PREFERRED ALTERNATIVES EVALUATION AND COST ESTIMATES TECHNICAL MEMORANDUM

EVALUATION OF ALTERNATIVES TO REDUCE OR ELIMINATE DISCHARGE OF ELEVATED LEVELS OF NUTRIENTS FROM THE BOYNTON FARMS BASIN TO THE EVERGLADES PROTECTION AREA

SFWMD Contract No. CN040928-WO05

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

1.1 EVERGLADES FOREVER ACT

The 1994 Everglades Forever Act (EFA), F.S. 373.4592, identifies the Everglades as a system "unique in this world and one of Florida's greatest treasures." Recognizing that "waters flowing into the Everglades Protection Area (EPA) contain excessive amounts of total phosphorus (TP)," the Florida Legislature established a water quality standard of no greater than 10 parts per billion (ppb) TP to be achieved by December 31, 2006. The criterion is outlined in Rule 62-302.540 of the Florida Administrative Code.

The EFA acknowledges the impact of this legislation to the agricultural industry. The Act seeks to preserve the ecological integrity of the Everglades, while minimizing the effects of the water quality requirement on agriculture and other South Florida commerce. It states that the TP criterion may include "moderating provisions" during the initial implementation of a Long-Term Plan.

The EFA was amended in 2003 to include a Long-Term Plan as the most appropriate strategy to meet water quality goals. The plan addresses the implementation of optimal combinations of resources such as nutrient source controls, stormwater treatment areas (STAs), advanced treatment technologies, and regulatory programs.

Moderating provisions would authorize discharges based upon Best Available Phosphorus Reduction Technology (BAPRT) providing net improvement to impacted areas. This study addresses conceptual water quality improvements, including BAPRT, in conjunction with the Boynton Farms Basin, and outlines preferred alternatives and cost estimates for reducing or eliminating the discharge of elevated levels of nutrients from the basin to the EPA.

1.2 NON-ECP PERMIT & EVERGLADES STORMWATER PROGRAM

The Florida Department of Environmental Protection issued a non-Everglades Construction Project (non-ECP) permit in 1998, authorizing the South Florida Water Management District (District) to operate and maintain water control structures that discharge into, within, or from the EPA, and which are not included in the ECP permit. The ECP focuses on larger basins that are tributary to the Everglades Construction Project STAs. These are primarily the Everglades Agricultural Area and the C-139 Basin.

For basins under the non-ECP permit, which are now incorporated into the Everglades Stormwater Program (ESP), the District is required to implement schedules and

strategies to achieve and maintain water quality standards; evaluate existing programs, permits, and water quality data; develop a regulatory program, where needed; improve water quality, and develop a monitoring program to track progress toward achieving compliance with water quality standards to the maximum extent practicable. The District created the ESP as a means of achieving the required water quality goals; the Boynton Farms Basin is one of eight basins in the ESP.

1.3 BOYNTON FARMS BASIN

The Boynton Farms Basin is the smallest non-ECP basin at approximately 341 acres, yet historically has exhibited the highest TP concentrations of any non-ECP basin. Located in southern Palm Beach County in Township 45 South, Range 41 East, Sections 25 and 36, the Boynton Farms Basin is south of Boynton Beach Boulevard and west of US 441.

There are two farms in the basin, referred to as the DuBois property, and the Palm Beach County property. Farm structures and drainage canals are privately owned, and are associated with the production of row crops such as green peppers and cucumbers. The 216-acre Palm Beach County property is planned for lease in the Fall 2006 growing season. The duration of the lease currently is unknown.

Immediately west of the basin is the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), owned and operated by the US Fish and Wildlife Service (USFWS). The Refuge headquarters recreation area is adjacent to the Boynton Farms Basin, and includes administration offices, visitor center, cypress wetland habitat, and research test sites. The entire property is defined as part of the EPA although it falls east of the protective levee for Water Conservation Area 1. The Refuge has established that elevated nutrient levels on its property are linked to discharges from basin farms.

During the course of this study, phosphorus loads to the Refuge were partially reduced when one farm – the Gayler property – eliminated its discharge to the Refuge and instead diverted runoff to the E-1 Canal. This was accomplished by moving two surface water pump stations from the western side of the farm to the eastern side. All runoff currently is pumped to the E-1 Canal through culverts located beneath US 441.

This Task 4 evaluation of alternatives is intended to create a list of water quality improvement options for stakeholders in the Boynton Farms Basin to consider for implementation. Although no specific project recommendation results from this

analysis, the anticipated benefits, obstacles, and estimated costs of several alternatives are outlined and discussed.

1.4 BEST AVAILABLE PHOSPHORUS REDUCTION TECHNOLOGY

BAPRT is defined as “a combination of Best Management Practices (BMPs) and STAs that includes a continuing research and monitoring program to reduce outflow concentrations of phosphorus so as to achieve the phosphorus criterion in the Everglades Protection Area at the earliest practicable date.”

BMPs are a practice or combination of practices that are the most effective and practicable on-farms means of balancing water quality improvements and agricultural productivity, while taking into account economic and technological considerations.

In accordance with FAC 62-302.540, BAPRT uses an adaptive management approach based on the best available information and data to develop and implement incremental phosphorus reduction measures with the goal of achieving the phosphorus criterion. Implementation of BAPRT in the initial phase of the Long-Term Plan (through 2016) is intended to result in net improvement to impacted areas of the EPA.

The rule’s “moderating provisions” are beneficial for landowners subject to EPA standards in that:

- Until December 31, 2016, discharges into or within the EPA shall be permitted using net improvement as a moderating provision upon a demonstration by the applicant that the permittee will implement, or cause to be implemented, BAPRT, as defined by Section 373.4592(2)(a) F.S., and further provided in this section, which shall include a continued research and monitoring program designed to reduce outflow concentrations of phosphorus.

2.0 TASK OBJECTIVES

The purpose of this final study task is to analyze preferred concept alternatives for the Boynton Farms Basin to meet long-term water quality goals for discharges to the EPA. This task does not discredit the possibility of other options, but is intended to allow further study of what have been identified as the most feasible current alternatives. Scheda Ecological Associates, Inc. (SEA) and HSA Engineers and Scientists (HSA) developed these alternatives in coordination with the District and other stakeholders including landowners, the Refuge, Lake Worth Drainage District (LWDD), Florida Department of Transportation (FDOT), Palm Beach County Facilities Development & Operations, and Palm Beach County Soil & Water Conservation District.

To reach this final study phase, previous tasks included the identification of existing farm structures, the establishment of survey benchmarks, and the development of a "long list" of conceptual alternatives to reduce nutrient load to the Refuge headquarters property. The conceptual alternatives addressed various methods of reducing or eliminating discharge of elevated concentrations of nutrients to the EPA while preserving flood protection and farm irrigation.

In this Technical Memorandum, the SEA Team presents a schematic plan and cost estimate for each preferred alternative, along with parameters for stormwater conveyance, storage, and discharge. The possible obstacles and advantages of each alternative are outlined and discussed to allow for future in-depth study of these options.

3.0 EXISTING FARM STRUCTURES

Prior to formulation of conceptual alternatives, the SEA Team surveyed existing farm structures in the Boynton Farms Basin (Table 3-1). All pumps, culverts, and ditches are noted in Figure 3-1.

- **Palm Beach County Property**

There are seven pumps on the Palm Beach County property: six diesel and one electric. Four of the diesel pumps, P1, P2, P4, and P5, are 24 inches in diameter, and are situated along the farm's western boundary. They discharge directly to the Refuge. Pump 3, a 12-inch diameter diesel pump situated along the western boundary, also discharges directly to the Refuge. Pump 6 is a 36-inch diesel pump located along the eastern boundary, and discharges through culverts to the E-1 Canal. Pump 7 is an 18-inch electric pump adjacent to P6. The electric pump provides irrigation from the E-1 Canal. Within the property, there are three ditch gates with riser boards in the east-west internal canals; these are used to control the east-west water elevation gradient. One culvert with flashboard risers controls water elevations in the northernmost blocks of crops.

