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Collier County Comprehensive Watershed Improvement Plan

Collier County

Co-sponsored by
Rookery Bay National Estuarine Research Reserve

Rookery Bay
National Estuarine Research Reserve

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Acronyms

BA	Biological Assessment
BMSMMP	Belle Meade Area Stormwater Management Master Plan
CBC	Concrete Box Culvert
CERP	Comprehensive Everglades Restoration Project
CCCWIP	Collier County Comprehensive Watershed Improvement Plan
CCWMP	Collier County Watershed Management Plan
cfs	Cubic Feet per Second
CWA	Clean Water Act
DBHYDRO	SFWMD hydrometeorologic, water quality, and hydrogeologic data retrieval system
DEM	Digital Elevation Model
ECM	Existing Conditions Model
ERP	Environmental Resource Permit
ESA	Endangered Species Act
EXP	Exponent
FDOT	Florida Department of Transportation
FFS	Florida Forest Service
FPL	Funded Priorities List
FWC	Florida Fish and Wildlife Commission
GGC	Golden Gate Canal
GGWIP	Golden Gate Watershed Improvement Program
GIS	Geographical Information System
NAVD88	North American Vertical Datum of 1988
NFWF	National Fish and Wildlife Foundation
NSM	Natural Systems Model
NRD	Natural Resource Damages
NNC	Numeric Nutrient Criteria
NGVD29	National Geodetic Vertical Datum of 1929
ppt	Parts Per Thousand
PSRP	Picayune Strand Restoration Project
PSSF	Picayune Strand State Forest
Q	Flow
RCW	Red-cockaded Woodpecker
RFMU	Rural Fringe Mixed Use
SFWMD	South Florida Water Management District
SWIM	Stormwater Improvement Plan
TDR	Transferrable Development Rights
TN	Total Nitrogen
TP	Total Phosphorous
Regional NSM	Big Cypress Basin Natural Systems Model
SEP	State Expenditure Plan

Executive summary

History of the Region

Collier County encompasses over 2,300 sq miles and is located in southwestern Florida. Approximately 70 percent of Collier County (ca. 1,400 sq miles) has been altered by human modifications of the local hydrology (Atkins 2011). Prior to human alterations, rainfall either infiltrated into the surficial aquifer or flowed through extensive wetland features into the coastal waters of Collier County. Most of these hydrologic alterations were due to coastal development in Collier County since the early 1950s, as dredge-and-fill became the established method to meet the growing post-World War II demand for waterfront housing. The canals served to create waterfront property, increasing access for boating, and provided fill material needed for the creation of buildable lots (Antonini et al 2002).

In addition to shoreline modifications, extensive canal construction for urban and agricultural drainage has changed the timing and quantity of freshwater inflows to coastal waters. These changes have dramatically affected water quality and quantity of many of Collier County's estuaries. For example, the construction of the Golden Gate Canal (GGC) network increased the size of the Naples Bay watershed and freshwater flows to Naples Bay, as lands that originally drained southward into the Rookery Bay watershed were redirected. Consequently, the Rookery Bay watershed is now much smaller and, combined with alterations in drainage pathways and changes in wet and dry season storage capcities, receives less freswater inflow than it did historically. These altered freshwater inflow patterns have been identified as the most important threat to the natural biodiversity of Rookery Bay. **Figure ES-1** shows the current extents of these watersheds in Collier County.

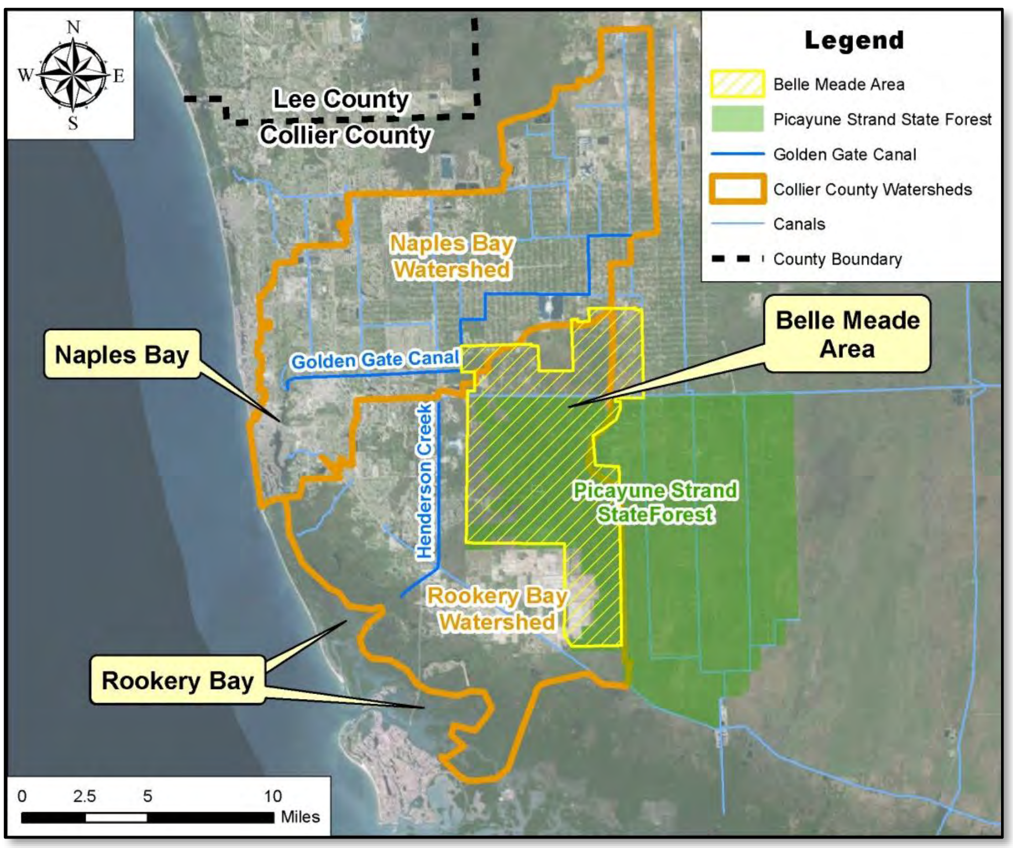

Figure ES-1 Watershed Location Map

Modifications to drainage patterns have resulted in significant impacts throughout the watersheds in Collier County. The historic areal extents of oyster bars and seagrass beds have been reduced by salinity alterations, reduced water clarity, and increased sediment loads. Tidal mangrove habitat has also been affected by coastal development and hydrologic alterations. Changes in the timing and amount of freshwater inflows into coastal waters, drainage alterations, and urbanization have also lowered groundwater levels, degraded or eliminated wetlands, altered wildlife distribution patterns or reduced populations, and increased the delivery of nutrients and other pollutants to coastal waters. This plan has been developed to address these conditions.

In addition to the altered hydrology of Naples Bay and Rookery Bay caused by the hydrologic alterations within Collier County, the natural systems of the Belle Meade area within the Picayune Strand State Forest (PSSF) have also been impacted by hydrologic alterations. In 1985, Conservation and Recreation Land (CARL) funds under the Save Our Everglades Project were used to start the purchase of properties which became the PSSF in 1996. These lands were purchased to help promote hydrologic and ecologic restoration and encourage passive recreation in this area.

While there is broad scientific consensus that Naples Bay is adversely impacted by excessive freshwater inflow, and that the Rookery Bay estuary is adversely impacted by too little freshwater inflow, the location of any proposed freshwater diversion (restoration) has not received as much attention. Existing management plans may have used the location of Henderson Creek as a default location for waters diverted out of the GGC system. However, more recent modeling work has suggested that areas farther east would benefit the most from flow diversions. As such, current information suggests that the benefit of a freshwater flow diversion out of the Naples Bay watershed from the Golden Gate Canal and into the Rookery Bay watershed would be greatest if freshwater was diverted through the Belle Meade region of the PSSF, rather than via Henderson Creek. Hydrologic restoration projects focusing on diversions in the Belle Meade region are included in both the Belle Meade Area Stormwater Management Master Plan (Parsons 2006) and the Collier County Watershed Management Plan (Atkins 2011). Such actions thus represent both project types and locations that are consistent with both the historical literature and the most recent modeling efforts.

Project Background

Recently, Collier County and the City of Naples developed the Golden Gate Watershed Improvement Program Initiative. The goal of this initiative is to foster the implementation of recommended projects based on environmentally sustainable management system strategies aimed at protecting, preserving, and restoring the resource in areas that have experienced the highest impact due to human activity, while encouraging efficient urban development in areas with the highest existing and potential urban development in the County.

To further implement the Golden Gate Watershed Improvement Program Initiative, the Collier County Comprehensive Watershed Improvement Plan (CCCWIP) was created. The purpose of this project, described herein, is to identify and develop a specific series of linked projects identified in the previous watershed management plans that will have the largest impacts to hydrologic and ecologic recovery within the County. The goals of this CCCWIP report are to:

- identify and address all of the critical issues related to each project;
- identify any issues that could possibly derail a project;
- utilize existing studies as the basis for the overall project concept;
- develop each project such that it is comprehensive, feasible, fundable and can be completed within the next 10 years ;
- validate that recommended projects can be accomplished ; and
- develop projects consistent with objectives of the RETORE Act

The CCCWIP is being co-sponsored by the Rookery Bay National Estuarine Research Reserve (RBNERR). RBNERR has been involved from the very beginning of project development and are represented on the Technical Advisory Committee for Collier County Watershed Management Plans. This project is, in part, based on the modeling that the Rookery Bay National Estuarine Research Reserve has recently completed. In addition, Collier County has worked diligently to gain the support and partnership of all other interested local groups/organizations. These groups/organizations include the following:

- Audubon of the Western Everglades/ Audubon Florida
- Big Cypress Basin/South Florida Water Management District
- City of Naples
- Conservancy of Southwest Florida
- Florida Fish and Wildlife Conservation Commission
- Fish and Wildlife Service
- Florida Wildlife Federation
- Florida Forest Service
- Collier County Watershed Technical Advisory Committee

Diverted Flow Capacity

This project included an evaluation of the availability of flows to be diverted from the GGC and the capacity of the downstream (Rookery Bay) watershed and estuary to receive additional flows (which includes the Belle Meade portion of the PSSF). Both the Collier County Watershed Management Plan and the Restoring the Rookery Bay Estuary (Henderson Creek Watershed Engineering Research Project) modeling results were used to evaluate existing flows to estuary systems in comparison to estimates of pre-development flow rates.

The flow analysis focused on defining the appropriate diversion flow rate for the project based on the ability of Rookery Bay to assimilate additional flows. The constraint in the system is, then, the receiving water body, the Rookery Bay. Previous studies considered various pumping rates to divert water from the GGC and reduce flows to Naples Bay. Although these studies indicated larger pumps would have a greater benefit on Naples Bay via great diversions, they would likely result in too much water to the receiving wetland systems and Rookery Bay. Review of the data indicated that a 100 cubic feet per second (cfs) pump station would divert enough water from the GGC to benefit both Naples Bay and Rookery Bay.

Project Conceptual Plan

Figure ES-2 presents an overview of the primary set of recommended projects for the CCCWIP. This set of projects has been carefully planned out with respect to potential effects to both Naples Bay and receiving wetlands (in the PSSF major road crossings (in Florida Department of Transportation right-of-ways), agricultural lands and Rookery Bay. These projects have also been developed in concert with the governmental, non-governmental and citizen groups (mentioned above) that will be directly impacted by the implementation of this plan, as to be consistent with the Golden Gate Watershed Improvement Program. A brief description of how the overall system would work is described below.

The projects start in the north where a 100 cfs pump station (Pump Station A) will be constructed on County-owned property along the GGC, appromixately one mile east of Collier Blvd. and upstream of the GG-3 structure. The pump station would start pumping when the gate for the GG-3 structure is lowered to elevation 6.5 ft NAVD88, which roughly corresponds to elevation 8.0 ft NAVD88 in the Golden Gate Canal. The pump station would then pump to a one-mile long channel flow-way (linear pond) controlled by outfall structures. The linear pond flow-way would be designed with wetland plantings to improve water quality and have a multi-use recreational trail amenity. This would divert flows south, under White Lake Blvd. to the north I-75 cross canal. Once flows enter the I-75 north canal, flows would be converyed through the existing box culverts under this section of I-75 to the south canal. Operational structures or ditch blocks would be designed to contain the flows within the west segment of the canals. The I-75 south canal is not contiguous, so portions between the ditch segments would need to be excavated to convey flows the entire to the next pump station intake.

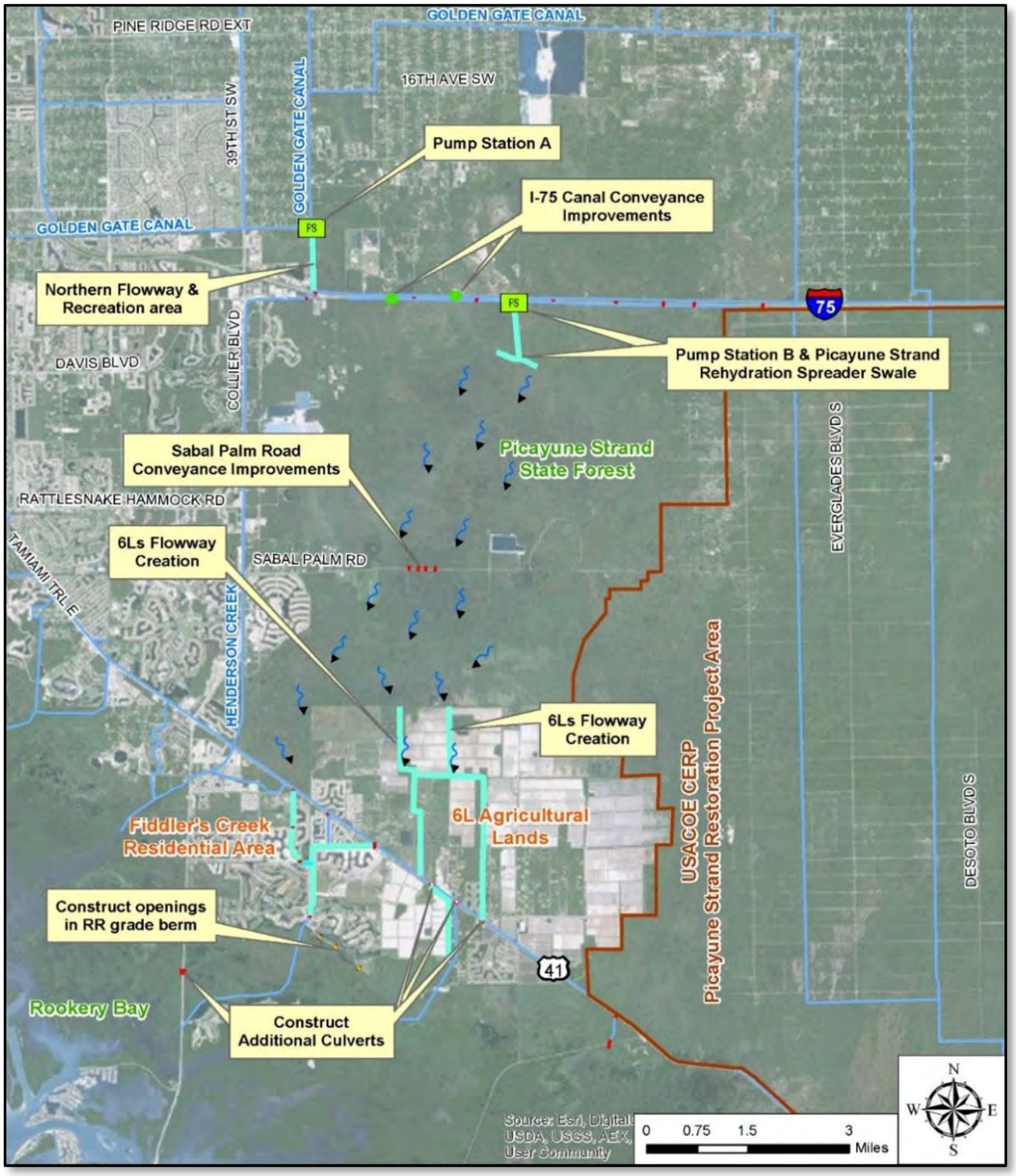

Figure ES-2 Overall Project Concept

A second pump station (Pump Station B) will be constructed on the south side of the I-75 south canal, also with a 100 cfs capacity, and would start pumping when water begins flowing into the north I-75 canal. The pump station would pump into a 4,000 foot (dry) channel flow-way which would convey flows south to a spreader swale that would discharge flows south through the Belle Meade wetland area flow-way. This flow would continue south to Sabal Palm Road where additional siphon culvert cross drains would be constructed to convey the additional flow under the road and south through the flowway.

As diverted flow continues south, it would flow in one of three directions. Some flow could circumvent the Six L's agricultural lands to the west, while the majoity would flow into one of two control structures, each with a designed flow-way that would take flows through the Six L's lands. All flows would continue to the existing north US 41 drainage system, where additional culverts would be installed under US 41. From there the flows would continue south through the Fiddler's Creek residential area stormwater system and ultimatelty to Rookery Bay.

Critical Issues

One of the primary goals of this report was to determine the critical issues associated with implementing the CCCWIP, particularly the issues that could derail the project, and to identify and/or perform the preliminary analyses needed to resolve these issues. The following are the critical issues that were identified and evaluated as part of this study:

- Flow Capacity through the I-75 corridor
- Flows through the Picayune Strand State Forest (Particularly the effects on RCW habitat)
- Picayune Strand Restoration Project (PSRP) Coordination
- South Belle Meade Property Evaluation
- Six L's Agricultural Area Plan and Future Coordination
- Flow Capacities through US 41 to Rookery Bay

Project Benefits

The water quality in Naples Bay, specifically salinity, has been drastically impacted within the last 50 years, particularly from the construction of the canal system. The impacts of the magnitude of freshwater surplus and the extreme freshwater "shock loads" to the bay during the wet season, have been long documented. The benefit to Naples Bay by diverting flows south during the wet season is not necessarily as large as previous studies concluded, but the volume of freshwater that can be diverted represents a significant enhancement to the Naples Bay estuary.

On average, the proposed project would operate 42 days per year. On those days when operating, it would divert approximately 19 percent of flows to Naples Bay (18.78 percent). The amount diverted would equal about 9.5 percent of the wet season inflows to Naples Bay, and 8 percent of the total inflow each year. The amount of water diverted from Naples Bay would average 2,688 million gallons per year (2.7 billion gallons per year), which is equivalent to 8,250 acre-feet per year, or just over 10 billion liters per year.

The vegetation in the PSSF has shifted over the past 50 years due to hydrologic alterations and subsequent impacts to wetlands in general swamp forest in particular. Hydroperiods and water depths in this area have declined and there is general consensus that the Belle Meade area of the PSSF is in need of rehydration. This is validated by the forest's Ten-Year Resources Management Plan (dated 8/15/2008) under Goal 1, Objective 3, *"Evaluate and develop work plan for restoring hydrology"*. With the implementation of the CCCWIP, at least a portion of the historical flows would be restored within the region helping to re-establish historical wetland hydroperiods to at least some degree and assisting the Florida Forest Service with their goals for the PSSF. Although full restoration would likely include more than 100 cfs of additional wet season flow diversions, it has been shown that the limitations of the system that are now in place (Red-cockaded Woodpecker habitat, Picayune Strand Restoration Project and Rookery Bay), currently prevent more than the 100 cfs based on the conservative and preliminary analyses conducted as part of this project.

The CCCWIP also significantly benefits Rookery Bay. When comparing the areas within the Rookery Bay estuary that have flow deficits, to the location(s) of the diverted flows to the estuary from the CCCWIP project, it can be seen that these areas correspond, indicating the diverted flows are going to the areas that need water. Not only do diverted inflow locations correspond to the locations of inflow deficits, but diverted flow volumes (approximately 50 cfs from the preliminary modeling estimates) are also consistent with the documented inflow deficit volumes in corresponding areas of Rookery Bay.

Project Costs

The preliminary opinion of probable construction costs for the projects is presented below in **Table ES-1**. These estimates are based on best available information for quantities and unit prices for the year 2016, and are equivalent to a 15 percent design level. Sources for these estimates include the current Florida Department of Transportation tabulated costs for item average unit cost; and local bid tabs for similar projects in Collier County and throughout the South Florida Water Management District and the Southwest Florida Water Management District. Costs for any property acquisition (if needed) are not included. Construction costs include 2 percent for Maintenance of Traffic (MOT), 10% for Mobilization and a 30% contingency.

Additional costs are presented in the overall CCCWIP project cost estimate including a more detailed project development (5%), design/plans preparations (10%), permitting (5%) and mitigation (5%). An estimated cost is also included for monitoring and SCADA telemetry systems. Considering that this project has a ten-year planning horizon (approximate) for completion of construction, a cost escalation factor of 23% (3% per year compounded over 7 years) has also been included. Also included in the overall cost is funding for other minor projects that may be necessary or beneficial to enhance the system and for the future phase projects (North Belle Meade Flow-way and the Six L's Area Masterplan).

Table ES-1 Planning-Level Opinion of Probable Costs

Project Element	Estimated Cost
Total Construction Cost	$18,800,000
Project Development	$1,000,000
Design/Engineering/Permitting/Mitigation (20%)	$3,800,000
Monitoring and SCADA Telemetry Systems	$1,000,000
Associated Projects, Engineering and Master Planning	$3,000,000
Cost Escalation over 7 years (3% per year)	$4,400,000
Total	$**32,000,000**

System Operations Management

Additional planning and analysis will be required to accurately manage the flow diversions throughout the project area. Although preliminary analysis has been completed to determine how and where the diverted water will flow, including a modeling analysis using the MIKE SHE/MIKE-11 2D surface water/groundwater model, some level of uncertainty remains as to the flow direction. Collier County recognizes this uncertainty and the need for further analysis and plans additional in-depth analyses in future planning phases prior to project design. For this reason, this project includes an adaptive management approach to operating the diversion system.

Adaptive mnagement is a structured and systematic process for continually improving decisions, management policies and practices by learning from the outcomes of decisions previously taken, and changing operations accordingly, as needed. In this manner, the operational protocol for the system will be continuously refined and optimized such that maximum benefit can be obtained while eliminating or minimizing any impacts. Monitoring sites will be set up throughout the project area that would encompass not just hydrologic monitoring, but wetland and habitat monitoring as well. The results and careful evaluation of these monitoring efforts will help drive the future operations and management of the system. These monitoring efforts will be defined as part of the future project development phase and will address system optimization and permitting needs.

1. Introduction

1.1. History of the Region

Collier County encompasses over 2,300 sq miles and is located in southwestern Florida. Approximately 70 percent of Collier County (ca. 1,400 sq miles) has been altered by human modifications of the local hydrology (Atkins 2011). Prior to human alterations, rainfall either infiltrated into the surficical aquifer or flowed through extensive wetland features into the coastal waters of Collier County. The majority of these hydrologic alterations resulting from coastal development in Collier County began in the early 1950's, as dredge-and-fill became the established method to meet the growing post-World War II demand for waterfront housing. The canals served to create waterfront property, increase access for boating, and provided fill material needed for the creation of buildable lots (Antonini et al 2002).

