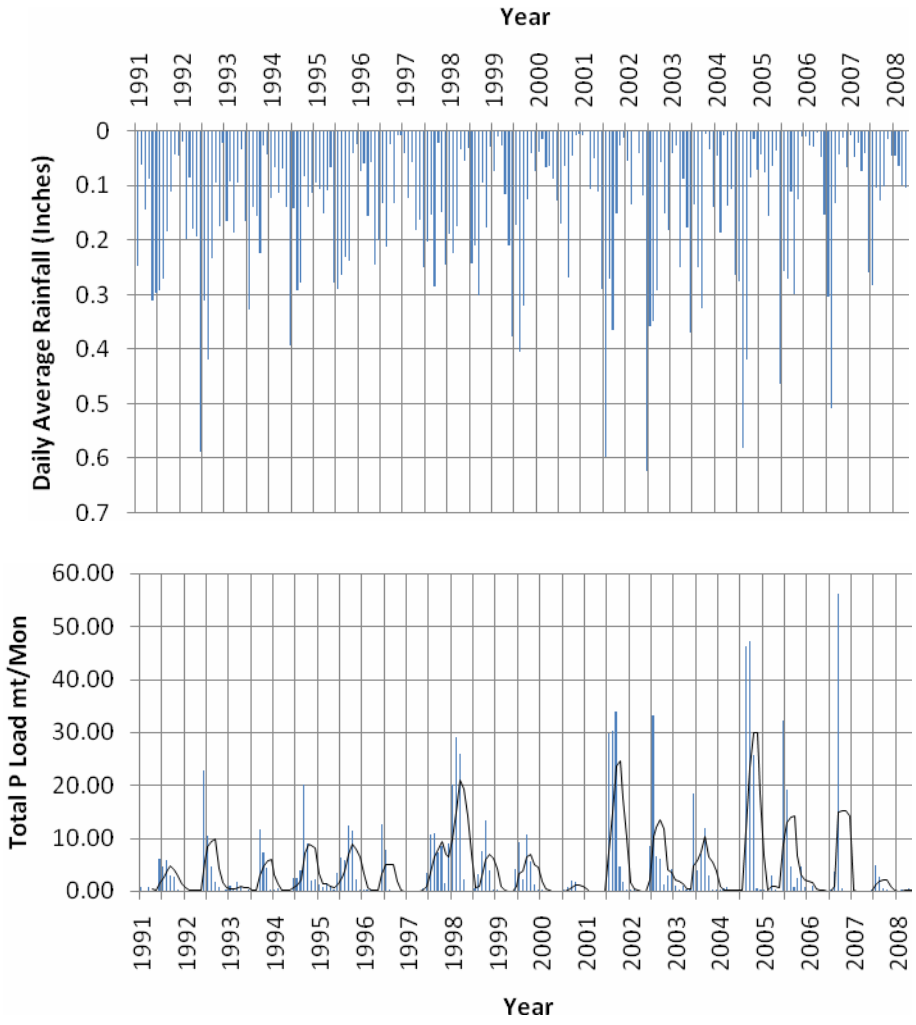

Figure 57. Monthly Averaged Rainfall and Phosphorous Loads Around FISHP Station
(SFWMD DBHYDRO (Station ARCHBO 2_R, FECSR78 and FISHP) 1991-2008)

The correlation between phosphorous loadings and hydrological conditions also exists in the relation of rainfall and phosphorous loads. **Figure 57** presents monthly averaged rainfall and phosphorous loads around FISHP station for the period from 1991 to 2008. As shown in the 12-month moving average on the P load series, in years with higher rainfall higher phosphorus loads are observed. This is due to more phosphorus being flushed from the sub-watershed during these higher rainfall events. Peak values of phosphorous loads occurring slightly later than the rainfall peaks is also observed on **Figure 57**.

The phosphorous loads generated from the agricultural non-point sources in the upstream section of the FEC sub-watershed are estimated by using the flow measurement data at USGS02255600 station and water quality data sampled at FE36382811 Station. The results are plotted in **Figure 58**.

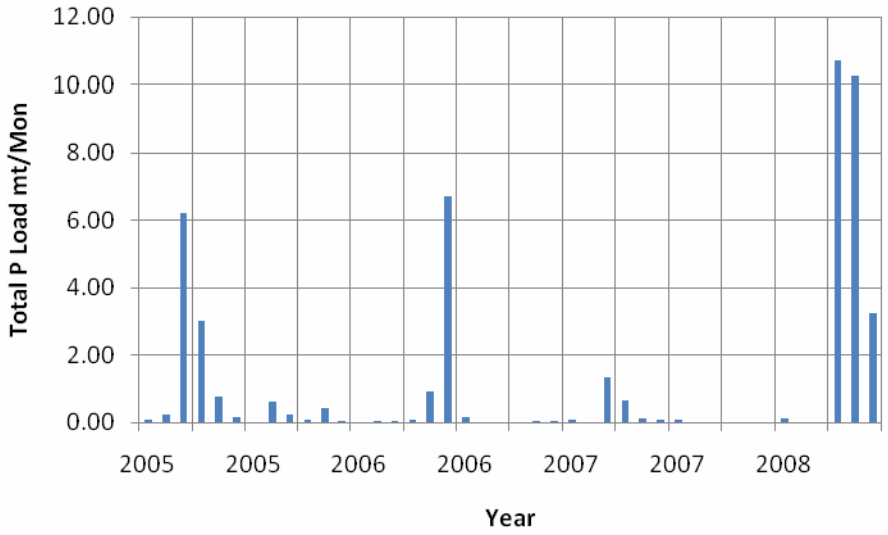

Figure 58. Total Phosphorous Loads in the Upstream Stream Section (SFWMD DBHYDRO (Station FE36382811) and USGS (Station 02255600) 1991-2008)

5.7 Land Ownership and Water Use Permit

The land ownership and current water use permits within the Fisheating Creek Sub-Watershed Area and Nicodemus Slough (Study Area) are presented in this Section. Land ownership information for Glades County was obtained from the 2001 Plat Maps and for Highlands County was obtained from 2003 Plat Maps and the Highlands County Property Appraiser Website (Highlands Property Appraiser, 2008). Water Use information was obtained from the SFWMD website through the "Application & Permit Information Database" (SFWMD, 2008a).

5.7.1 Land Ownership

Figure 59 presents the approximate location of properties and identifies the names of the owners with areas equal or greater than 640 acres (1 sq. mi.) within the Study Area. The landowners that have less than one square mile within the Study Area are identified as "Other Landowners" on the figure. Lykes Brothers Inc. is the major owner of the southern portion of the Study Area (43%); and Blue Head Ranch is the major owner of the northwestern portion of the

Study Area (18%). State, FDEP, SFWMD are also shown in **Figure 59**, and they represent 2% of the Study Area. **Table 14** lists all the owners that possess land areas equal or greater than one square mile within the Study Area and their respective percentage.

Table 14. FEC Landownership Map

Landowner	Ownership Percentage (%)
Atlantic Blue (Blue Head Ranch)	18.36
Baker	0.33
Braha	0.33
Bullrich	0.25
CFI USA	0.52
Carlton	2.72
Florida Game	0.40
Heart Groves	0.31
Henscratch (Highland Farms)	0.68
J&D Hendrie	0.48
J&J Hendrie	1.81
Lykes Brothers, Inc.	42.93
Pella	0.42
Perry Brothers	0.31
Smoak	2.78
Southern Farms	0.90
Trochet	0.40
Waldron Daphne	0.77
Westby	3.25
XL	0.29
TIITF and SFWMD	1.67
Other Land Owners	14.64
Not Available	5.47

5.7.2 Water Use Permit

Landowners are required to obtain a Water Use Permit from the SFWMD to withdraw a specified amount of water, either from the ground, a canal, a lake or a river.

The water can be withdrawn for a public water supply; for agriculture, nursery plants or golf courses; or for industrial processes. Certain users are not required to obtain a water use permit, such as, single family homes or duplexes, fire fighting water wells, salt water use or reclaimed water use (SFWMD, 2008b).

Information on water permits awarded by the SFWMD from 1978 to 2008 was gathered, summarized and analyzed. The complete data obtained from the SFWMD water use permit database is provided in **Appendix A**, including expired permits.

These data are for Township/ Range blocks located within the Fisheating Creek Sub-Watershed and Nicodemus Slough (Study Area). For those blocks that are partially within the study area, all the sections in the block are included in this study, therefore, some of the water use permits are outside of the study area.

There are 88 active water use permits within the Study Area, with their total project area estimated in approximately 50,000 acres. Since the water use permit area analyzed has a total area of approximately 510,000 acres; the active water use permits represent serving 10% of the total area. The water use permits data obtained from the SFWMD website do not list the allowed withdrawal for every permit; therefore, the permitted withdrawal daily flow is not presented in this report.

Most of the project areas that obtain water use permits are designated to agricultural use (64%); followed by livestock (26%). The remaining 10% of the project areas are used for public water supply, landscape, nurseries, and industrial uses among others.

The Florida Aquifer seems to be the main source of water within the Study Area (47%), followed by Onsite and SFWMD Canals with 28% of the project area being served by them; however due to the lack of permitted flow information for all the water use permits, this statement may be confirmed when this information is made available.

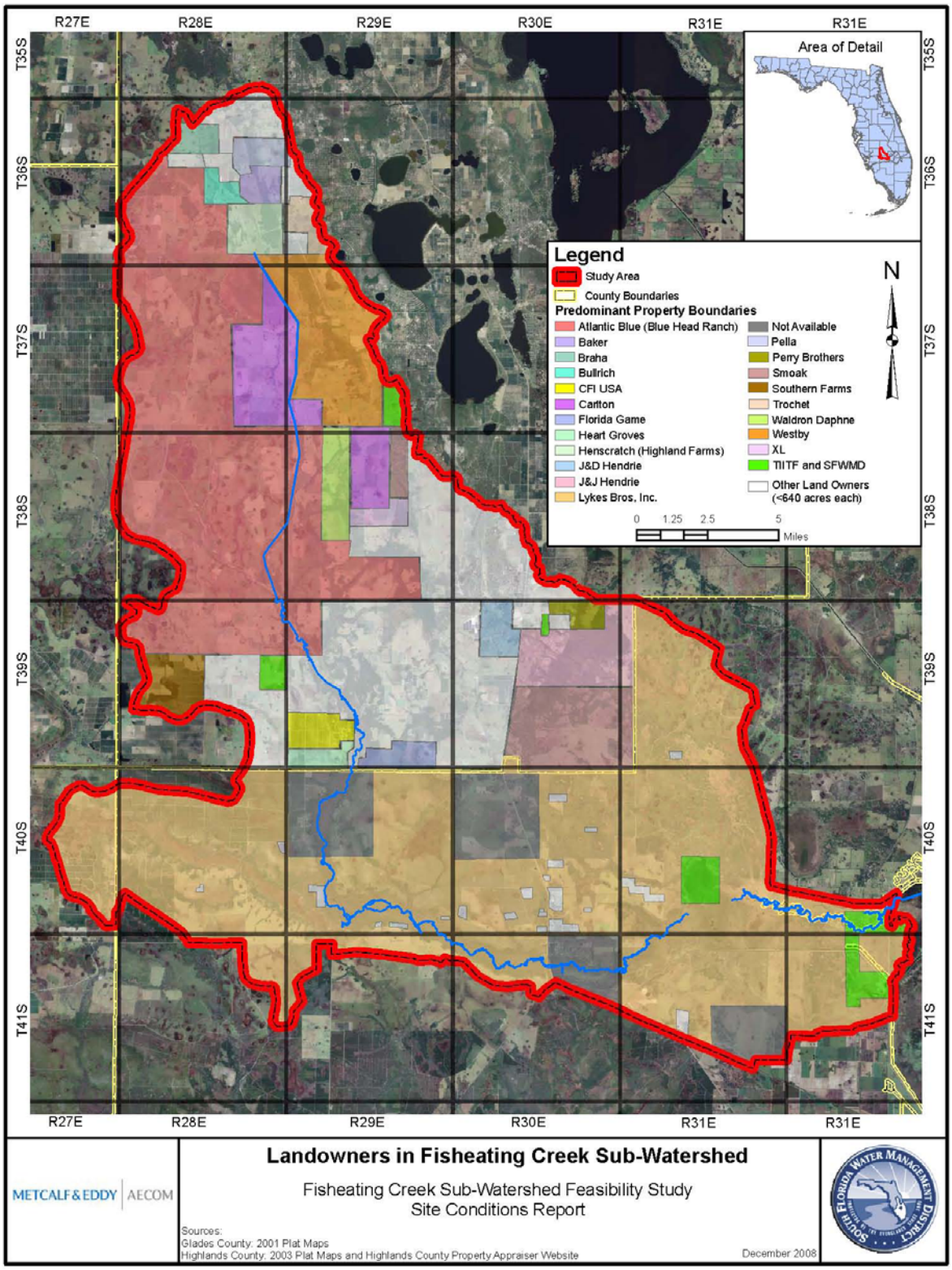
R27E
R28E
R29E
R30E
R31E
R31E
T35S
T36S
T37S
T38S
T39S
T40S
T41S
Area of Detail
Legend
Study Area
County Boundaries
Predominant Property Boundaries
Atlantic Blue (Blue Head Ranch)
Baker
Braha
Bullrich
CFI USA
Carlton
Florida Game
Heart Groves
Henscratch (Highland Farms)
J&D Hendrie
J&J Hendrie
Lykes Bros, Inc.
Not Available
Pella
Perry Brothers
Smoak
Southern Farms
Trochet
Waldron Daphne
Westby
XL
TIITF and SFWMD
Other Land Owners (<640 acres each)
N
0 1.25 2.5 5
Miles
Landowners in Fisheating Creek Sub-Watershed
Fisheating Creek Sub-Watershed Feasibility Study
Site Conditions Report
Sources:
Glades County: 2001 Plat Maps
Highlands County: 2003 Plat Maps and Highlands County Property Appraiser Website
December 2008
METCALF & EDDY | AECOM
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Figure 59. Landownership Map of FEC Study Area

5.8 Vegetation, Wetlands and Floodplains

The sections below discuss vegetation, wetlands, and floodplains located in the Fisheating Creek watershed. These resources were identified based on the following:

- US Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) data layers;
- USGS topographic mapping
- Results of the aerial flyover of the site on October 7, 2008;
- A reconnaissance survey to some of the publicly accessible portions of the watershed on October 28, 29, and 30, 2008;
- Flood elevation data from FEMA online FIRM maps;
- Information available on the Florida Fish and Wildlife Conservation Commission (FWC), Florida DEP (FDEP), and USFWS websites;
- Previous SFWMD Reports discussing natural resource conditions in the watershed

The Fisheating Creek watershed includes a combination of pristine natural vegetation areas as well as areas with vegetation substantially altered due to cattle ranching, pine plantations, and citrus production. Vegetation types present include freshwater marsh, upland hammock, wet prairie and grazed ranchland in the upper reaches of the watershed, and a mosaic of floodplain forest, freshwater marsh, wet and dry prairie, upland tree hammocks and pine/palmetto upland in the lower reaches of the watershed (FWC, undated and 2008a; FDEP, 2008; Audubon, 2002). Ranchland and citrus production areas are also located in the lower reaches of the watershed.