Four sets of culverts connect the E-1 Canal to the Palm Beach County property. A double-barrel culvert, C1 and C2 (both 66-inch diameter), is located east of the pump station containing P6 and P7. A third culvert, C3, is 72 inches in diameter, and includes a sluice gate at the southeast corner of the property. The fourth culvert, C4, is 72 inches in diameter, and is located on the southeast corner of the property. Although some questions as to the property line relative to this culvert have been raised, this memorandum assumes the culvert to be located on the county property due to appearance relative to fields and ditches.

- **DuBois Property**

Water conveyance structures on the DuBois property include four pump stations with diesel-driven, axial flow pumps: P8, P9, P10, and P11. Pump 8 is 24 inches in diameter, and is located at the northwestern side of the farm. It is the only pump on the DuBois property that discharges directly to the Refuge. Pumps 9, 10, and 11 are 24-inch pumps that lift water to an onsite natural area for farm drainage; thus, they do not discharge directly to the Refuge, but overland discharges are assumed to occur as a result of their operation. Pump 9 is located centrally on the property; P10 and P11 are located on the western side of the property.

A pump station on the eastern side of the farm includes a vertical lift pump (box pump), P12, with a diesel motor and two electric pumps, P13 and P14. The eastern pump station is used for both irrigation and drainage.

Two sets of culverts were installed under US 441 to provide hydraulic connection from the DuBois property to the E-1 Canal. One set of 60-inch diameter culverts, C5 and C6, is adjacent to the eastern pump station (P12, P13, and P14). A second set of culverts, C7 and C8, consists of two 60-inch diameter pipes located approximately one-quarter mile north of Lee Road. These culverts currently are not being utilized. An additional culvert, C9, is located immediately south of Lee Road. This culvert is 60 inches in diameter and connects the S-10 Canal on the south side of Lee Road with the E-1 Canal. Two 24-inch culverts, C13 and C14, are located in the FPL easement immediately west of P8. The culverts appear to be on the Refuge property within the FPL easement to convey water discharged through P8 from east to west under the FPL access road. In 1982, the District also permitted a 24-inch and a 36-inch culvert within the FPL easement that would allow water to flow west to the Refuge. These two culverts were not located in the field, and it is not known if they are in place and functional today. Two 36-inch diameter culverts were identified within the natural area, to the southeast of pump P11, allowing east to west flow under the FPL access road on the DuBois property.

- **Gayler Property**

Although the Gayler property no longer is part of the Boynton Farms Basin, its structures were inventoried for possible future use. The property's two pumps, P15 and P16, recently were moved to the east side of the farm, and no longer impact the Refuge. A ditch block also was installed to prevent water from draining south onto the Palm Beach County property. Three 48-inch culverts connect the northeast corner of the Gayler property to the E-1 canal. Culvert 10 features a sluice gate on the west side of US 441. Culverts 11 and 12 are south of C10 approximately 26 feet apart. According to FDOT roadway plans, C12 receives roadway runoff drainage.

Table 3-1. Boynton Farms Basin Existing Surface Water Conveyance Structures

IRRIGATION/DRAINAGE PUMPS

Property	Number on Map	Diameter (inches)	Pump Location	Information
Palm Beach County	P1	24	Northwest	Discharges to Refuge
Palm Beach County	P2	24	Northwest	Discharges to Refuge
Palm Beach County	P3	12	Central west	Discharges to Refuge
Palm Beach County	P4	24	Central west	Discharges to Refuge
Palm Beach County	P5	24	Southwest	Discharges to Refuge
Palm Beach County	P6	36	East	Discharges to E-1
Palm Beach County	P7	18	East	Irrigation
DuBois	P8	24	Northwest	Discharges to Refuge
DuBois	P9	24	Central	Discharges to onsite natural area
DuBois	P10	24	Central west	Discharges to onsite natural area
DuBois	P11	24	South central	Discharges to onsite natural area
DuBois	P12	60	Northeast	Irrigation/drainage, box pump
DuBois	P13	12	Northeast	Irrigation, electric
DuBois	P14	12	Northeast	Drainage, electric
Gayler	P15	unknown	East	Does not discharge to Refuge
Gayler	P16	unknown	East	Does not discharge to Refuge

MAJOR CULVERTS

Property	Number on Map	Internal Diameter (inches)	FDOT Roadway Station	Pipe Material	Comment
Palm Beach County	C1 and C2	66	704+90	RCP	Due east of Pumps 6 and 7
Palm Beach County	C3	72	682+66	RCP	Sluice gate; SE corner of PBC property
Palm Beach County	C4	72	681+89	RCP	Changes direction under US 441
DuBois	C5 and C6	60	668+47	RCP	Due east of Pump 11
DuBois	C7 and C8	60	646+00	RCP	
South of Lee Road	C9	60	629+10	RCP	Sluice gate; south of Lee Road
Gayler	C10	48	734+50	RCP	Sluice gate; not part of BFB
Gayler	C11	48	730+64	RCP	Not part of BFB
Gayler	C12	48	730+38	RCP	Not part of BFB
DuBois	C13	24	not applicable	CMP	Culvert at property line
DuBois	C14	24	not applicable	CMP	Culvert at property line
DuBois	C15	36	not applicable	CMP	Culvert at FPL easement
DuBois	C16	36	not applicable	CMP	Culvert at FPL easement

BFB: Boynton Farms Basin
RCP: Reinforced Concrete Pipe
CMP: Corrugated Metal Pipe

G\x\Projects\W06 Boynton Farms\Figure_3-1_Final.mxd MB/JF

Gayler Property

Palm Beach County Property

Arthur R. Marshall Loxahatchee National Wildlife Refuge

DuBois Property

C10
L-24 Canal
C11 (TBM2)
C12
441
7
(TBM6) P15
P16
(TBM7) P1
P2
E-1 Canal
L-25 Canal
105th St S.
P3
(TBM8)
(TBM9) P4
C1, C2 (TBM1)
P6, P7
P5
C3
L-26 Canal
C4
P8
P12, P13, P14
C5, C6 (TBM3)
C13, C14
P9
(TBM5) P10
L-27 Canal
C7, C8 (TBM4)
(2) 36" Culverts
P11
E-1 Canal
C9
S-10 Canal
L-28 Canal
Lee Rd.

Legend

- Existing Pump
- Berm
- Culvert
- Ditch Block
- Ditch Gate with Riser Boards
- Canal
- Ditch
- Overhead Power Lines
- Other Boundary
- Project Boundary

500 250 0 500 Feet

N

Boynton Farms Basin
Palm Beach County, FL

Pumps, Culverts, and Ditches

Figure 3-1

4.0 CONCEPTUAL ALTERNATIVES

The SEA Team initially developed a list of 11 conceptual alternatives for stakeholder consideration. These are outlined in Table 4-1.

4.1 ASSUMPTIONS AND TECHNICAL SUMMARY

4.1.1 Basic Site Information

The 341-acre Boynton Farms Basin consists of the 216-acre Palm Beach County property and the 125-acre DuBois property. The two properties include five natural areas totaling approximately 76.6 acres. All acreages are approximate.

4.1.2 Design Storm Description

Site modifications have been developed to manage the rainfall/runoff from a 25-year/72-hour storm. The design storm would precipitate 12 inches of water over 72 hours. The storm characteristics are taken from the *Environmental Resource Permit Information Manual Volume IV* (2000).

4.1.3 Pumping Capacity

Pump capacities have been estimated based on pump diameters and 4 feet of head (low lift pumps). With all existing structures, it is estimated that the Palm Beach County property can cumulatively pump approximately 243 cubic feet per second (cfs), and the DuBois property can cumulatively pump approximately 221 cfs. Some of the pump structures for DuBois are considered internal and do not directly discharge from the site.