In addition to modifications along the shoreline, extensive canal construction for urban and agricultural drainage has changed the timing and quantity of freshwater inflows to coastal waters. These changes have dramatically affected the health of many of Collier County's estuaries . For example, the construction of the Golden Gate Canal (GGC) network dramatically increased the size of the Naples Bay watershed (Atkins 2011). As a result, Naples Bay now receives much more freshwater inflow than in pre-development times, as lands that originally drained southward into the Rookery Bay watershed have now been redirected. Consequently, the Rookery Bay watershed is now much smaller than it was historically. Combined with alterations in drainage pathways and changes in wet and dry season storage capcities, Rookery Bay now receives less freswater inflow than it did historically, paticularly in specific locations. These altered freshwater inflow patterns have been identified as the most important threat to the natural biodiversity of Rookery Bay (Shirley et al., 2004). **Figure 1-1** shows the locations of these watersheds within Collier County.

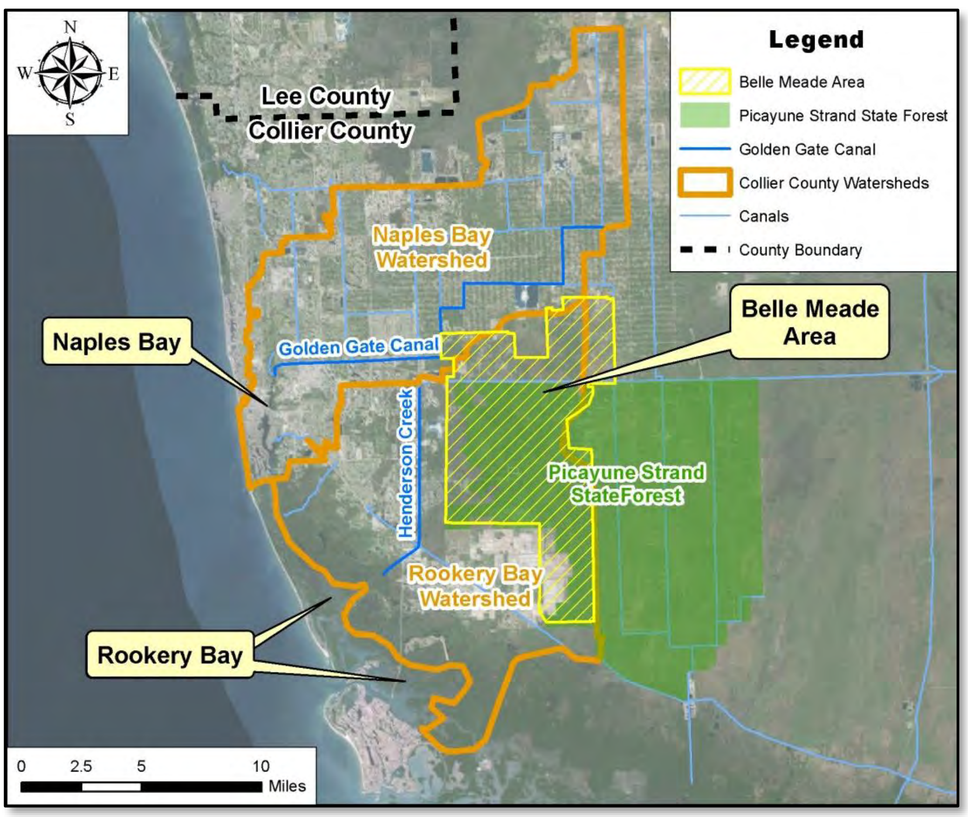

Figure 1-1 Watershed Location Map

Significant impacts have been experienced throughout the watersheds of Collier County as a result of the modifications to drainage patterns. The historic areal extents of oyster bars and seagrass beds have been reduced by salinity alterations, reduced water clarity, and smothering from increased sediment loads. Tidal mangrove habitat has also been affected by coastal development and hydrologic alterations as well. Changes in the timing and amount of freshwater inflows into coastal waters, drainage alterations and urbanization have also lowered groundwater levels, damaged wetlands, altered wildlife distribution patterns, and increased the delivery of nutrients and other pollutants to coastal waters. These impacts generated the need for a plan(s) to improve these conditions.

1.2. Future Challenges and Guidance Documents

Collier County's population is expected to continue to grow at a rapid rate, highlighting the need for a comprehensive approach to address the issues of flood protection, protecting water supplies, and preserving or restoring water quality and natural habitats. As far back as 1980, the need for restoring the historical water flows was identified. Over the past thirty-five (35) years, there have been many studies that looked at restoring the historic flow-way from the Naples Bay watershed (sometimes referred to as the Naples Bay-GGC watershed) to Rookery Bay. Some of these studies include:

- Golden Gate Water Management Plan (Johnson Engineering for SFWMD-BCB, 1980)
- Big Cypress Basin Water Management Plan (SFWMD BCB 1998)
- Belle Meade Area Stormwater Management Master Plan (Parsons, 2006)
- SWIM Plan for Naples Bay (SFWMD 2007)
- Horsepen Strand Conservation Area Feasibility Study Phase 1 (Collier County, 2008)

With all of this prior work that had been accomplished, the groundwork was laid for the Collier County Watershed Management Plan (CCWMP) which developed a holistic approach to protecting and/or restoring the altered hydrology of the priority watersheds of the Cocohatchee River and Corkscrew Swamp; Golden Gate Canal and Naples Bay; Rookery Bay and its watershed; and the watersheds and estuaries of the Ten Thousand Islands. The plan was subsequently adopted by the Board of County Commissioners in 2011. The CCWMP identified a number of linked hydrologic and ecological restoration projects that would function on a regional basis to allow the County to manage its natural resources in a more holistic manner. More than 100 potential projects were identified in the CCWMP (Atkins 2011). The plan was presented at a number of public workshops and was reviewed for technical accuracy by staff from Collier County, the Florida Department of Environmental Protection, and the South Florida Water Management District.

Projects from the CCWMP were preliminarily screened for their ability to be permitted and constructed. Twenty-seven (27) projects were recommended for further detailed evaluation. After a final detailed evalution, ten (10) projects were determined to be capable of being permitted and constructed. The CCWMP prioritized these capital improvements projects (structural projects) for each of the County's main watersheds based on a methodology that evaluated potential projects on their viability to be permitted and constructed; the benefits yielded though performance measures; estimated cost; and calculated benefit versus cost (B/C) ratio. Additionally, the CCWMP proposed complementing the recommended structural projects with non-structural initiatives in order to achieve the plan's restoration goals.

More recently, Collier County and the City of Naples developed the Golden Gate Watershed Improvement Program (GGWIP) initiative. The goal of this initiative is to foster the implementation of recommended projects based on environmentally sustainable management system strategies aimed at protecting, preserving, and restoring the resource in areas that have experienced the highest impact due to human activity, while encouraging efficient urban development in areas with the highest existing and potential urban development in the County.

The proposed series of linked projects outlined in this report are consistent with both the CCWMP and the GGWIP. In addition, the implementation of these proposed projects is also consistent with the goals of the RESTORE Act. The bipartisan RESTORE Act was passed by the U.S. Congress on June 29, 2012 and signed into law on July 6, 2012 by President Obama. The purpose of the Act is to optimize the distribution and use of Clean Water Act fines paid by the parties responsible for the Deepwater Horizon oil spill to improve the ecology and economies of the Gulf of Mexico area. Among the five Gulf States impacted by the oil spill, Florida is unique in terms of the significant role played by County governments.

1.3. Goals of this Report

To further implement the GGWIP inititive, the Collier County Watershed Improvement Project (CCCWIP) was created. The purpose of this project, described herein, is to identify and develop a specific series of linked projects idenitified in the previous watershed management plans that will have the largest impacts to hydrologic and ecologic recovery within the County. The goals of this report are to:

- identify and address all of the critical issues related to each project
- identify any issues that could possibly derail a project
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- develop each project such that it is comprehensive, feasible, fundable and can be completed within the next 10 years
- validate that recommended projects can be accomplished
- develop projects consistent with objectives of the RETORE Act

2. Studies Completed and Summary of Findings

2.1. Overview of Impacts to Coastal Waters and Ecosystems

Historically, Naples Bay was a shallow estuarine system containing mangrove islands that were surrounded by oyster reefs and seagrass beds. Extensive oyster bars were found along the shorelines and at the mouths of various tidal creeks and seagrass beds were likely more limited in their distrubion, compared to oysters and mangroves (Schmid et al 2006). The combination of hardened shorelines and newly dug residential canals resulted in an increase in the amount of shoreline in Naples Bay of nearly 50 percent between 1927 and 1965, followed by an additional 11 percent increase between 1965 and 1978 (Schmid et al 2006). While the Naples Bay shoreline may have increased significantly over the past few decades, the direct and indirect impacts of this level of development resulted in a 90 percent decline in seagrass habitat and an 80 percent decline in the amount of oyster reef habitat over the same time period (Schmid et al 2006). Schmidt et al also reported that 70 percent of the fringing mangrove shoreline of Naples Bay had been converted to residential development. More recent assessments have verified the magnitide of the loss of these important habitats in Naples Bay (Atkins 2011). Along the shoreline of Rookery Bay, there has been a net loss of 2,170 acres of mangrove/tidal marsh habitat, or 12 percent of the pre-development quantity, with losses occurring primarily due to conversion to urban land uses (Atkins 2011).

In addition to direct impacts to coastal ecosystems, the natural resoruces of both Naples Bay and Rookery Bay have been adversely impacted by changes to the quantity, quality, and timing of freshwater inflows to their coastal waters. For example, the Naples Bay watershed increased from approximately 10 square miles to 120 square miles in size, due to various land drainage activities (SFWMD 2007). As a result, Naples Bay now receives much more freshwater inflow than in pre-development times. Consequently, the Surface Water Improvement and Management (SWIM) Plan for Naples Bay highlighted the need to reduce freshwater inflows into Naples Bay from its expanded watershed (SFWMD 2007). As much of the increase in the Naples Bay watershed came from land that originally drained southward, Rookery Bay's watershed is now smaller than it was historically. The salinity regime of the Naples Bay and Rookery Bay estuaries are more influenced by canal management than by tides or rainfall, and altered freshwater inflow has been identified as the most important threat to the natural biodiversity of these coastal waters (e.g., SFWMD 2007, Shirley et al. 2004, 2005). Rubec et al. (2006) concluded that Rookery Bay's ecological health is impacted by altered hydrology, and Lewi et al. (undated manuscript) concluded that "…a number of estuarine species would benefit from more freshwater inflow into the Rookery Bay system during the latter part of the wet season…" However, Shirley et al. (2004 and 2005) concluded that Rookery Bay, and in particular the tidal portions of Henderson Creek, was impacted by both too little freshwater inflow in the dry season, as well as too much freshwater inflow in the wet season.

Oyster reefs are critical to the estuarine ecosystems of southwest Florida, as they provide the foundation on which mangrove islands develop and also serve as habitat for many fish and shellfish species. In addition, the eastern oyster (*Crassostrea virginica*) is the primary suspension feeder in the area's estuaries, which helps to reduce the impacts of sediments and algal blooms in estuarine waters. As many of Southwest Florida's estuaries lack large seagrass beds, oyster reefs (which are sensitive to the impacts of increased freshwater discharges) have been promoted as being a superior indicator of estuarine health and a bio-indicator of the efficacy of various restoration and management efforts (Savarese et al. 2003).

Studies in the Faka Union Bay, the Blackwater River estuary and the tidal portions of Henderson Creek have shown that excessive amounts of freshwater inundation have adversely affected oysters and oyster reef development, and that greater mortality of juvenile oysters occurs in estuaries that receive excessive amounts of freshwater inflow (Savarese et al. 2003).

2.2. Overview of Impacts to the Watersheds

The CCWMP confirmed prior reports of widespread impacts to the vegetative communities of the Naples Bay and Rookery Bay watersheds. The approach taken was to build upon prior documentation of impacts by developing an assessment of the potential for increased wet weather storage, if appropriate, associated with some of these changes. This task was accomplished by comparing two data sets: 1) historical vegetation maps developed by the South Florida Water Management District (SFWMD), as summarized by Duever (2004), and 2) recent vegetation data based on SFWMD Land Use/Land Mapping data from 2004, as updated to reflect changes through 2007. Changes in vegetation types were then interpreted based on likely hydrologic causes for such changes, based on established relationships between vegetation and the combination of water depths and hydroperiods (Atkins 2011, as informed by Duever 2004). In this way, vegetation changes could be associated with the hydrologic impacts that likely caused such changes. The amount of wet weather storage capacity available in these areas could thus be determined. However, it should be noted that output from these comparisons represent "average" conditions for each of the ecological communities and that the differences between historical and current hydrology would vary from year to year due to differences in rainfall, as well as short and long-term flood and drought cycles.

In the Naples Bay-GGC watershed, the CCWMP concluded that the ecological health of the vegetative communities was quite low, mostly due to the finding that 67 percent of the watershed had been converted to urban or agricultural land uses. However, the eastern portion (approximately one-third) of the watershed was less impacted by development, although impacts were evident due to altered hydrology from the extensive canal systems (Atkins 2011).

In the Rookery Bay watershed, impacts of reduced wet season water depths and shorter hydroperiods were found in the areas of Belle Meade and near Henderson Creek. However, since only 27 percent of the Rookery Bay watershed had been converted to urban or agricultural land uses, the vegetative communities of the Rookery Bay watershed were mostly healthier than those in the adjacent Naples Bay-GGC watershed. The most significant impact to the vegetative communities of the Rookery Bay watershed was found to be hydrologic alteration, particularly in those portions of the watershed north of Belle Meade.

2.3. Proposed Restoration Projects to Address Hydrologic Alterations

The ecological impacts associated with alterations in the amount, quantity and timing of freshwater inflows into Collier County's estuaries have been noted for at least 30 years (e.g., Yokel, 1975; Browder et al. 1988, Shirley et al. 2004, 2005, and multiple references within). As a result, resource management plans have attempted to build upon the general consensus of diagnosed problems in Naples Bay and Rookery Bay to develop resource management projects to act on those problems.

For example, the latest SWIM Plan for Naples Bay included a budget request for $2,500,000 for a project to divert water from the GGC into Henderson Creek, which would then flow to Rookery Bay (SFWMD 2007). This proposed project was intended to not only address the well-documented problem of excess freshwater inflow into Naples Bay, but it would also address the goal to "…provide a more natural timing and variation in patterns of freshwater inflow into Henderson Creek, thereby creating more suitable habitats for various species' life stages" (Rubec et al. 2006). In a report produced for the Florida Department of Environmental Protection (FDEP), the water quality responses of both Naples Bay and Rookery Bay were modeled based on the scenarios of 50 and 100 cubic feet per second (cfs) diversions of water out of the GGC and into Henderson Creek (Weisberg and Zhang 2007).

The CCWMP included a list of priority actions for the County to consider implementing, including the proposed project to take water out of the GGC system and divert those flows into Henderson Creek (Atkins 2011). More recently, a report for the City of Naples stated that "diversion of GGC flow from Naples Bay to the Henderson Creek watershed to restore a more natural salinity regime is a major focus of Naples Bay restoration" (Cardno 2015) which is consistent with the project description included in the Naples Bay SWIM Plan (SFWMD 2007).

While there is a scientific consensus that Naples Bay is impacted by too much freshwater inflow, and that Rookery Bay is impacted by too little inflow, there has not yet been the same level of consensus on the specific locations for diversions of freshwater inflow. Although the SWIM Plan for Naples Bay (SFWMD 2007), the CCWMP (Atkins 2011) and the Naples Bay Water Quality and Biological Analysis Project (Cardno 2015) all focus on diversions of water out of the GGC system and then into Henderson Creek, there is some disagreement about the need for a diversion of flows into Henderson Creek, versus other locations in the Rookery Bay watershed.

2.4. Location of Freshwater Diversion

Although a diversion of freshwater inflows from the expanded Naples Bay watershed to the diminished (in size) Rookery Bay watershed has been called for in various resource management plans and research papers, the need for a diversion out of the GGC and into Henderson Creek is perhaps an assumption of the most beneficial location for added flows to the Rookery Bay watershed. And while prior studies have concluded that Rookery Bay is impacted by reduced freshwater inflows (e.g., Rubec et al. 2006, Lewi et al., undated manuscript) there is evidence that Henderson Creek in particular may not be similarly impacted. Shirley et al. (2004 and 2005) concluded that water management activities in the Henderson Creek watershed were strongly influenced by weir operations, rather than simply changes in the size of the watershed. Henderson Creek was determined to suffer from both too little freshwater inflow when water control structures are closed in the dry season (to prevent saltwater intrusion) and too much freshwater inflow when these same structures are opened in the wet season (to prevent flood damage). Thus, Henderson Creek was thought to be impacted by too little inflow, too much inflow, and too variable a salinity regime (Shirley et al. 2004 and 2005). This is a more complex understanding of the impacts to Henderson Creek than that outlined by Rubec et al. (2006) and Lewi et al. (undated manuscript).

Within the CCWMP, two different techniques were used to determine if the coastal waters of the County were impacted by hydrologic alterations, and if so, what was the general pattern of impact? The two methods used were empirical (aka statistical) approaches, based on deriving flow vs. salinity relationships for coastal waters and using Fakahatchee Bay as a "reference" site (as in Yokel 1975, Browder et al. 1988, Shirley et al. 2004, 2005) vs. the use of a combined surface water and groundwater model (MIKESHE/MIKE 11). For Faka Union Bay, Naples Bay and the Cocohatchee River / Wiggins Pass estuary, the two techniques (empirical vs. mechanistic model) gave very similar findings. However, for Henderson Creek, the empirical model suggested freshwater inflow deficits in both the wet and dry season, while the mechanistic model concluded that inflow deficits were restricted to the dry season alone.

In a summary of recent findings from a separate modeling exercise run for the Rookery Bay National Estuarine Research Reserve (Interflow, 2014), it was concluded that overall flows into Rookery Bay via Henderson Creek have stayed "about the same…" when comparing current conditions to modeled flows from a pre-disturbance landscape (slide 26 in presentation by Tabitha Whalen Stadler, Principal Investigator). However, the same model output concluded that freshwater inflows into the wider Rookery Bay estuary had decreased from historical conditions in the vicinity of Belle Meade and in that portion of the Rookery Bay estuary's watershed east of Belle Meade and west of County Road 92 (slide 26).

Thus, while the portion of the Rookery Bay watershed that would benefit from increased freshwater inflow might have been given as Henderson Creek as a sort of default location in various management plans, more recent work suggests that diversions might be more appropriate into portions of the Rookery Bay watershed located farther east than Henderson Creek. Fortunately, freshwater diversions from the GGC system into that portion of the Rookery Bay watershed near Belle Meade appear to be consistent with prior hydrologic restoration project planning efforts (e.g., Parsons 2006, Atkins 2011).

In the CCWMP, a comparison was made between the hydrological characteristics of pre-development and current (2007) vegetation communities throughout the County (Atkins 2011). This assessment concluded that there were several areas that had untapped potential for additional wet season water storage. The largest opportunity for storage, based strictly on the difference in hydrological characteristics between pre-development and 2007 vegetation, was the central and eastern portion of the Rookery Bay watershed, which includes the south Belle Meade area within the Picayune Strand State Forest (PSSF). In that region, there were found (at the time) to be over 20,000 acres that had capacity for additional wet season storage, with a range between 0.5 feet up to more than 2.5 feet. **Figure 2-1** below shows the potential for additional wet weather storage in select Collier County watersheds based on the comparison of the historical (Deuver) and 2007 (SFWMD) vegetation maps.

A diversion of water from the GGC system into the Belle Meade region could thus be done without overwhelming the existing wetland systems in the Rookery Bay watershed, as long as the additional water would not exceed the tolerances in terms of water depths and hydroperiods for those currently impacted wetlands. A diversion of freshwater from the GGC system into the wetlands of the Rookery Bay watershed thus could have several advantages over previously discussed diversions into Henderson Creek: 1) diversions into Henderson Creek would not benefit the impacted wetlands of the Rookery Bay watershed, while a diversion into the Belle Meade region could benefit those wetlands, 2) diversions into Henderson Creek may not have the same amount of freshwater inflow loss as a diversion into the impacted wetlands of Belle Meade, and as such might not allow for as much diversion from the Naples Bay watershed without adversely impacting Rookery Bay, and 3) diversions into Henderson Creek would not allow for as much nutrient assimilation prior to entering Rookery Bay, as opposed to discharges into the types of wetland systems found in South Florida (i.e., Rudnick et al. 1999). Furthermore, a Henderson Creek diversion would not allow for additional water quality enhancements or the re-hydration of wetland areas within south Belle Meade.

2.5. Conclusion

While there is broad scientific consensus that Naples Bay is adversely impacted by too much freshwater inflow, and that the Rookery Bay estuary is adversely impacted by too little freshwater inflow, the location of any proposed freshwater diversion has not received as much attention. Existing management plans may have used the location of Henderson Creek as a default location for waters diverted out of the GGC system. However, more recent modeling work has suggested that areas farther east would benefit the most from flow diversions. As such, current information suggests that the a diversion of freshwater inflows out of the Naples Bay watershed from the GGC and into the Rookery Bay watershed would be most advantageous if such a diversion would take place in the Belle Meade region of the PSSF, rather than via Henderson Creek. Hydrologic restoration projects focusing on diversions in the Belle Meade region are included in both the Belle Meade Area Stormwater Management Master Plan (Parsons 2006) and the Collier County Watershed Management Plan (Atkins 2011). Such actions thus represent both project types and locations that are consistent with both the historical literature and the most recent modeling efforts.