The headwaters of Fisheating Creek are located in Highlands County, approximately 40 miles to the northwest of Lake Okeechobee **(Figure 47** and **Appendix B).** The creek flows south through Highlands County, crossing under State Route (SR) 70 before it enters Glades County. Approximately 5 miles south of the county line, the creek crosses SR 731 and then makes a sharp turn to the east and continues towards SR 27. Rainey Slough enters Fisheating Creek from the west in the general area where the creek turns to the east towards SR 27. Approximately five miles east of SR 27, Fisheating Creek enters Cowbone Marsh and then discharges to Lake Okeechobee.

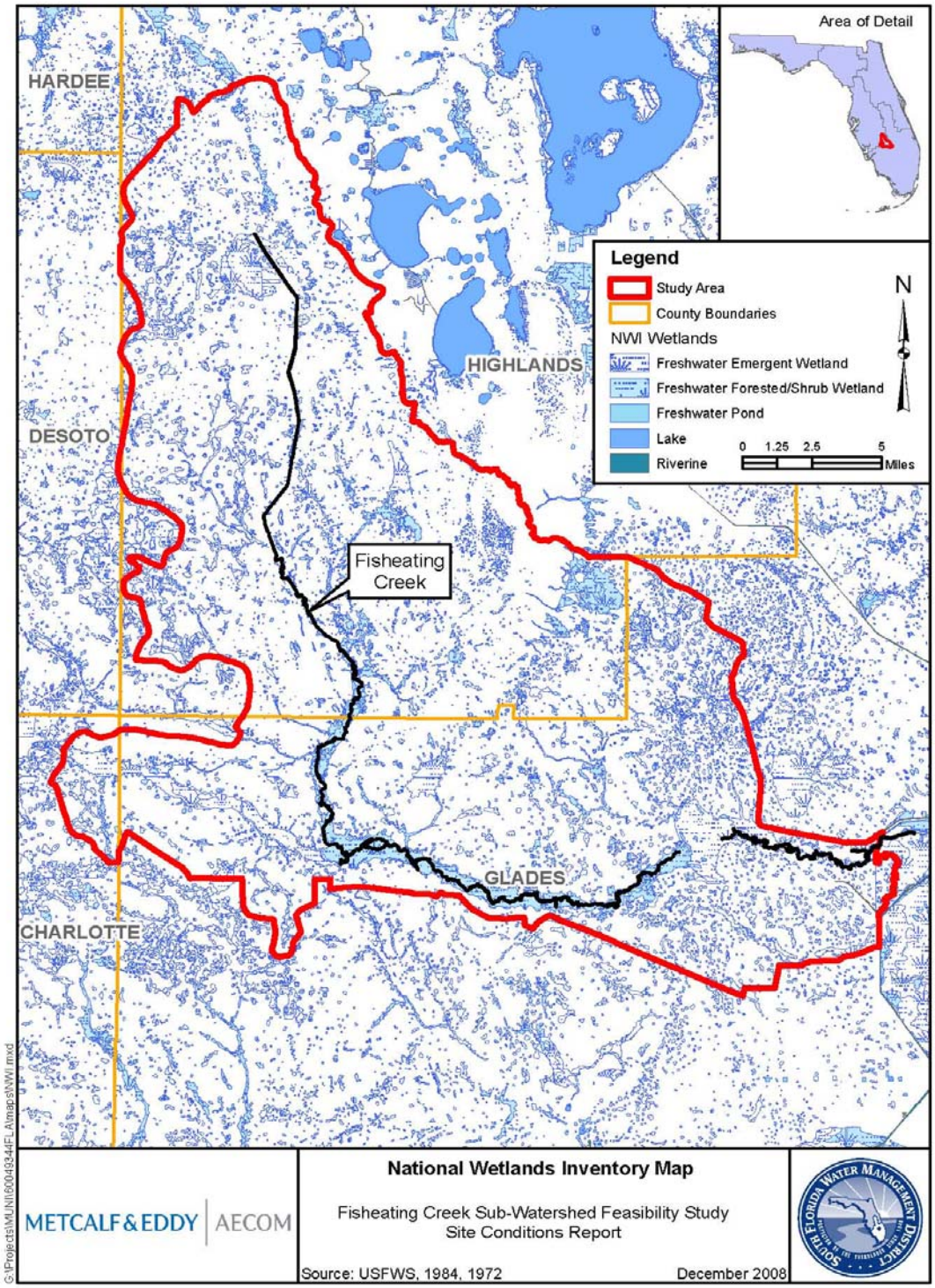

Figure 60. FEC Sub-Watershed Study Area Wetland Map

Fisheating Creek itself is classified as riverine from just below its headwaters to approximately two miles south of SR 70; at the locations where it crosses SR 731 and SR 27; and in a few other sporadic locations between SR 731 and Cowbone Marsh. The NWI indicates no discernible channel or riverine characteristics present within Cowbone Marsh, and that the channel returns on the western side of the marsh and continues to Lake Okeechobee **(Figure 60 and Appendix C)**.

The USGS topographic map indicates that the far northern areas of the watershed, where the headwaters of the creek are located, include vast areas of marsh bisected by a system of drainage ditches and canals **(Figure 47 and Appendix B).** The NWI map identifies this area as predominantly upland, with a mosaic of small palustrine emergent wetlands and a linear ridge of forested wetland along the eastern side of the watershed **(Figure 60 and Appendix C)**. The USGS maps were created in 1953, with some updates incorporated based on aerial photographs and local knowledge gathered in 1984, but not field verified. The NWI data layer was created from 1984 data. It is likely that a more extensive marsh system existed in the upstream headwaters of Fisheating Creek in 1953 than were present in 1984 or in the current time. The extensive network of drainage ditches has likely served to effectively drain much of a previously larger marsh area to reduce it to an area now intermingled with wet and dry prairie and upland forest.

The NWI and USGS topographic maps both show a large palustrine emergent wetland area over 600 acres in size adjacent to either side of the beginning of the stream channel known as Fisheating Creek. This area was observed in October 2008 and a variety of wetland plants were evident, including pickerelweed (*Pontederia cordata*), cattail (*Typha* spp.), rush (*Juncus* spp.) and sedge (*Carex* spp) species (**Figure 61)**. All these are typical of South Florida marshes and expected to represent the species present in many of the smaller emergent wetlands identified by the NWI as scattered throughout the watershed. It is within this marsh that the stream channel identified as Fisheating Creek is first noted. Within this marsh and further south the channel of Fisheating Creek has been channelized, and is bordered on either side by relatively high banks of presumably dredged material ranging up to heights of ten feet or greater above the creek bed **(Figure 62).** Much of the water surface of Fisheating Creek in this area is vegetated by water hyacinth (*Eichornia crassipes*) **(Figure 63).**

The area immediately south of the creek headwaters and adjacent marshes is dominated by cattle ranches on which vegetation has been altered by historic ditching and draining as well as current cattle grazing **(Figure 64).** These land cover types extend south throughout much of the lower watershed in its outer portions away from the channel and floodplain wetlands along Fisheating Creek. Large tracts within this portion of the watershed consist predominantly of grazed grasses and dog fennel (*Eupatorium capillifolium*) intermingled with numerous interspersed pockets of emergent marsh and wet prairie. The NWI map characterizes these

Figure 61. Large Marsh Adjacent to Upstream Portion of Fisheating Creek, View to the North

Figure 62. Channelized Portion of FEC Just South of Headwaters, View to the North

Figure 63. Water Hyacinth in Fisheating Creek Channel, View to the South

1228

1249 **Figure 64. Cattle Grazing, View Towards the East**

portions of the watershed as predominantly upland, with a mosaic of both large and small palustrine emergent wetlands present throughout. Species observed in these pocket wetlands included pickerelweed, cattail, sedge and rush species. Other species characteristic of marshes and wet prairies that may be present would include sawgrass (*Cladium jamaicense*), spikerush (*Eleocharis* spp.), starrush whitetop (*Rhynchospora colorata*), beak sedges (*Rhynchospora* spp.), and wetland grasses (*Panicum* spp.)(Lodge, 2005). Stands of upland forest are also sporadically present along the margins and interiors of ranch fields, including oak (*Quercus* spp.) and pine (*Pinus* spp.), palmetto (*Serenoa repens*), cabbage palm (*Sabal palmetto*), and frequent Spanish moss (*Tillandsia usneoides*).

In the general vicinity of where Fisheating Creek crosses CR 731, the creek returns to a more natural, unchannelized condition. The portion of Fisheating Creek between the county line and Cowbone Marsh is part of a Florida Fish and Wildlife Conservation Commission (FWC) Wildlife Management Area. This area is dominated by native vegetation, although FWC reports that invasive plants are present in some areas, including climbing fern (*Lygodium microphyllum*) and wetland nightshade (*Solanum tampicense*; FWC, undated). The NWI classifies the area within a one-half to one-mile width adjacent to the creek as palustrine scrub-shrub/forested wetland (PSS/PFO) along this entire stretch of the creek until it reaches Cowbone Marsh east of SR 27 (**Figure 65**). The vegetation adjacent to Fisheating Creek in this area includes an extensive and majestic cypress swamp **(Figure 666).** Dominant species in the floodplain forest along the creek include bald cypress (*Taxodium distichum*), willow (*Salix caroliniana*), red maple (*Acer rubrum*), sweet bay (*Magnolia virginiana*), wax myrtle (*Myrica cerifera*), and cabbage palm. The WMA includes substantial populations of three plants endemic to central Florida Edison's ascyrum (*Hypericum edisonianum*), cutthroat grass (*Panicum abscissum*), and nodding pinweed (*Lechea cernua*) (FDEP, 2008).

Numerous sloughs and smaller tributary creeks are present throughout the lower half of the watershed, between approximately SR 731 and SR 27, including Rainey Slough, Joe Slough, John Henry Slough, Gannett Slough, and Clay Slough, all of which enter Fisheating Creek from the west **(Figure 47** and **Appendix B).** Rainey Slough is the largest of these, originating in Charlotte County and covering an area of over 14 miles in length and approximately 0.5 miles in width. A variety of wetland plants were observed in this area on the day of the reconnaissance visit, including cattail, sawgrass, pickerelweed, and alligator flag (*Thalia geniculata*) **(Figure 67)**. This area is characterized by features associated with a typical slough, including slow moving, relatively shallow water lacking a well defined channel. Each of the smaller sloughs throughout the watershed was not observed, but would be expected to have similar hydrology and vegetation characteristics.

Bootleg Creek and the Platt Branch both enter Fisheating Creek from the east in the vicinity of SR 731 **(Figure 47** and **Appendix B).** Bootleg Creek drains an extensive forested wetland

Figure 65. Fisheating Creek Crossing at SR 731, View to the North

Figure 66. Cypress Swamp Along Lower Reaches of Fisheating Creek, View to the North

Figure 67. Rainey Slough, View to the West

complex in the mid-eastern portion of the watershed between Fisheating Creek and SR 17. This area was not accessible during the site visit, but would be expected to include tree and shrubs typical of forested wetlands throughout South Florida, including many of those described above in the floodplain forest adjacent to Fisheating Creek.

Much of the outer margins of the lower watershed away from the Fisheating Creek channel and adjacent floodplain forest is similar to that described above for the upper reaches, and contains numerous small, interspersed wetlands identified as palustrine emergent wetlands by the NWI **(Figure 60** and **Appendix C).** These are wet prairie and freshwater marsh wetlands similar to those described above, and are interspersed with grazed and ungrazed dry prairie as described above for the upper reaches of the watershed. Other vegetation cover types present in the outer margins of the watershed in its lower reaches include upland hammock forest vegetated by live oak (*Quercus virginiana*) and cabbage palm and pine/palmetto upland, vegetated by slash pine (*Pinus elliotti*), cabbage palm, and palmetto.

Once entering Cowbone Marsh, no discernible channel for Fisheating Creek is denoted on the USGS or NWI map. Cowbone Marsh is classified as PEM by the NWI and is over 600 acres in size. Species typical of a Florida marsh are present, including cattail, sedges, rushes, pickerelweed, and others (**Figure 688**). The watershed in the vicinity of Cowbone Marsh

narrows considerably as the creek nears Lake Okeechoobee, due to the presence of the Herbert Hoover Dike along the northern and southern boundaries of Cowbone Marsh. After exiting Cowbone Marsh, the creek crosses underneath Route 78 in multiple channels and continues towards Lake Okeechoobee. Vegetation east of Route 27 along the floodplain associated with the creek includes scrub-shrub species, including willow and wax myrtle (**Figure 69**).

Floodplains are located along the length of Fisheating Creek, along Rainey Slough, and along the smaller tributaries and sloughs entering Fisheating Creek and throughout the marsh and ditched areas forming the creek headwaters (**Figure 70**). The Federal Emergency Management Agency (FEMA) has not established an elevation for the 100-year floodplain in the watershed. Areas predicted to flood typically follow the topography of the creek and bordering wetlands and sloughs, and form an extensive network throughout the entire watershed. The northeastern portion of the watershed in Highlands County in the vicinity of SR27 and SR17 are the only areas lacking extensive floodplains.