4.1.4 Culvert Capacity

Manning's Equation was used to approximate the flow rate capacity through the culverts connecting the basin to the E-1 Canal. With the conservative assumption of 1 foot of head, gravity would force water through the culverts, excluding the culvert south of Lee Road, at a cumulative rate of 196 cfs. The roughness coefficient provided in the FDOT Drainage Manual was used in this calculation.

4.1.5 Permitted Discharges

Two permits for the area now encompassed by the County property calculated the allowable discharge at a total of 59.7 cfs (13.7 cfs under 50-00423-S, and 46 cfs under 50-00430-S). The DuBois property previously was permitted under 50-00985-S with an

allowable discharge of 54 cfs. The permitted discharge applies only to discharges from the site, not pumping to internal storage or treatment areas.

Table 4-1. Conceptual Alternatives to Reduce or Eliminate Discharge of Elevated Levels of Nutrients from the Boynton Farms Basin to the Everglades Protection Area

Alternative No. & Description	Requirements	Comments
1. Continued interim discharge to Refuge until 2015-2020	• Voluntary implementation of farm BMPs • Discharge to refuge until 2015-2020 CERP project is completed, then reroute flows to planned CERP reservoir or land acquisition for buffer. (Palm Beach County Agriculture Reserve Reservoir Project) • Refine pump operations to discharge through existing facilities to the E-1 Canal, when practical, to minimize discharge to Refuge	• Some P reduction would occur as a result of implemented BMPs • Short term, most cost effective alternative • Interim water quality sampling and target P plan would be implemented • Limited facilities in place to convey water east
2. Improve capacity of stormwater flow to E-1 with peak flows still discharging to Refuge	• Voluntary implementation of farm BMPs • Would require installing some pumps on east side of properties • Some new rip rap basins would be required • Pump water east to E-1 Canal, when practical • Existing pumps on west side of basin would be used only during peak rain events to prevent property flooding	• Some P reduction would occur as a result of implemented BMPs • Existing culvert capacity under U.S. 441 would be used with no plans to expand size or number • Interim water quality sampling would be implemented
3. Continued interim discharge to Refuge until 2015-2020 CERP project with enhanced onsite water storage	• Voluntary implementation of farm BMPs • Stormwater would be rerouted to some or all existing natural areas • Berms would be constructed around natural areas or in place of crops to provide 4-foot-deep temporary storage of stormwater • After storage, stormwater would be discharged to Refuge	• Some P reduction would occur as a result of implemented BMPs and temporary storage in detention ponds • Interim water quality sampling and target P plan would be implemented • Need to determine feasibility of short term impoundment storage over natural areas
4. Pump stormwater east to Lake Worth Drainage District E-1 Canal, thus eliminating discharge to Refuge	• Voluntary implementation of farm BMPs • Would require moving existing pumps or installing new pumps east side of properties • Flow would be pumped using existing culverts under U.S. 441 • Some new riprap basins would be required • Internal hydraulic changes may be needed on County property due to slope of land from east to west; additional culverts and risers may need to be installed	• Some P reduction would occur as a result of implemented BMPs • Need to determine hydraulically if stormwater flows can be routed through existing culverts under U.S. 441 or if larger / more culverts would be needed • Need to confirm that Lake Worth Drainage District would accept flow and quality of the water (P concentration)

Table 4-1. Conceptual Alternatives to Reduce or Eliminate Discharge of Elevated Levels of Nutrients from the Boynton Farms Basin to the Everglades Protection Area

Alternative No. & Description	Requirements	Comments
5. Pump directly to E-1 Canal by routing discharge piping through some existing culverts, thus eliminating discharge to Refuge	• Voluntary implementation of farm BMPs • Would likely require installing new pumps on east side of properties to produce required head pressure • More complex design, permitting, and construction of piping within existing culverts relative to gravity flow • Internal hydraulic changes may be needed on County property due to slope of land from east to west; additional culverts and risers may need to be installed	• Some P reduction would occur as a result of implemented BMPs • More flow possible relative to gravity discharge • Lake Worth Drainage District E-1 Canal stages could rise affecting other properties and FDOT roadway discharges
6. Pump stormwater east to Lake Worth Drainage District E-1 Canal with additional onsite storage, thus eliminating discharge to Refuge	• Voluntary Implementation of farm BMPs • If hydraulic analysis indicated peak stormwater flows could not otherwise be discharged to E-1, 4-foot berms would be constructed around natural areas or in place of crops to provide temporary storage of stormwater • After storage, water would be pumped east using existing culverts under U.S. 441 • Would require moving existing pumps or installing new pumps east side of properties and at impoundment locations • Internal hydraulic changes may be needed on County property due to slope of land from east to west; additional culverts and risers may need to be installed at end of ditches	• Would provide a degree of P removal as a result of implemented BMPs and detention areas • Need to determine hydraulically if all stormwater flows can be routed through existing culverts, but more likely with aid of onsite storage for attenuation of peak discharges • Need to determine feasibility of short-term impoundment storage over natural areas
7. Install ASR and / or deep well discharge system for stormwater, thus eliminating discharge to Refuge	• Berms would be constructed around five natural areas to provide 4-foot-deep temporary storage (flow equalization) of stormwater prior to ASR discharge • Hydraulic analysis will determine number of ASR wells required; previous studies have indicated each ASR well can accommodate 5 to 10 MGD of stormwater (7.7 to 15.4 CFS)	• Elimination of discharge to Refuge • No surface water discharge, but water would need to be pretreated to remove coliform bacteria and potentially TSS • Recovered waters could be used to irrigate during low rainfall months • Potential long-term use for CERP Agriculture Reserve Reservoir • High cost / CFS benefit

Table 4-1. Conceptual Alternatives to Reduce or Eliminate Discharge of Elevated Levels of Nutrients from the Boynton Farms Basin to the Everglades Protection Area

Alternative No. & Description	Requirements	Comments
8. Chemical pretreatment of stormwater to 10 ppb P content and continue to discharge to Refuge	• Reroute flow to chemical treatment facility equipped with a flow equalization basin prior to discharge to Refuge	• Significant reduction in P concentrations • Advantage to the Refuge is continued source of water • Historical concerns expressed relative to residual solids disposal and possible impact of treatment on water quality other than P removal • Interim water quality sampling would be implemented • High capital and maintenance costs
9. Owner-operated impoundment and stormwater treatment area on one or both farm properties	• Voluntarily implement farm BMPs • Route stormwater drainage to impoundment / STA • Construct minimal infrastructure needed for treatment on fallow area of property, as consistent with CERP project as possible	• Significant reduction of P entering Refuge in long term, but leaching of nutrients from area previously farmed may delay P concentration reduction • Water flow maintained to Refuge, with less intense peak storm inflows • Treated waters could be used to irrigate properties during low rainfall months • Goal would be to limit construction features to those that are consistent with CERP project
10. District-owned impoundment and stormwater treatment area on one or both farm properties	• Implement farm BMPs • Land acquisition and project funding agreements • Route stormwater drainage to impoundment / STA • Construct minimal infrastructure needed for treatment on fallow area of property, as consistent with CERP project as possible	• Significant reduction of P entering Refuge in long term, but leaching of nutrients from area previously farmed may delay P concentration reduction • Water flow maintained to Refuge, with less intense peak storm inflows • Treated waters could be used to irrigate County property during low rainfall months • Goal would be to limit construction features to those that are consistent with CERP project

Table 4-1. Conceptual Alternatives to Reduce or Eliminate Discharge of Elevated Levels of Nutrients from the Boynton Farms Basin to the Everglades Protection Area

Alternative No. & Description	Requirements	Comments
11. Use individual alternatives best suited for each farm property	• Unique conditions for each property may dictate that varying methods be used independent of one another. • Determine for County property the degree to which owner / lessee can cooperate to accomplish goals (infrastructure improvements, reduction in crop area, operation of pumped impoundment)	• DuBois property currently utilizes natural areas, which could be enhanced by minor re-plumbing and operation • County property has not utilized available natural areas, and faces more of a challenge to move water east

Note: As a result of coordination in the preliminary stages of this evaluation, stormwater discharges from the Gayler property have been voluntarily redirected east to the Lake Worth Drainage District E-1 Canal. This has reduced the contributing basin area by approximately 20%.