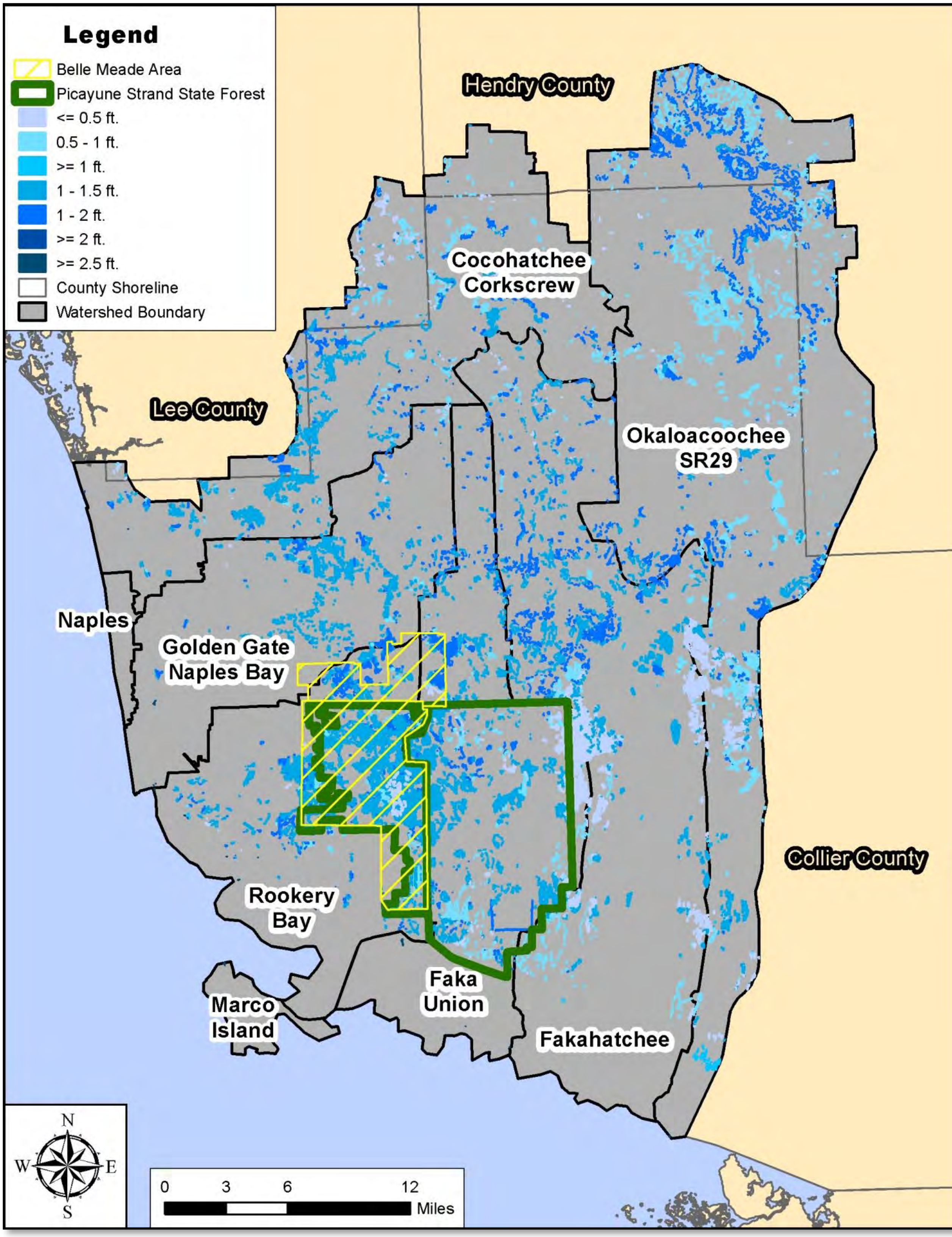

Figure 2-1 Potential for additional wet weather storage in select Collier County watersheds

3. Evaluation of Diverted Flow Capacity

Just as there were some differing views on the location of the freshwater diversion from the GGC, there was also differing views for the magnitude of the potential flow diversion. This section outlines the availability of flows to be diverted from the GGC and the capacity of the downstream (Rookery Bay) watershed and estuary to receive additional flows. Both the CCWMP and the Restoring the Rookery Bay Estuary (Henderson Creek Watershed Engineering Research Project) modeling results were used to evaluate existing flows to estuary systems in comparison to estimates of pre-development flow rates.

3.1. Collier County Watershed Management Plan Model

The CCWMP evaluated the existing conditions in terms of volume and timing of fresh water discharges to the Naples and Rookery Bay estuary systems from the contributing watersheds by comparing them to a baseline, which was represented by the predevelopment condition. The evaluation consisted of comparing the results of a MIKE SHE/MIKE11 Existing Conditions Model (ECM) to those of a MIKE SHE/MIKE11 Natural Systems Model (NSM) to define the monthly water surplus or deficit in each estuary. The ECM was a model updated specifically for the CCWMP, whereas the NSM, or pre-development model, was developed as part of the USACE Southwest Florida Feasibility Study. A full description of the NSM can be found in the report titled "Final Report, Natural Systems Model (NSM) Scenario Southwest Florida Feasibility Study" (SDI, 2007).

The ECM represents the 2007 land use condition in Collier County and was calibrated against measured flow and stage data in the canal network, as well as measured groundwater head elevation data. The simulation period for this model was January 2002 through October 2007. The primary drainage system and most of the secondary drainage system was explicitly represented in the model. The average monthly flow to each estuary was extracted from the model results for comparison purposes.

The NSM was developed as part of the Unites States Army Corps of Engineers Southwest Florida Feasibility Study by modifying the original SFWMD Big Cypress Basin (BCB) model in terms of land use and conveyance systems to represent pre-development conditions. The NSM simulation period extended from 1976 to 1986. The NSM uses overland flow to predict the movement of water across the ground surface and into the estuaries. The average monthly flow to each estuary was extracted from the model results for comparison purposes.

3.2. Restoring the Rookery Bay Estuary Project Model

As part of the Restoring the Rookery Bay Estuary project, two local scale MIKE SHE/MIKE11 models were developed and are documented in the technical report, Henderson Creek Watershed Engineering Project (Interflow, 2014). The first model was a Local Scale - Existing Conditions Model (Existing LSM) developed from the existing Collier County Existing Conditions Model (CC-ECM). The Existing LSM was developed with a refined model domain covering 167 square miles, at a grid-cell size of 375-ft. Features added to local scale MIKE11 network included the Marco Island Utilities Lakes, Winding Cypress Subdivision, and three branches which were deemed to contribute flows to Henderson Creek. Each of these branches run east/west south of Sabal Palm Road. Another revision to the MIKE11 network, was the removal of the Belle Meade Flow-Way. While the Belle Meade Flow-Way is still represented within the MIKE-11 model, it is now simulated explicitly in the overland flow portion of the MIKE SHE. This model was run for the 2002 – 2012 time period.

The second model, a Local-Scale - Historical Conditions Model (Historical LSM), was also prepared for the Henderson Creek / Rookery Bay watershed study for the purpose of estimating the changes in volumes and timing of freshwater inflows to Rookery Bay that have occurred over the past several decades due to anthropogenic impacts. These changes in flow were estimated by comparing the results of the Existing LSM with the results of the Historical LSM. Development of the Historical LSM utilized components of the Existing LSM model in conjunction with the BCB Natural Systems Model (Regional NSM) provided by the SFWMD (District). The Historical LSM was run using the same rainfall data (2002 – 2012) as the Existing LSM model.

3.3. Modeling Results for Naples Bay

Modeling results for Naples Bay are only available from the CCWMP model as the Restoring the Rookery Bay Estuary model only includes the Rookery Bay watershed. **Figure 3-1** shows a comparison of the average monthly volume of fresh water discharge to the Naples Bay Estuary from the Golden Gate-Naples Bay watershed as predicted by the CCWMP. The results indicate a significant increase in the magnitude of water volume released to the estuary, particularly in the wet season. The results do not indicate a significant change in the timing of discharges. The increased discharges are primarily attributed to construction of the GGC that resulted in an increase of the watershed's drainage area from approximately 10 square miles to approximately 120 square miles. It is apparent from **Figure 3-1** that increases of freshwater flow volumes to Naples Bay are significant. Based on estimates and preliminary assessments from the previous studies (Belle Meade Stormwater Management Mater Plan, CCWMP and others) it was presumed that diversions of 200 cfs (or higher) would be available from the GGC to divert south through the historical flow-way. These presumptions were based strictly on the flow data from the existing conditions and natural systems (historical conditions) model comparisons from these projects. **The diversion flow rates (200 cfs or higher) from these previous studies were never explicitly modeled in scenarios, or coordinated with the SFWMD in terms of groundwater impacts from withdrawing water from the GGC.**

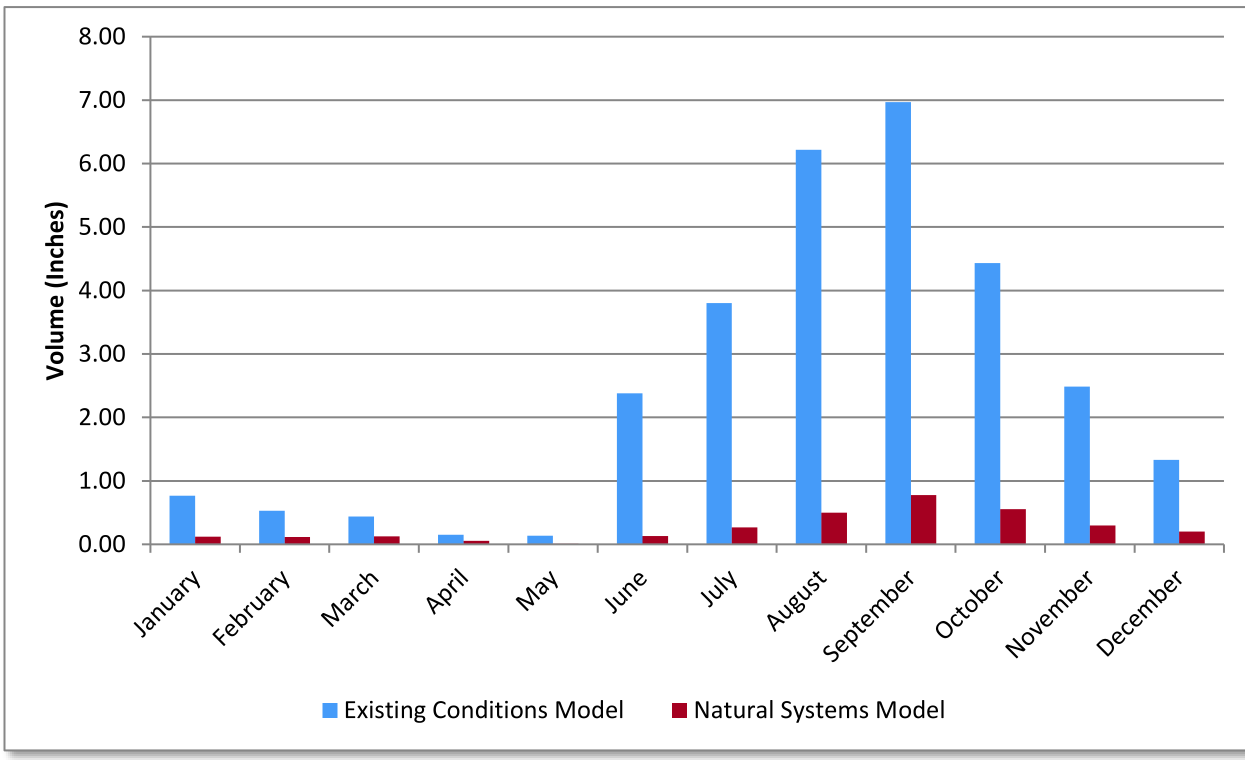

Figure 3-1 Comparison of the NSM vs. ECM Average Monthly Discharge to Naples Bay Estuary

3.4. Modeling Results for Rookery Bay

Modeling results for Rookery Bay were available from both the Restoring the Rookery Bay Estuary model and the CCWMP model. The models gave similar overall results, although the Rookery Bay model completed a more detailed analysis as the results were analyzed by distinct inflow locations to the estuary. **Figure 3-2** shows a comparison of the average monthly volume of fresh water discharge to the Rookery Bay Estuary as predicted by the ECM and NSM models developed for the CCWMP. The results indicate a small increase in the total volume of water released to the estuary, primarily in the early part of the wet season. It is noted that the ECM model tended to over-predict wet season flows at the Henderson Creek monitoring station, so the wet season flows for the ECM may be over-estimated. The CCWMP also completed a salinity-based flow evaluation of the inflows to Rookery Bay to confirm the seasonal flow patterns shown by the ECM vs. NSM comparison. The results of the salinity based analysis are shown in **Figure 3-3** and confirm the magnitude of the flow volume surplus to Naples Bay, but actually predict a wet season flow deficit in Rookery Bay, opposing the model results.

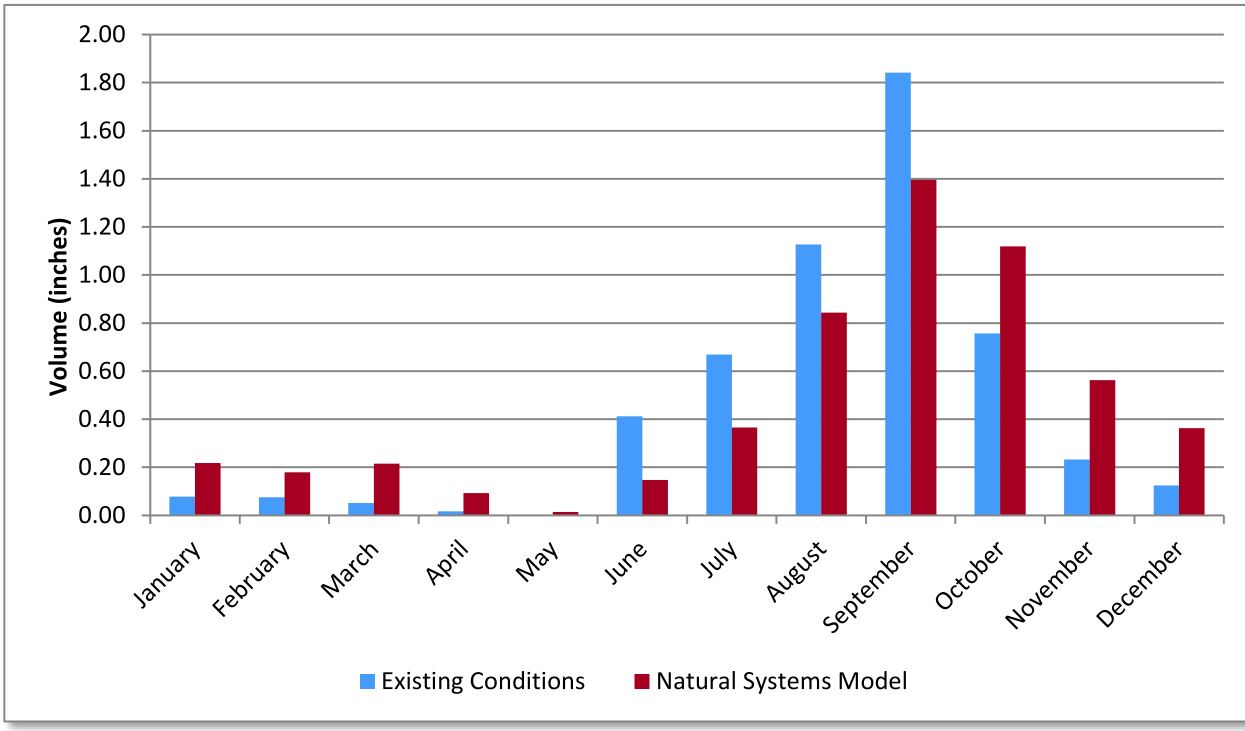

Figure 3-2 Comparison of the NSM vs. ECM Average Monthly Discharge to Rookery Bay Estuary

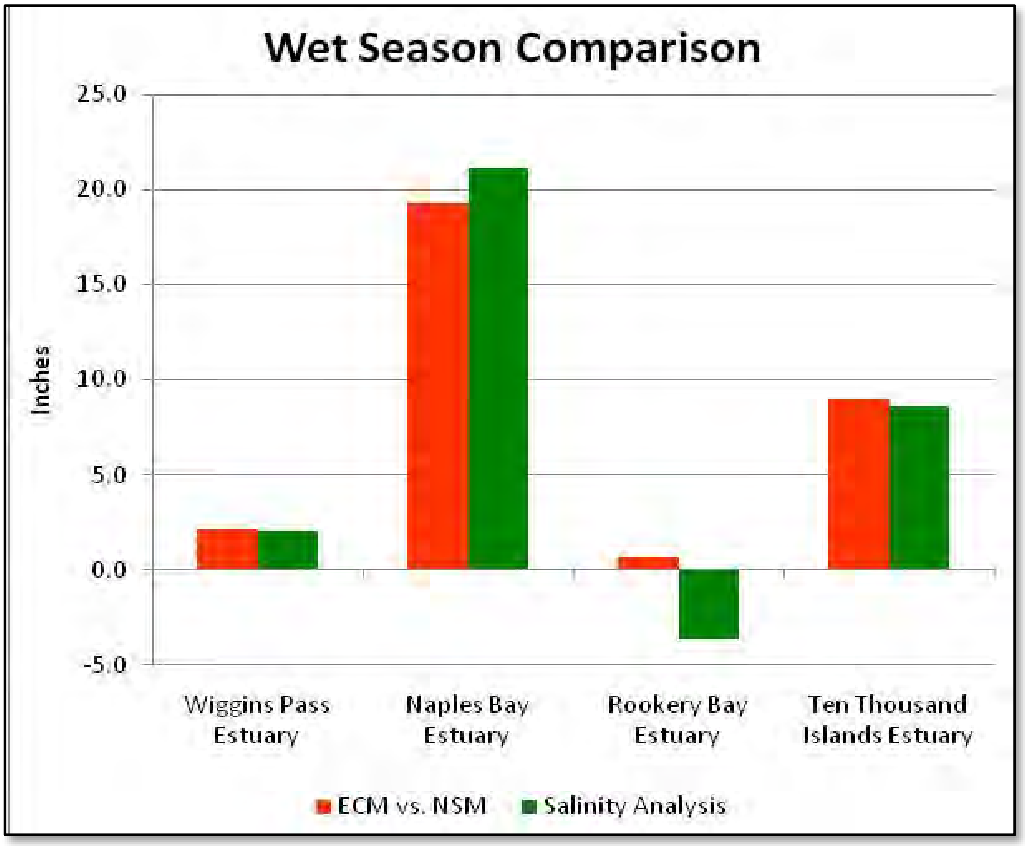

Figure 3-3 Comparison of the Modeling Results to Salinity-Based Analysis Results for Rookery Bay Estuary

The Restoring the Rookery Bay Estuary model included a more detailed analysis of flow to Rookery Bay from each of six sub-basins in the watershed. The analysis included comparisons of surface water flows to Rookery Bay and the surrounding estuarine waters for specific locations within the estuary. **Table 3-1** below shows a summary of the difference in flows calculated by subtracting the Historical LSM results from the Existing LSM results. **Figure 3-4** shows the locations of the MIKE-11 model inflow points as well as the alignment of their corresponding coastal transects (summarized in the table below) based upon upstream contributing basins (Lely Main, Lely Manor, Henderson Creek, BelleMeade-9, US-41 Outfall Swale No-2, and Bridge 37). A negative value indicates that natural system flows exceed existing condition flows.

Table 3-1 Comparison of Wet Season Model Predicted Flows

Transect	Flow Difference (cfs) (Calculated as Existing LSM – Historical LSM)			
	July	August	September	October
Lely Main	5	3	3	8
Lely Manor	3	0	0.25	4
Henderson Creek	-10	12	25	20
Belle Meade-9	-8	-10	-23	-4
US 41 Outfall Swale No-2	0	4	-1.5	2
Bridge 37	-8	-11	-25	-10
Totals	**-3**	**-2**	**-21.25**	**20**

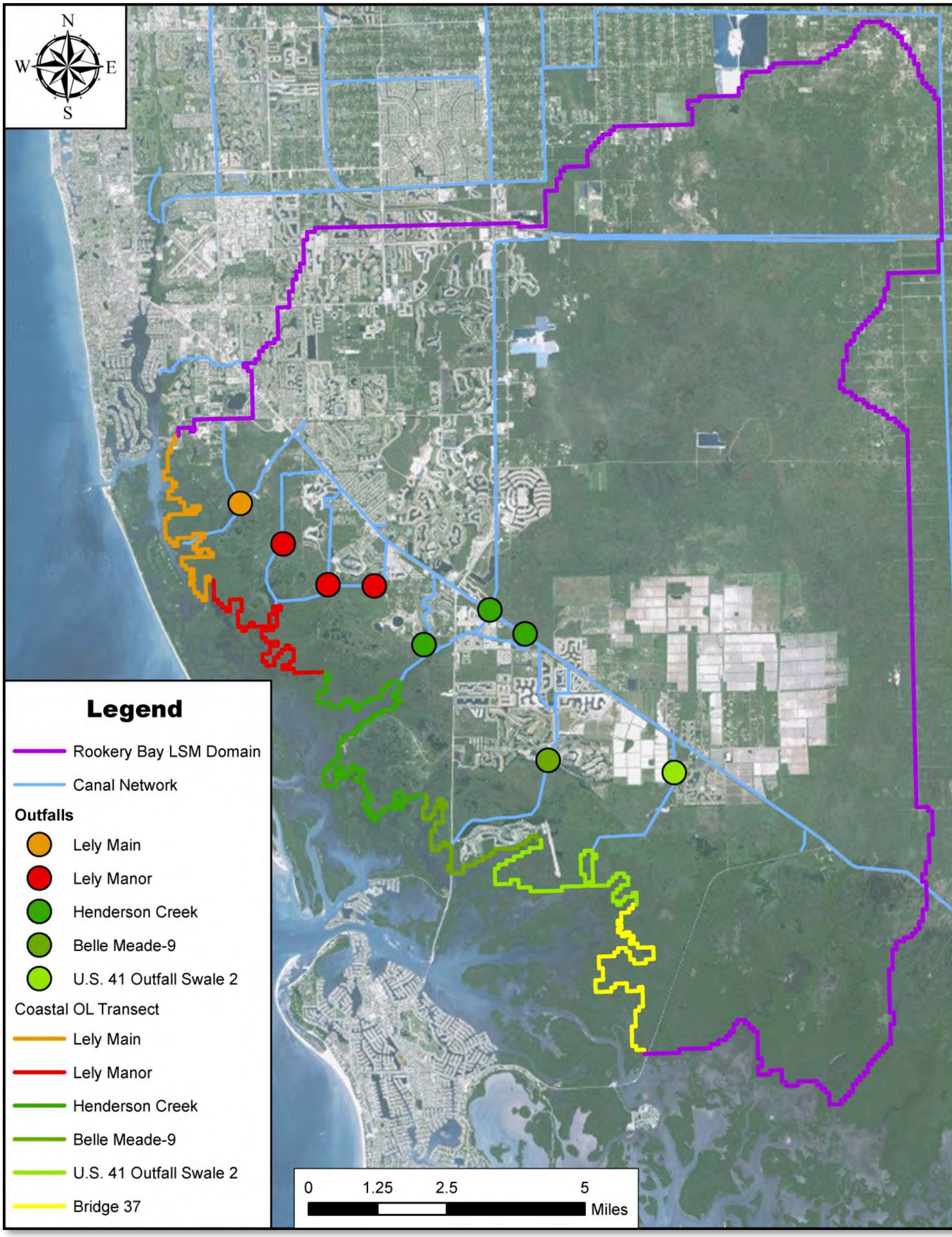

Figure 3-4 Transect Locations for Inflow Comparisons to Rookery Bay

As **Table 3-1** indicates, the modeling analysis shows an overall flow deficit under existing conditions, which also agrees with the salinity flow analysis from the CCWMP. It also shows that specific locations have flow deficits while others have a flow surplus, particularly the Belle Meade 9 and Bridge 37 locations which show a combined 50 cfs flow deficit. **It should be noted that this analysis also shows a flow surplus at Henderson Creek, further indicating that Henderson Creek is not the optimal discharge location for a freshwater diversion project.**

3.5. Preliminary Flow Diversion Modeling and Flow Availability

Considering the results of the previous studies, in terms of Rookery Bay's capacity to receive additional flows from a flow diversion project, it was appropriate to simulate the downstream effects of pumping water from the GGC, through the Belle Meade area within the PSSF, and down to Rookery Bay. The MIKE SHE/MIKE 11 model from the CCWMP was used simulate various pumping scenarios with the focus being on the availability of Rookery Bay to receive additional flows. Because it is recognized that not all of the diverted flows will make it to Rookery Bay due to the hydrologic losses of storage, infiltration and evapotranspiration, the MIKE SHE/MIKE 11 model is the best way to make reasonable estimates of the portion of the diverted flows that are likely to discharge to Rookery Bay and where in Rookery Bay they would go to. Model simulations of 100 cfs and 200 cfs were simulated to obtain some preliminary results. Model results indicated that, in general, about 50 cfs of diverted flows would go to losses. For the 100 cfs pumping scenario, that meant that roughly 50 cfs would make it to Rookery Bay, corresponding to the flow deficit identified in the Restoring the Rookery Bay Estuary project. These preliminary results indicated that a flow rate of 100 cfs was a feasible diversion rate.