There are several sites in the Fisheating Creek Watershed where degraded wetlands have been restored as part of the USDA Wetland Reserve Program. Information regarding the locations of these sites has been requested via a Freedom of Information Act Request. Once this information is received, it will be used as part of the subsequent phases of the project

Figure 688. Cowbone Marsh Emergent Wetland Vegetation East of SR 78, View to the West

Figure 69. Fisheating Creek Channel Downstream of Cowbone Marsh, with Scrub-Shrub Wetland Habitat in Background, View to the East

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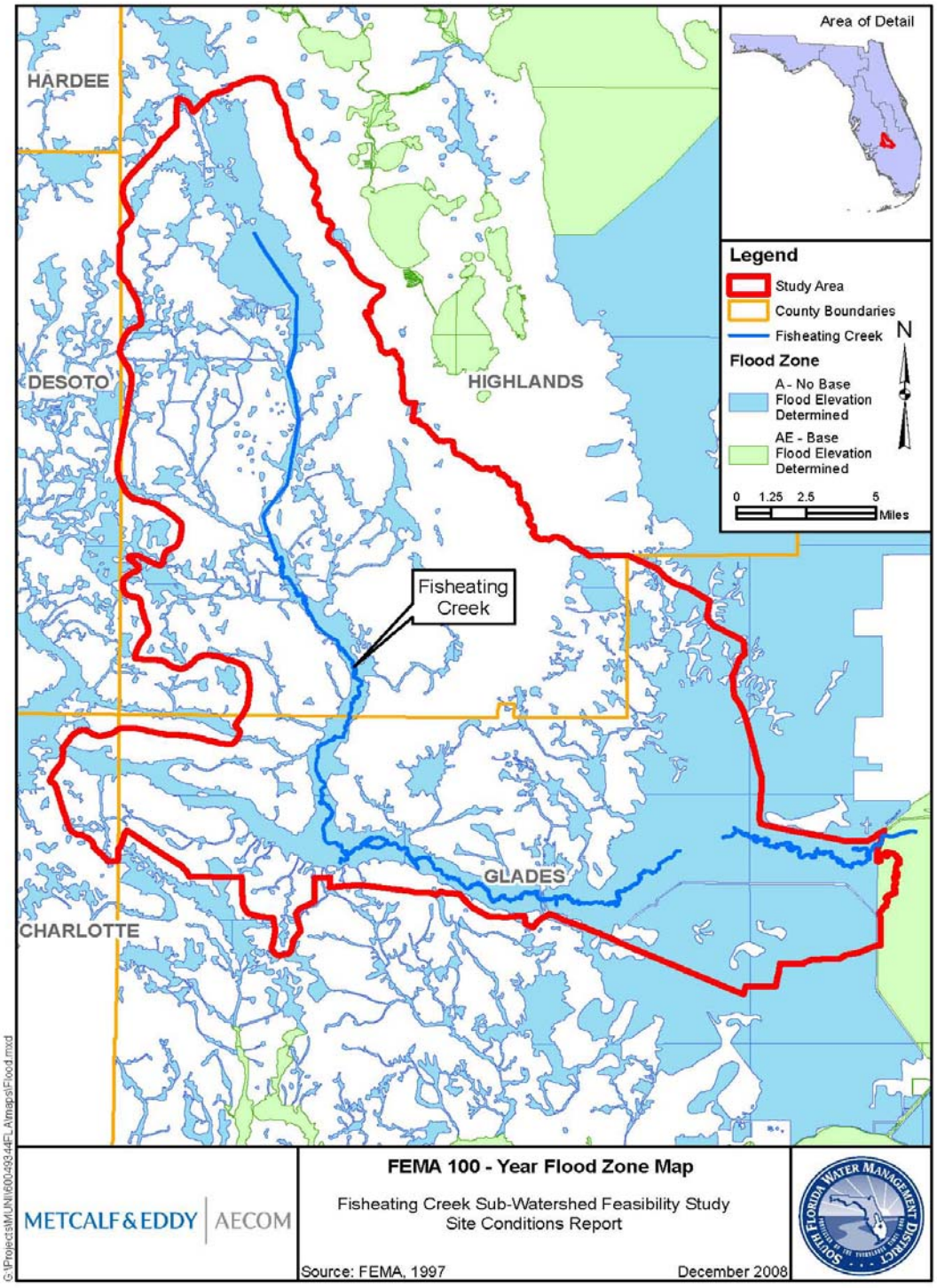

Figure 70. FEC Sub-Watershed Study Area 100-year Flood Zone Map

5.9 Fish and Wildlife

The Fisheating Creek watershed supports a diverse and abundant array of fish and wildlife species, including many endangered and threatened species (see **Section 5.10**). There is no single comprehensive published document describing the fish and wildlife resources, although many state and federal agencies and local experts have extensive knowledge of the fish and wildlife resources present. The information describing the faunal resources of the watershed is summarized below based on information available from the following sources:

- A reconnaissance survey to some of the accessible portions of the watershed on October 28, 29, and 30, 2008;
- Information available on the Florida Fish and Wildlife Conservation Commission (FWC), Florida DEP (FDEP), and U.S. Fish and Wildlife Service (USFWS) websites;
- Previous SFWMD Reports discussing natural resource conditions in the watershed

5.9.1 Fisheries Resources

Stream habitat along the length of Fisheating Creek, Bootleg Creek, Platt Branch and the many sloughs present in the watershed provide a high diversity of aquatic habitat for fish. Freshwater fishes are able to occupy several habitats in the watershed, including marshes, stream channels, sloughs, oxbows, submerged hardwood forests, and seasonal ponds during flooding events. Fish species occurring in the watershed include a variety of resident native species such as largemouth bass, crappie, catfish, and bream in addition to introduced species such as armored catfish and tilapia (FWC, undated; **Table 15**). Although few published data regarding fish species present in the watershed are available, many other common freshwater fish that are known to occur in Lake Okeechobee and throughout the Everglades would also be expected to occur in the habitats of the Fisheating Creek watershed, including gar, sunfishes and a variety of other fish species such as those listed in **Table 15**. Forage species are likely abundant in the watershed, including minnows, such as the golden shiner and pugnose minnow, sailfin molly, golden topminnow, flagfish, and mosquitofish (**Table 15**; Lodge, 2005). These species are extremely important as they form the base of the food chain that supports higher tropic levels (Lodge, 2005).

5.9.2 Wildlife Resources

Abundant and diverse wildlife resources are present within the Fisheating Creek watershed including many species of reptiles, mammals, and bird species. The lower portion of the watershed is largely within the FWC's Fisheating Creek Water Management Area (WMA)(**Figure 71**).

Table 155. Fish Species Potentially Present in the Fisheating Creek Sub-Watershed Study Area

Common Name	Scientific Name
Florida Gar	*Lepisosteus platyrhincus*
Bowfin (mudfish)	*Amia calva*
Golden shiner	*Notemigonus crysoleucas*
Coastal shiner	*Notropis petersoni*
Lake chubsucker	*Erimyzon sucetta*
Yellow bullhead (butter cat)	*Ameiurus natalis*
Tadpole madtom	*Noturus gyrinus*
Walking catfish	*Clarias batrachus*
Sheepshead minnow	*Cyprinodon variegatus*
Golden topminnow	*Fundulus chrysotus*
Marsh killifish	*Fundulus confluentus*
Seminole killifish	*Fundulus seminolis*
flagfish	*Jordanella floridae*
Bluefin killifish	*Lucania goodei*
Pike killifish	*Belonesox belizanus*
Eastern mosquitofish	*Gambusia holbrooki*
Least killifish	*Heterandria formosa*
Sailfin molly	*Poecilia latipinna*
Everglades pygmy sunfish	*Elassoma evergladei*
Bluespotted sunfish	*Enneacanthus gloriosus*
Warmouth	*Lepomis gulosus*
Bluegill (bream)	*Lepomis macrochirus*
Dollar sunfish	*Lepomis marginatus*
Redear sunfish (shellcracker)	*Lepomis microlophus*
Spotted sunfish (stump-knocker)	*Lepomis punctatus*
Largemouth bass	*Micropterus salmoides*

Swamp darter	*Etheostoma fusiforme*

(Source: Lodge, 2005)

The watershed is known to provide habitat for a variety of snake species, including cottonmouth (*Agkistrodon piscivorous conanti*) , dusky pygmy rattlesnake (*Sistrurus miliarius barbour*), eastern diamond rattlesnake (*Crotalus adamanteus*), and eastern indigo snake (*Drymarchon corais couperi*) (FWC, 2008a; FDEP, 2005).

Alligators (*Alligator mississippiensis*) are abundant in the watershed, and a crocodile (*Crocodylus acutus*) has been documented in the Fisheating Creek WMA. During the reconnaissance survey two alligators were observed in Fisheating Creek in the WMA near the junction with US 27, and are likely abundant throughout the watershed's creeks, marshes, sloughs, and hammocks. Numerous invertebrate and amphibian species are likely present throughout the watershed, including snails, crayfish, grass shrimp, dragonflies, frogs, tree frogs, and toads (Lodge, 2005).

A variety of both large and small mammals inhabit the watershed, including black bear (*Ursus americanus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), white-tailed deer (*Odocoileus virginianus*), river otter (*Lutra canadensis*), armadillo, raccoon (*Procyon lotor*), and opossum (*Didelphis virginiana*)(FWC, 2008a). Numerous other small mammal species are likely present, including short-tailed shrew (*Blarina brevicauda*), rabbit (*Sylvilagus* spp.), squirrel (*Sciurus* spp.), cotton mouse (Peromyscus gossypinus), skunk (*Mephitis mephitis*), mink (*Mustela vison mink*), and others (Lodge, 2005). Florida panther (*Felis concolor coryi*) has also been documented in the watershed (FWC, 2008a). Although the primary habitat areas are currently located to the south **(Figure 71)**, the area near Fisheating Creek is thought to provide habitat important for the recovery of the panther in Florida (FDEP, 2008d) The FWC designated primary and secondary range for black bear both extend into the watershed north and east of Fisheating Creek **(Figure 71)**. Feral boar, an introduced species, is also present in the watershed (FWC, undated) and was observed during the reconnaissance survey.

Fisheating Creek and its watershed supports an extremely high diversity of bird species, including those listed in **Table 16**, and has been designated as an Important Bird Area by the Audubon Society (Audubon, 2002). The WMA is a key location for swallow-tailed kites migrating to their wintering locations in South America; half of the U.S. population is reported to utilize the habitat here during their migration (FWC, 2008a; USACE/SFWMD/HDR, 2006). Their communal roosting area is located in the vicinity of Cowbone Marsh (FWC, undated). Numerous other species are common in the area, including Florida scrub jay, crested carcara, snail kite, ducks, hawks, bald eagle, warblers, herons, egrets, wood storks, osprey, wild turkey and many others **(Table 16)**. Numerous bald eagle nests have been recorded in and around the WMA, as well as in the upper watershed **(Figure 71)**. Although much of the high value wildlife

habitat in the watershed is concentrated in the WMA centered on the creek itself, many of the species discussed above occur throughout the watershed. Wood storks, herons, egrets, and other bird species were also observed in the upper reaches of the watershed in the vicinity of ranchland during the reconnaissance survey.

In 2008 the FWC developed a GIS tool to assist planners and decision-makers in identifying important wildlife habitat throughout the state of Florida (FWC, 2008b). This tool ranks land areas in terms of their relative importance for wildlife within the state based on a number of factors, including land uses, potential wildlife habitat for listed and non-listed species with known habitat requirements, greenway data, and existence of land under conservation protection or in need of such protection. The resulting data ranks land areas on a scale from 1, least important, to 10, most important, in terms of their value for wildlife. The results for the Fisheating Creek watershed are shown in **Figure 72.** and indicate that much of the watershed is extremely valuable for wildlife, which received ranking predominantly higher than a value of 5 throughout its boundaries. The lower watershed in the vicinity of the WMA was ranked with values of 9 and 10, indicating that this area is extremely valuable for wildlife. Although the upper reaches generally received lower rankings, they were still primarily over 5, indicating that much of the watershed, including managed ranchland, has very high wildlife value.

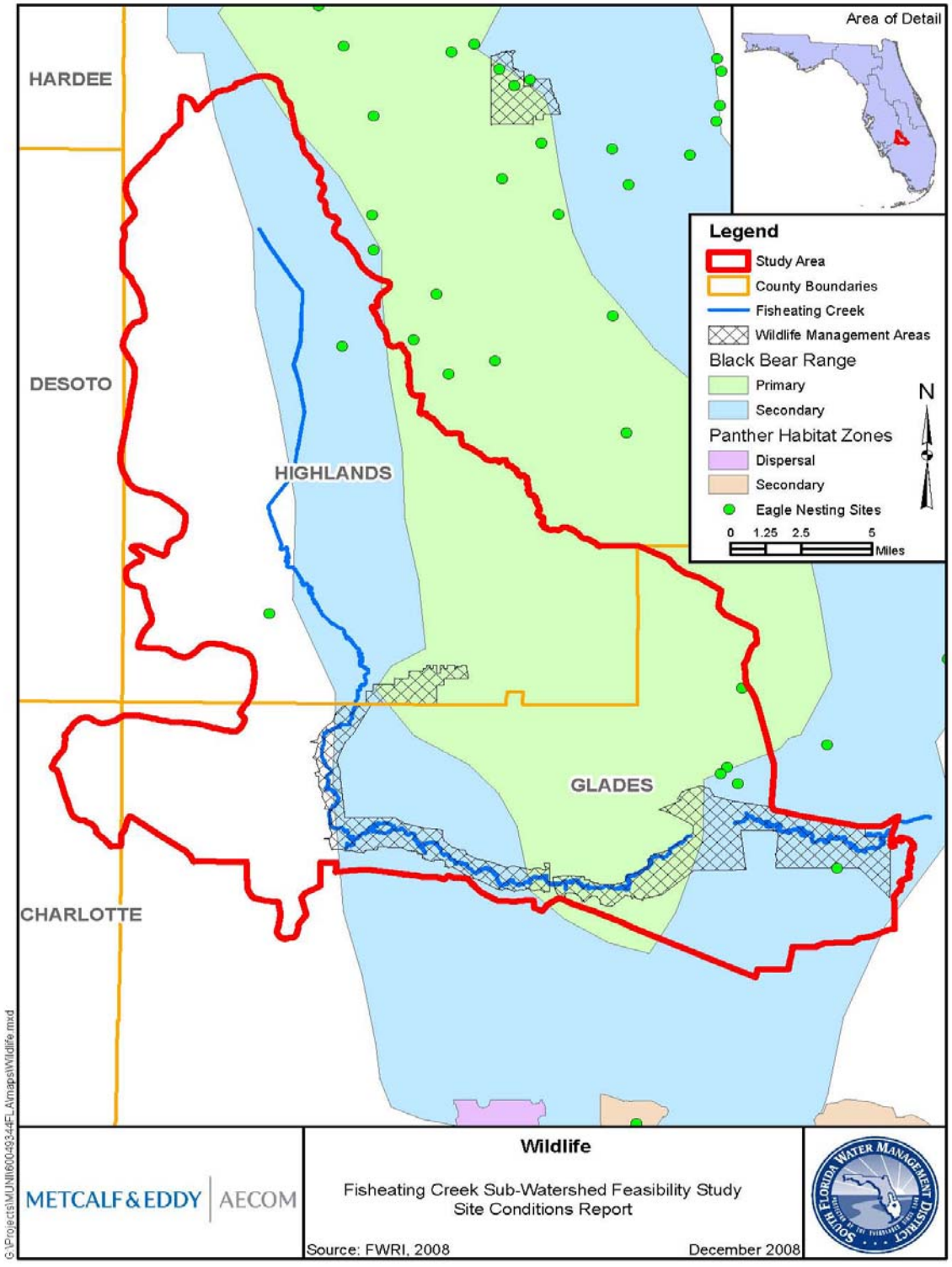

Figure 71. Wildlife in FEC Sub-Watershed Study Area

Table 166. Bird Species Present in the Fisheating Creek Watershed Study Area

Common Name	Scientific Name
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Double-crested Cormorant	*Phalacrocorax auritus*
Anhinga	*Anhinga anhinga*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night Heron	*Nycticorax nycticorax*
White Ibis	*Eudocimus albus*
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartes aura*
Snow Goose	*Chen caerulescens*
Wood Duck	*Aix sponsa*
Mottled Duck	*Anas fulvigula*
Bluewinged Teal	*Anas discors*
Ring-necked Duck	*Aythya collaris*
Hooded Merganser	*Lophodytes cucullatus*
Osprey	*Pandion haliaetus*
Swallow-tailed Kite	*Elanoides forficatus*
Snail Kite	*Rostrhamus sociabilis*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Short-tailed Hawk	*Buteo brachyurus*
Red-shouldered Hawk	*Buteo lineatus*