5.0 ALTERNATIVES ANALYSIS

The following section discusses each of the 11 conceptual alternatives and the rationales used for eliminating some from further consideration. The resulting Preferred Alternatives are identified and further analyzed in Section 6.0. All the alternatives considered include implementing agricultural BMPs. Currently, the Palm Beach County Soil & Water Conservation District is planning to develop a farm-level BMP program for the Palm Beach County property.

5.1 DISCHARGE TO THE REFUGE

Alternatives that maintain discharge to the Refuge were eliminated from further consideration - even those with only peak-flow discharges - unless treated water meets standards established in the EFA. The eliminated alternatives are:

- Alternative 1 - *Continue interim discharge to the Refuge until 2015-2020.*
- Alternative 2 - *Improve capacity of stormwater flow to the E-1 Canal with peak flows discharging to the Refuge*.
- Alternative 3 - *Continue interim discharge to the Refuge until the 2015–2020 CERP project is accomplished, coupled with enhanced onsite farm storage*.

Refuge personnel indicated that the supply of water from the Boynton Farms Basin to the Refuge (affecting hydrologic conditions on the Refuge property) is not a concern, and therefore, there is no conflict if all farm runoff is retained and/or diverted to the east.

5.2 STORMWATER RUNOFF DIVERSION

Any alternative that involves discharging stormwater runoff without improving water quality does not meet the intent of the EFA, or the state phosphorus requirement for the EPA. Farm-level BMPs are recommended for all alternatives, and will satisfy the intent of the EFA. Alternatives involving stormwater runoff diversion to the east, eliminating discharge to the Refuge, were therefore given further consideration. These alternatives are:

- Alternative 4 - *Pump stormwater east to the E-1 Canal, eliminating discharge to the Refuge.*
- Alternative 5 - *Pump directly to the E-1 Canal by routing discharge piping through some existing culverts, eliminating discharge to the Refuge*.

These two alternatives are similar in concept, but differ in the delivery of runoff to the E-1 Canal. Alternative 4 involves runoff discharging by gravity to the E-1 Canal. Alternative 5 involves pumping directly through the culverts and discharging to the E-1 Canal. Because of the similarities, only one alternative was further developed. However, a detailed analysis of the pressure versus gravity systems should be evaluated before implementation.

- Alternative 4 - *Pump stormwater east to the E-1 Canal, eliminating discharge to the Refuge*, is a **Preferred Alternative**.

5.3 STORMWATER RUNOFF DIVERSION WITH ONSITE STORAGE

Alternatives involving stormwater runoff diversion to the east with onsite storage, eliminating discharge to the Refuge, were given further consideration. The following **Preferred Alternative** was further developed:

- Alternative 6 – *Pump stormwater east to the E-1 Canal with additional onsite farm storage, eliminating discharge to the Refuge.*

Pretreatment of runoff for water quality improvement - beyond agricultural BMPs - prior to overflow to onsite natural areas for flood attenuation was included in this option. The size of pretreatment areas was determined by an assumption of runoff (0.5 inch) from the contributing drainage area (total area less natural area).

Concerns over the operation and carrying capacity of the S-10 Canal, located on the south side of Lee Road, resulted in the concept of conveying runoff to the E-1 Canal using the S-10 Canal and the culvert located on the south side of Lee Road (C9) being removed from further consideration. Additionally, routing a portion of the runoff to the west using the S-10 Canal was not considered.

The LWDD has indicated it is willing to work with stakeholders in receiving all or a portion of the runoff from the Boynton Farms Basin into its system.

5.4 AQUIFER STORAGE AND RECOVERY

Alternatives including aquifer storage and recovery (ASR) and/or deep well discharge were not given additional consideration due to the costs associated with crop loss because of equalization basin/pretreatment requirements, deep well drilling, and extensive operations and maintenance (O&M). Therefore, Alternative 7 - install ASR and/or deep well discharge system for stormwater, eliminating discharge to the Refuge -

was removed from further study. Future deliberation may be given to an ASR system if there are significant changes in land ownership and economics.

5.5 CHEMICAL TREATMENT

The Refuge has indicated it is a permit violation to accept chemically treated water onto its property. This, along with high capital and O&M costs, and the costs and uncertainty associated with disposal of residual solids generated during the treatment process, served to eliminate chemical treatment options. Therefore, Alternative 8 - chemical pretreatment of stormwater to 10 ppb TP and continued discharge to the Refuge - was removed from further consideration.

5.6 IMPOUNDMENTS AND STORMWATER TREATMENT AREAS

Alternatives including impoundments and stormwater treatment areas were further considered. This approach provides more improvement in water quality than does managing stormwater runoff only through pretreatment canals and portions of the natural areas. The following **Preferred Alternative** was further developed:

- Alternative 9 – *Owner-operated impoundment and stormwater treatment area on one or both farm properties*.

The District currently is not in the position to purchase land or fund construction or operation of an STA within the basin. Therefore, Alternative 10 - District-owned/operated impoundment and stormwater treatment area - was removed from further consideration. This alternative may be revisited in the future if the situation changes.

5.7 FARM-SPECIFIC ALTERNATIVES

A cost estimate for alternatives is provided in Section 6.0. A combination of alternatives can be considered using the costs presented; however, individual alternatives best suited for each farm were not further developed.

5.8 PREFERRED ALTERNATIVES

After careful analysis of state water quality standards, and the potential costs involved with individual alternatives, the following were identified as **Preferred Alternatives**:

- Alternative 4 - *Pump stormwater east to the E-1 Canal, eliminating discharge to the Refuge*.

- Alternative 6 - *Pump stormwater east to the E-1 Canal with additional onsite farm storage, eliminating discharge to the Refuge*.
- Alternative 9 – *Owner-operated impoundment and stormwater treatment area on one or both farm properties.*

6.0 CONCEPTUAL DESIGN AND COST ESTIMATES FOR PREFERRED ALTERNATIVES

The conceptual design includes diverting runoff to the east and managing any excess runoff on the farms. The pumping rate will be in accordance with the permitted maximum discharge rate for each farm, while not exceeding the carrying capacity of the culverts. Any runoff that is not diverted must be managed on site in ditches, pretreatment canals, natural areas, and/or impoundments, while preventing discharge to the Refuge. Onsite runoff management is discussed further in Sections 6.2 and 6.3.

The Palm Beach County property is permitted a maximum discharge of 59.7 cfs, and the DuBois property is permitted a maximum discharge of 54 cfs.

The following Preferred Alternatives include runoff conveyance to the east through culverts located beneath US 441 to the E-1 Canal. Manning's Equation suggests that the C1, C2, C3, and C4 culverts can cumulatively convey 116 cfs from the Palm Beach County property, and that C5, C6, C7, and C8 can cumulatively convey 80 cfs from the DuBois property. Therefore, the culverts connecting each farm to the E-1 Canal have sufficient capacity to convey the permitted maximum discharge from each farm. These calculations are summarized in Table 6-1.

The southwest quadrant of the DuBois property features two 36-inch diameter culverts that convey water from the farm to a natural buffer area and are near the Refuge's border. The storage capacity of the natural buffer area is unknown, and should be further investigated before it is used for onsite water management.