To continue the due diligence on selecting the most appropriate flow rate, a flow availability analysis was completed for the GGC in terms of diverting freshwater flows during the wet season. This analysis and results were completed in coordination with the SFWMD to assure flow diversion would not affect groundwater stages for local water use. The results of the analysis determined, at least at this time, that flows could only be diverted when the GGC GG-3 weir structure is lowered to elevation 6.5-feet NAVD88. Based on this elevation and the available data from the structure gage (from 2009-2014), water could be diverted, on average, 40 days per year at 100 cfs. This diversion protocol is considered conservative and appropriate at this time considering the project is still in the preliminary phase.

3.6. Conclusion

This chapter focused on defining the appropriate diversion flow rate for the project based on the limiting constraint of the system. This constraint is the receiving water body, the Rookery Bay. Previous studies considered various pumping rates to divert water from the GGC in order to reduce flows to Naples Bay. Although these studies indicated that larger pumps would provide a greater impact to Naples Bay, they would likely provide too much water to the wetland systems and Rookery Bay. **Review of the data indicate that a 100 cfs pump station used to divert water from the GGC will provide a benefit to Naples Bay, while hydrating wetlands in the PSSF and providing an appropriate volume of water to Rookery Bay.**

4. Project Goals and Approach to Project Design

Based on the findings from the previous studies, the overwhelming consensus is that Naples Bay is adversely impacted by too much freshwater inflow and that Rookery Bay is adversely impacted by too little freshwater inflow. As such, a project (or set of projects) that would divert flow from the GGC (Naples Bay watershed) to Rookery Bay would serve to enhance both estuaries. A regional project (or set of projects) of this magnitude would certainly have a high potential for overarching impact to Collier County. For this reason, the set of projects developed in this report focuses specifically on those projects. In previous studies, various diversion volumes and flow-way configurations through the Belle Meade area have been investigated. This section briefly describes the previous study efforts and an overview of the recommended set of projects based on the previous work, new information and the evaluation of the most recent data and information.

4.1. Use of Existing Studies

As discussed in **Chapter 1**, this area of Collier County has had many studies completed that have identified ecologic and hydrologic restoration projects, specifically, that include flow diversions through the north and south Belle Meade areas. Because so much time and effort have already been spent on studying this area, the goal of this report is to build upon that which has already been accomplished and not “reinvent the wheel”.

In all of the previous studies (listed in **Chapter 1**), identified projects were very conceptual and all analysis were very preliminary in nature. Further evaluation was still needed to determine the optimal set of projects that would maximize project benefits while considering the system’s hydrological and ecological constraints. That being said, these projects provided a great “starting point” and are the basis for the proposed set of projects discussed in detail in **Chapter 6** of this report.

4.2. Changes that Affect Previous Concepts

Since the completion of the above-mentioned studies, not a lot has changed in terms of land use (development). While development has not significantly changed, more data and information has been acquired in terms of the availability and use of lands, as well as hydrological and ecological constraints of the system. The subsections below describe each of the major changes that have occurred relative to previous project assumptions.

4.2.1. Use of the North Belle Meade Area for Flow-way Conveyance

In previous studies (particularly the CCWMP and the Belle Meade Area Stormwater Management Master Plan), it was presumed that a significant portion of the north Belle Meade area, which are natural wetland areas and are predominantly sending lands in the County’s Transferrable Development Rights (TDR) program (see **Section 5.4** for more discussion on sending lands and the TDR program), could be used to convey flows south via a spreader swale system. After some further investigation by Collier County, it appears that these lands will likely not be available within the immediate project timeframe, although they may become available in the future. This project concept assumes the lands are not available, but the possibility of adding a north Belle Meade spreader system as a future phase is discussed later in the report **(Chapter 8).**

4.2.2. Limitation of Rookery Bay to Accommodate Excess Flows

In the previous reports, pumping diversions at flow rates of 400 cfs up to 800 cfs were evaluated (Northern Golden Gate Estates Flow-way Restoration Project). In some of these evaluations, the downstream impacts of conveying that much flow were not fully investigated. The most recent research into the overall system indicates that flow rates of 400 – 800 cfs would likely be problematic to the ecology of not only the south Belle Meade area, but also Rookery Bay itself. Further research and analysis concluded that diverting that much water into the south Belle Meade area and ultimately Rookery Bay could have negative effects to habitat and water quality in the receiving estuary. As concluded in **Chapter 3**, analysis of flow receiving areas (PSSF) and estuary systems (Rookery Bay), and preliminary modeling results indicate a pumping rate of 100 cfs is more practical.

4.2.3. APAC mining pits

In previous reports, the use of the existing APAC mining pit located just south of the GGC in north Belle Meade could be used as a location for the pump withdrawals to divert water. Additionally, the area to the south of the mining pit was to be used as part of the location for the north Belle Meade spreader swale. Based on the most recent information acquired by Collier County, APAC plans to expand the mining operations to the south and does not desire to have their property used as part of this project.

4.3. Conceptual Design Approach

In the studies previously mentioned, project concepts were identified that have become the basis for the conceptual project design described herein. The goal of this report was to take the concepts from the previous efforts, re-eveluate and re-configure them, and turn them into a series of implementable and constrcutable projects that provide a significant benefit to Naples Bay, PSSF and Rookery Bay while also holistically improving hydrology and ecology throughout the Collier County region. The goal of the conceptual designs in this report is to provide a thorough and comprehensive evaluation of each project component, and sketch out project concepts that are conservative, realistic, feasible and can become the foundation for full project designs in the future. Designs are completed such that cost estimates are practical for establishing preliminary project budgets to secure future project funding.

Conceptual design project elements were developed using best available information. This includes the Collier County digital elevation model (DEM) for ground elevation references. No survey was accomplished as part of the project development. Generally available soil survey information was used to estimate soil infiltration characteristics and depths to water tables. Existing groundwater well information was also used to estimate groundwater information. No geotechnical work was performed during his project. Property data was obtained from Collier County’s latest GIS property boundary information. Predicted surface water elevations and flows through the region for pumping scenarios were based on the latest MIKE SHE/MIKE-11 model. This model is the County-accepted model and is the best information for simulating such a complex set of projects. Conceptual design details are presented by project area in **Chapter 6** and Engineer’s opinions of probable cost (at a 15% design level) are included in **Chapter 9**.

4.4. Project Overview

Figure 4-1 presents an overall view of the primary set of recommended projects for the CCCWIP. This set of projects has been carefully planned out, considering its effects to not only Naples Bay, but also to receiving wetlands (in the PSSF), major road crossings (in FDOT right-of-ways), agricultural lands and Rookery Bay. These projects have also been developed in concert with the governmental, non-governmental and citizen groups that will be directly impacted by the implementation of this plan, as to be consistent with the GGWIP. A brief description of how the system would work in the five major project areas is descrbed below. The overall project concept is described in more detail in **Chapter 6**.

The projects start in the north where a 100 cfs pump station (North Belle Meade Pump Station) will be constructed on County-owned property along the GGC, appromixately one mile east of Collier Blvd. and upstream of the GG-3 structure. The pump station would start pumping when the gate for the GG-3 structure is lowered to elevation 6.5 ft NAVD88, which roughly corresponds to elevation 8.0 ft NAVD88 in the GGC. The pump station would then pump to a one-mile long channel flow-way (linear pond) controlled by outfall structures. The linear pond flow-way would be designed with wetland plantings to improve water quality and have a multi-use recreational trail amenity. This would convey flow diversions south, under White Lake Blvd to the north I-75 cross canal. Once flows enter the I-75 north canal, flows would be converyed through the existing box culverts under this section of I-75 to the south canal. Operational structures or ditch block would be designed to contain the flows within the west segment of the canals. The I-75 south canal is not contiguous, so portions between the ditch segments would need to be excavated to make the south canal contiguous.

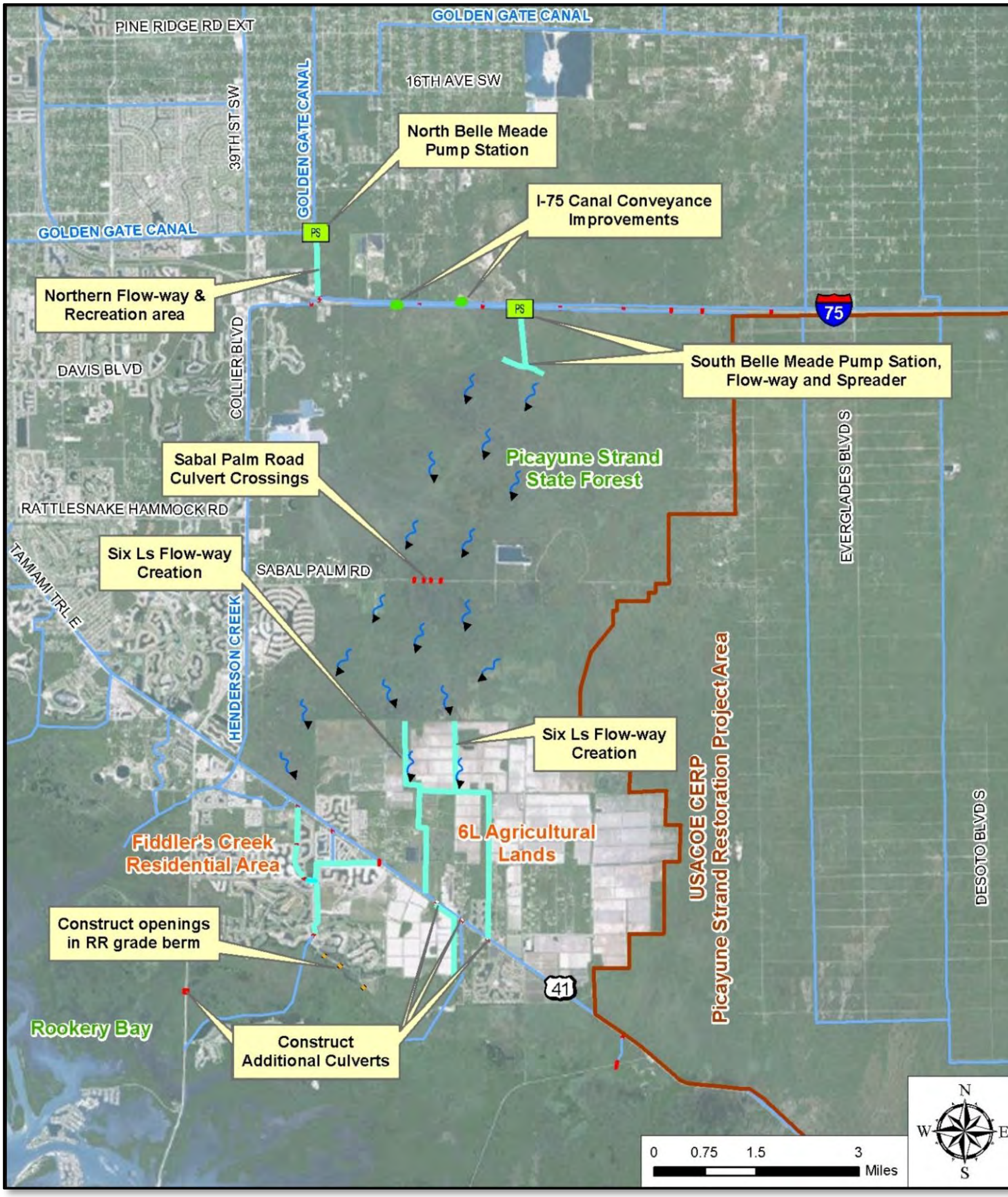

Figure 4-1 Overall Project Concept

A second pump station (South Belle Meade Pump Station) will be constructed on the south side of the I-75 south canal, also with a 100 cfs capacity, and would start pumping when water begins flowing into the north I-75 canal. The pump station would pump into a 4,000 foot (dry) channel flow-way which would convey flows south to a spreader swale that would discharge flows south through the south Belle Meade wetland area flow-way. This flow would continue south to Sabal Palm Road where additional siphon culvert cross drains would be constructed to convey the additional flow.

As diverted flow continues south, it would flow in one of three directions. Some flow will circumnavigate the Six L's agricultural lands to the west, while the remaining flows would flow into one of two control structures, each with a designed flow-way that would take flows through the Six L's lands. All flows would continue to the north US 41 drainage system, where additional culverts would be installed under US 41. From there the flows would continue south through the Fiddler's Creek residential area stormwater system and ultimatelty to Rookery Bay.

5. Critical Issues

As mentioned previously in **Chapter 1**, one of the primary goals of this report was to determine the critical issues associated with implementing the CCCWIP, particularly the issues that could derail the project, and to identify or perform the preliminary analyses needed to resolve these issues. The following sub-sections discuss these issues, the evaluation(s) and analyses performed during this phase, as well as what actions would need to be taken during the next phases of the CCCWIP project development.

5.1. Flow Capacity through the I-75 corridor

The proposed flow diversion from Naples Bay will start with pumping water from the GGC. The proposed pump station at the GGC and the downstream flow-way are proposed on a County-owned property. These elements can be designed to meet the flow rate capacity proposed, so conveying the diverted flows from the GGC south to the I-75 canal system should be without issue. Once the diverted flow discharges to the north I-75 canal from the designed flow-way, it must pass through a Florida Department of Transportation (FDOT)-owned property. **Figure 5-1** shows the general location of the project relative to the I-75 corridor. Because this property is not County-owned (or controlled), measures must be taken to assure the additional flows to the I-75 do not cause adverse impacts.

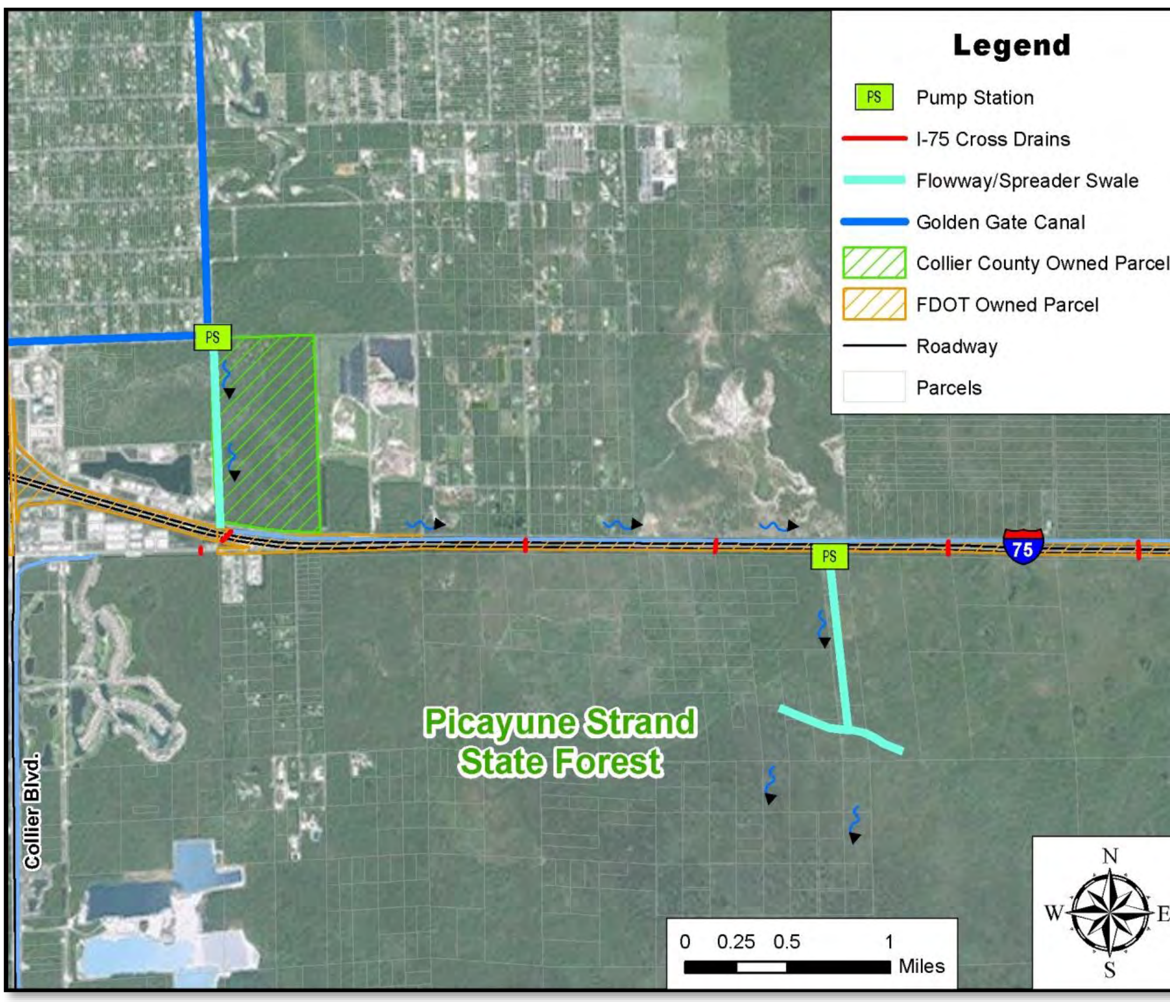

Figure 5-1 I-75 Corridor Area Map

In the CCCWIP conceptual plan, diverted flows would enter the north I-75 canal south of White Lake Blvd, just east of the location where the north I-75 canal crosses under I-75. When diverted flows are discharging to the canal, an operable weir structure would force water to the east and prevent flows from heading south under I-75. East of this location there are four concrete box culverts (CBC) within the project area that connect the north and south canals, equalizing stages within the two canals. The CCCWIP concept proposes to pump flows to the north canal and utilize the existing CBC cross drains to convey flows to the south canal where the second pump station will withdraw flows to continue the diversion to the south through Belle Meade. Preliminary analysis using the CCWMP existing conditions MIKE SHE/MIKE 11 model showed minimal changes in water levels in the two canals under pumping scenarios, indicating that the existing CBCs under I-75 will be sufficient to convey flows during normal flow conditions. Conveyance improvements within the canals themselves would need to be conducted to optimize canal conveyance in terms of clearing vegetation and silt (or ditch blocks).

A phone meeting was held with the FDOT District 1 Drainage Engineer on April 7, 2016 to inform them of this potential project and to start open communications. The FDOT was supportive of the project and indicated they would be cooperative in future phases of the project. The CCCWIP project would need to obtain a FDOT drainage connection permit and demonstrate that the project would not impact any of the FDOT's facilities. It should be noted that a more complete and detailed modeling analysis would need to be conducted in a future project development phase to define operable weir configurations and refine model analysis.

5.2. Picayune Strand State Forest (PSSF)

The PSSF is the fourth largest state forest in Florida and is named after the largest of several cypress strands that once occupied much of the eastern portion of the property. The 78,000-acre forest is comprised of two tracts, the South Golden Gates Estates Tract to the east and the Belle Meade Tract to the west. It is located in southwest Florida in eastern Collier County, approximately 2 miles east of Naples. **Figure 5-2** shows the location of the PSSF. The PSSF is a critical element in the CCCWIP project concept. Because flow diversions would travel through the Belle Meade portion of the PSSF, coordination efforts and preliminary analyses are necessary to determine the effects and benefits of diverting flows through the PSSF.

The forest is currently undergoing hydrologic restoration, similar to the CCCWIP initiative, from the Picayune Strand Restoration Project (PSRP) in the South Golden Gates Estates Tract. The improvements proposed as part of the CCCWIP has many of the same goals and actually compliments the work being accomplished in the PSRP. Not only does the CCCWIP compliment the PSRP, it is also consistent with the PSSF overall management plan. However, the CCCWIP project described in this report is strictly limited to the Belle Meade Tract of the PSSF, and coordination with the PSRP during future project development will be necessary (the PSRP is discussed later in this section). Because the hydrology and ecology of the PSSF in Belle Meade has changed since the construction of the interstate and canal systems in the 1950`s, several critical issues must be addressed. The following sub-sections discuss these issues and the actions taken during this phase to address them.

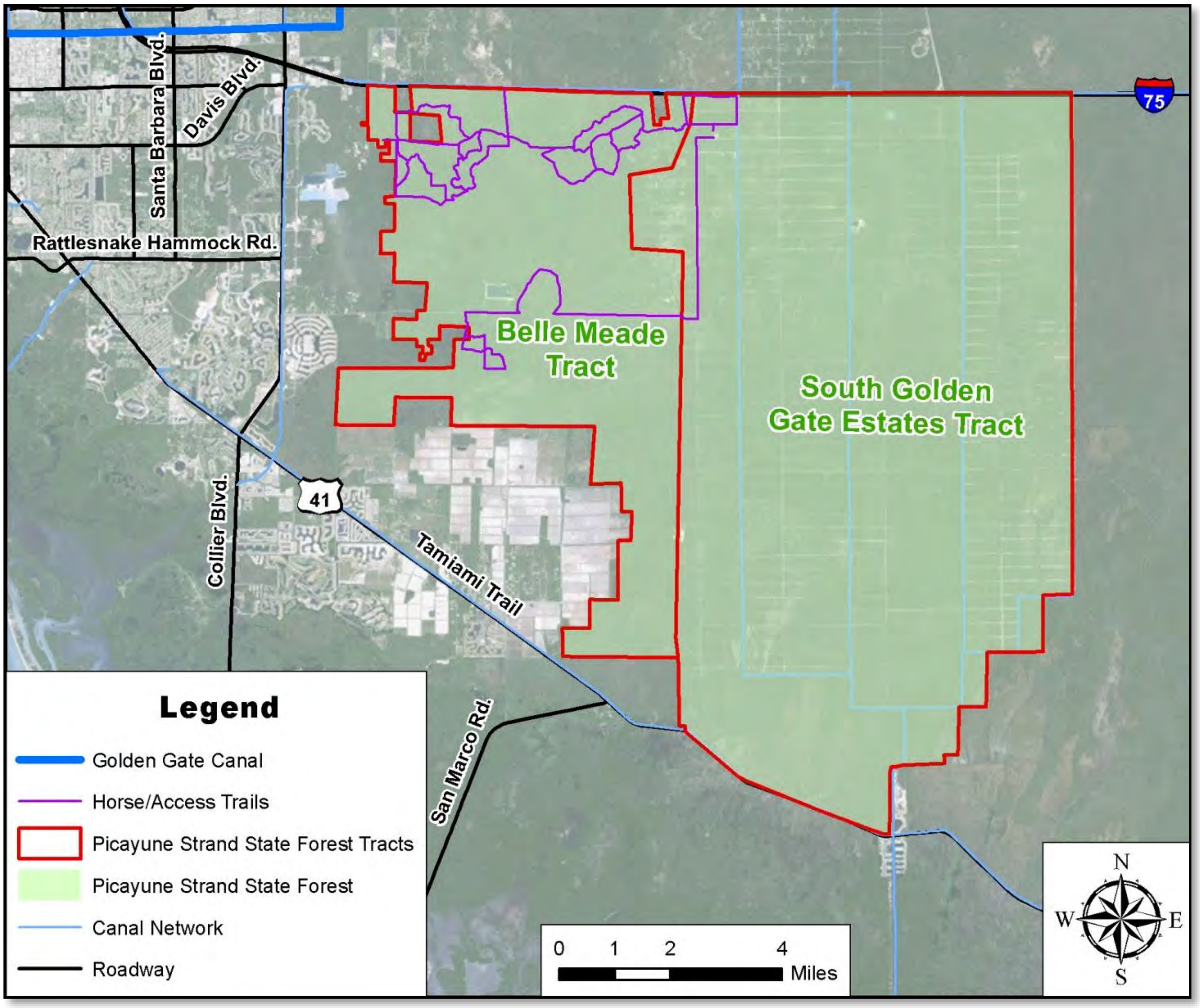

Figure 5-2 Picayune Strand State Forest (PSSF) Area Map

5.2.1. Vegetation Community Changes (2007 vs. Historical)

Because of the regional hydrologic alterations from development, the vegetation communities within the PSSF have changed as well. These changes need to be understood in order to fully optimize project benefits and prevent project impacts. This section provides a comparison of the pre-development (historic) vegetation versus the 2007 vegetation (land use). An area around the South Belle Meade project area within the PSSF was defined for the purpose of this comparison. **Figure 5-3** shows the distribution of land use vegetation for the pre-development and 2007 land cover conditions.