Table 166. Bird Species Present in the Fisheating Creek Watershed Study Area

Red-tailed Hawk	*Buteo jamaicensis*
Common Name	**Scientific Name**
American Kestrel	*Falco sparverius*
Wild Turkey	*Meleagris gallopavo*
Northern Bobwhite	*Colinus virginianus*
Purple Gallinule	*Porphyrio martinica*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Limpkin	*Aramus guarauna*
Sandhill Crane	*Grus canadensis*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularius*
Wilson's Snipe	*Gallinago delicata*
American Woodcock	*Scolopax minor*
Mourning Dove	*Zenaida macroura*
Common Ground-Dove	*Columbina passerine*
Eurasian Collared Dove	*Streptopelia decaocto*
White-winged Dove	*Streptopelia reichenowi*
Yellow-billed Cuckoo	*Coccyzus americanus*
Barn Owl	*Tyto alba*
Eastern Screech Owl	*Megascops asio*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Common Nighthawk	*Chordeiles minor*
Chuck-will's-widow	*Caprimulgus carolinensis*
Chimney swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-cockaded Woodpecker	*Picoides borealis*
Red-bellied Woodpecker	*Melanerpes carolinus*

Table 166. Bird Species Present in the Fisheating Creek Watershed Study Area

Common Name	Scientific Name
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Wood-Pewee	*Contopus virens*
Acadian Flycatcher	*Empidonax virescens*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Loggerhead shrike	*Lanius ludovicianus*
White-eyed Vireo	*Vireo griseus*
Yellow-throated Vireo	*Vireo flavifrons*
Red-eyed Vireo	*Vireo olivaceus*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Fish Crow	*Corvus ossifragus*
Purple Martin	*Progne cryptoleuca*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Barn Swallow	*Hirundo rustica*
Florida Scrub-Jay	*Aphelocoma coerulescens*
Tufted Titmouse	*Baeolophus bicolor*
Carolina Wren	*Thryothorus ludovicianus*
House Wren	*Troglodytes aedon*
Marsh Wren	*Cistothorus palustris*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Eastern Bluebird	*Sialia sialis*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*

Table 166. Bird Species Present in the Fisheating Creek Watershed Study Area

Common Name	Scientific Name
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
European Starling	*Sturnus vulgaris*
Common Name	**Scientific Name**
Northern parula	*Parula americana*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow Warbler	*Dendroica petechia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow- rumped Warbler	*Dendroica coronata*
Yellow-throated Warbler	*Dendroica dominica*
Pine Warbler	*Dendroica pinus*
Prairie Warbler	*Dendroica discolor*
Palm Warbler	*Dendroica palmarum*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Prothonotary Warbler	*Protonotaria citrea*
Ovenbird	*Seiurus aurocapilla*
Northern Waterthrush	*Seiurus noveboracensis*
Common Yellowthroat	*Geothlypis trichas*
Summer Tanager	*Piranga rubra*
Eastern Towhee	*Pipilo erythrophthalmus*
Bachman's Sparrow	*Aimophila aestivalis*
Savannah Sparrow	*Passerculus sandwichensis*
Swamp Sparrow	*Melospiza Georgiana*
Florida Grasshopper Sparrow	*Ammodramus savannarum*
Northern Cardinal	*Cardinalis cardinalis*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Common Grackle	*Quiscalus quiscula*

Table 166. Bird Species Present in the Fisheating Creek Watershed Study Area

Boat-tailed Grackle	*Quiscalus major*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
American Goldfinch	*Carduelis tristis*
Common Name	**Scientific Name**
Crested Caracara	*Caracara cheriway*
Wood Stork	*Mycteria Americana*
Ring-billed Gull	*Larus delawarensis*
Rock Pigeon	*Columba livia livia*

1456 (Source: FWC, 2006, FWC 2007, FDEP 2008 and Audubon 2002)

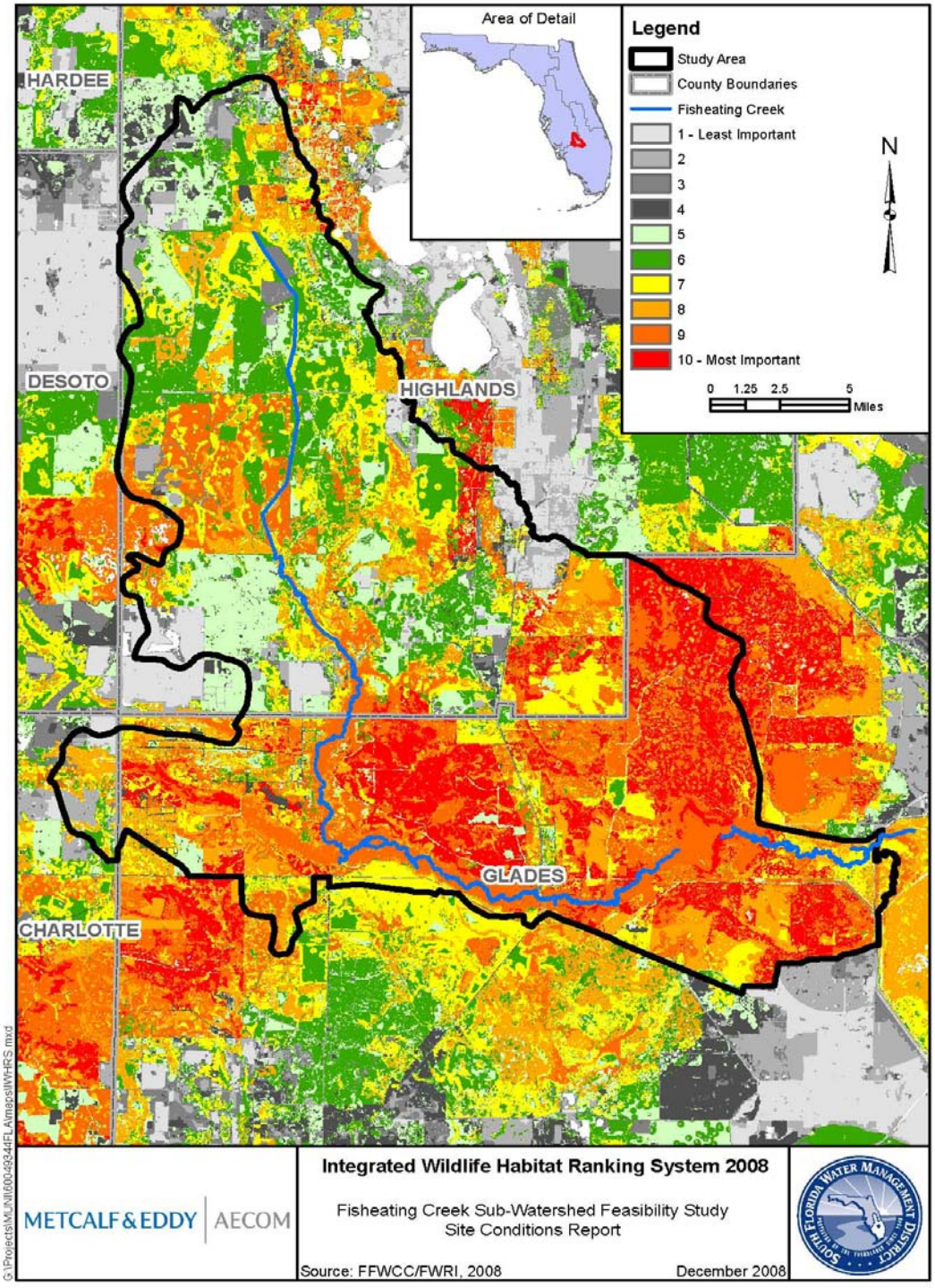

Figure 722. Integrated Wildlife Habitat Ranking System (IWHRS) for FEC Sub-Watershed Study Area

5.10 Threatened and Endangered Species

A large number of federally designated threatened and endangered plant and animal species are present in South Florida, and many are known to be, or have the potential to be, present in the Fisheating Creek watershed (**Table 15 and Table 16**). Initial consultation with USFWS and FWC (2009) has assisted in the development of Tables 15 and 16. The number of species listed in **Table 15** highlights the high value of the habitat for threatened and endangered species and the importance of siting any facilities in areas that avoid or minimize impacts to these species to the extent possible. The Florida Panther is one of the most endangered large mammals in the world. There are only an estimated 87 individuals in South Florida, which represents the only wild population of panther that once thrived throughout most of the southeastern United States (Mazourek 2007). Further consultation with USFWS is needed to ascertain the presence of federally listed species within particular locations that may be considered for stormwater storage and treatment facilities. USFWS (2009) has indicated that they can review the detailed Land Use map and provide comments on particular types of land cover codes that should be avoided when siting any facilities. USFWS further indicated that similar review by FWC, Audubon, Lykes Brothers, The Nature Conservancy, and Archbold Biological Station would provide useful information regarding potential locations of protected species.

In addition to the federally listed species, the FWC also designates plants and animal species as endangered, threatened or special concern in accordance with state of Florida laws and regulations. The additional species listed by the FWC that may occur in the Fisheating Creek watershed are identified in **Table 17.** As discussed above for USFWS, additional consultation with FWC is needed to identify the potential presence of particular species in locations throughout the watershed. However, much of the watershed does provide habitat for state-listed species. The FWC has designated much of the watershed as Strategic Habitat Conservation Area (SHCA), which represents habitat areas in need of protection for listed, rare, and imperiled wildlife (FWC, 2008c; **Figure 73**). Information regarding the particular species associated with the SHCA is not available in the FWC's 2008 report describing the recently created Integrated Wildlife Habitat Ranking System (IWHRS), although earlier reports from the Audubon Society (Audubon, 2002) indicate that the SHCAs in the watershed have been designated for swallow-tailed kite and crested caracara. Although the IWHRS does not identify particular species present in various locations, it does identify the number of state-listed species present in the watershed (FWC, 2008c; **Figure 74**). Two state-listed endangered species are present in the lower reaches of the watershed in the vicinity of the FWC Wildlife Management Area (WMA). Much of the remainder of the watershed is shown as providing habitat for two or

more threatened species or one endangered species. Only small areas of the watershed are shown has providing habitat for no state-listed species.

Table 17. Additional State – Listed Species Potentially Occurring in FEC Sub-Watershed Study Area[1]

Common Name	Scientific Name
AMPHIBIANS	
Flatwoods salamander	*Ambystoma cingulatum*
Georgia blind salamander	*Haideotriton wallacei*
Pine barrens treefrog	*Hyla andersonii*
Florida bog frog	*Rana okaloosae*
Gopher frog	*Rana capito*
REPTILES	
American alligator	*Alligator mississippiensis*
American crocodile	*Crocodylus acutus*
Key ringneck snake	*Diadophis punctatus acricus*
Red rat snake	*Elaphe guttata*
Florida pine snake	*Pituophis melaneoleucus mugitus*
Short-tailed snake	*Stilosoma extenuatum*
Florida brown snake	*Storeria dekayi victa*
Rim rock crowned snake	*Tantilla oolitica*
Florida ribbon snake	*Thamnophis sauritus sackeni*
Florida Key mole skink	*Eumeces egregius egregius*
Gopher tortoise	*Gopherus polyphemus*
Barbour's map turtle	*Graptemys barbouri*
Alligator snapping turtle	*Macroclemys temminckii*
Striped mud turtle	*Kinosternon baurii*
Suwannee cooter	*Pseudemys concinna suwanniensis*
BIRDS	

Common Name	Scientific Name
Piping plover	*Charadrius melodus*
Snowy plover	*Charadrius alexandrinus*
American oystercatcher	*Haematopus palliatus*
Brown pelican	*Pelecanus occidentalis*
Black skimmer	*Rynchops niger*
Least tern	*Sterna antillarum*
Roseate tern	*Sterna dougalli(Sterna dougallii dougallii)*
Limpkin	*Aramus guarauna*
Reddish egret	*Egretta rufescens*
Snowy egret	*Egretta thula*
Little blue heron	*Egretta caerulea*
Tricolored heron	*Egretta tricolor*
White ibis	*Eudocimus albus*
Florida sandhill crane	*Grus canadensis pratensis*
Whooping crane	*Grus americana*
Wood stork	*Mycteria americana*
Roseate spoonbill	*Platalea ajaja*
Burrowing owl (Florida burrowing owl)	*Athene cunicularia (Athene cunicularia*
Crested caracara (Audubon's crested	*Caracara cheriway (Polyborus plancus*
Peregrine falcon	*Falco peregrinus*
Southeastern American kestrel	*Falco sparverius paulus*
Osprey	*Pandion haliaetus*
Snail kite (Everglades snail kite)	*Rostrhamus sociabilis plumbeus*
Florida scrub jay	*Aphelocoma coerulescens*
Florida grasshopper sparrow	*Ammodramus savannarum floridanus*
White-crowned pigeon	*Columba leucocephala*
Kirtland's warbler	*Dendroica kirtlandii*
Bachman's warbler	*Vermivora bachmanii*
Ivory-billed woodpecker	*Campephilus principalis*
Red-cockaded woodpecker	*Picoides borealis*
Marian's marsh wren	*Cistothorus palustris marianae*