Conceptual designs were developed for each of the Preferred Alternatives, and are presented in Sections 6.1, 6.2, and 6.3. A cost estimate for each of the Preferred Alternatives is presented in Section 6.4. The approaches described are intended to present one option for implementing the alternative (concept). There remains flexibility for the detailed design depending on farm or owner-specific considerations.

6.1 PUMP STORMWATER EAST TO THE E-1 CANAL, ELIMINATING DISCHARGE TO THE REFUGE

This alternative is similar to the improvements recently completed at the Gayler property. The Gayler property eliminated its discharge to the Refuge, and diverted its runoff to the E-1 Canal. This was accomplished by moving two surface water pump stations from the western side of the farm to the eastern side. All runoff currently is

pumped through culverts located beneath US 441 to the E-1 Canal. The concept applied to the Palm Beach County and DuBois properties includes discontinuing and redirecting the discharge of pumps to eliminate discharge to the Refuge; installing pumps at the property outfalls, and improving ditches to convey runoff to the outfalls on the eastern sides of the properties. This analysis does not present a detailed design or calculate a level of flood protection associated with the alternative. Detention pond or other surface water runoff storage may be required to maintain current protection when limited to previously permitted discharge rates.

6.1.1 Palm Beach County Property

A conceptual design for the Palm Beach County property is shown in Figure 6-1. The design includes:

- Installing a new pumping station near outfall C3/C4, located at the southeastern corner of the farm.
- Conveyance improvements and pump relocations to direct flows from the western half of the property to the eastern outfalls, eliminating discharge to the Refuge.
- Improving the fore bay area of the outfall location C3/C4 to store the additional volume delivered before runoff drains from the farm.

6.1.2 DuBois Property

A conceptual design for the DuBois property is shown in Figure 6-1. The design includes:

- Installing a new pumping station near outfall C7/C8.
- Limiting discharge to the natural areas to what can be retained without overland discharge to the Refuge.
- Conveyance improvements and pump relocation to direct flows from the western side of the fields to the eastern outfalls, eliminating discharge to the Refuge.

The fore bay areas will serve as settling basins, and may slightly improve water quality by reducing phosphorus in the runoff prior to discharge from the properties.

6.2 PUMP STORMWATER EAST TO THE E-1 CANAL WITH ADDITIONAL ONSITE STORAGE, ELIMINATING DISCHARGE TO THE REFUGE

Further evaluation of stormwater runoff and conveyance showed that combining pretreatment and onsite farm storage could be accomplished without significant additional loss of cropland, compared to an option of runoff diversion without onsite storage. Therefore, this alternative was developed by incorporating some degree of onsite storage while considering minimum pretreatment requirements, topographic farm features, locations of natural areas, and locations of off-farm pump stations for the properties.

The US Soil Conservation Service (SCS) method was used to calculate farm runoff volume and peak discharges. For these runoff calculations, input data included hydrologic soil group, land use, curve number (CN), rainfall amount, District rainfall distribution data, and time of concentration.

The equation is:

$$\mathbf{Q = (P-0.2*S)^2 / (P+0.8S)}$$

Q = accumulated direct runoff (inches)

P = accumulated rainfall (inches)

S = potential maximum retention (inches)

A curve number of 89 was used in the calculations, and the 72-hour/25-year return period rainfall was estimated at approximately 12 inches in accordance with rainfall curves in the "Surface Water Design Aids" of the District's *Environmental Resources Permit Information Manual Volume IV* (2000). Using the SCS method, approximately 11 inches of runoff from the farm drainage areas was estimated.

The minimum pretreatment area size was determined considering 0.5-inch runoff from the contributing drainage area (total area minus natural area). For example, the contributing drainage area for the Palm Beach County property is approximately 171 acres (216 total acres minus 45 acres of natural area). The stormwater runoff to the pretreatment area was determined by using 0.5 inches of runoff from the drainage area, resulting in approximately 7.1 acre-feet (AF) of pretreatment for the Palm Beach County property, and 3.9 AF of pretreatment for the DuBois property.

An iterative process was used to develop a conceptual design balancing pretreatment and onsite storage. In this scenario, pretreatment is accomplished by determining the

approximate dimensions of a pretreatment rim canal, and the location of natural area on the properties. Spoil materials excavated from the perimeter ditch and rim canal are used to construct a perimeter levee and a berm on the downstream side of the rim canal. Stormwater runoff is conveyed to a collection ditch, pumped into the pretreatment rim canal, flows through a riser culvert installed in the berm, and discharges to the natural area. Riser culverts are installed to allow runoff to flow out of the natural area, and ultimately be conveyed to pumps located on the eastern side of the property. A cross section of this pretreatment system is shown in Figure 6-2. Table 6-2 summarizes the results of the pretreatment/onsite storage balance.

Pretreatment occurs mainly within the rim canal, with additional pretreatment within the smaller ditch constructed immediately upstream, and around the perimeter of the natural area. Only the rim canal volume was counted as pretreatment for this analysis. Oldsmar is the primary soil throughout the farms, with a water table within 10 inches of the surface for one to three months during most years under natural conditions. For the purpose of these calculations, a seasonal high groundwater elevation of 1 foot below land surface (BLS) was used. The pretreatment was estimated by calculating the volume of water in the rim canal (minus the volume below 1-foot BLS). The top of berm (TOB) elevation is approximately 4 feet above grade, with a 1-foot freeboard for the water elevation within the rim canal. This results in a 4-foot water column in the rim canal for pretreatment.

Using the information presented above, the equivalent lengths of rim canal and perimeter ditch were calculated. These values represent the lengths required to meet the minimum runoff pretreatment volumes (7.1 and 3.9 AF).

These equivalent lengths of canals and ditches were compared to the approximate length of potential rim canals constructed in conjunction with the existing natural areas (i.e., the perimeter of the 27-acre natural area located in the southwestern corner of the Palm Beach County property is approximately 4,500 LF). The approach used for each farm is provided below. This same approach can be applied to other onsite natural areas by varying the pretreatment canal configuration to match the pretreatment volume required.

6.2.1 Palm Beach County Property

A conceptual design for the Palm Beach County property is shown in Figure 6-3. The design includes:

- Constructing a rim canal of approximately 2,600 LF around the 11-acre natural area in the central portion of the farm to provide storage for at least 7.1 AF of runoff.
- Improving internal farm ditches to convey runoff to the pretreatment rim canal pumps and from the natural area to the property outfalls.
- Installing a new pumping station at outfall C3/C4, located at the southeastern corner of the farm.
- Improving the fore bay area of the outfall location C3/C4 to store the additional volume delivered by the pretreatment system before runoff drains from the farm.
- Installing pumping stations to lift runoff from both the west basin and the east basin into the pretreatment area.
- Removing the western pumps to eliminate discharge to the Refuge.

6.2.2 DuBois Property

A conceptual design for the DuBois property is shown in Figure 6-3. The design includes:

- Constructing a rim canal of approximately 2,000 LF around the 6-acre natural area in the southeastern portion of the farm to provide storage for at least 3.9 AF of runoff.
- Improving internal farm ditches to convey runoff to the pretreatment rim canal pumps and from the natural area to the property outfalls.
- Installing a pumping station near outfall C7/C8.
- Eliminating or restricting existing pumps to western natural areas to eliminate discharge to the Refuge.
- Installing a new pump station on the southwestern side of the natural area.

Improved water quality may be expected via phosphorus reduction due to settling in the rim canals and fore bay areas, and biological uptake in the natural areas. Further analysis of these alternatives is required to determine hydrological impacts to the wetlands.