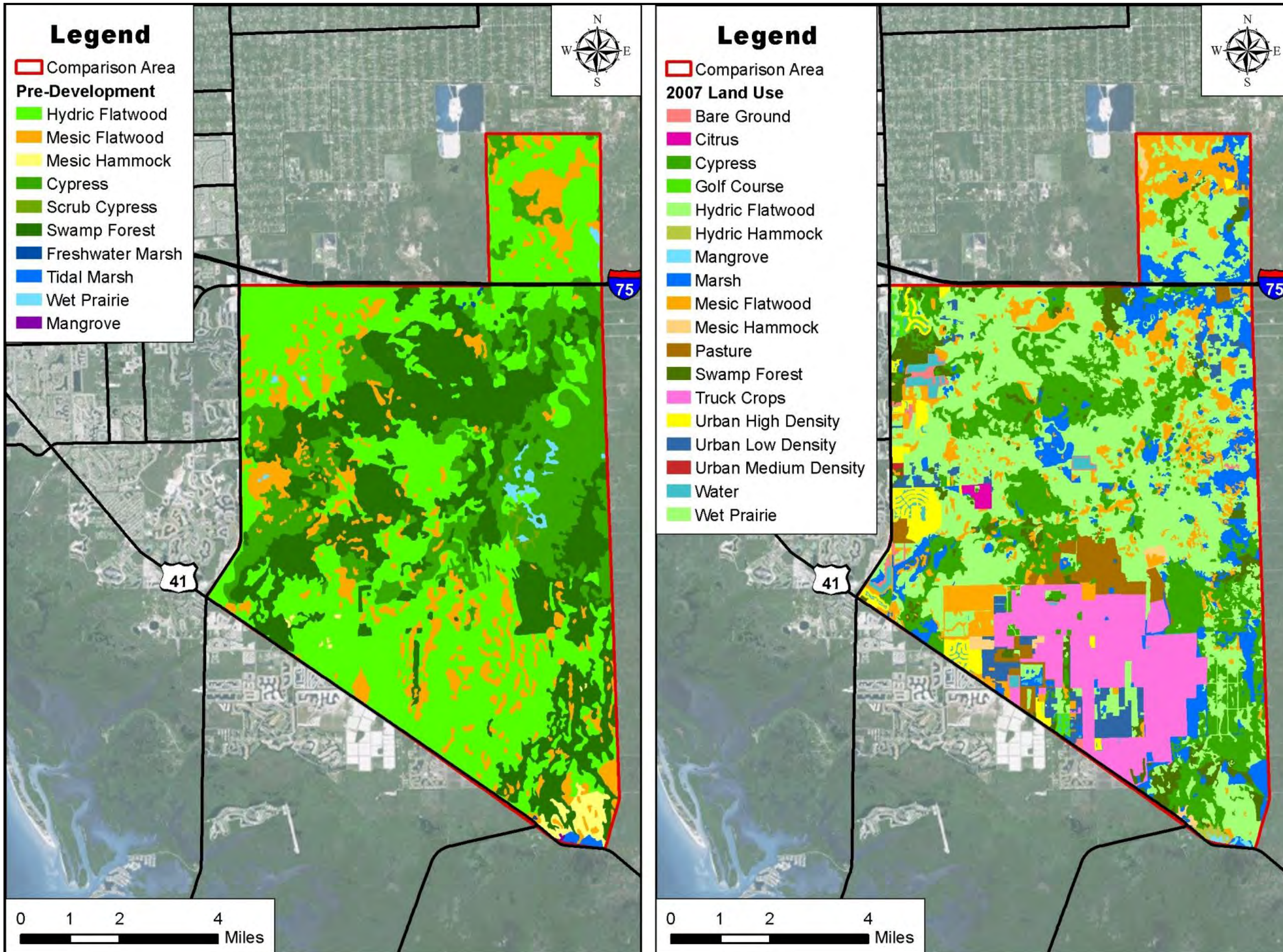

Figure 5-3 Belle Meade Area Historical & 2007 Land Use Comparison

A visual inspection of **Figure 5-3** indicates that large areas of Mesic and Hydric Flatwood have been converted to agriculture and urban land uses. It is also clear the general hydrology of the area has changed. Large areas of pre-development Swamp Forest that would typically have a hydroperiod of 8 – 10 months have changed to Cypress or Hydric Flatwood, which have hydroperiods of 6 - 8 months and 1 – 2 months, respectively (Deuver). **Table 5-1** shows a comparison of land use classification for the pre-development and 2007 periods. The total acreage of urban and agricultural land uses is approximately 10,600 acres which is almost equal to the loss of Swamp Forest lands.

Table 5-1 Comparison of Land Use Types by Acres

Land Use Type	Historical Land Use		2007 Land Use	
	Area (ac.)	**Percent of Area (%)**	**Area (ac.)**	**Percent of Area (%)**
Bare Ground	0	0	254.9	0.5
Citrus	0	0	137.8	0.3
Cypress	8,897.9	17.9	8,939.1	18.0
Golf Course	0	0	194.1	0.4
Hydric Flatwood	21,076.4	42.4	16,654.9	33.4
Mangrove	34.2	0.1	50.7	0.1
Marsh	139.4	0.4	4,871.6	9.8
Mesic Flatwood	6,111.8	12.4	5,339.9	10.7
Pasture	0	0	1,416.5	2.8
Swamp Forest	13,200.5	26.6	2,006.8	4.0
Truck Crops	0	0	5,336.4	10.7
Urban	0	0	2,720.3	5.5
Water	0	0	571.4	1.2
Wet Prairie	347.8	0	1,313.6	2.6
Totals	**49,808**	**100**	**49,808**	**100**

The increase in marsh lands appears to be related to the construction of roads and berms in the area. The construction activities appear to prevent the natural sheet flow that would have occurred in the pre-development condition. The total areas of Cypress, Hydric Flatwood and Mesic Flatwood in 2007 are approximately equal to the pre-development areas; however, the areas have shifted to lands that previously were considered to be Swamp Forest. Generally, it is apparent that the overall land cover within the Belle Meade area has shifted to vegetation types with shorter hydroperiods and shallower water depths. This indicates that increased flows to this area would serve to rehydrate areas similar to pre-development conditions.

5.2.2. Wildlife

The PSSF is home to many species of flora and fauna. Confirmed sightings of wildlife in the forest currently listed as endangered, threatened or of special concern include the eastern indigo snake, Florida black bear, Florida panther, gopher tortoise, Red-cockaded woodpecker, Florida bonneted bat and wood stork. All of these species will need special attention during the development of the CCCWIP project. Because there are known endangered species within the forest, a full Biological Assessment (BA) will have to be performed to conform with Section 7 of the Endangered Species Act (ESA). The purpose of a BA is to describe proposed actions and their effects on ESA-listed species. No BA was completed as part of this project, but preliminary discussions with the Florida Fish and Wildlife Commission (FWC) took place and the project concept was developed using their guidance.

During the project concept development, it was noted that there are large colonies of Red-cockaded woodpeckers (RCWs) within the Belle Meade area. Considering that the scope of this project is to increase flows through to forest, slightly increasing wetland depths and hydroperiods, the RCWs became the species of biggest concern for this project in terms of the location and the amount of flows that could be diverted to the PSSF. RCWs make their nests within the Mesic Flatwood areas of the PSSF and it is critical that the existing trees that have established active nests/colonies are not impacted. For this reason, preliminary modeling efforts were accomplished to determine the effects (changes in water depths and hydroperiods) to wetland areas with the Belle Meade area of the PSSF. **Figure 5-4** shows the locations of the RCW colonies relative to the project rehydration area.

The modeling analysis was accomplished using the MIKE SHE/MIKE 11 model from the Restoring the Rookery Bay Estuary project (discussed in **Chapter 3**). The results of the preliminary modeling analysis concluded that the most significant changes to water depths and hydroperiods in wetlands would be to Cypress and Hydric Flatwoods. In areas of Mesic Flatwood, minimal changes were observed with average water surface depth increases of less than one inch and hydroperiods increases of 5-10 days. These are both very small numbers and would likely not impact Mesic Flatwood areas. Furthermore, all of the active RCW colonies actually lie outside the "project flow-way area" based on the modeled pumping scenarios. Based on this analysis, it appears no RCW habitat would be impacted by the proposed pumping flow rates through the PSSF.

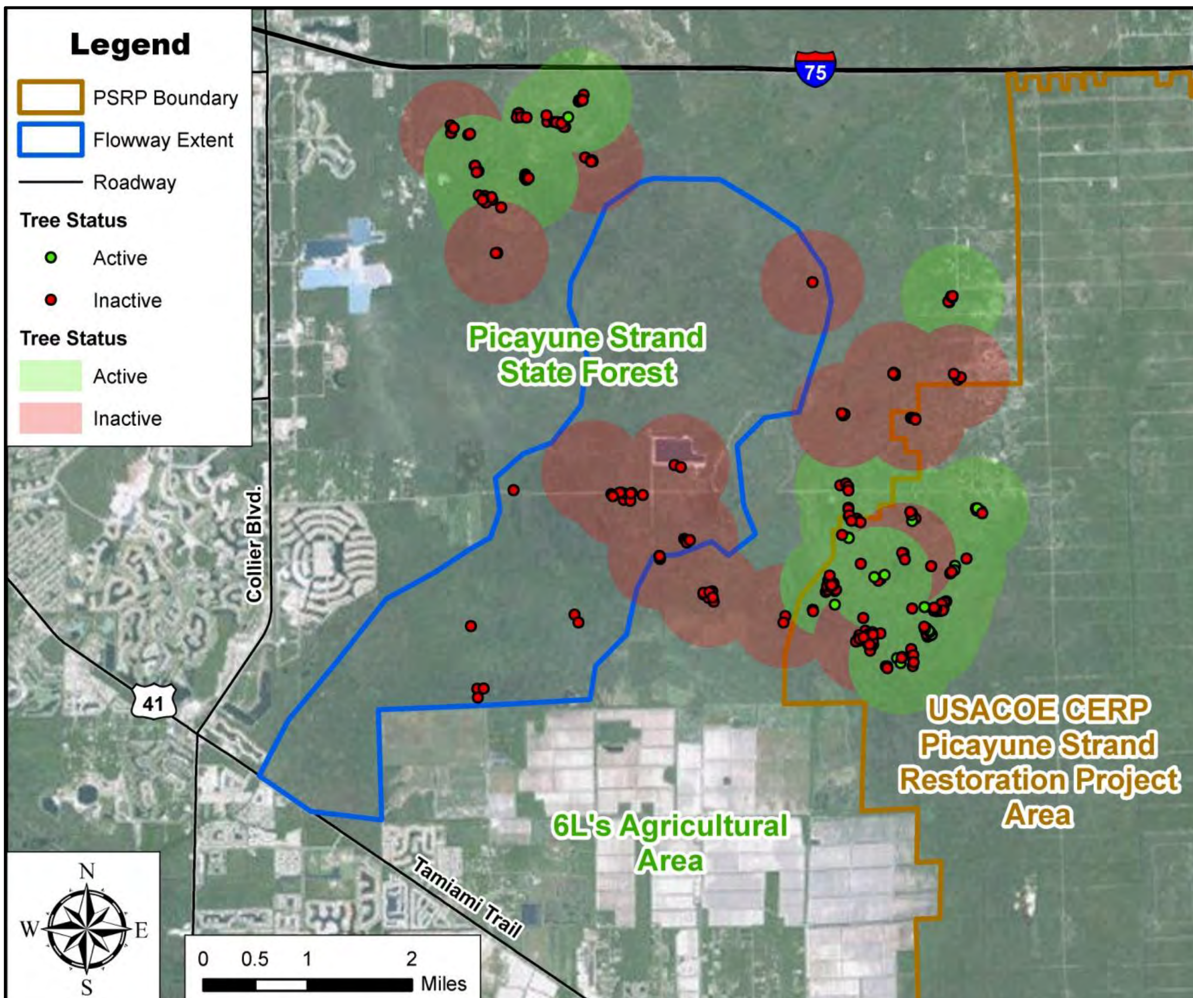

Figure 5-4 Red-cockaded Woodpecker Habitat

5.2.3. PSSF Hiking/Horse Trails

Over 25 miles of trails exist within the Belle Meade tract of the PSSF (see **Figure 5-2**). These trails are used for a variety of recreational activities including hiking and equestrian and are one of the primary reasons that attract the public to the PSSF. The Florida Forest Service (FFS) staff also uses these trails frequently for maintenance access during their daily activities. Several coordination meetings were held with forest staff to garner input on the CCCWIP project concept. One of the concerns that was raised by the staff was maintaining trail connectivity. A portion of the project area involves constructing a large conveyance swale and spreader swale to convey flows from the I-75 canal through some high ground and discharge them to the cypress wetlands to the south. This would be constructed through two of the primary trails. It was agreed that any earthen features constructed through the existing trails would be designed such that they would either be reconstructed at the nearest location or have a crossing installed as part of the design.

5.2.4. Sabal Palm Road

Sabal Palm Rd is primarily a dirt road that essentially bisects the Belle Meade tract of the PSSF. It runs east to west between Collier Blvd (to the west) and Miller Blvd (to the east). The road is paved for the first mile and a half from the Collier Blvd intersection and is dirt from there on. The road serves as the primary entrance to the PSSF and most of the hiking/horse/access trails are connected to Sabal Palm Rd. Although the road can be accessed from both ends, at roughly its half way point the road is usually impassable due to soggy conditions and the road is therefore often closed by forest service staff. Sabal Palm Rd has several siphon culvert cross drains at its low points along the west segment that allow flow to continue south during the wet season when the water table is high. As part of the CCCWIP project concept, additional siphon culverts would be installed adjacent to the recently installed existing culverts to convey the additional flows. During coordination meetings, staff members indicated that it is critical to add these culverts and keep Sabal Palm Rd. drivable as it is often the best or only road to access the forest during the wet season.

5.3. Picayune Strand Restoration Project (PSRP) Coordination

The PSRP was the first Comprehensive Everglades Restoration Project (CERP) to begin construction. The project involves plugging of almost 50 miles of drainage canals, removing 250 miles of roads, and constructing three large-scale pump stations that restore the natural surface flow to 85 sq. miles of natural Florida habitat. The project is led by the US Army Corps of Engineers (USACE) in partnership with the SFWMD. The intent of the project is to restore historic flows to benefit coastal estuaries, recharge the aquifer, and protect water supply. The project is being constructed within the South Golden Gates Estates tract within the PSSF.

Three pump stations will be constructed as part of this project: the Merritt Pump Station, the Faka Union Pump Station and the Miller Pump Station. Currently only the Merritt Pump Station is operational, but all three stations will be online within the next two years. Because the PSRP is directly adjacent to the CCCWIP conceptual project, it is important to coordinate the planning efforts. Meetings have been held with SFWMD staff to begin this process. The input from SFWMD staff indicated that no flows (surface water or groundwater) from the CCCWIP project can impact the PSRP area. Considering this input from the SFWMD, preliminary modeling analyses were conducted to determine what flows, if any, could possibly impact the PSRP.

Again, the MIKE SHE/MIKE 11 model from the Restoring the Rookery Bay Estuary project was used for the modeling analysis. It should be noted that the modeling analysis conducted did not incorporate any information from the PSRP pumping, as no information was available at the time of this report. **Figure 5-5** shows that preliminary model results, without PSRP pumping, do indicate the potential for a small increase of water stages on the fringe of the PSRP boundary. However, these results do not include the effects of the Miller Pump Station which will be online within the next few years and capable of pumping 1,250 cfs. A review of the groundwater data from the Merritt Pump Station (which started full-scale pumping in August 2015) shows that average groundwater elevations increased by than one foot after pumping started. It is anticipated that when the Miller Pump Station begins pumping activities (before the CCCWIP project would be permitted) that similar groundwater increases would be observed and the adjacent groundwater effects

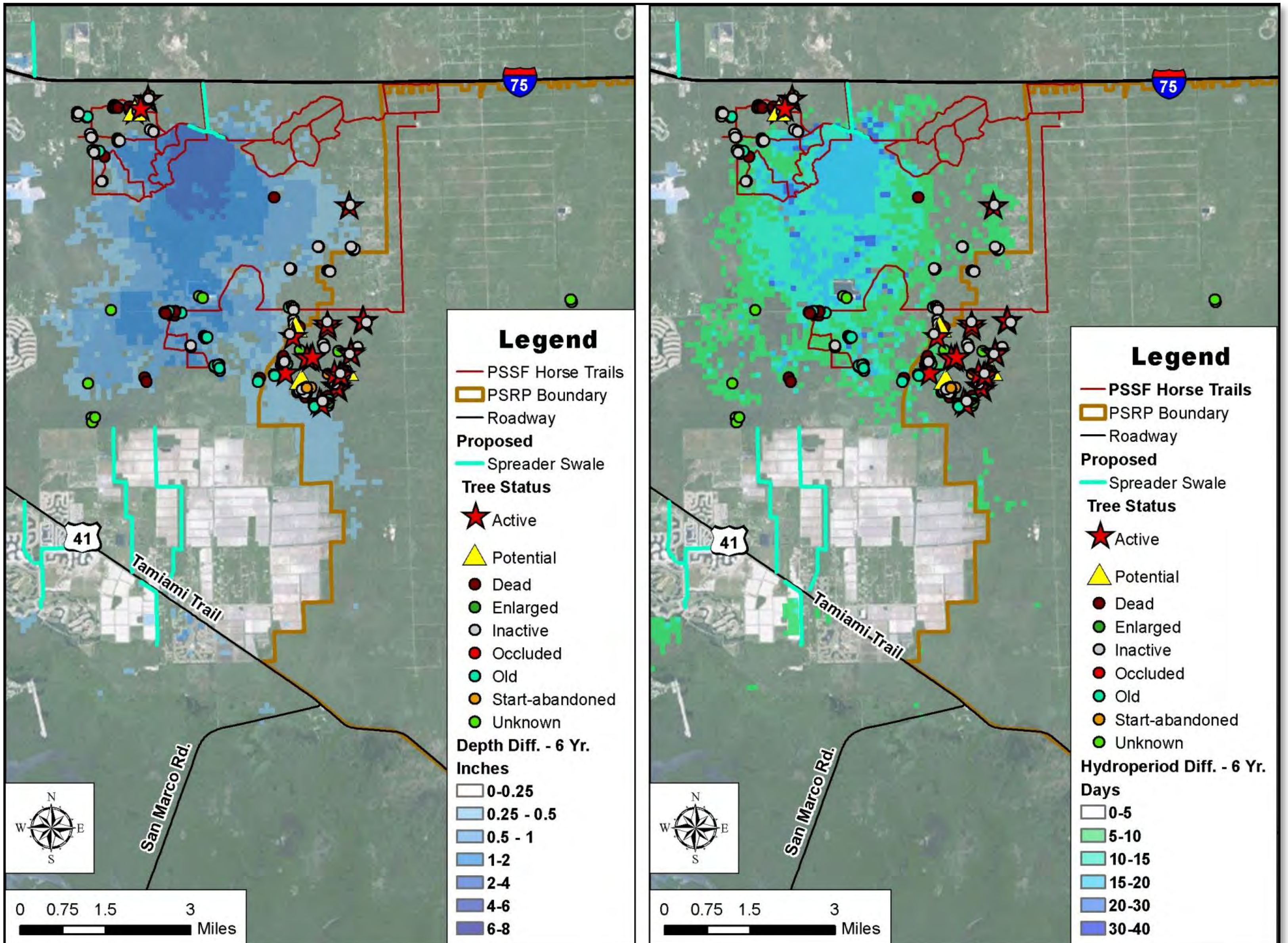

Figure 5-5 Water Depth and Hydroperiod Changes During Model Pumping Scenarios

would prevent water from “leaking” to the PSRP project area, whereby meeting the SFWMD requirements. Currently the PSRP is building a model that will incorporate pumping from all the pump stations. Once that model is available, the data can be used to refine the MIKE SHE/MIKE 11 boundary conditions and re-analyze the results.

5.4. South Belle Meade Property Evaluation

The project area within the PSSF encompasses about 8,000 acres, most of which is publically-owned lands. There are, however, several tracts of privately-owned land. **Figure 5-6** shows the project rehydration area and the privately-owned parcels that are within the project boundary (flow-way extent). Collier County has several options in dealing with these properties. In addition to potentially avoiding the properties by controlling pumping or constructing protection features, the County could bring them into the Transferable Development Rights (TDR) program. Because these private parcels lie within the PSSF, Collier County has designated them as “Sending Lands” and eligible for the TDR program. *By owning Sending Land property, a property owner can retain use of the land for limited permitted and conditional uses as listed in the Collier County Growth Management Plan’s Rural Fringe Mixed Use (RFMU) District Sending Lands, while gaining some monetary benefit from selling off the development rights. Market conditions will determine the price between a willing seller and buyer (Collier County Growth Management Plan)*. Once the property owner sells the development rights, the property enters the TDR program and the property could be used for public purposes. Collier County is currently in the process of assisting these property owners in entering the TDR program which would ultimately benefit the CCCWIP project. Currently there are 61 private parcels within the project area: 16 are already in the TDR program and there are 45 parcels for which the TDRs must be addressed. There is also some new development occurring at this time in the most south-western portion of the project area. Coordination efforts need to be taken in the future to fully determine the effects, if any, of this development on the CCCWIP. It is anticipated that the majority of the flows will discharge through the Six L’s agricultural lands, so the effects will likely be minimal or none.