Common Name	Scientific Name
Worthington's marsh wren	*Cistothorus palustris griseus*
Bald Eagle	*Haliaeetus leucocephalus*
MAMMALS	
Florida black bear	*Ursus americanus floridanus*
Everglades mink	*Mustela vison evergladensis*
Big Cypress fox squirrel	*Sciurus niger avicennia*
Sherman's fox squirrel	*Sciurus niger shermani*
Eastern chipmunk	*Tamias striatus*
Florida mouse	*Podomys floridanus*
Florida mastiff bat	*Eumops glaucinus floridanus*
Gray bat	*Myotis grisescens*
Indiana bat	*Myotis sodalis*
Sherman's short-tailed shrew	*Blarina carolonensis*
Homosassa shrew	*Sorex longirostris eionis*
CRUSTACEANS	
Black creek crayfish	*Procambarus pictus*
INSECTS	
Miami blue butterfly	*Cyclargus [=Hermiargus] thomasi*
MOLLUSKS	
Florida tree snail	*Liguus fasciatus*

1502 (Source: FWC, 2008c)

1503 [1]Note that state-listed species that are also federally listed are included in **Table 13**

Table 18. Federally Listed Threatened and Endangered Plant Species in Florida

Common Name	Latin Name	Status
Beargrass, Britton's	*Nolina brittoniana*	E
Blazingstar, scrub	*Liatris ohlingerae*	E
Bonamia, Florida	*Bonamia grandiflora*	T

Table 18. Federally Listed Threatened and Endangered Plant Species in Florida

Common Name	Latin Name	Status
Buckwheat, scrub	*Eriogonum longifolium var. gnaphalifolium*	T
Cladonia, Florida perforate	*Cladonia perforate*	E
Fringe-tree, pygmy	*Chionanthus pygmaeus*	E
Gourd, Okeechobee	*Cucurbita okeechobeensis ssp. okeechobeensis*	E
Harebells, Avon Park	*Crotalaria avonensis*	E
Hypericum, highlands scrub	*Hypericum cumulicola*	E
Lupine, scrub	*Lupinus aridorum*	E
Mint, Garrett's	*Dicerandra christmanii*	E
Mint, scrub	*Dicerandra frutescens*	E
Mustard, Carter's	*Warea carteri*	E
Pigeon wings	*Clitoria fragrans*	T
Plum, scrub	*Prunus geniculata*	E
Polygala, Lewton's	*Polygala lewtonii*	E
Rosemary, short-leaved	*Conradina brevifolia*	E
Sandlace	*Polygonella myriophylla*	E
Snakeroot	*Eryngium cuneifolium*	E
Whitlow-wort, papery	*Paronychia chartacea*	T
Wireweed	*Polygonella basiramia*	E
Ziziphus, Florida	*Ziziphus celata*	E

1504 Source: USFWS, 2008

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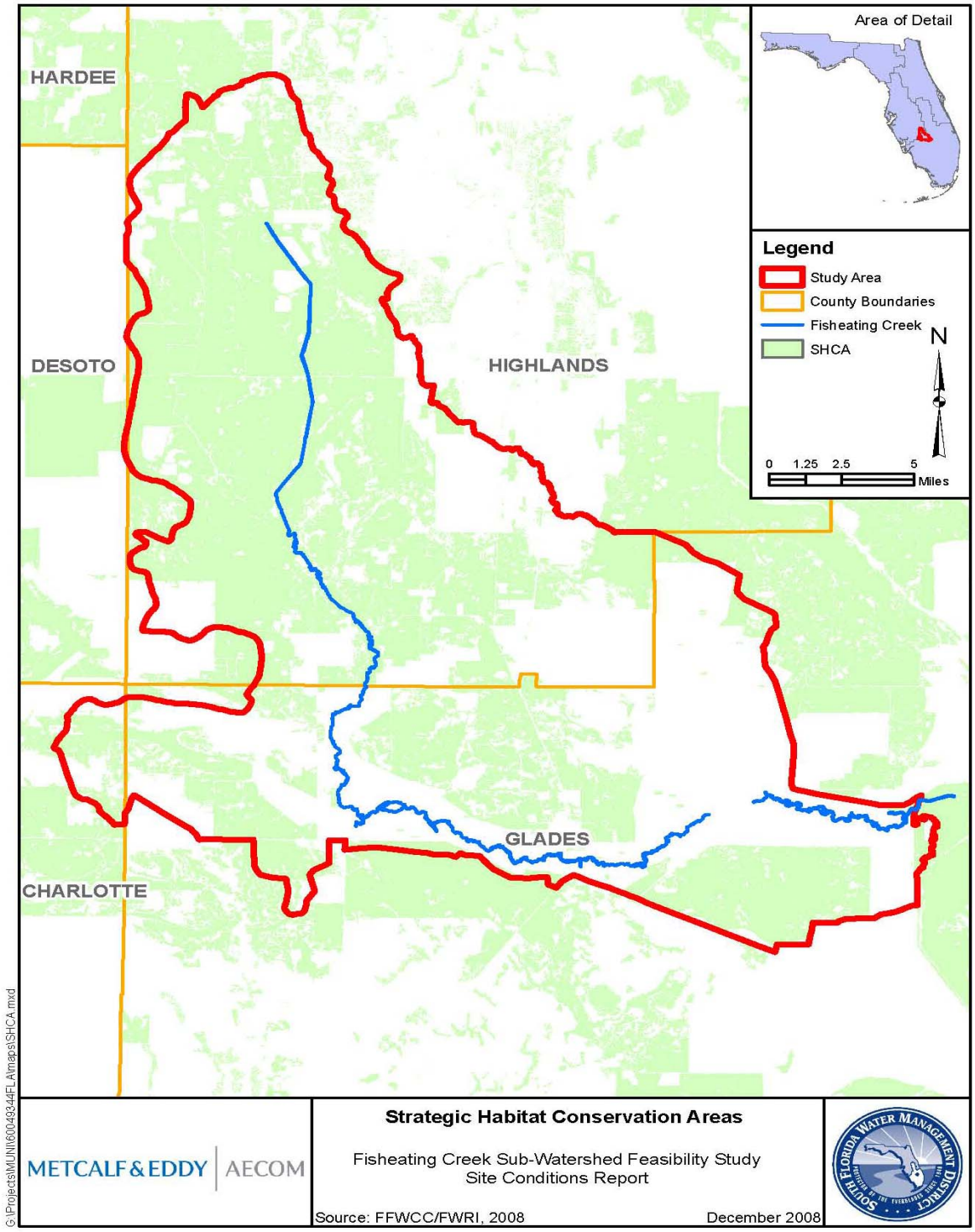

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1508 **Figure 73. Strategic Habitat Conservation Area (SHCA)**

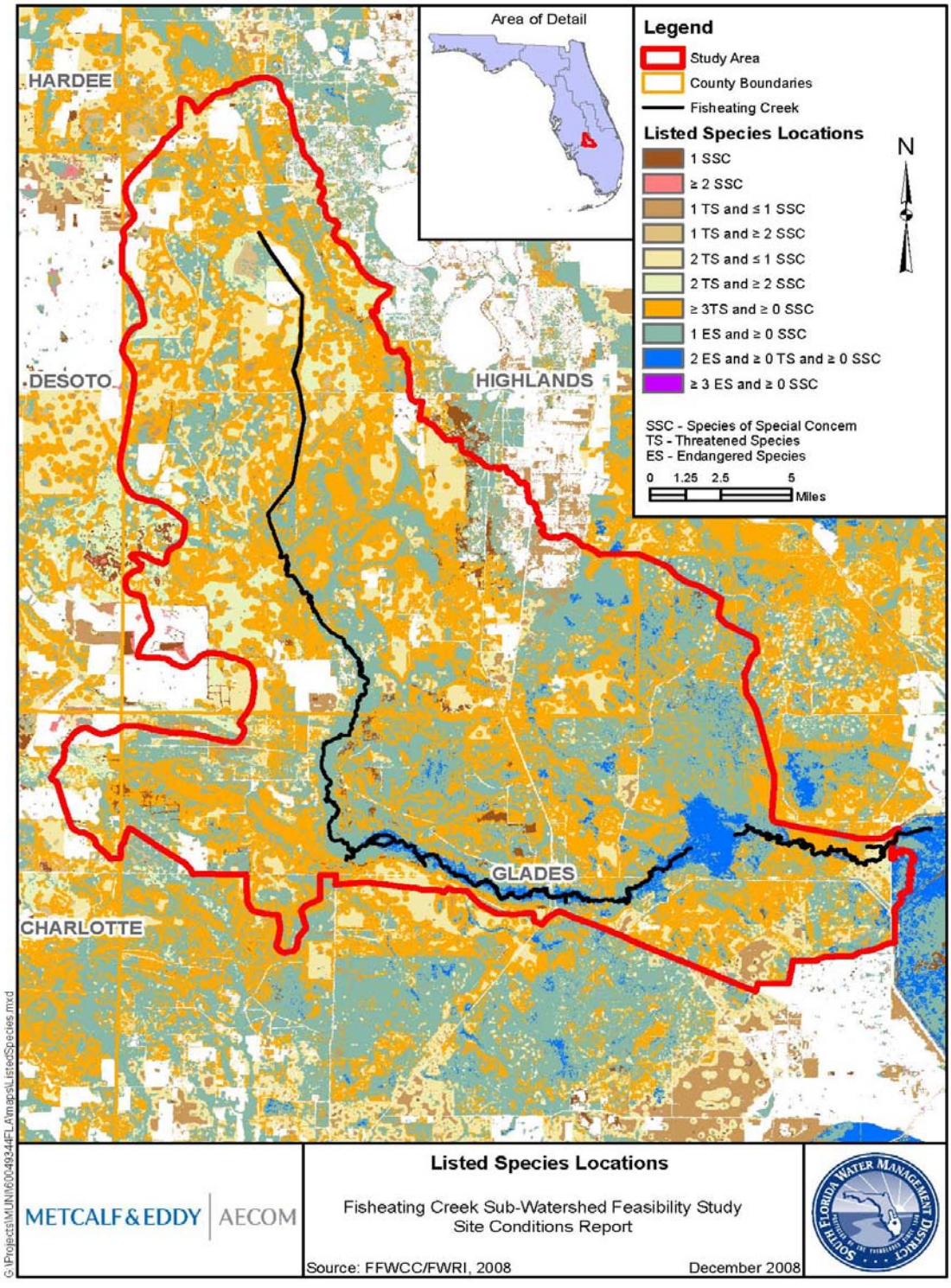


Figure 744. Location of State Listed Species in FEC Sub-Watershed Study Area

5.11 Recreational Resources

The Fisheating Creek Wildlife Management Area (FCWMA) and Gatorama are two (2) recreational places located in the FEC study area.

The FCWMA considers the Fisheating Creek as a very important part of the ecosystem for Florida panthers, Florida black bears, swallow-tailed kites, whooping and sandhill cranes, crested caracara, and a number of other species native to the area. The FCWMA covers an area of 18,272 acres along the Fisheating Creek in the Glades County **(Figure 755)**. Access to the Management Area other than by foot, bicycle or boat is not allowed. Entrance to the area is permitted via designated entrance points around US 27 and SR 78 as shown on **Figure 75**. Only registered and licensed vehicles are allowed to operate within the Camp Ground located at Palmdale. The airboat area between Cowbone Marsh and Lake Okeechobee can only be accessed with a no-cost airboat permission provided by Florida Wildlife Conservation Commission (FWC). This site can be accessed through the boat ramp located 1 mile south of Lakeport at SR 78. Aside from fishing, deer, feral hog and Osceola turkey can also be hunted within the Area. Part of the Management Area located at the east side of the US 27 is used for Turkey hunting. There are several primitive camp sites present along the creek as shown on the **Figure 75** (FCWMA, 2008). The FCWMA Camp Ground, located on US 27 around 1 mile south of Palmdale, offers recreational activities such as recreational vehicle (RV) and tent camping, canoe and kayak rental and daytime use area with pond and picnic tables (FCWMA, 2008).

Gatorama is a roadside attraction park, located at Palmdale, FL on US 27 around half mile north of FCWMA. Visitors of the place can take pictures of the nature which is mostly covered with oak trees and palm trees. The attraction area covers around fifteen acres. The park has 1000 ft long walkway and wooden bridge built in it. Tours through these paths are offered to observe alligators, crocodiles, monkeys, bobcats, raccoons, peacocks, ducks and geese panthers, birds and other Florida Wildlife. Gatorama is home for six species of crocodiles including the American Crocodile. It is also the largest captive breeder of the Acutus Crocodile in North America (Gatorama, 2008).