6.3 IMPOUNDMENTS AND STAS

Alternatives including impoundments and STAs were further considered. This approach provides more improvement in water quality than does the previous option of managing stormwater runoff through a series of pretreatment canals and portions of the natural areas. This concept includes conveying runoff to STAs constructed on the Palm Beach County and DuBois properties. Using natural areas as long-term impoundments was considered; however, due to the unknown impacts that could occur due to changes in wetland hydrology, the alternatives were further developed using existing cropland for the impoundments.

The impoundments were designed with a maximum water depth of 4 feet, and their sizes were calculated to contain 1 inch of runoff from the contributing drainage area (total area minus natural area). Additional flood protection could be provided by increasing the area of the impoundments. The runoff from the onsite impoundment could be routed to the E-1 Canal, as in the runoff diversion alternatives, or released back to the fields for irrigation as a BMP termed “tailwater recovery.” However, the STA-treated water should be given future consideration for possible discharge to the Refuge if it meets water quality standards. The approach used for each farm is provided below:

6.3.1 Palm Beach County Property

A conceptual design for constructing a STA/impoundment on the Palm Beach County property is shown in Figure 6-4. The design includes:

- Constructing a 3.2-acre STA on the farm to store 12.7 AF runoff.
- Improving internal farm ditches to convey runoff to the STA, and from the STA to the property outfalls.
- Installing a new pumping station near outfall C3/C4, located at the southeastern corner of the farm.
- Installing a new influent pump station on the southern side of the STA.
- Improving the fore bay area of the outfall location C3/C4 to store the additional volume delivered by the pretreatment system before runoff drains from the farm.

6.3.2 DuBois Property

A conceptual design for constructing a STA/impoundment on the DuBois property is shown in Figure 6-4. The design includes:

- Constructing a 1.6-acre STA on the property to store 6.5 AF runoff.
- Improving internal farm ditches to convey runoff to the STA, and from the STA to the property outfalls.
- Installing a new pumping station near outfall C7/C8.
- Redirecting the flow from two existing pumps (P8 and P10) to convey runoff to the STA/impoundment.
- Installing a new influent pump station on the northern side of the STA.

The proposed locations of the impoundments were chosen based on farm topographical features. Additionally, the impoundments were not proposed to be adjacent to US 441 to avoid possible concerns with seepage, etc., affecting the road right-of-way. Improved water quality is expected via phosphorus reduction due to settling in the rim canal and fore bay areas, and biological uptake in the STA/impoundment.

6.4 ENGINEERING COST ESTIMATES

An engineering cost estimate was developed for each of the Preferred Alternatives. The cost components include:

- **Improve existing fore bays**: Improve existing fore bay areas, assuming the removal of 50 cubic yards of soil for a bottom depth of 8-foot BLS, and improve the excavation sidewalls with riprap.
- **Conveyance riser culverts with stop logs**: Install 30-foot-long, 72-inch-diameter riser culverts to convey runoff from rim canals to natural areas, and from natural areas to conveyance canals. Multiple smaller culverts may be substituted.
- **Sod berms:** Place sod on constructed berms.
- **Site grading/improvements:** Site grading and ditch cleaning to improve conveyance to natural areas, outfalls, etc.

- **Internal riser culverts with stop logs:** Install 20-foot-long, 24-inch-diameter riser culverts in internal farm conveyance ditches.
- **Pump relocation:** Remove existing pump stations, piping, and fuel tanks, and place at new locations on the farms.
- **New pumping stations:** Install new pump stations (36-inch-diameter axial flow low lift pump station with diesel motor and fuel tank; farm scale application, minimum enclosure).
- **Collection ditch:** Construct a collection ditch for the pretreatment/conveyance alternatives and STA/impoundment alternatives.
- **Pretreatment rim canal:** Construct rim canals around natural areas and STA/impoundments.
- **Perimeter berm:** Construct perimeter berms/levees with spoil from the rim canals/collection ditches (4:1 side slope, 4 feet tall, 5 feet wide at the top, "crowned").
- **Internal berm (natural area berm)**: Construct internal berms with spoils from the rim canals/collection ditches (4:1 side slope, 4 feet tall, 5 feet wide at the top, "crowned").

Table 6-3 summarizes the cost estimates for each of the Preferred Alternatives.

Table 6-1. Estimation of Culvert Capacity using Manning's Equation

$$Farm\ Total\ \ Flow\ rate(cfs) = \sqrt{\frac{Head \times Diameter^{5.33}}{Length \times Roughness \times 4.61}}$$

Property	Culvert	Diameter (feet)	Length (feet)	Head (feet)	Roughness coefficient	Flow rate (cfs)	Farm total flow rate (cfs)
P.B. County	C1	5.5	235	1	0.012	26	
P.B. County	C2	5.5	235	1	0.012	26	
P.B. County	C3	6.0	246	1	0.012	32	
P.B. County	C4	6.0	249	1	0.012	32	**116**
DuBois	C5	5.0	250	1	0.012	20	
DuBois	C6	5.0	250	1	0.012	20	
DuBois	C7	5.0	232	1	0.012	20	
DuBois	C8	5.0	232	1	0.012	20	**80**

Notes:

1. Flow capacity calculation is an approximation and does not account for entrance and exit losses as well as debris or other pipe blockage.
2. Head loss assumption is conservative based on expected stage in the LWDD E-1 Canal.