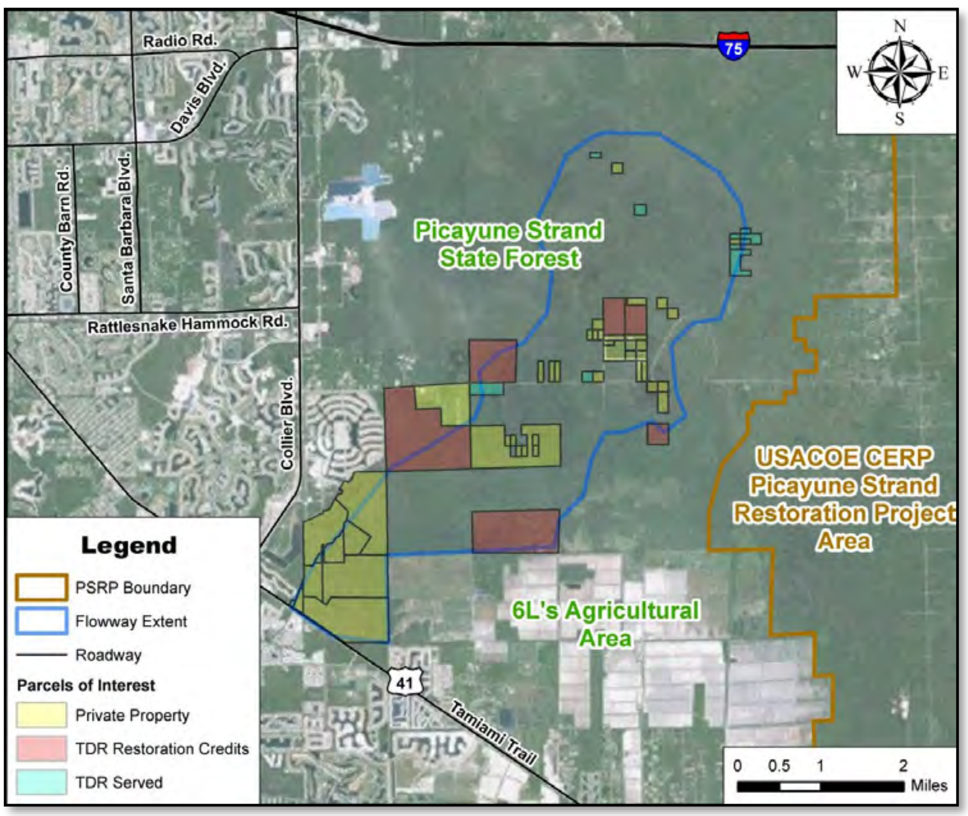

Figure 5-6 Properties of Interest within the Picayune Strand State Forest

5.5. Six L's Area Plan and Future Coordination

The Six L's agricultural lands encompasses almost 10 square miles in southern Collier County. The properties generally lie north of US 41 about five (5) miles south of the Collier Blvd/US 41 intersection, see **Figure 5-7**. The properties have grown tomatoes and vegetables for the Six L's Packing Co. for about 50 years, and are one of the largest tomato producers in the United States. The property lies in a strategic area in terms of surface water flows from the Belle Meade area to Rookery Bay. . This area was identified in the Belle Meade Area Stormwater Management Master Plan (BMSMMP) as an area that contains historical flow-ways for surface water flows from the Belle Meade area to Rookery Bay. The BMSMMP identified these flow-ways using overlay analysis that utilized historical soils data, wetlands inventory and historical aerial imagery dating back to the 1940's. See **Figure 5-7** for the identified flow-ways and alignments from the BMSMMP.

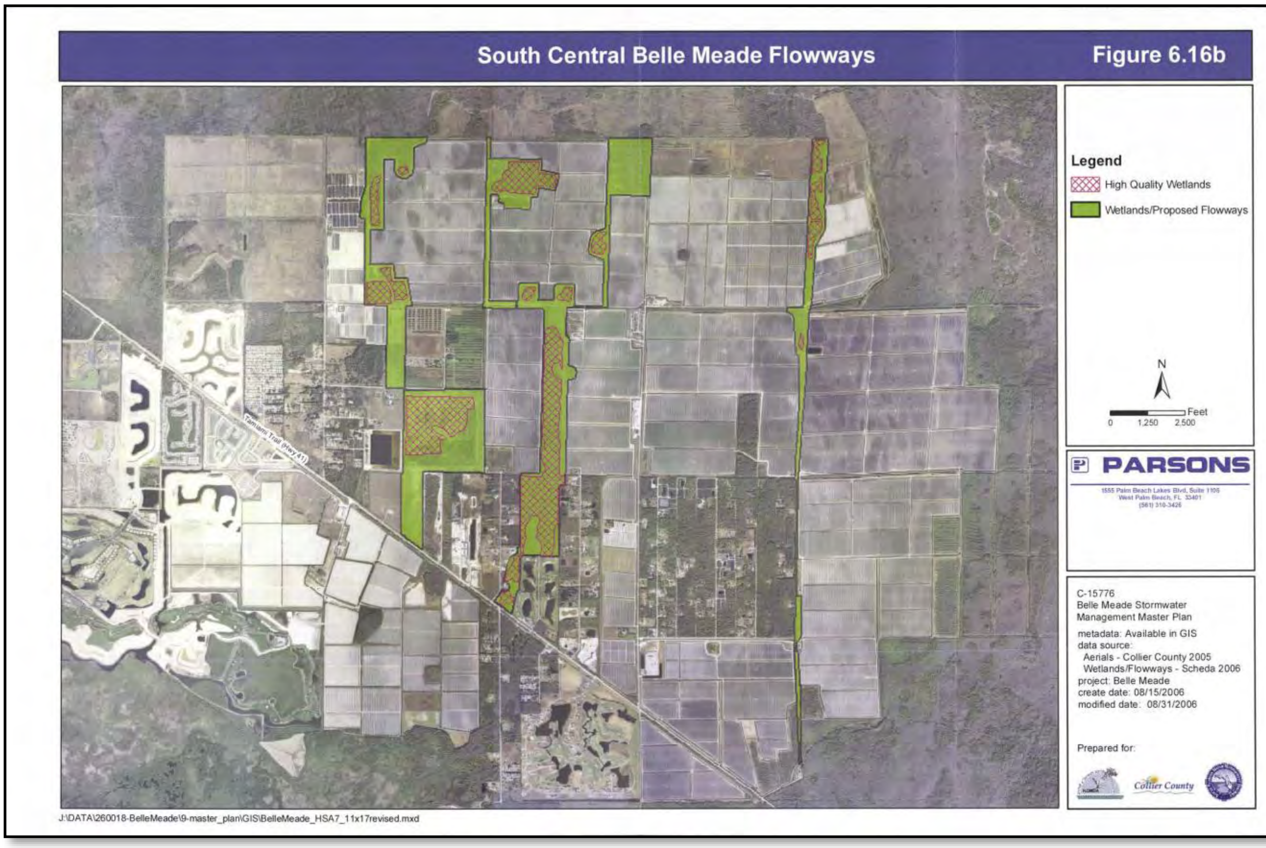

Figure 5-7 Identified Historical Flow-ways from the BMSMMP (Figure from the BMSMMP Report)

Because the Six L's agricultural lands lie in such a strategic location, it is critical to the CCCWIP that, at least, a portion of these historical flow-ways be re-established. The County has already begun preliminary discussions with Six L's representatives. The County's plan is to work together with the Six L's group and develop a plan for this project that would allow the County to obtain the much needed easements within the area over the next ten (10) years, while not interfering with the current operations on the properties, and potentially benefitting the Six L's group if/when the properties transition to development in the future.

5.6. Flow Capacities through US 41 to Rookery Bay

US 41 (Tamiami Trail E) lies south of the Six L's agricultural area and north of Rookery Bay. The state road runs diagonally from northwest to southeast through the overall project flow-way. **Figure 5-8** shows the overall area. The County understands that additional conveyance is needed to convey the diverted flows through US 41. Once diverted flows pass through the Six L's properties area, they must pass under US 41 and through the Fiddler's Creek area. The segment of US 41 between Collier Blvd and Greenway Rd has already been widened from 2 lanes to six lanes by the FDOT as development along this stretch of road has increased dramatically over the last 10 years. The next segment of US 41 to the south is from Greenway Rd to Six L's Farm Rd and is currently in design by the FDOT. The County has already been in contact with the FDOT about adding additional cross drains under US 41 as part of the road widening design for this section, as well as adding additional crossings under the existing Collier Blvd/Greenway Rd segment.

In addition to constructing the additional culverts under US 41 to improve conveyance, it is recognized that the roadside ditch/canal on the north side of US 41 would need conveyance improvements as well. This canal is contiguous, but there are several locations along this 5 mile stretch of canal that have very thick vegetation, and removal of these flow obstructions will likely be necessary. After flows pass under US 41 the majority of the additional flows would traverse through the Fiddler's Creek outfall system, which is considerable in size. Preliminary modeling analysis of pumping scenarios indicate the system would have capacity to pass additional water during normal wet season flows (non-storm events), but a more comprehensive modeling is needed in future phases. Additional flow-way conveyance improvements will likely be needed as well and the County has developed a preliminary plan to incorporate them.

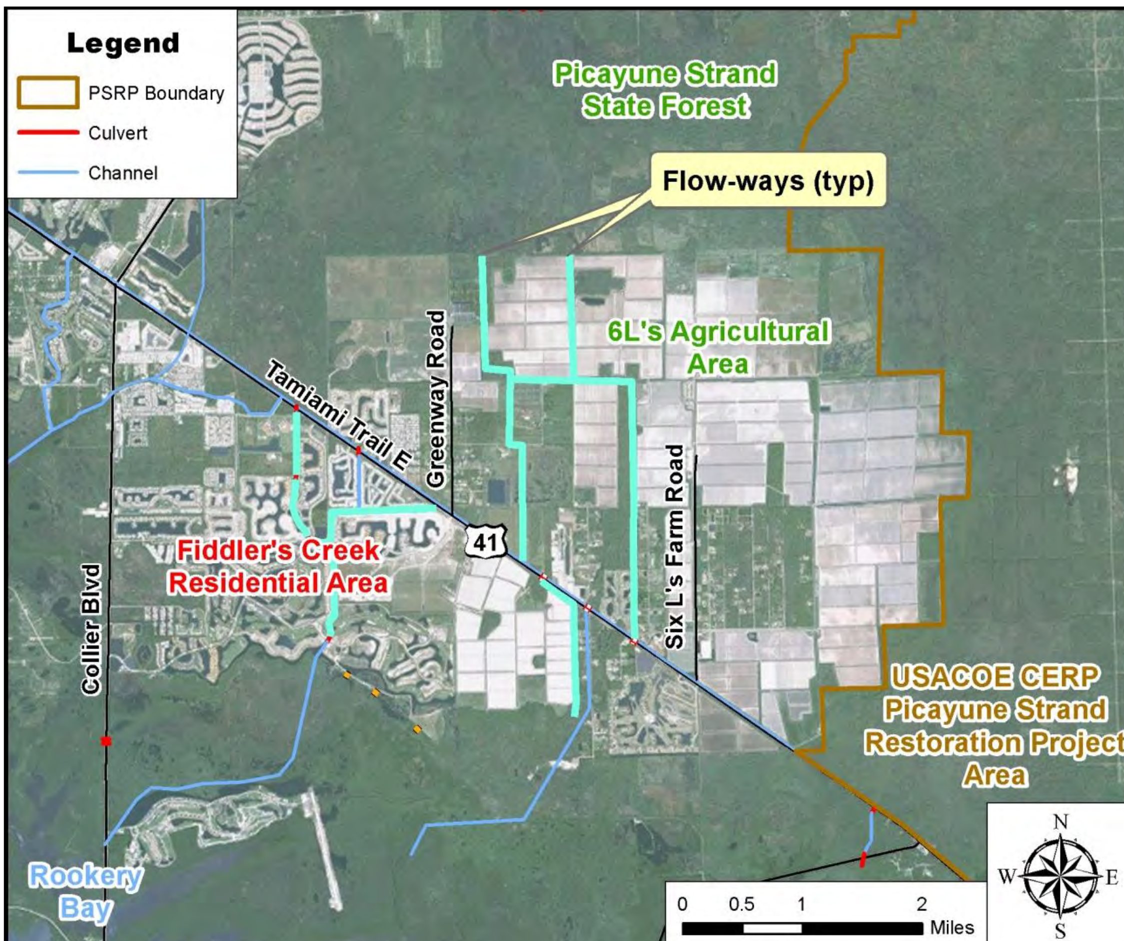

Figure 5-8 Six L's/US 41/Fiddler's Creek Area Map

5.7. Adaptive Management

Additional planning and analysis will be required to accurately manage the flow diversions throughout the project area. Although preliminary analysis has been completed to determine how and where the diverted flows will go, including a modeling analysis using the MIKE SHE/MIKE-11 2D surface water/groundwater model, there is still some some level of uncertainty of where a portion of the water may go. Collier County understands this, and realizes there is more analysis needed, and the County intends on completing more, in-depth analyses in future planning phases prior to project design. At the same time, the County is confident in the preliminary model results and that any future challenges or issues that may arise can be overcome. The series of projects proposed in this report does involve diverting millions of gallons of freshwater flows through more than 15 miles of flow-ways. These flows will traverse through channel flow-ways, existing cross-canals, portions of the PSSF and several other existing water conveyance features. These flows will constantly be interacting with groundwater in the wet season and be subject a significant evepotraspiration during its path. Because of this, the County realizes that, to better operate the system, they must adopt management techniques that allow for a better understanding and adapt the system operations accordingly. For this reason, this project will adopt an adaptive management approach to operating the diversion system.

Adaptive mnagement is essentially a structured and systematic process for continually improving decisions, management policies, and practices by learning from the outcomes of decisions previously taken, and changing operations accordingly. In this manner, the operational protocol for the system will be continuously refined and optimized such that maximum benefit can be obtained while eliminating or minimizing any impacts. **Figure 5-9** shows an illustration of the typical adaptive management process. Monitoring and evaluation are the key steps in the adaptive management process. Once the series of projects have been designed and implemented, monitoring sites will be set up throughout the project area. This effort would encompass not just hydrologic monitoring, but wetland and habitat monitoring as well. The results and careful evaluation of these monitoring efforts will help drive the future operations and management of the system. These monitoring efforts will be defined in the future project development phase and will consider not just system optimization, but also be consistent with permitting requirements.

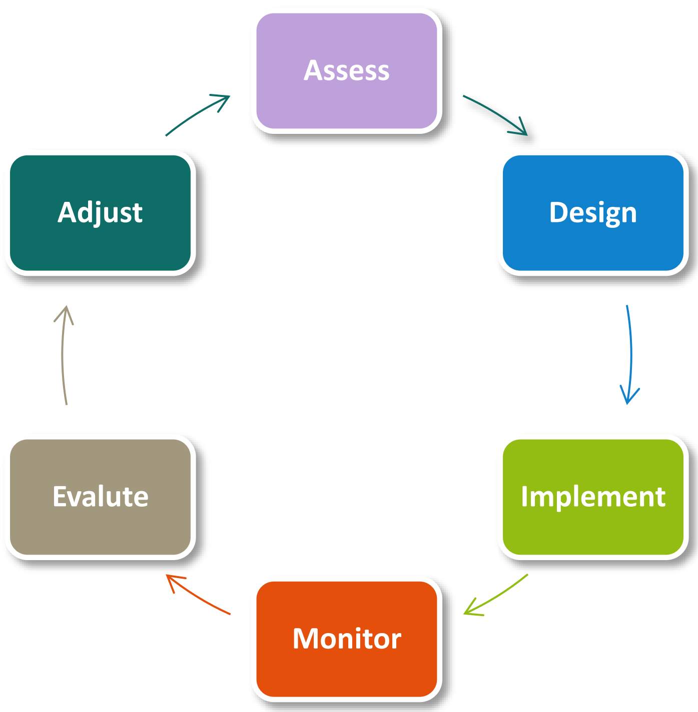

Figure 5-9 Typical Adaptive Management Process

6. Overall Project Scope & Plan

As briefly discussed in **Chapter 4**, this project can be broken down into 5 major areas. A preliminary conceptual design for each project element has been prepared using the best available information. It should be noted that no topographical or geotechnical surveys were conducted as part of the development of these conceptual designs, but best available data (including the latest digital DEM) was used and is adequate to develop realistic and feasible project design concepts. Site-specific ground thruthing and surveys would need to be accomplished during the next project phase. The following subsections present the conceptual designs for each project component and discusses the assumptions and details associated each component. Project components are listed in order from north to south (and upstream to downstream) for reference. See **Figure 4-1** for an overview of all project components.

6.1. Project Area A (North Belle Meade Pump Station and Flow-way Recreational Area)

The first component in Project Area A is a pump station that initiates the flow diversion from the GGC. The pump station, shown in the project conceptual plan set in sheets A-1 – A-3 in **Appendix A**, would be located on the east side of the bend of the GGC located about 5,000 feet east of Collier Blvd and 3,000 feet east of the GG-3 strucure. The pump station would, initially, be equipped with 2 – 50 cfs variable speed electric pumps (100 cfs total) that would pump water from the GGC into a 4,500 foot channel flow-way that would convey flows to the south. Each pump would draw water from the GGC (when stages in the canal allowed, per system pumping protocol) through an intake pipe that would discharge south to a 60-foot armorred section at the north end of the channel flow-way. Pumps would be remotely operated either by telemetry or user operations. The pump station would be accessed by a constructed access road that runs north from White Lake Blvd. and be equipped with fence protection and stabilized areas for parking and station access.

The pump station would also be designed to easily expand to a 200 cfs facility by installing pipe, conduits and pump housing infrastructure during the original construction. As discussed eariler in the report (**Chapter 3**) initial evaluations indicate pumping (diverting) 100 cfs from the GGC south towards Rookery Bay is optimal and conservative based on preliminary analysis. It should be noted that, additoinal flow diversions may be allowable in the future depending on hydrologic system response and results of future monitoring. Designing the pump station for possible future expansion would be financially judicious and additional costs would be relatively minimal compared to the overall cost of the project and much less expensive than expanding the existing facility later without the existing infrastructure.

The second component in Project Area A is a 4,500 foot long channel flow-way that would start just south of the pump station, and continue southward to White Lake Blvd. Both the pump station and the channel flow-way would be constructed in a 230 foot wide section on the western side of the County-owned parcel fronting White Lake Blvd. The channel would convey the diverted flows from the pump station south to the I-75 canal system. The channel would be armorred with fabric formed concrete rip rap on the very north end where the pump outfall pipes discharge to prevent erosion. The channel would be designed as a dry channel with the bottom elevation at approximately ground level (9.5 ft - 12.0’ ft NAVD88). The flow-way would have a 100 foot top width at typical water surface when pumping and a 62 foot bottom width. Typical water surface elevations when pumping would be about elevation 13.5 ft. NAVD88. The channel flow-way would have 6:1 sideslopes and a top-of-bank at elevation of 15.0 ft. NAVD88. The channel flow-way would contain a series of created wetalnd islands planted with Cypress trees and other wetland plantings that can become habitat for local wildlife. **The flow-way design will also function as a linear pond, and combined with the wetland planted islands will provide significant water quality benefits to the diverted flows, with expected nutrient removals of 29 and 62 percent for nitrogen and phosphorus, respectively**. The flow-way parcel would also be designed with a 10 foot wide multi-use path that would circumvent the entire channel flow-way and be a recreational park amentity. Other park features would be added including parking, shelter and additional landscape features. The flow-way channel will discharge through an outfall structure into a small ditch before crossing under White Lake Blvd. and discharing into the north I-75 canal.

6.2. Project Area B (I-75 Canals Improvements)

Once the flows from the North Belle Meade Flow-way discharge under White Lake Blvd., the water will enter the I-75 canal system. This component consists of the imperovements required along the I-75 canal system (see sheet B-1 in **Appendix A**). The segment of I-75 between north and south Belle Meade and west of the Miller canal has two large canals on either side. The north canal is approximatly 80 feet wide and is contiguous through this section of the highway. The south canal is approximately 50 feet wide but is not completely contiguous. Currently there are seven 5-ft x 10-ft concrete box cross culverts that connect these two segments of ditch from north to south. The four western-most culverts will be utilized as part of this project concept. Once the diverted flows enter the north I-75 canal the water would be free to flow west to Henderson Creek or east to the Miller canal. Because additional flows are prohibited from entering the Miller canal (as it discharges to the PSRP area, described in **Section 5.3**) and not desired to pass through Henderson Creek the north I-75 canal with be equipped with operable control structures at both ends of the canal. The west I-75 canal structure will be located just west of the North Belle Meade Flow-way outfall and the east control structure wil be located about 18,000 feet east of the North Belle Meade Flow-way location. The structures would be open during normal conditions, but would close during periods of pumping diversions. The east control structure could possibly be designed as an earthern weir (ditch block) but more pumping scenario modeling would need to be accomplished to determine if this is viable. Approximately 2,000 linear feet of canal would need to be cleared of excessive vegetation/silt at six locations and two canal ditch blocks must be removed to have contiguous canal segments and to optimize flow capacity within both the north and south canals.

6.3. Project Area C (South Belle Meade Pump Station, Flow-way and Spreader)

The next component in the overall project is a second pump station that would continue the flow diversion from the south I-75 canal. This pump station, shown sheets C-1 & C-2 in Appendix A, would be located just south of the I-75 corridor about 2.5 miles east of the intersection of Benfield Rd and Beck Blvd. The exact location of the pump station would be determined in the future, but would be located east of the north/south PSSF trail that dead end's at I-75 .The pump station would also, initially, be equipped with 2 – 50 cfs variable speed electric pumps (100 cfs total) that would pump water from the I-75 south canal into a 4,000 foot dry channel flow-way that would convey flows south to a spreader swale system. Each pump would draw water from the I-75 south canal (when diverted flows from the North Belle Meade system entere the north canal) through an intake pipe that would discharge south. Pumps would be remotely operated either by telemetry or user operations. The pump staion would be accessed either by a constructed, stabilized access road that would run along the south bank of the I-75 south canal starting at Beck Road or from I-75, and be equipped with fence protection and stabilized areas for parking and station access. Similar to the North Belle Meade Pump Station, it would also be designed to easily expand to a 200 cfs facility by installing pipe and pump housing infrastructure during the original construction phase.

A wide and shallow dry channel flow-way would receive flows from the pump station and convey them south to a 1,600 foot spreader swale. The channel flow-way would be armorred with fabric formed concrete rip rap for the first 60 feet to prevent erosion during times of pump discharges.The ditch would be nearly flat with less than a 0.001 ft/ft slope, so flow velocities would be very low. The ditch would be designed as a dry ditch which would minimize excavation but, because it is dry, would need to be maintained several times a year to prevent excessive vegetation from growing and reducing conveyance capacity. The channel would be about 4,000 feet long, have a bottom width of 100 feet (at roughly elevation 10.0 ft NAVD88) and be 3 feet deep with 4:1 sideslopes. The maintence berms would be 15 feet in width on either side for a total corridor width of about 175 feet.

The spreader swale portion of this component would be located at the end of the ditch just north of the subtle drop off in elevation to the south where the large areas of cypress are located. The swale would be approximately 1,600 feet in length and have a 50 foot wide bottom width. The spreader swale would be equipped with six 100-foot spreader concrete weirs at elevation 10.5 ft NAVD88 that would convey flows to the receiving wetlands. The spreader system would also have four 12-inch bleeder pipes that would bleed the system dry during times of no pumping. This would allow the system to dry out for maintenance activities.