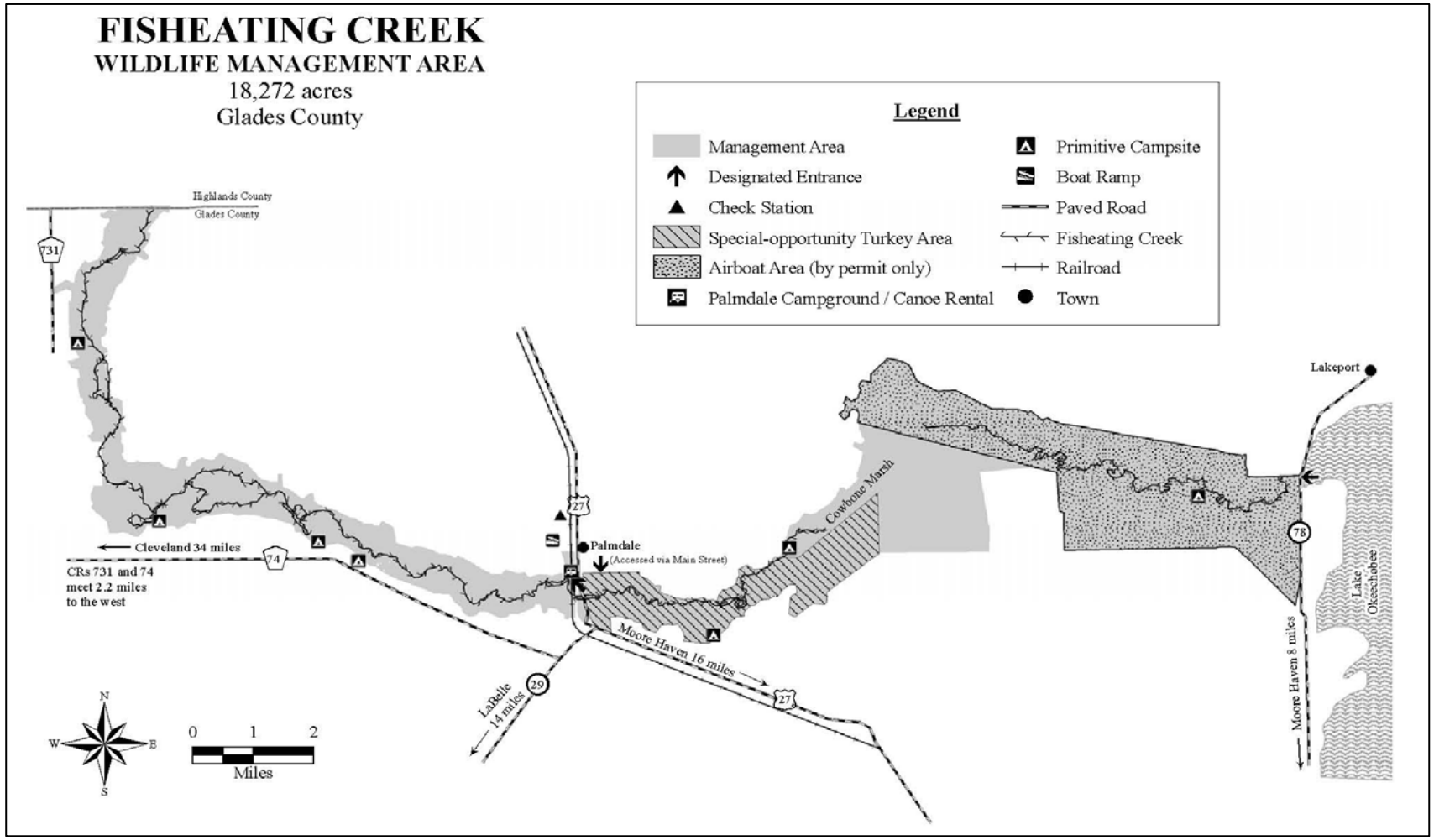


Figure 755. Fisheating Creek Wildlife Management Area

5.12 Aesthetics

The purpose of this section is to characterize the aesthetic quality of the areas surrounding Fisheating Creek, and within the sub-catchment, in order to provide a framework for determining the potential changes that could occur as a result of the project. Access to the watershed via SR 25/US 27 and CR 731 is quite limited; there are only a few scattered residences, and development in general is extremely low. The overall visual aesthetic of the Fisheating Creek sub-watershed is characterized by a divergent range of natural communities that include dry prairies and flatwoods interrupted by numerous freshwater marshes of various kinds, including seepage slopes, wet prairies, and depression marshes. Diverse prairie hammocks occur east of US 27. Hydric hammocks, bottomland forests, and floodplain swamp along Fisheating Creek make up most of the remainder of the natural communities. Large areas of the project area are improved pasture, former eucalyptus plantations, or current pine plantations (DEP, 2008) **(Figure 76** through **Figure 81**). Thus aesthetics in the watershed include a variety of natural settings, such as open fields and marshes, and forests, as well as areas altered and managed by humans such as ranchlands. Much of the managed land occurs in the upper half of the watershed whereas the lower half (Glades County), in the area where Fisheating Creek turns east and then further downstream, contains more of the natural, pristine viewsheds. In this portion of the watershed there is virtually no development and few roads. The majority of the watershed within Highlands County, both north and south of SR 70, consists of ranchland with occasional views of ranch dwellings and out-buildings. Utility lines are visible running adjacent to both state and county roads.

The marshy pasturelands surrounding the upper reaches of the creek are privately held, and therefore are not accessible for public viewing. This portion of the basin is characterized by a fairly extensive system of drainage canals extending west and east of Fisheating Creek. From this area, Fisheating Creek transitions to a channelized waterway which continues for approximately ten miles before again reverting to an open-bank creek. The lower reaches of Fisheating Creek, which flow within the Wildlife Management Area (WMA) between Palmdale and Lakeport (east of U.S. 27), represent the last unaltered tributary to Lake Okeechobee. The portion of the watershed within the WMA offers rustic and pristine views of a natural setting little influenced by humans. In the lower reaches of the WMA, extensive areas of freshwater marsh are associated with the creek for several miles including Cowbone Marsh and Rainey Slough. This area offers expansive marsh views of an undisturbed natural habitat, including many birds and other wildlife that frequent the region. As it approaches the lake, Fisheating Creek passes through open prairie and marshland areas that have been converted to rangeland for cattle.

Figure 76. An Aerial View of the Upper Reaches of Fisheating Creek

Figure 77. View of Channelized Portion of Fisheating Creek

Figure 78. From CR 731 Approximately 3 miles North of SR 25/US 27, Downstream of the Channelized Portion of Fisheating Creek

Figure 79. An Aerial View of Cowbone Marsh

Figure 80. View of Fisheating Creek before it passes under Check Dam No.1 PL-566 Structure

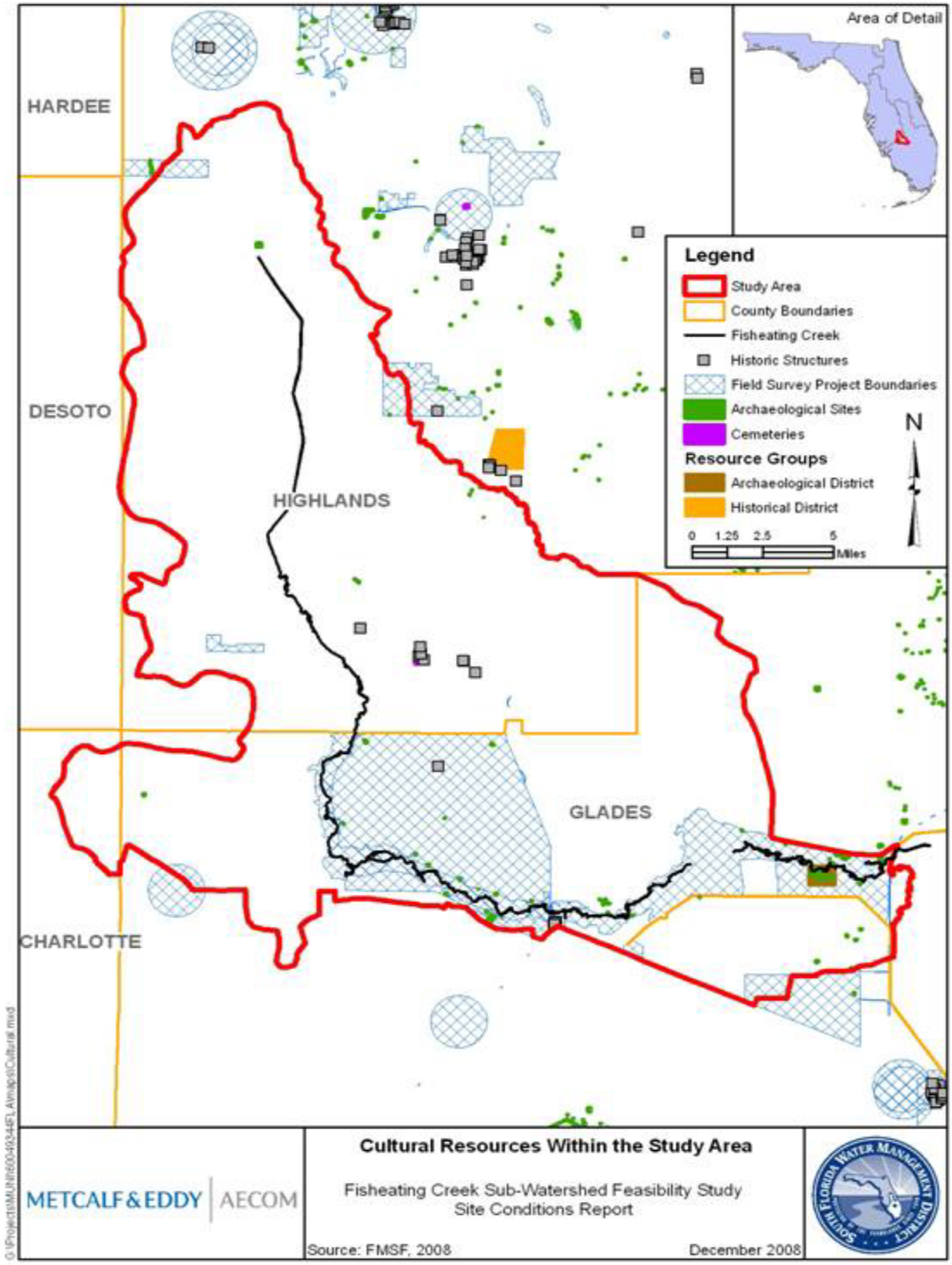
Figure 81. Discharge of Fisheating Creek to Lake Okeechobee

5.13 Cultural and Archaeological Resources

This section describes cultural and archaeological resources with the Fisheating sub-watershed study area based on available data. The National Register of Historical Places website was reviewed online for historic areas in Highlands and Glades counties (NRHP, 2008), and the Office of Cultural and Historical Preservation (OCHP) was contacted in order to obtain access to the Florida Master Site File GIS data for Glades and Highlands Counties.

The project area includes at least 31 archaeological sites, many associated with the important Fort Center Site Complex of the Belle Glades culture (DEP, 2008a). The Fort Center site, located east of Palmdale adjacent to Fisheating Creek consists of mounds, ponds, circular ditches, and linear embankments built over at least 2000 years.

Various archaeological and cultural surveys have been conducted within the study area, particularly within Glades County adjacent to Fisheating Creek. For example, in 2005 an inventory and assessment of cultural and resources in the Fisheating Creek Wildlife Management Area was prepared. The combined extent of these surveys is noted on **Figure 82**. Based on discussion with OCHP staff, it is very likely that a site archaeological survey would be required before any work could be conducted within these areas (OCHP, 2008).



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1615 **Figure 82. Cultural Resources Within the FEC Sub-Watershed Study Area**

5.14 Hazardous Waste Sites

The following section describes current conditions within the Fisheating Creek sub-watershed related to hazardous waste. Spatial hazardous waste data distributed by the Florida Department of Environmental Protection (FDEP) were reviewed (FDEP, 2008a). Error! Reference source not found. presents the results of the data-base search. These data include the following:

- Brownfields Sites, defined as abandoned or underused sites that may require environmental remediation prior to redevelopment (FDEP, 2001)
- Environmental Protection Agency (EPA) National Priorities List (NPL) sites, which includes EPA Superfund sites (FDEP, 2007a)
- Groundwater Contamination Areas (FDEP, 1990)
- US EPA Resource Conservation and Recovery Act (RCRA) Facilities, which includes the locations of hazardous waste handlers regulated under RCRA (EPA, 2008)
- Hazardous Materials Sites in the State of Florida (FDOT, 1997)
- Solid Waste Facilities in the State of Florida (FDEP, 2005)
- Florida DEP State-Funded Hazardous Waste Cleanup Sites (FDEP, 2007b)

There are no Brownfields, EPA NPL, Hazardous Materials, Solid Waste, or Hazardous Waste Cleanup sites located with the Fisheating Creek sub-watershed according to review of FDEP distributed spatial hazardous waste data. However, the data-base search indicated seven EPA RCRA facilities within the study area, and two overlapping regions of groundwater contamination located in Highlands County approximately two miles east of Fisheating Creek.

A siting concern associated with the proposed project is the possible existence of Cattle Dip Vats (CDV's) within the study area. During the early and mid 1900's, more than 3,500 cattle vats were constructed across Florida in order to assist in eradicating the cattle fever tick (Boophilus annulatus) (UF/IFAS, 2000). Livestock was required by state law to be dipped biweekly into these vats, which were concrete-lined channels containing arsenic solution, including synthetic pesticides such as DDT, BHC, chlordane and toxaphene (UF/IFAS, 2000). Although cattle vats are no longer used, soil and groundwater may be contaminated in the vicinity of some vats. To-date only about 120 CDV's have been located state-wide (DOH, 2008). Based on historic records, there are 41 known cattle dipping vat locations in Glades County and 56 within Highlands County (FDEP, 2008b); however, the exact locations of these vats are not known (DOH, 2008). Historically, cattle ranchers typically

constructed CDV's in upland areas to avoid flooding (UF, IFAS, 2008); therefore it is unlikely that any vats would be located in the low lying regions adjacent to Fisheating Creek.

5.15 Existing Utilities

According to the information provided by City of Moore Haven both electricity and water is provided by City of Moore Haven to the residents within its limits. The city also provides water to the residents that are within a 2 mile distance to the City limits. The residents in the rest of the Glades County are using their own wells. There are some associations founded by the residents like Lake Port Association that manage the water supply (City of Moore Haven, 2008).

Electricity is provided to the rest of the Glades County by Glades Electric Coop, Inc. According to the conversation with Glades Electric Cooperative, Inc., they provide electricity to the Glades County and rural areas of Highlands County. Glades Electric Coop, Inc. service territory boundaries and power lines are shown on **Figure 84**. The orange color on the figure represents the service territory boundary. The power lines on the FEC study area are shown with circles on the figure. If more detailed information is required such as the details for the power lines, submittal of a formal requisition is required by the company which should be approved by the Company Board of Directors. It was also mentioned by the staff that electricity to the urban areas of Highlands County is provided by Progress Energy (Glades Electric Cooperative, Inc. , 2008).

Progress Energy was also contacted for information regarding their service territory boundary for the Highlands County. A staff from the company contacted with mentioned that they couldn't release such information as it is private but they promised to get in touch with M&E, Inc. However, no respond was provided by them after that conversation. If necessary, further correspondence with this company could be done.

According to the literature as mentioned in Section 2 presence of one permitted landfill and one wastewater treatment facility discharging treated flow to groundwater within the FEC Sub-Watershed Study Area is known. . Figure 82 provides an illustration of known solid waste facilities and wastewater facilities in the area. Detailed information regarding the wastewater treatment facilities and landfills should be further investigated in the Study AreaHowever, it does not inhibit moving forward with the project. In addition, information for water treatment facilities, phone line and water service for Highlands County was not available at the time of the report. Additional infrastructure and potential siting contraints within the watershed are illustrated on the Figure in Appendix D.