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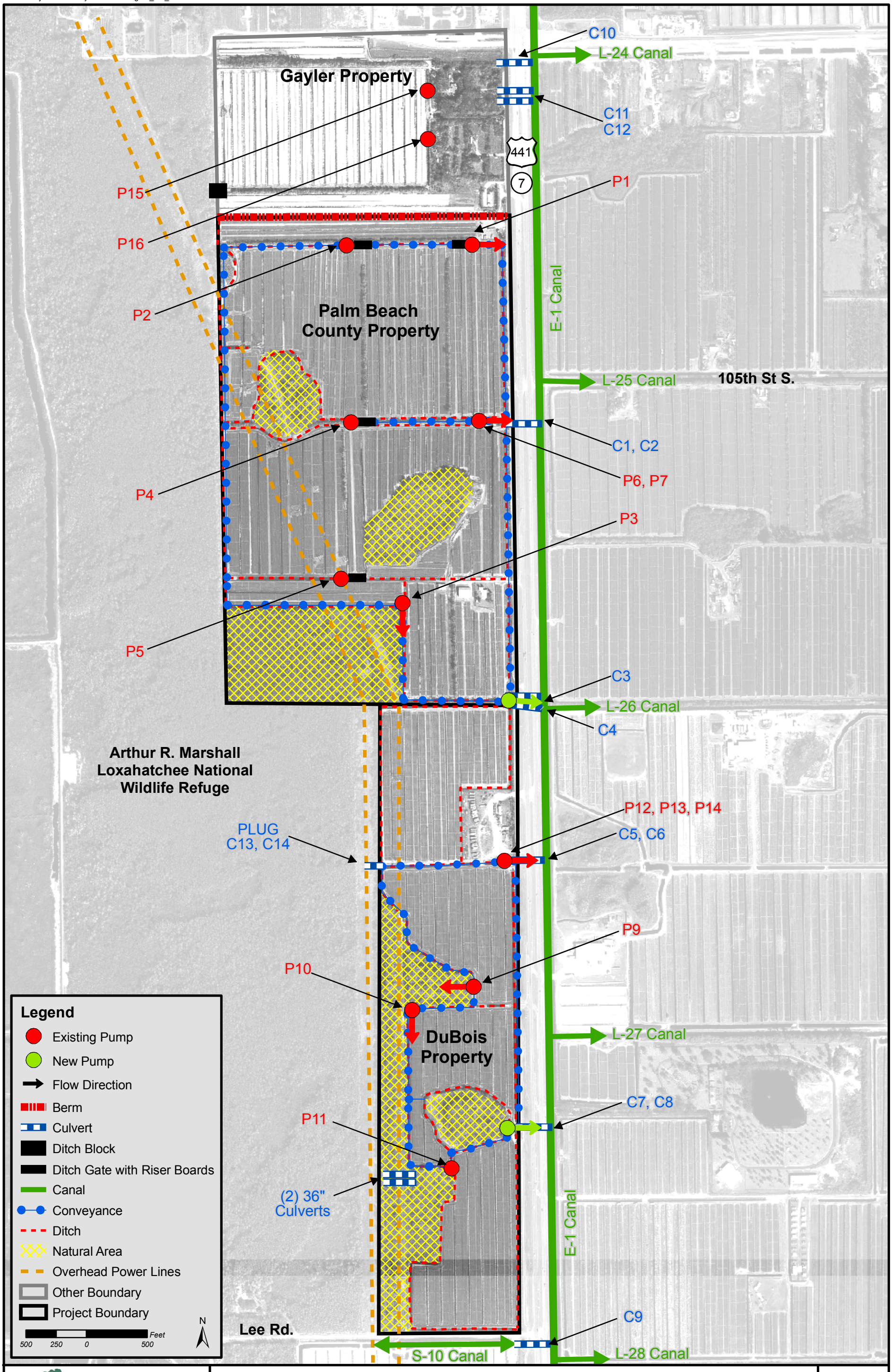
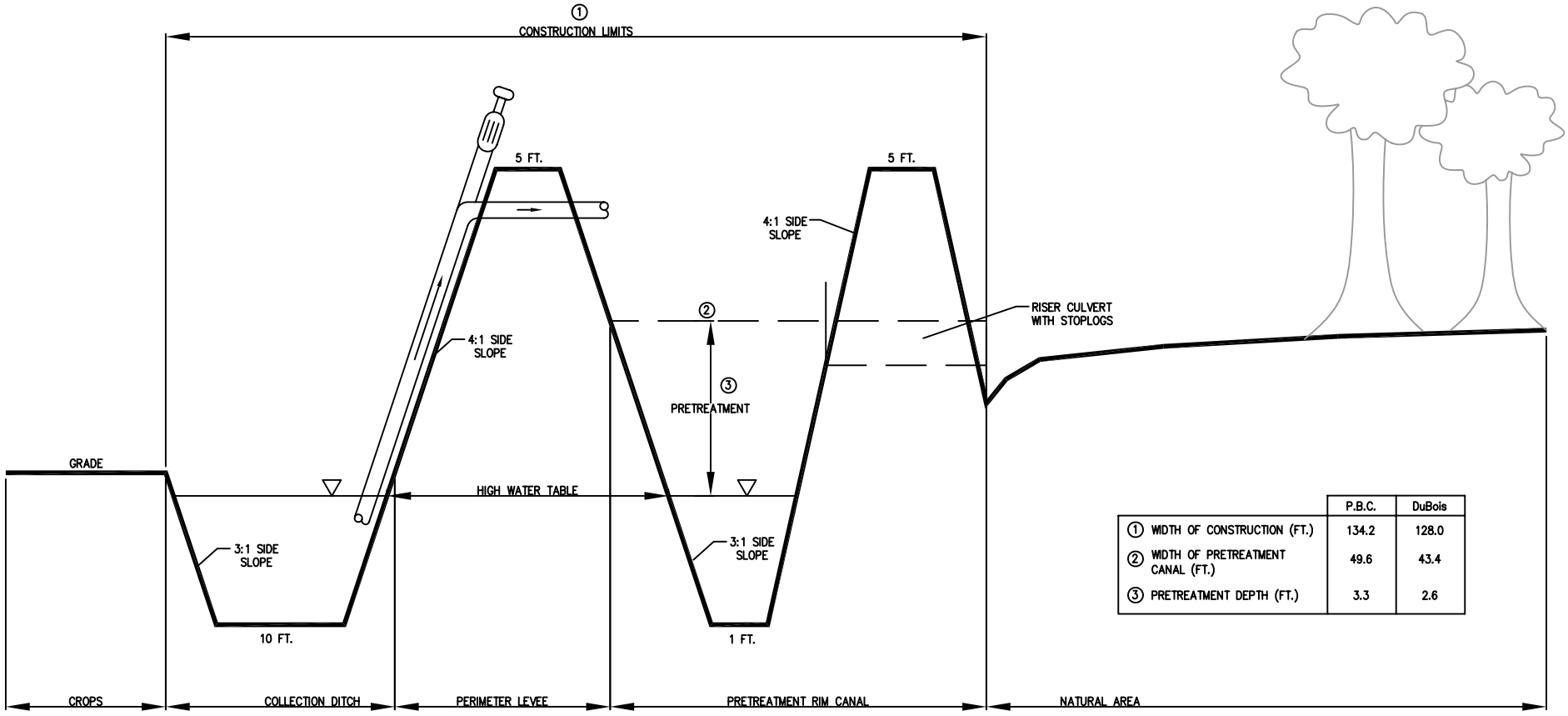


Boynton Farms Basin
Palm Beach County, FL

Pump East To E-1 (Eliminate Discharge To Refuge)

Figure 6-1



	P.B.C.	DuBois
① WIDTH OF CONSTRUCTION (FT.)	134.2	128.0
② WIDTH OF PRETREATMENT CANAL (FT.)	49.6	43.4
③ PRETREATMENT DEPTH (FT.)	3.3	2.6

BOYNTON FARMS
PALM BEACH COUNTY, FLORIDA

CROSS SECTION OF PRETREATMENT RIM CANAL

FIGURE 6-2

Table 6-2. Pretreatment Requirements

Pretreatment Requirements	**Palm Beach County property**	**DuBois property**
Drainage area, acres	171	94
Runoff, inches	0.5	0.5
Volume required, acre-feet	7.1	3.9
Length of rim canal assumed, linear feet	2,600	2,000

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Gayler Property

Palm Beach County Property

DuBois Property

Arthur R. Marshall Loxahatchee National Wildlife Refuge

C10
L-24 Canal
C11
C12
441
7
P15
P16
E-1 Canal
L-25 Canal
105th St S.
C1, C2
P6, P7
P2
P4
P5
C3
L-26 Canal
C4
P8
P12, P13, P14
C5, C6
PLUG
C13, C14
P9
L-27 Canal
P10
C7, C8
P11
(2) 36"
Culverts
E-1 Canal
Lee Rd.
C9
S-10 Canal
L-28 Canal

Legend

- Existing Pump
- New Pump
- Flow Direction
- Berm
- Culvert
- Ditch Block
- Ditch Gate with Riser Boards
- Canal
- Conveyance
- Ditch
- Pretreatment Canal
- Natural Area
- Overhead Power Lines
- Other Boundary
- Project Boundary

500 250 0 500 Feet

N

Boynton Farms Basin
Palm Beach County, FL

Pump East To E-1 With Onsite Storage (Eliminate Discharge To Refuge)