The designed ditch and spreader swale system would easily convey the 100 cfs flows diverted from the GGC. As in the North Belle Meade Flow-way, the system would be designed to handle 200 cfs in the event future analysis and evaluations from monitoring determine additional flow diversions could be handled by the downstream receiving waters (south Belle Meade wetlands and Rookery Bay). Again, designing and constructing the system for expanded capacity now would be much more cost efficient than enlarging the system in the future.

6.4. Project Area D (Sabal Palm Road Culvert Crossings)

This component consists of constructing four (4) additional double 48" siphon culvert cross culverts under Sabal Palm Road that would be required to convey the increased flow from the spreader swale system (see sheet D-1 in **Appendix A**). Recently, Collier County construcuted four (4) double 48" siphon culvert cross drains under Sabal Palm Road to help restore flow through this corridor that the existing road had restricted. This component would simply mimic these structures.

6.5. Project Area E (Six L's/U.S. 41 Flow-ways and Conveyance Improvements)

The next series of project components combine to convey diverted flows through the Six L's agricultural area, US 41 and the Fiddler's Creek residential area to convey the flows to their ultimate destination of Rookery Bay (see sheet E-1 in **Appendix A**). This flow-ways concept that would be created through the Six L's agricultural area would be a slightly modified version of the South Central Belle Meade flow-ways concept identified and idealized in the BMSMMP. **Figure 6-1** shows the general flow-ways concept from the BMSMMP as developed in 2006. Several things have changed since the South Central Belle Meade flow-ways as conceptualized in the BMSMMP. The most notable concern that has impacted the CCCWIP updated design concept is the implementation of the PSRP. The PSRP, as permitted, has set strict requirements concerning additional flows entering the project area (refer to **Section 5.3** for more details about the project). Due to the PSRP, the CCCWIP flow-ways concept for this area has eliminated the eastern-most flow-way (D) from the BMSMMP concept. **Figures 5-5 – 5-7**, in the previous section, shows the proximity of this flow-way to the PSRP project area. It is essential that diverted flows avoid the PSRP area, and keeping the flow-way entries into the Six L's properties away from the PSRP helps to prevent CCCWIP flows from entering the PSRP area. Furthermore, the CCCWIP project, as conceptualized herein, is currently estimating 50 cfs of flows to convey, whereas the BMSMMP concept was designed for 200 cfs, so flow-way D conveyance in not necessary.

Sluice gate control structures would be installed at the northernmost end of the Six L's area at the inflow points of the flow-ways to control the flows into the area. The flow-ways, as conceptualized in this report, would utilize (to the extent possible) the existing canals and canal berms that currently exist along the flow-way corridors. The existing berms are typically 20 – 25 feet across and are drivable which would allow access for maintenance and construction activities. The existing berms would require inspection, and geotechnical surveys would need to be conducted to confirm their stability for use. The rim ditches around the farming cells would not be utilized and are assumed to be filled in, if/when those areas are developed in the future. In several cases, there are parallel canals that could be utilized. Multiple large culverts would be installed between them along their parallel path to equalize the flows, utilizing both as one conveyance. Installing culverts (instead of just creating berm openings) would preserve access along the berms. In some cases berms would be degraded to allow flow into adjacent wetlands, and in other cases, berms or levels would need to be constructed (or rehabilitated) to contain and direct the flows to the designed outfall locations. Additional control structure weirs would be installed at specific locations along the flow-ways to maintain groundwater elevations as they southward, and to maintain preserved wetland water surface elevations. Two outfall locations have been identified for conveyance into the large canal on the north side of US 41.

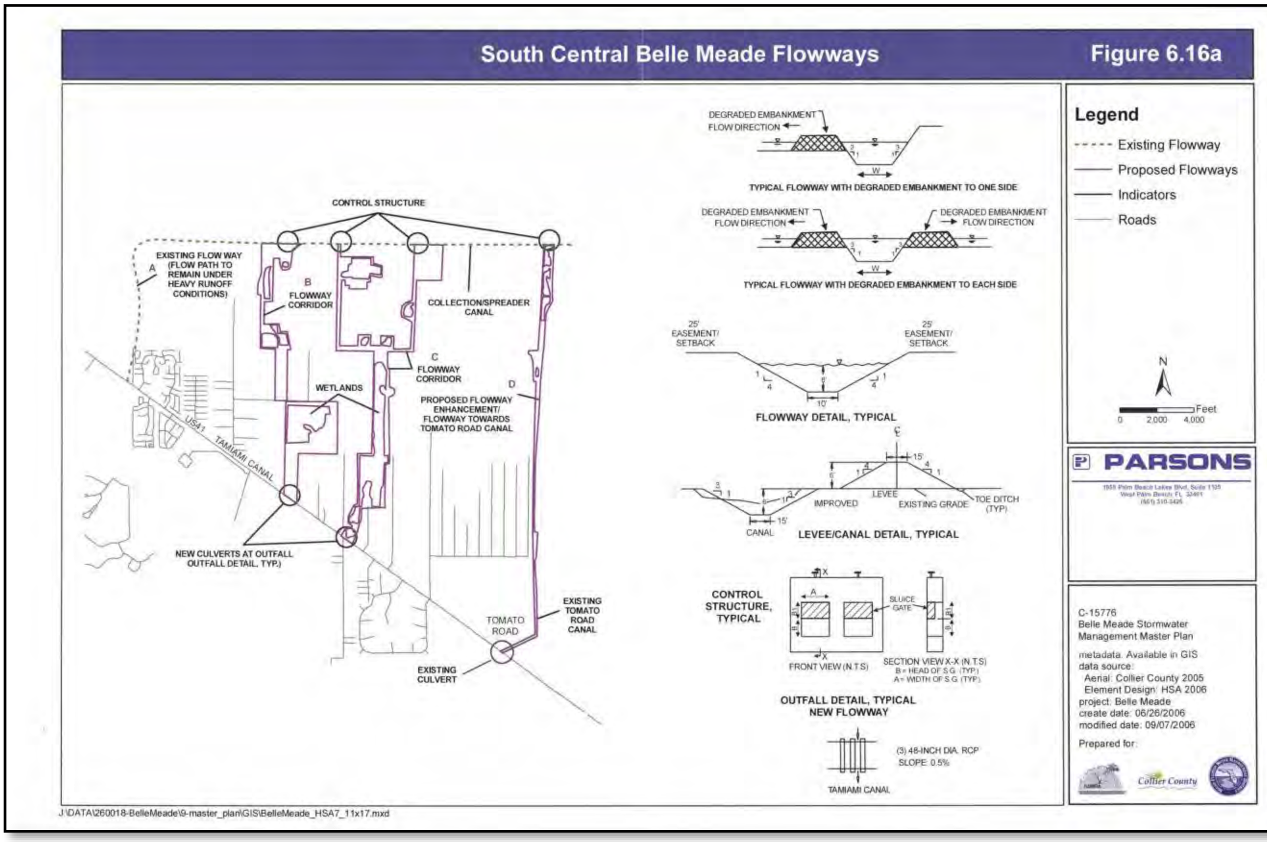

Figure 6-1 Conceptual Six L's Area Flow-ways Design from the BMSMMP (Figure from the BMSMMP Report, Parsons, 2006)

When the diverted flows leave the Six L's area, they will enter the north roadside canal of US 41. This canal extends the length US 41 across the entire project area. The canal is essentially flat and is contiguous allowing flows entering it to make their way to one of the many cross drains along these segment. Although the canal is sizeable, about 30 feet wide, in some cases the canal is fairly shallow and there are several locations along the roadside canal that have excessive vegeation. These locations would need to be cleared to allow flows entering the canal to be evenly distributed along the road and utilize all of the cross drains under US 41. Additional cross drains will be incorporated into the design of the Greenway Rd/Six L's Farm Rd segment and additional culverts will be jack and bored under the Collier Blvd/Greenway Rd segment just west of Greenway Rd.

To assist in enhancing flows discharging to Rookery Bay, a water quality treatment area would constructed on the (triangle-shaped) parcel, located north of US 41 at Manatee Blvd., and just west of Naples Reserve Blvd (see sheet E-1 in **Appendix A**). The parcel is publically-owned and was identified in the CCWMP as a prime location for water quality treatment. For this element, flows would be pumped from the US 41 canal north to north-eastern most corner of the property. These flows would be pumped to a sediment forebay where they would settle and then discharge to the south by shallow sheetflow before discharging back into the US 41 canal and then flowing south to the Fiddler's Creek area outfall systems to Rookery Bay.

Once flows pass under US 41, they will have multiple routes to take to make it to before making it to Rookery Bay. The majority of the flows will pass through the Fiddlers Creek outfall system which currently has two inflow locations (and will have a third added via jack and bore described above). A small amount of flows could also currently make it to the Henderson Creek system to the north or can go south to the agricultural area on the southern side of US 41 and near Auto Ranch Rd. A new flow-way will be added just west of Auto Ranch Rd to convey the flows from the added culverts under US 41 in this area. The existing, and sizable, Fiddler's

Creek conveyance system combined with the new flow-way will have the capacity to convey the additional 50 cfs.

When flows get through the development, a portion of the water must circumvent an old railroad embankment which runs east/west, just south of the Fiddler’s Creek area. Several openigs will be created along the railroad grade to allow water to flow more freely and south to Rookery Bay. Conveyance improvements (construction of a new culvert crossing) will also be constructed along Collier Blvd (CR 951) just north of Marco Shores Country Club to permit water to flow freely to the west and allow better assimilation of fresh and saltwaters.

7. Project Benefits

7.1. Naples Bay

As discussed in **Chapters 1 & 2**, the water quality in Naples Bay, specifically in terms of salinity, has been drastically impacted within the last 50 years, particularly from the construction of the canal system. The impacts of not only the magnitude of freshwater surplus, but also the extreme freshwater "shock loads" to the bay during the wet season, have been long documented. The benefit to Naples Bay by diverting flows south during the wet season is not necessarily as large as previously conceived studies believed, but the overall enormity of the project and magnitude of freshwater that can be diverted are still significant enhancements to the Naples Bay estuary. The following subsections describe those benefits and document the methodology used to determine them.

7.1.1. Data Sources Used

The benefits of the proposed hydrologic restoration project are described below in terms of the expectations of benefits in terms of eutrophication and moderation of altered historical salinity regimes. The data set used to calculate these benefits was derived from a combination of sources:

1) flow data from the SFWMD,
2) salinity data from the City of Naples,
3) water quality data from the GGC system, and
4) empirically-derived equations relating salinity at various locations in Naples Bay to freshwater inflows from the GGC Canal system, as contained within the *Naples Bay Water Quality and Biological Analysis Project* (Cardno, 2015).

Hydrologic and water quality data were both downloaded from DBHYDRO, the public website maintained by SFWMD for the dissemination of hydrologic and water quality data. The website may be found at this address: http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.main_menu.

For the purposes of this effort, flow data were evaluated over the time period of January 1, 2011 to September 9, 2015. Water quality data from the station titled "Golden Gate Canal at White" was used to characterize the nutrient concentrations relevant for project implementation. This location is the most relevant long-term water quality sampling site in the GGC system, based on potential freshwater diversion locations outlined in the BMSMMP and the CCWMP.

Previously derived flow vs. salinity relationships at four long-term water quality sampling location in Naples Bay were used, as shown in Cardno (2015). The equations used varied between locations, but all four equations represent statistically significant relationships between inflows into Naples Bay at the GG1 structure vs. salinity, described below in more detail.

7.1.2. Methodology

Flow data from the GGC at the G1 structure represents the farthest downstream measurement of freshwater inflows into Naples Bay. Farther upstream, gate level data from the structures at GG2 and GG3 were used to determine the dates during which freshwater could be diverted out of the GGC system, and into the Rookery Bay watershed. Both the GG2 and GG3 structures are Obermeyer Weirs (overflow structures) that operate automatically to maintain upstream water levels. Since the gate crest is lowered to increase flow, the data was carefully reviewed to identify a minimum gate level that ensures excess flow over the weir. After consultation with staff at the BCB office of the SFWMD, it was agreed that the 85th percentile gate level value of 6.5 ft. NGVD29 would be used to identify days when excess flow was available upstream of the GG3 structure. If the measured gate level was greater than 6.5 ft. NGVD29, then the diversion pump could not be operated. **Figure 7-1** shows the locations of the GGC structures relative to Naples Bay and the local watersheds.

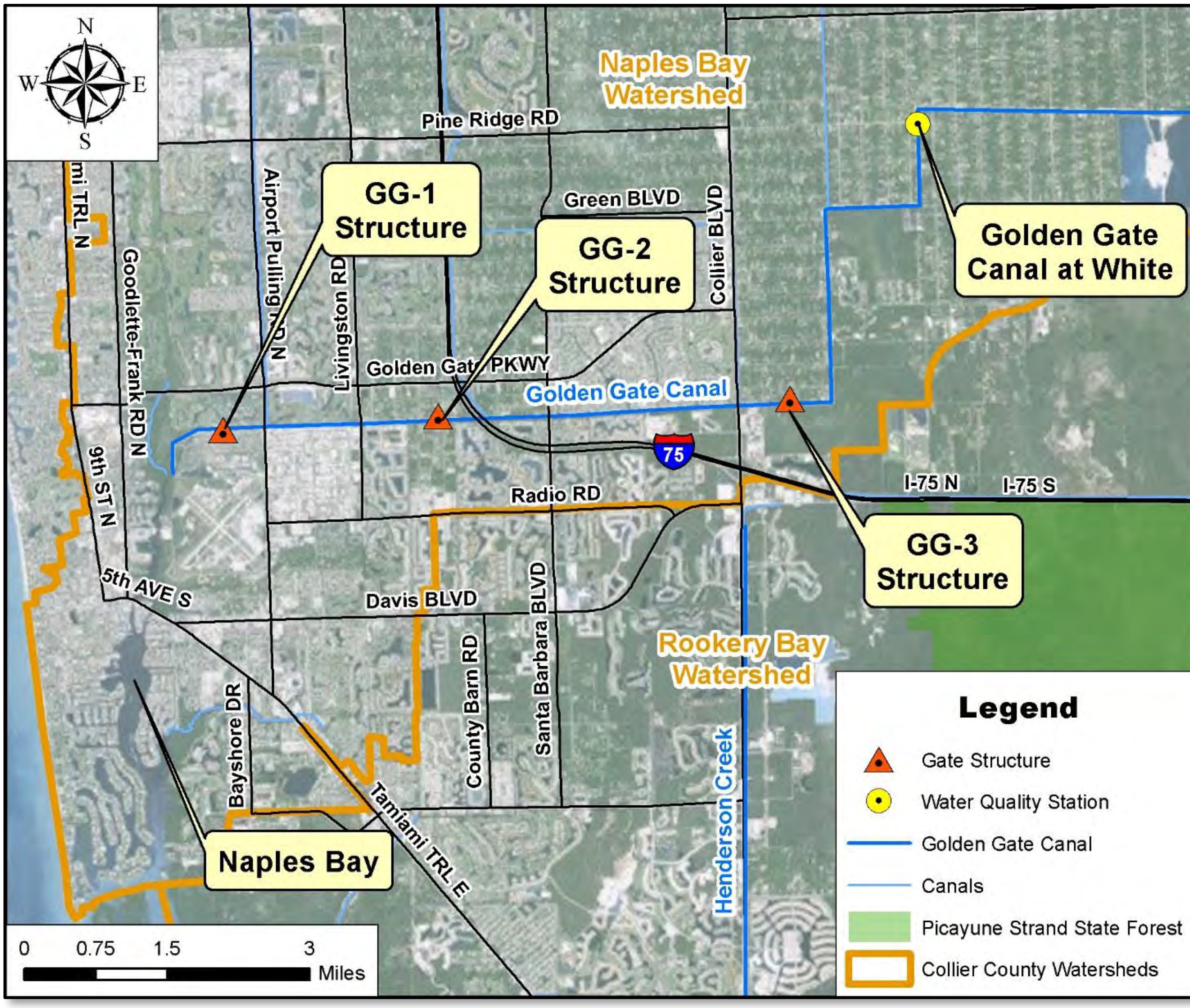

Figure 7-1 Golden Gate Canal Structures and Gages

According to the latest modeling efforts for the Rookery Bay watershed (Whalen-Statler, updated Rookery Bay presentation), the coastal waters of Rookery Bay have a freshwater inflow deficit of approximately 50 cfs when comparing historical to existing conditions. Based on model runs using an integrated surface water/groundwater model (MIKE SHE/MIKE 11) that was recently calibrated for the BCB, it was estimated that approximately 50 percent of wet weather flows added to the upper reaches of the Rookery Bay watershed would eventually reach the coast. The remaining 50 percent of additional wet weather flows would not make it to the tidal waters of Rookery Bay, as they would end up being “lost” to the atmosphere via evapotranspiration, or they would end up restoring some of the lost historical wet weather storage capacity in this altered landscape. Consequently, on those days where water could be available for diversions out of the GGC (without interfering with consumptive water use via private and public water supplies), a maximum of 100 cfs would be diverted from the GGC system so as not to exceed the 50 cfs wet weather inflow deficit for Rookery Bay.

To determine the nutrient reduction benefits to Naples Bay, water quality data from the GGC at White station were analysed (see **Figure 7-1**). Consistent with the Numeric Nutrient Concentration (NNC) criteria for Naples Bay (FAC Chapter 620-302.531), nutrients were characterized for both Total Nitrogen (TN) and Total Phosphorous (TP). To estimate the concentrations of nitrogen and phosphorous in runoff from the Rookery Bay watershed, nutrient concentrations in Rookery Bay (WBID 3278U) were compared for conditions when concurrent values for specific conductance were lower than the highest specific conductance value from the GGC at the White water quality station. In this way, nutrient concentrations for the freshwater inflow from the existing Rookery Bay watershed were compared to the nutrient concentrations in the waters of the GGC system closest to the location of proposed diversions.

To develop estimates of the benefits of reduced freshwater inflows to Naples Bay, salinity values were derived for all days during the period of January 1, 2011 to September 9, 2015, based on the salinity vs. flow equations listed in Cardno (2015).

For the Gordon River at Rowing Club location, the relationship between inflows and salinity is represented by:

> *Salinity (ppt) = 22.4241*EXP(-0.007*Q); where Q = daily average flow (cubic feet per second; cfs) at the GG1 structure on the same day that salinity was measured.*

For the Naples Bay at City Dock location, the relationship between inflows and salinity is represented by:

> *Salinity (ppt) = =31.269*EXP(-0.003*Q) where Q = daily average flow (cfs) at the GG1 structure on the same day that salinity was measured.*

For the Naples Bay at Mid Estuary location, the relationship between inflows and salinity is represented by:

> *Salinity (ppt) = 34.359*EXP(-0.0023*Q) where Q = daily average flow (cfs) at the GG1 structure on the same day that salinity was measured.*

For the Naples Bay at Gordon Pass location, the relationship between inflows and salinity is represented by:

> *Salinity (ppt) = =34.641*EXP(-0.0004*Q) where Q = daily average flow (cfs) at the GG1 structure on the same day that salinity was measured.*

7.1.3. Results

Flow Reductions

To determine the amount of freshwater inflow that could be diverted from Naples Bay, consultations with staff at hydrologists at the BCB office of the SFWMD were made to ensure concurrence with all estimates, and the best available data to derive estimates. Based on these discussions, it was concluded that:

1) the most recent (as of January 2016) and revised flow data from site GG1 would be used as the baseline
2) the data to be used would be for the dates of January 1, 2009 up to September 16, 2014,
3) diversions would only occur on days when the measured gate levels at the GG2 or GG3 structures were below the defined elevation, indicating that excess flows were available,
4) flow diversions would be restricted to the “wet season” which was defined as the period of May 15 to October 31 of each year,
5) the list of days when diversions could be made would be dependent on meeting agreed-upon criteria to protect upstream water users, and
6) a flow diversion of 100 cfs at GG1 would equal the flow diversion benefit applied to Naples Bay.

Flow data were found to be problematic for the year 2011, as there was no flow data for the period of March 20, 2011 until August 2, 2011, a period of 137 days. As such, discussions with SFWMD staff led to the decision to exclude data from 2011 from further calculations. Also, although data from 2014 did not include the entire wet season, it included a substantial amount of the 2014 wet season, and as such it was concluded that the values from 2014 should also be used in further calculations.

The data used to estimate flow reductions with anticipated operation of the proposed freshwater diversion are shown below in **Table 7-1**.

Table 7-1 Flow diversions expected with anticipated diversion schedule in operation

Flow Reduction							
Year	Total Diversion Days	Percent of Flow Diverted when Operating (%)	Percent of Flow Diverted During the Wet season (%)	Percent of Flow Diverted for the Year (%)	Total Volume Diverted		
					Million Gallons	Acre-feet	Liters
2009	27	25.95	13.62	10.42	1,745	5,354	6,604,538,908
2010	40	20.54	7.87	5.83	2,585	7,932	9,784,502,086
2012	18	18.96	6.64	5.39	1,163	3,570	4,403,025,939
2013	90	12.64	10.45	10.10	5,816	17,848	22,015,129,693
2014*	33	15.83	8.72	8.72	2,132	6,544	8,072,214,221
Average	**41.6**	**18.78**	**9.46**	**8.09**	**2,688**	**8,250**	**10,175,882,169**

*The year 2014 data only went through September – not the entire calendar year

On average, the proposed project would operate 42 days per year. On those days when operating, it would divert approximately 19 percent of flows to Naples Bay (18.78%). The amount diverted would equal about 9.5 percent of the wet season inflows to Naples Bay, and 8 percent of the total inflow each year. The amount of water diverted from Naples Bay would average 2,688 million gallons per year (2.7 billion gallons per year), which is equivalent to 8,250 acre-feet per year, or just over 10 billion liters per year.

Nutrient Loads

Table 7-2 compares the data sets for water quality representing freshwater inflows into Rookery Bay with water quality in the GGC system.

Table 7-2 Summary of water quality data from Rookery Bay freshwater inflow and the GGC at White water quality station

Location	Specific conductance (μmhos/cm)			Total Phosphorous (mg/l)			Total Nitrogen (mg/l)		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Rookery Bay freshwater inflow	NA	620	253	0.002	0.181	0.008	0.09	1.34	0.56
Golden Gate Canal	NA	650	509	0.004	0.079	0.021	0.33	2.00	0.91

Water within the GGC system appears to have approximately twice the mineral content of typical watershed-level freshwater runoff into Rookery Bay, based on mean (average) specific conductance values of 509 and 253 μmhos/cm, respectively. However, maximum specific conductance values were similar, and maximum values from both data sets are well below the maximum allowable value for specific conductance, 1,275 μmhos/cm, for drinking water supplies in Florida (water quality standards for Class I waters; FAC 62-302).

For phosphorous, the mean value for TP in the Golden Gate Canal was 2.6 times as high as the mean value derived for runoff into Rookery Bay, at 0.021 and 0.008 mg TP / liter, respectively. For nitrogen, the mean value for TN in the Golden Gate Canal was 1.6 times higher than the mean value derived for runoff into Rookery Bay, at 0.91 and 0.56 mg TN / liter, respectively.