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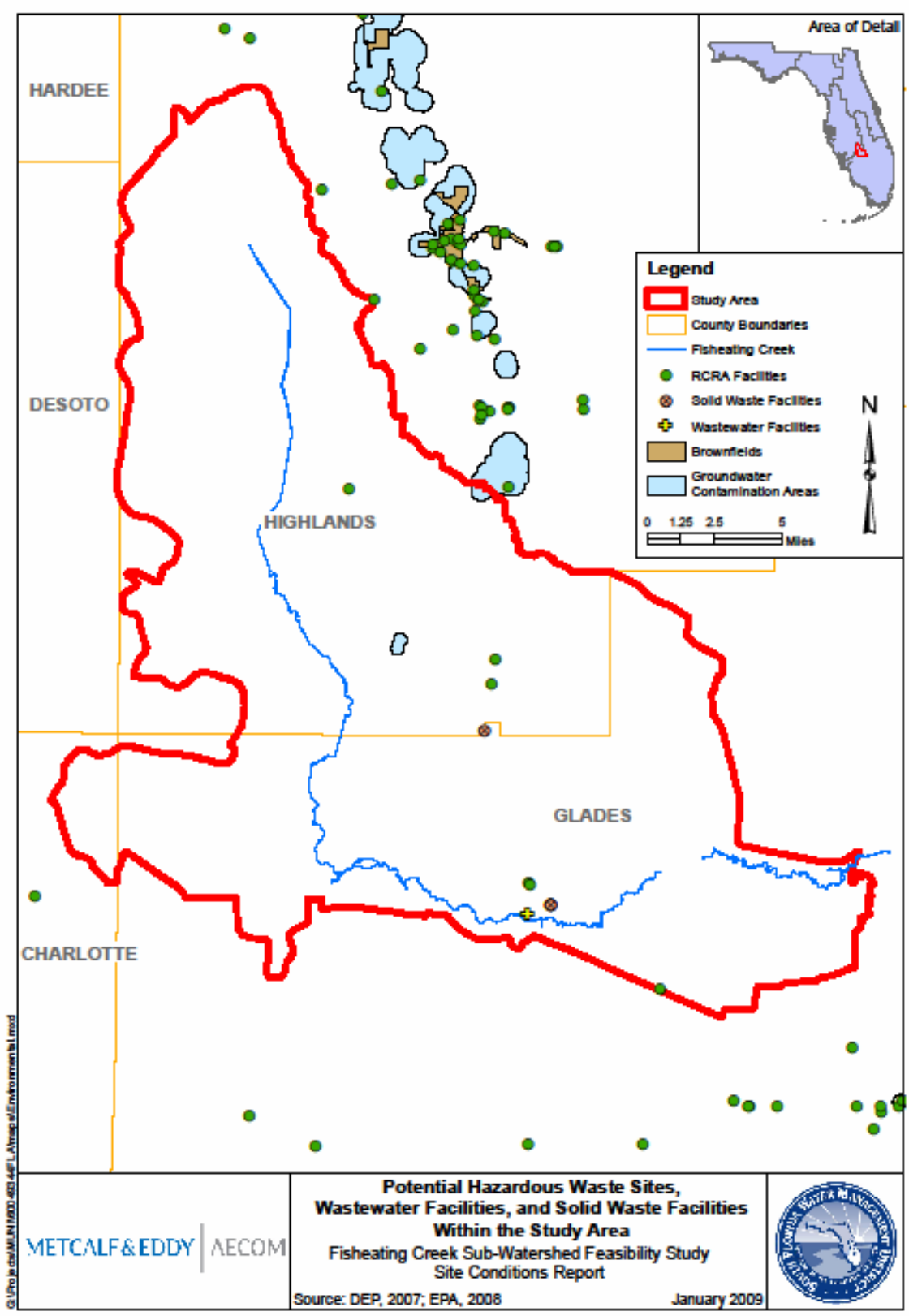

Figure 83. Potential Hazardous Waste Sites, Wastewater Facilities and Solid Wastes Facilities within the FEC Sub-Watershed

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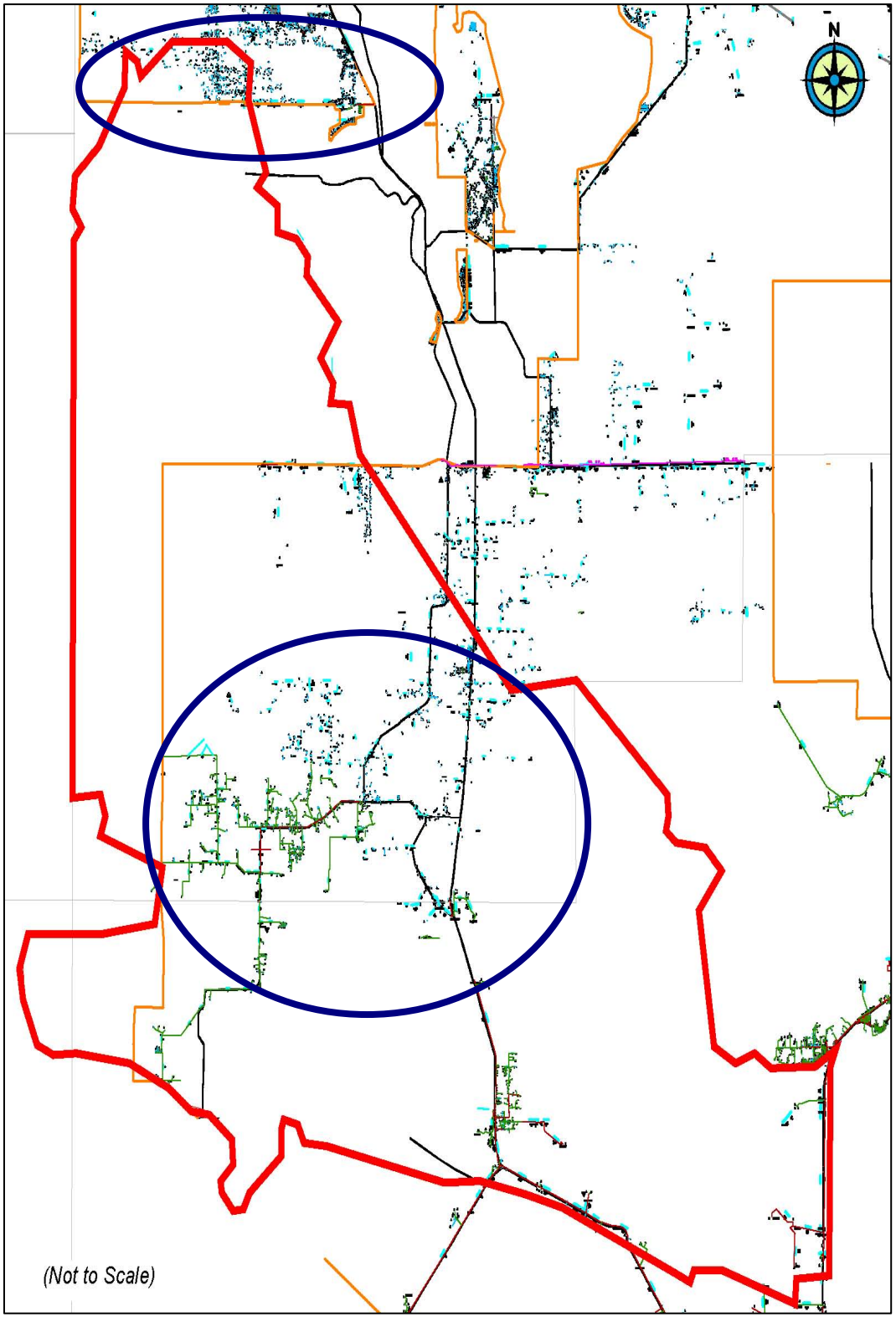

(Source: Glades Electric Co., Inc., 2008)

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Figure 84. Service Boundary of the Power Utility Map in the Study Area

5.16 Data/Information Gaps

This section below identifies information gaps that may be useful, not critical, for the completion of the Feasibility Report

During the preparation of this report, discussions with the SFWMD staff and previous consultant HDR indicated that meeting minutes identifying sensitive ecological areas based on local expert knowledge within the watershed were available on the Comprehensive Everglades Restoration Plan (CERP) website on the Lake Okeechobee Restoration Watershed page. A search of the website identified minutes from two meetings, one in June 2003 and one in March 2004 (Everglades, 2008). Neither of these meeting minutes discusses natural resources. If such meeting minutes do exist, obtaining them to provide summaries of previous investigation would be a useful component to include in this document summarizing existing knowledge of the watershed. Similarly, SFWMD staff indicated that a Uniform Mitigation Assessment Method (UMAM) analysis of district-owned lands in the watershed had been conducted and would be provided for summary and inclusion in this report. The UMAM results have not yet been provided, but would also be a valuable element of the existing conditions information that could be added to the report.

The exact location of cattle vats in the watershed, if any, would be another useful piece of information to obtain as part of the baseline information describing the watershed. Although this information was not readily available, direct consultation with landowners may assist in obtaining this data.

More detailed information regarding potential locations of threatened and endangered species would also benefit the project, as this would allow for more refined application of the site selection model during subsequent project phases. Consultation with the USFWS (2009) and the FWC (2009) has narrowed the list of species potentially located in the basin, however USFWS has indicated that additional review of the land use map by the following individuals and agencies would allow identification of specific areas that should be avoided during site selection in order to minimize impacts to protected species:

- US Fish and Wildlife Service
- Florida Fish and Wildlife
- Lykes Brothers
- Archbold Research Station
- Florida Audubon Society
- The Nature Conservancy

It is envisioned that this additional consultation may occur as part of the next public meeting, or as one of the first tasks in Phase II of the project during the application of the Land Suitability Model.

There currently is not enough data to compare the phosphorus loads generated in the upstream portions of the sub-watershed with those generated in its downstream portions. Additional sampling performed through the USGS (Station 02255600) located at where FEC croses SR 70 to measure the P-load upstream of the FEC could be conducted by the District in parallel with the next phases of the study. In addition, FDEP will provide 2009 TMDL sites data for FEC Sub-Watershed to the Study Team as soon as available.

The permitted water use daily flows and actual water withdrawals would be useful to determine the water availability in the Study Area. However, such information is not considered crucial as the Study Area is not mainly utilized for residential use.

In this regard, information gathered on the existing site conditions is considered to be sufficient to pursue the next phases of the Fisheating Creek Sub-Watershed Feasibility Study.

5.17 Summary and Preliminary Conclusions

Information presented in this section aims to provide a detailed overview of the most up to date conditions in Fisheating Creek Sub-Watershed Study Area, which will then be used to evaluate and define the potentially feasible sites that could be utilized for water storage and P-load reduction to the Lake Okeechobee using engineering techniques.

In this regard, existing conditions of the Study Area were investigated based on site visits and information gathering from reliable resources such as officially recognized websites and communications with relevant parties. Site visits were conducted to increase familiarity of the Study Team with the Study Area. Data provided in this section of the report was presented for climate, land use, geology and soils, topography, existing watershed hydrology, land ownership and water use permit, vegetation, wetlands and floodplain, fish and wildlife, threatened and endangered species, recreational resources, aesthetics, cultural and archaeological resources, hazardous waste site, existing utilities specific for the Study Area.

Observations based on the preliminary site visits were somewhat limited to the areas that were accessible as the majority of the Study Area is privately owned. Overall the majority of the Study Area visited was occupied with pasture lands, cattle grazing, wetlands and marshes along with the Fish and Wildlife Management Conservation Areas. Although, the site visits were limited to the accessible areas, they were still beneficial to get a better understanding of the Study Area.

Climate in the Study Area was presented in terms of temperature, precipitation and evapotranspiration data gathered from the monitoring stations within and/or in the vicinity of the Study Area. Results suggested that these parameters should be taken into account during the evaluation, decision, planning and conceptual and real design steps of water storage and water treatment technique(s) such as reservoirs and wetlands in the Study Area.

Land use in the Study Area was presented based on the data provided by SFWMD. The most abundant land use cover type in the basin is Cropland and Pastureland, followed by Freshwater Marsh and Wet Prairie. A variety of other land use types comprise the remainder of the watershed, but each represents less than five percent of the watershed.

The soil distribution was classified according to the predominant surficial soil types, soil hydrologic groups and subsurface properties of the Study Area. Main surficial soil types in the Study Area were determined as Immokalee sand, Myakka fine sand, Basinger fine sand and Valkaria fine sand. Investigations showed that approximately 78% of the Study Area was covered with soils that fall under the hydrologic Group B/D. This implies that the Study area is mainly covered with both drained soil (Group B) and undrained soil (Group D). Subsurface properties were located for the Nicodemus Slough which is located in the southeast part of the Study Area. Results showed that sand is the predominant material in this area together with lesser amounts of clay, silt, and shells. Additional subsurface information to be used was also included in this report for two areas approximately 17 to 22 miles away from the center of the Study Area.

Topography of the Study Area showed slopes gradually from about 85 feet NGVD in the northwest section to about 20 feet NGVD in the southeast section. In addition, the northeast portion of the Study Area is bound by the south extension of the Lake Wales Ridge which showed up to 160 feet NGVD elevation in some parts within the Study Area.

The Hydrology of the sub-watershed was also reviewed and presented in the report. Data showed that for any future restoration and planning purposes including the modeling efforts to reduce the P-loads to the Lake Okeechobee, data belong to individual years should be preferred due to the seasonal fluctuations in the climate of the area. This could help to better evaluate and validate the storage and treatment techniques for the sub-watershed as the change in the rainfall will also affect the P-load contribution to the Lake Okeechobee.

Approximate location of properties and their owners were also identified and presented in the report. It was found that majority of the area is privately owned in the Study Area.

Within the sub-watershed, there are some potentially sensitive sites that should be avoided, including 31 archaeological sites, habitat for threatened and endangered species, the pristine habitats of the Fisheating Creek Wildlife Management Area, and seven EPA RCRA facilities. As discussed above in Section 4.16, further refinement of exact locations of threatened and endangered species habitat is possible in consultation with a variety of state

and federal agencies and non-profit organizations knowledgeable about the watershed, and should occur as the project moves forward to identify site locations. Cattle vats may also be present throughout the watershed, although their exact locations are not currently well known. However, these areas tend to be small and contained, and can generally be remediated on a site-specific basis. Their presence at a particular site could be addressed prior to implementation of an alternative at any particular location.