Figure 6-3

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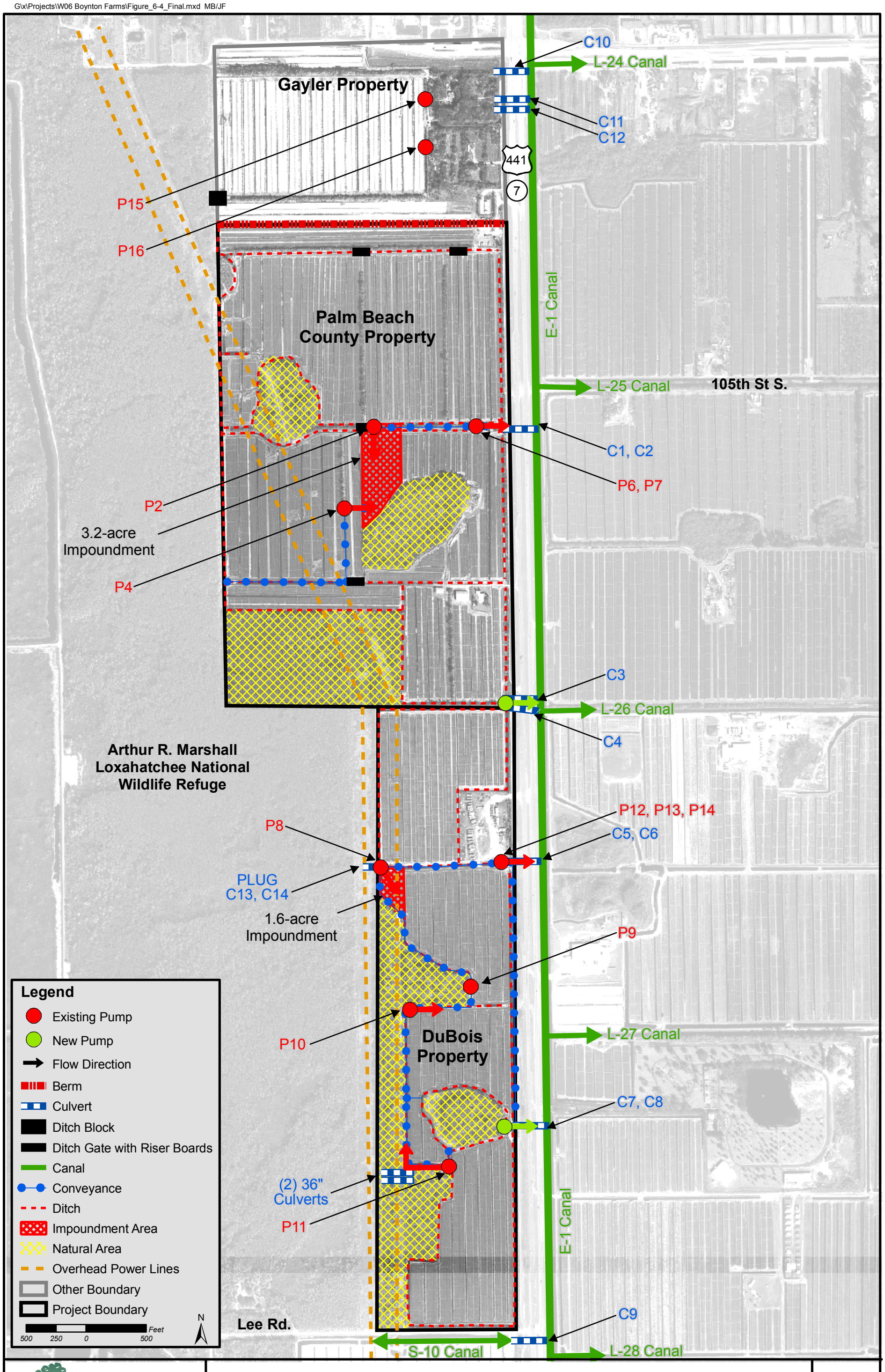

Boynton Farms Basin
Palm Beach County, FL

STA Impoundment on Palm Beach County and DuBois Property (Eliminate Discharge To Refuge)

Figure 6-4

Table 6-3
Preferred Alternatives Engineering Cost Estimates

				Pump stormwater east to E-1 Canal				Pump stormwater east to E-1 Canal, with onsite storage				STA/impoundment on Palm Beach County and DuBois Property			
				Palm Beach County Property		DuBois Property		Palm Beach County Property		DuBois Property		Palm Beach County Property		DuBois Property	
Item No.	Description	Unit rate	Units	Estimated units	Totals	Estimated units	Totals	Estimated units	Totals	Estimated units	Totals	Estimated units	Totals	Estimated units	Totals
1	Improve existing fore bays	$ 250.00	CY	50	$ 12,500.00		$ -	50	$ 12,500.00		$ -	50	$ 12,500.00		$ -
2	Riprap - fore bay area improvement (assumes 2.6 tons of RR/LF)	$ 650.00	RR/lf	50	$ 32,500.00		$ -	50	$ 32,500.00		$ -	50	$ 32,500.00		$ -
3	Riser culverts (purchase/install 20-foot-long, 72-inch-diameter CMP culvert with 5-foot riser (72-inch diameter)	$ 15,000.00	each		$ -		$ -	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00	1	$ 15,000.00
4	Sod berms	$ 0.25	sf		$ -		$ -	196,000	$ 49,000.00	152,000	$ 38,000.00	830,000	$ 207,500.00	760,000	$ 190,000.00
5	Site grading/remove ditch blocks - earth moving using excavator and off road dump	$ 10.00	CY	5,000	$ 50,000.00	5,000	$ 50,000.00	5,000	$ 50,000.00	5,000	$ 50,000.00	5,000	$ 50,000.00	5,000	$ 50,000.00
6	Internal farm riser culverts (purchase/install 20-foot-long, 24-inch-diameter CMP culvert, no risers)	$ 3,000.00	each	2	$ 6,000.00	2	$ 6,000.00	2	$ 6,000.00	2	$ 6,000.00	2	$ 6,000.00	2	$ 6,000.00
7	Pump relocation - set pumping station at new site location	$ 21,500.00	each	2	$ 43,000.00		$ -	2	$ 43,000.00	1	$ 21,500.00	2	$ 43,000.00		$ -
8	Pump redirection - reset direction of discharge at existing pumping station	$ 18,000.00	each		$ -	2	$ 36,000.00		$ -	1	$ 18,000.00		$ -	3	$ 54,000.00
9	Pumping stations (natural area/impoundment influent pump stations) - install new pump station (36-inch diameter axial flow low lift pump station with diesel motor and fuel tank - farm scale application, minimum enclosure)	$ 90,000.00	each	1	$ 90,000.00	1	$ 90,000.00	1	$ 90,000.00	1	$ 90,000.00	1	$ 90,000.00	1	$ 90,000.00
10	Collection ditch - (3:1 side slopes, 5-foot depth, 5-foot width - depth variable dependent on spoil requirement - use spoil to construct perimeter levee/ internal berm)	$ 1.60	LF		$ -		$ -	2,600	$ 4,160.00	2,000	$ 3,200.00	11,000	$ 17,600.00	10,000	$ 16,000.00
11	Pretreatment rim canal - (3:1 side slopes, 1-foot width, 5-foot depth - depth variable dependent on spil requirement - use spoil to construct perimeter levee/internal berm)	$ 1.60	LF		$ -		$ -	2,600	$ 4,160.00	2,000	$ 3,200.00	11,000	$ 17,600.00	10,000	$ 16,000.00
12	Perimeter berm - (4:1 side slopes, 4 feet high, 5 feet wide at top)	$ 2.12	LF		$ -		$ -	2,600	$ 5,512.00	2,000	$ 4,240.00	11,000	$ 23,320.00	10,000	$ 21,200.00
13	Internal berm (4:1 side slopes, 4 feet high, 5 feet wide at top)	$ 2.12	LF		$ -		$ -	2,600	$ 5,512.00	2,000	$ 4,240.00	11,000	$ 23,320.00	10,000	$ 21,200.00
14	Internal ditch cleaning/improvement - drag spoil and build up surface (improve conveyance)	$ 1.15	LF	14,600	$ 16,790.00	6,100	$ 7,015.00	14,600	$ 16,790.00	6,100	$ 7,015.00	14,600	$ 16,790.00	6,100	$ 7,015.00
	Engineer's Costs Estimate:				**$251,000**		**$189,000**		**$334,000**		**$260,000**		**$555,000**		**$486,000**
	30% contingency				**$75,000**		**$57,000**		**$100,000**		**$78,000**		**$167,000**		**$146,000**
	Total				**$326,000**		**$246,000**		**$434,000**		**$338,000**		**$722,000**		**$632,000**

The outfall pump stations are assumed to be new. Internal pump stations are assumed to be relocated.

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