SECTION 6 SUBSEQUENT ACTIONS

The information provided in this report will be used to establish criteria to select alternative sites within the Study Area. Alternative sites will be investigated for their feasibility to identify engineering practices to be used either alone or in combination with other sites to potentially achieve 200,000 acre-feet water storage and 55 m/yr P-load reduction to the Lake Okeechobee (totals of 33 mt/y and 21 mt/yr based on Best Management practices and the results from this project, respectively). In this regard, different type of storage components and treatment methods that would potentially meet the goals mentioned above will also be evaluated. For this reason, a preliminary decision matrix will be used based on all variables that are of importance on the selection of the method(s). Each variable in the decision matrix will be assigned with a weighting factor so that a thorough ranking could be conducted that will eventually help select the methods to meet the above goals.

Based on the above suggestions, a Feasibility Report Work Plan for Phase 2 and Phase 3 will be provided to the SFWMD. This Work Plan will be structured with a step by step approach that will include the work effort and incremental tasks required to prepare the Report. Detailed schedule for both phases will also be included in the Work Plan. Phases 2 and 3 will then be authorized under a separate work order.

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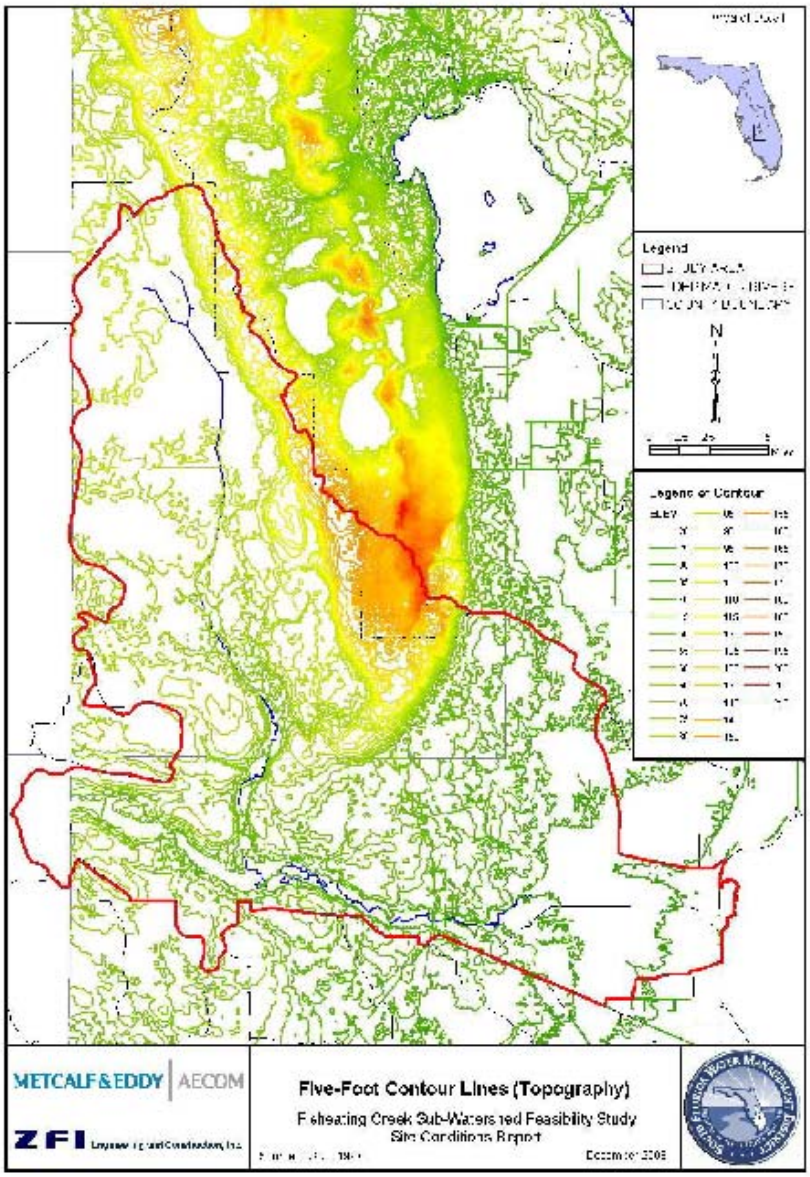
APPENDIX A

WATER USE PERMIT DATA

Due to the voluminous nature of the Data, the information is only contained in the accompanying CD

APPENDIX B

TOPOGRAPHIC MAP


Legend
N
METCALF & EDDY | AECOM
ZFI
Five-Foot Contour Lines (Topography)
Feasibility Study
Site Conditions Report
December 2003

2003

APPENDIX C

NATIONAL WETLANDS INVENTORY MAP

National Wetlands Inventory Map - North

December 2008

Fisheating Creek Sub-Watershed Feasibility Study Site Conditions Report

Legend

- Study Area
- Major Roads
- Minor Roads
- County Boundaries
- Fisheating Creek

NWI Wetlands

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine

Source: USFWS, 1984

0 1 2 4 Miles

N

METCALF & EDDY | AECOM

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Area of Detail

G:\Projects\MUNI\60249344\FLA\maps\NWIMapNorth.mxd

HARDEE CO.

DESOTO CO.

HIGHLANDS CO.

GLADES CO.

LK JOSEPHINE&LK WOOD

LAKE JUNE ROAD

CLOVERLEAF ROAD

LAKE CLAYTON

VIRGINIA AVE.

HIGHLANDS LAKE DR.

DALHALL BLVD

LINCO/JEFFCAT/DEER

HOLMES AVENUE

LAKE DRIVE

JEFFERSON AVE

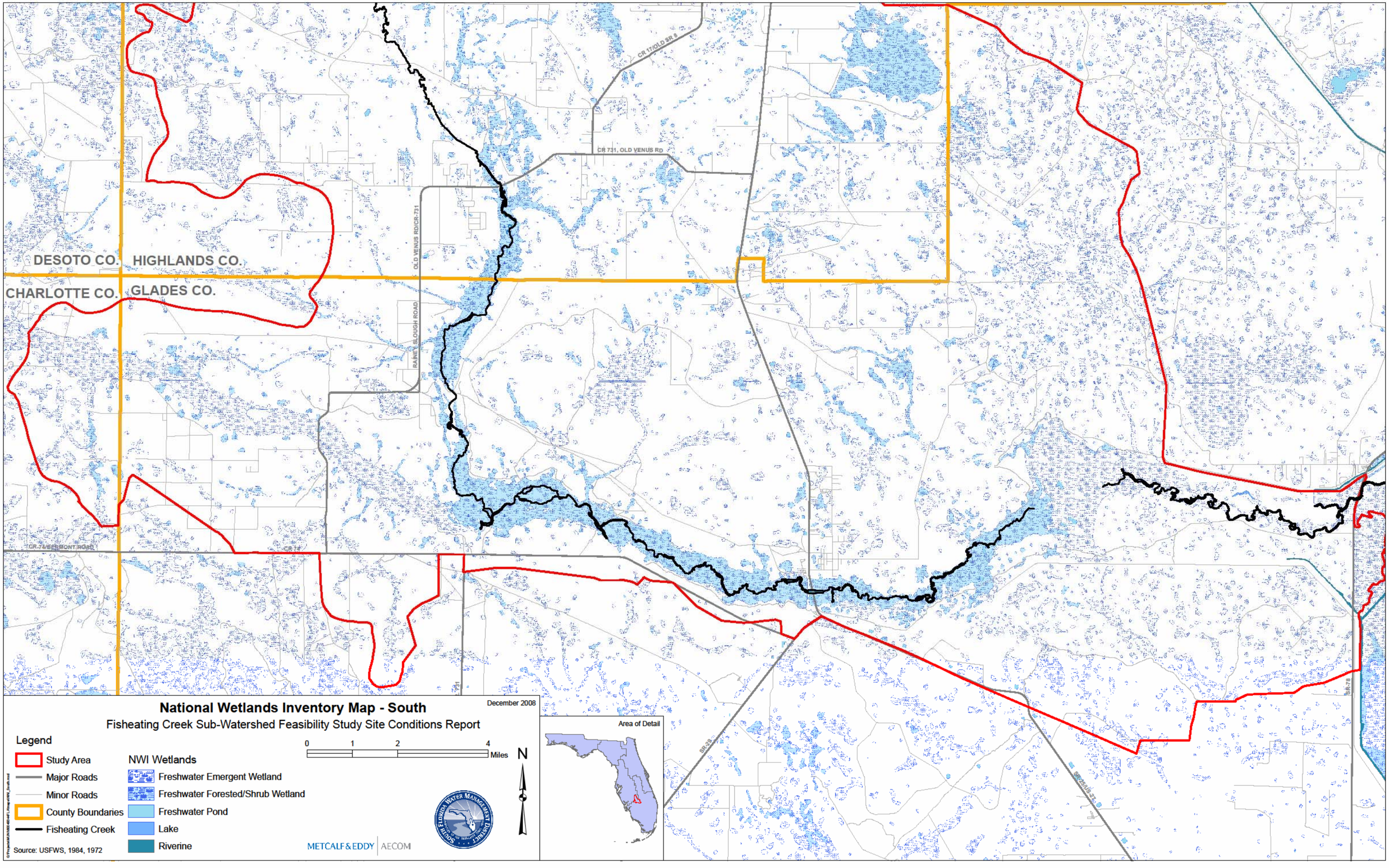
PLACID VIEW/LK MIRRO

SR-70

CR 17/OLD SR 9

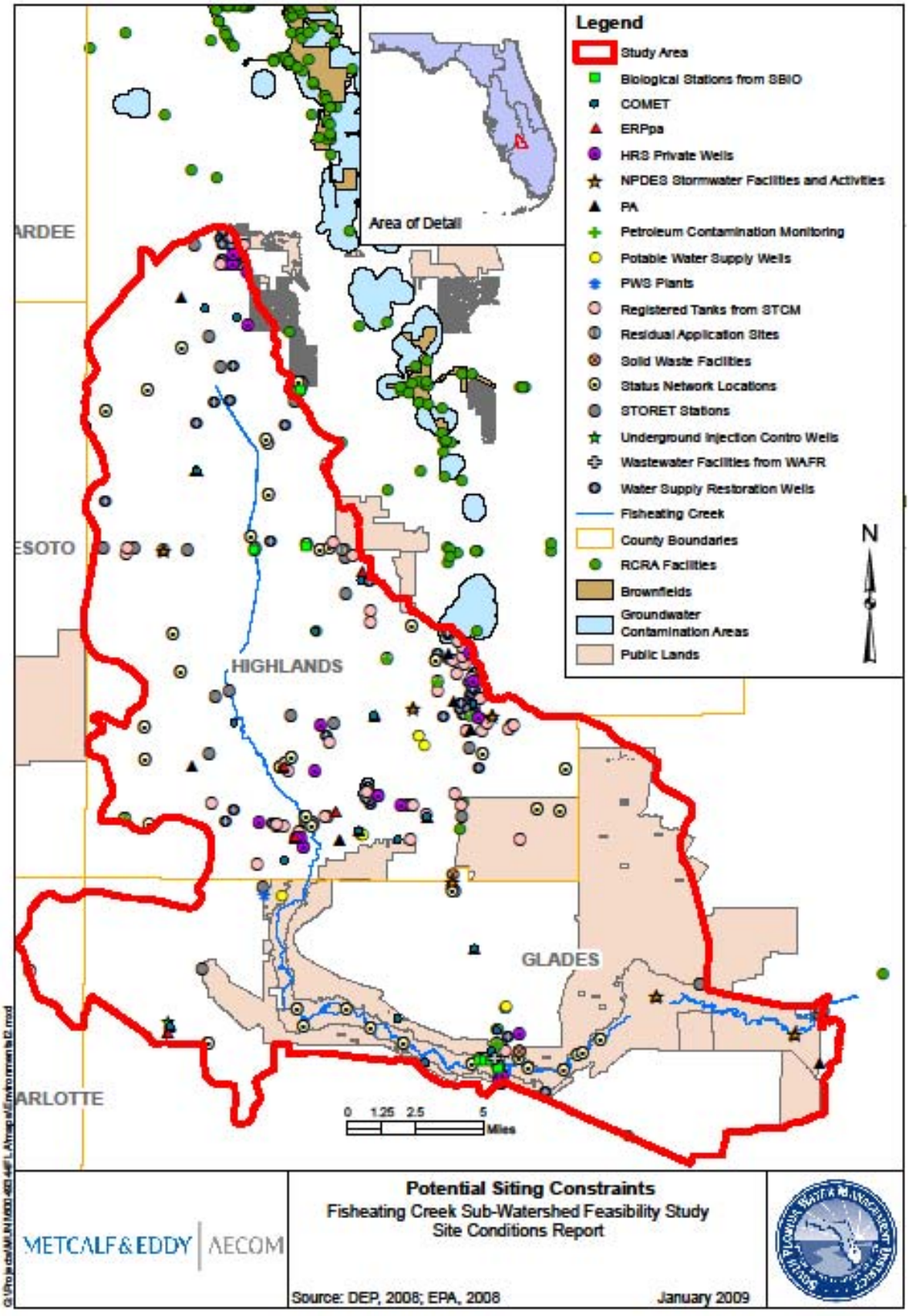
SR-25/US-27

SR-29


DESOTO CO.
HIGHLANDS CO.
CHARLOTTE CO.
GLADES CO.
CR 17/OLD SR 8
CR 731, OLD VENUS Rd
OLD VENUS RD/CR-731
RAINEY SLOUGH ROAD
CR-74/BERMONT ROAD
CR 74
SR-29
SR-78
National Wetlands Inventory Map - South
December 2008
Fisheating Creek Sub-Watershed Feasibility Study Site Conditions Report
Legend
Study Area
Major Roads
Minor Roads
County Boundaries
Fisheating Creek
NWI Wetlands
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Source: USFWS, 1984, 1972
0 1 2 4
Miles
N
Area of Detail
METCALF & EDDY | AECOM

APPENDIX D

SITING CONTRAINTS


Legend
Study Area
Biological Stations from SBIO
COMET
ERPpa
HRS Private Wells
NPDES Stormwater Facilities and Activities
PA
Petroleum Contamination Monitoring
Potable Water Supply Wells
PWS Plants
Registered Tanks from STCM
Residual Application Sites
Solid Waste Facilities
Status Network Locations
STORET Stations
Underground Injection Contro Wells
Wastewater Facilities from WAFR
Water Supply Restoration Wells
Fisheating Creek
County Boundaries
RCRA Facilities
Brownfields
Groundwater Contamination Areas
Public Lands
Area of Detail
N
ARDEE
ESOTO
HIGHLANDS
GLADES
ARLOTTE
0 1.25 2.5 5
Miles
METCALF & EDDY | AECOM
Potential Siting Constraints
Fisheating Creek Sub-Watershed Feasibility Study
Site Conditions Report
Source: DEP, 2008; EPA, 2008
January 2009