To calculate the estimated benefit to Naples Bay, in terms of nutrient reduction, the diverted flow volumes described above were combined with the average TN and TP estimates from the GGC at White station. Load reductions for both TN and TP were summed for each of the years of 2011, 2012, 2013, and 2014. Data from 2015 were not used, as the data set for 2015 ended in the middle of the typical wet season.

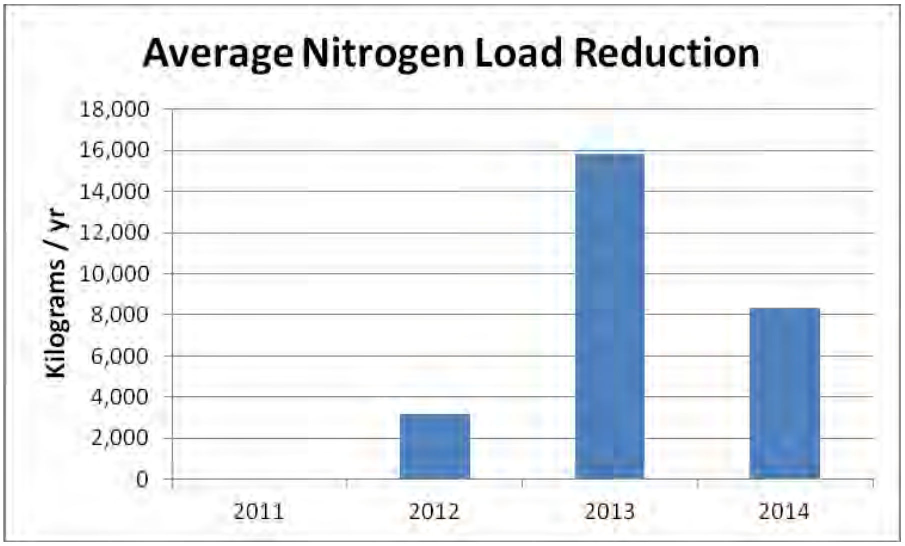

Figure 7-2 Estimated nitrogen load reduction (kg TN / yr) into Naples Bay associated with implementation of the proposed project

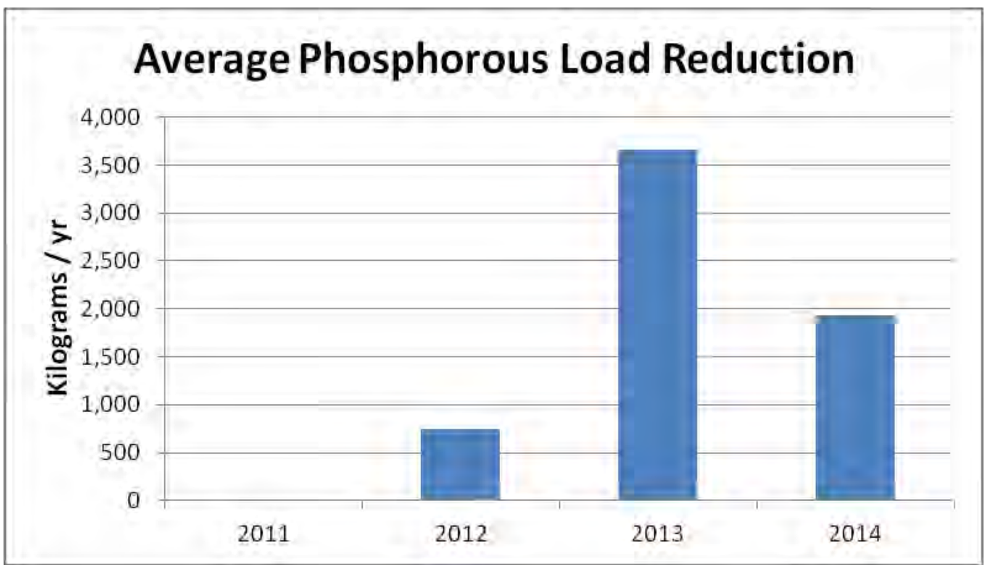

Figure 7-3 Estimated nitrogen load reduction (kg TP / yr) into Naples Bay associated with implementation of the proposed project

As shown in both **Figures 7-1 and 7-2**, no reductions in nitrogen or phosphorous loads to Naples Bay would have been expected in 2011, as a reduced amount of rainfall and lower than normal water levels in the GGC system would have precluded the diversion of water out of the GGC system at the GG3 structure. In 2012 and 2014, there was sufficient availability of water in the GGC system for substantial diversions, and thus nutrient load reductions in the range of 3,200 to 8,300 kg TN and 740 to 1,910 kg TP would occur. In the very wet year of 2013, nutrient load reductions of 15,800 kg TN and 3,700 kg TP would have been possible.

The SFWMD has previously summarized nutrient load reductions for various stormwater retrofit projects in terms of equivalent amounts of nutrients in bags of residential lawn fertilizer. Assuming a 20 pound bag of fertilizer with 32 percent nitrogen content, each bag contains approximately 6.4 pounds (2.9 kg) of nitrogen. In 2013, as an example, the proposed project would reduce nutrient loads to Naples Bay equivalent to the amount of nitrogen in more than 5,000 20-pound bags of lawn fertilizer. As many lawn fertilizers no longer contain phosphorous, a similar comparison cannot be made, although the magnitude of the nutrient load reduction to Naples Bay for phosphorous would be similarly impressive.

The nitrogen and phosphorous load reductions achievable with project implementation would be consistent with the desire of the City of Naples to continue to implement water quality improvement projects focusing on eutrophication, and to assist the City of Naples in their efforts to prevent Naples Bay from exceeding its newly established (as of 2013) numeric nutrient concentration criteria (NNC) for Naples Bay (FAC Chapter 62-302.531). The implementation of nutrient load reductions to Naples Bay is consistent with a recent report on the status and trends of water quality in Naples Bay (Cardno 2015) as well as the Surface Water Improvement and Management (SWIM) Plan for Naples Bay (SFWMD 2007).

For Rookery Bay, the proposed project is expected to have little impact, in terms of nutrient loads to coastal waters, as 50 percent of the diverted flows are not expected to reach tidal waters of Rookery Bay, and the proposed project involves the diversion of water into a vast area where it would flow overland for a considerable distance prior to encountering tidal waters. However, waters in the GGC system (**Table 7-1**) have a higher nutrient concentration than typical values for freshwater inflow into Rookery Bay. If those nutrient concentrations would not be altered during their passage from the GGC system to Rookery Bay, then the change in nutrient load would be similar to the expected change in the hydrologic load. However, prior experience in hydrologic restoration projects suggest that significant amounts of nutrient uptake and assimilation would be expected as water flows through wetland flow paths.

Quantification of expected nutrient reduction associated with the proposed freshwater diversion project was conducted using a two-step process. First, the amount of nutrient reduction associated with the Northern Flow-way (located north of I-75; see **Figure 4-1 and Appendix A**) was derived based on the size of the Northern Flowway and the previously derived relationship between nutrient removal efficiency (for both TN and TP) compared to area-normalized nutrient loads (grams / m^2 / yr). The equation used for nitrogen removal was derived from over a dozen studies, and is summarized from Richardson and Nichols (1985) as:

$$Y = -14.479 * LN(X) + 107.71$$

Where:

Y = expected nutrient removal efficiency for Total Nitrogen (TN),

14.479 = derived value from the empirical relationship,

LN = natural log,

X = area-normalized nitrogen load, in units of grams TN per square meter per year, and

107.71 = derived value from the empirical relationship.

The equation used for phosphorous removal, also from Richardson and Nichols (1985) was:

$$Y = -15.507*LN(X) + 87.399$$

Where:

Y = expected nutrient removal efficiency for Total Phosphorous (TP),

-15.507 = derived value from the empirical relationship,

LN = natural log,

X = area-normalized nitrogen load, in units of grams TP per square meter per year, and

87.399 = derived value from the empirical relationship.

These expected reductions in TN and TP concentrations were applied only to the Northern Flow-way, which is that portion of the project located north of I-75. Based on these equations, TN and TP loads would be expected to decrease by 29 and 62 percent, respectively, as diverted waters pass through the Northern Flow-way. The output from the Northern Flow-way would then become input to the rest of the project area.

To estimate additional nutrient reductions associated with the sheetflow of diverted waters across the landscape, results from Rudnick et al. (1999) were used. These authors studied water quality along a transect in the eastern Everglades, where the flow path was less than the anticipated length for those project elements located south of the Northern Flow-way. Based on Rudnick et al. (1999), it is anticipated that TN and TP loads would be further reduced by approximately 89 and 77 percent, respectively.

Combined, the passage of diverted waters into the Northern Flow-way followed by sheetflow across the remainder of the project's foot print would be expected to reduce nutrient loads by 89 and 77 percent, respectively, for TN and TP. This would likely result in reductions in nutrient concentrations of runoff into Rookery Bay and its watershed similar to that which occurs from the wider watershed. Thus, a nutrient load reduction of “X” pounds from Naples Bay does not result in an increased load to Rookery Bay of “X” pounds, as nutrient concentrations would decline based on uptake, assimilation, and (for nitrogen) denitrification as diverted volumes sheetflow across the project's landscape.

A freshwater diversion from the GGC system into Belle Meade thus has benefits of allowing for hydrologic restoration of these currently impacted wetlands without the concurrent likelihood of nutrient over-enrichment. This benefit may not arise should a diversion take place with waters added to Henderson Creek, which resembles a drainage canal in its northernmost portions.

Salinity

Based on the approach described above, differences in salinity were calculated by comparing the predicted salinity on days when diversions could occur to the same day salinities predicted without the flow reductions implemented.

At the Gordon River at Rowing Club location, the differences in salinities expected with project implementation are summarized in **Table 7-3**.

Table 7-3 Predicted salinities at Gordon River at Rowing Club during days when diversions would occur

During operation		
	Salinity (ppt) w/out project	Salinity (ppt) w/ project
min	0.01	0.02
max	8.92	15.62
mean	1.09	1.90
median	0.73	1.28

At the Naples Bay at City Dock location, the differences in salinities expected with project implementation are summarized in **Table 7-4**.

Table 7-4 Predicted salinities at Naples Bay at City Dock during days when diversions would occur

During operation		
	Salinity (ppt) w/out project	Salinity (ppt) w/ project
min	1.10	1.40
max	21.07	26.78
mean	7.44	9.46
median	7.17	9.11

At the Naples Bay at Mid Estuary location, the differences in salinities expected with project implementation are summarized in **Table 7-5**.

Table 7-5 Predicted salinities at Naples Bay at Mid Estuary during days when diversions would occur

During operation		
	Salinity (ppt) w/out project	Salinity (ppt) w/ project
min	2.65	3.18
max	25.38	30.51
mean	11.18	13.44
median	11.11	13.35

At the Naples Bay at Gordon Pass location, the differences in salinities expected with project implementation are summarized in **Table 7-6**.

Table 7-6 Predicted salinities at Naples Bay at Gordon Pass during days when diversions would occur

During operation		
	Salinity (ppt) w/out project	**Salinity (ppt) w/ project**
min	22.18	22.90
max	32.86	33.93
mean	28.16	29.07
median	28.46	29.39

On average, mean salinities at the Gordon River at Rowing Club location would increase 74 percent, from 1.09 to 1.90 ppt with the proposed project. However, there is little evidence that the absolute change in salinity (0.81 ppt) would have a meaningful impact on the biological communities in that portion of Naples Bay.

Although the percentage difference in mean predicted salinities at the Naples Bay at City Dock would differ by less than at the Gordon River at Rowing Club location (27 percent vs. 74 percent), the absolute difference in salinity (2.02 ppt) is potentially large enough to be detected, although ecological benefits might be expected only for the most stenohaline organisms that might occur or re-establish themselves in the uppermost portions of Naples Bay.

The percentage difference in mean predicted salinities at the Naples Bay at Mid Estuary location would be expected to differ by 20 percent with project implementation. The absolute difference in salinity (2.26 ppt) is likely large enough to be detected, with potential benefits to at least the more stenohaline organisms that might occur or re-establish themselves in this lower part of Naples Bay.

For those portions of Naples Bay from the City Dock location down to the Mid Estuary location, the predicted change in salinity during times of operation of the proposed project would average about 2 ppt. While this does not appear to be a very large change in salinity, similar changes in salinity were found to be sufficient to influence the ratio between stenohaline vs. euryhaline species of crabs, as shown in Figure 10 of Shirley et al. (2004). In that paper, the authors found that salinity changes less than 4 ppt were sufficient to bring about a change in the ratio between a stenohaline species of crab, Panopeus herbstii, and a more euryhaline species of crab, Eurypanopeus depressus (Shirley et al. 2004). For at least that portion of Naples Bay between the City Dock and Mid Estuary water quality stations, it is likely that the proposed project could bring about a change in salinity large enough to detect with a well-designed water quality monitoring program. In addition, the proposed project could potentially bring about a detectable change in the biological health of Naples Bay. The detection of an ecological benefit associated with project implementation would be dependent upon the development of a monitoring program that focuses on organisms particularly sensitive to salinity variation (e.g., Shirley et al. 2004).

In contrast, the differences in salinity predicted for the Naples Bay at Gordon Pass location are likely statistical noise, and also not likely to be large enough to have any ecological benefits.

7.2. Picayune Strand State Forest

7.2.1. Wetland Rehydration

As discussed in the previous section, the CCCWIP project proposed to divert 100 cfs, when flows are available, during the wet season months. These flows represent (at least a portion of) the flows that historically made its way to the PSSF prior to the construction of the GGC and I-75. As discussed in **Section 5.2,** and shown in **Figure 5-3** and **Table 5-1**, the vegetation in the PSSF has transformed over the past 50 years due to these hydrologic alterations (and others) causing impacts to all wetland land covers and particularly to the Swamp Forest areas. Hydroperiods and water depths in this area have changed significantly and there is general consensus that the Belle Meade area of the PSSF is in need of rehydration. With the implementation of the CCCWIP, at least a portion of the historical flows would be restored within the region helping to re-establish historical wetland hydroperiods to at least some degree. Although a true restoration would likely include more than 100 cfs of additional wet season flow diversions, it has been shown that the limitations of the system that are now in place (RCW habitat, PSRP and Rookery Bay) and discussed previously in **Chapters 3 and 5,** currently prevent more than that (100 cfs) based on the conservative and preliminary analyses conducted as part of this project.

7.2.2. Wildfire Suppression and Prevention

The Florida Forest Service (FFS) has over 1,000 employees and their mission is to protect and manage Florida's forest resources to be sure these valuable resources are available for future generations. Two key aspects of their efforts are fire prevention and suppression which help protect nearby homeowners from forest fires. The PSSF is no exception. The PSSF has had its share of wildfires during times of unusually dry weather during the past. The implementation of the CCCWIP project provides the infrastructure that can also become a tool to help reduce and/or control wildfires. Because the project uses pump stations to transfer and direct flow south directly through the middle of the Belle Meade tract of the PSSF, if water is needed at a given time to prevent the spread of wildfires, the pumps could potentially be turned on for just that purpose.

7.3. Rookery Bay

The project benefits to Rookery Bay are touched on briefly in **Chapter 3 (Evaluation of Diverted Flow Capacity)**. In that section of the report, the most recent studies that have been completed for the Rookery Bay are discussed, in terms of historical flows to the estuary relative to current conditions. Although there are minor inconsistencies with the studies, the majority of analyses (studies), including the most detailed and most recent (Restoring the Rookery Bay Estuary), conclude that Rookery Bay has a freshwater wet season inflow deficit. Furthermore, the study also indicates the specific locations of the flow deficits (as can be seen in **Table 3-1** and **Figure 3-4**), which is generally the southeastern-most area of the Rookery Bay estuary (Belle Meade-9, US 41 Outfall Swale 2 and Bridge 37). When comparing the areas within the Rookery Bay estuary that have flow deficits, to the location(s) of the diverted flows to the estuary from the CCCWIP project (**Figure 4-1**), it can be seen that these areas correspond, indicating the diverted flows are going to the areas that need water. Not only do diverted inflow locations correspond to the locations of inflow deficits, but diverted flow volumes (approximately 50 cfs from the preliminary modeling estimates) are also consistent with the documented inflow deficit volumes in corresponding areas of Rookery Bay (**Section 3.5**).

7.4. Secondary CCCWIP Project Benefits

The CCCWIP project provides a substantial hydrologic and ecologic uplift to a significantly large region within Collier County. The sub-sections above describe the primary benefits to the region which include the hydrologic and ecologic benefits. There are also secondary benefits to CCCWIP flow diversion. By sending additional water and restoring the wet season flows to a more historical regime, the project is also recharging the aquifer which, in turn, helps to protect the water supply for Collier County as this is the County's primary means of drinking water.

8. Future Phase Projects (Phase II)

The suite of projects described in detail in **Chapter 6,** together form the CCCWIP and make significant County-wide hydrologic and ecologic enhancements to Naples Bay, Rookery Bay and the PSSF. These are the projects that are feasible to construct within the next ten years. However, there are additional project components that have been identified that could increase the system capacity and enhance and expand the overall effects overall of the system. **Figure 8-1** shows the locations of these potential future phase projects relative to the primary system elements. These are additional projects that, given further analysis and years of monitoring data, could be integrated into the overall system. Details of these possible future phase projects are discussed below.

8.1. Increased Pumping Capacity

The current conceptual design discussed in **Chapter 6** includes pump stations that would convey 100 cfs, but the earthen infrastructure elements (Project Areas A & C) will be designed to accommodate 200 cfs in the primary phase of the project. Once constrcuted and operational, the system will be monitored to determine the potential for diverting as much as 200 cfs at given times. Currently the system limitations are the amount of additional flow that Rookery Bay could accommodate and the changes in wetland vegetation within the PSSF. If it turns out, through system monitoring, that hydrologic losses (storage, infiltration and evapo-transpiration) in the system are greater than expected, then more water could potentially be diverted from the GGC by adding additional pump stations and would further enhance the benefit to Naples Bay without impacting flow-ways and estuaries downstream.

8.2. North Belle Meade

Just like the south Belle Meade area within the PSSF, the north Belle Meade area has also been impacted by the construction of the GGC. Historically flows from the north flowed through this area to south Belle Meade and on to Rookery Bay. While the implementation of the CCCWIP will significantly benefit Naples Bay, Rookery Bay and south Belle Meade, it will not benefit north Belle Meade, and there will still be a need for wetland rehydration in this area. As mentioned previously (in **Section 4.2.1**), the acquisition (or use) of properties within the north Belle Meade area is not feasible within the County' desired 10-year timeframe for implementing the CCCWIP. However, because the majority of the north Belle Meade area is designated as Sending Lands in the Collier County Growth Management Plan, it is likely that these lands could be acquired in the future as many of the properties will most likely become part of the County's TDR program. As part of the CCCWIP, the County intends on planning beyond the 10-year time frame for this area by focussing on evaluating the properties while also conducting a preliminary engineering project for the North Belle Meade Flow-way based on the concept identified in the BMSMMP and the CCWMP. **Figure 8-2** shows the north Belle Meade Rydration project as conceptualized in the CCWMP. This preliminary evaluation and feasiblilty analysis would include the results of the more in-depth analysis of the overall CCCWIP flow capacity that will be conducted as part of the next phase of the CCCWIP. This will help better define the potential additional capacity of the system based on more thorough and detailed modeling and refined later based on collected monitoring data. Adding this project element to the overall system in the future, would not only rehydrate wetlands in the north Belle Meade areas but would also provide additional water quality benefits to the diverted flows by further reducing nutrient loads.

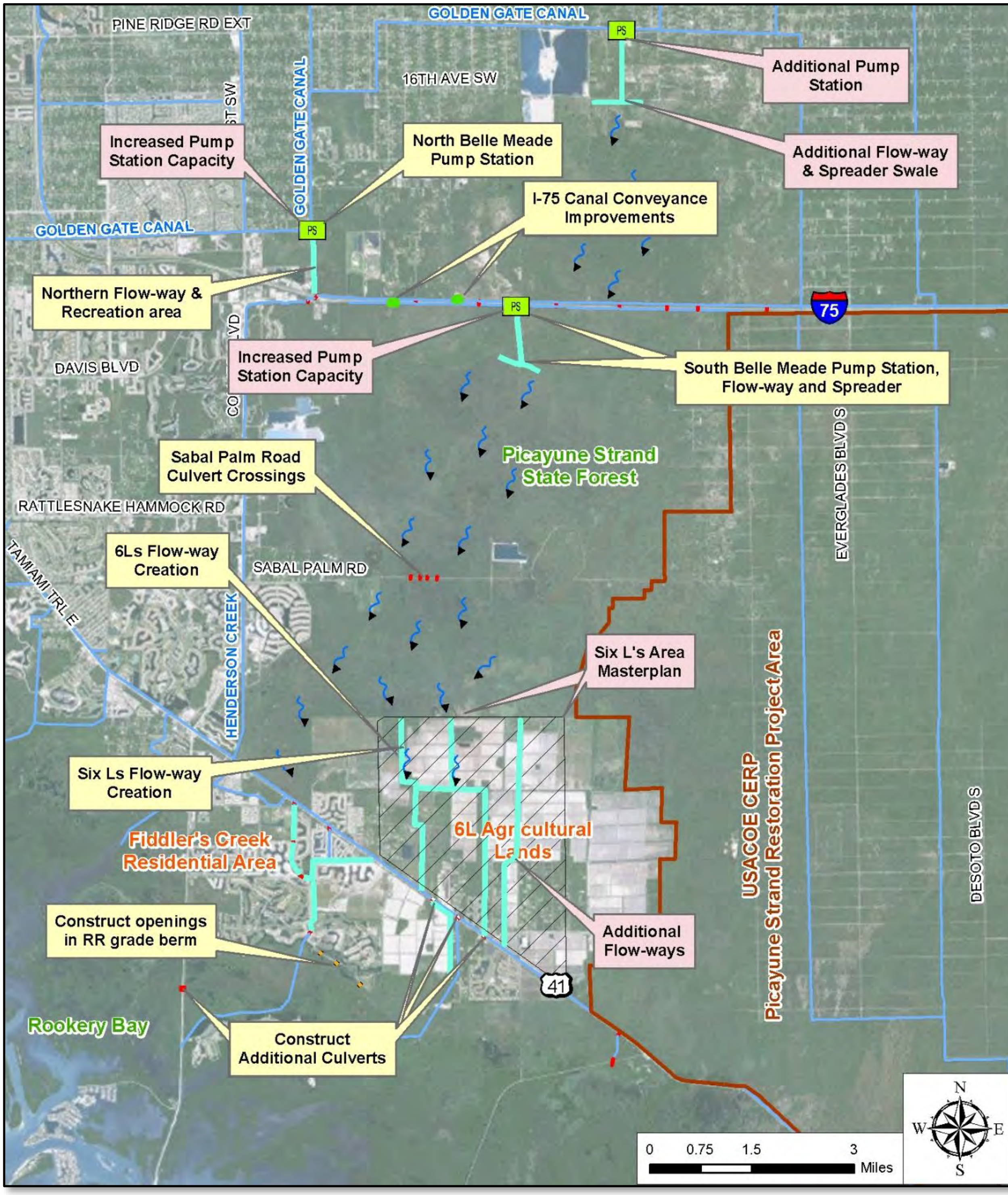

Figure 8-1 Locations of Potential Future Phase Projects

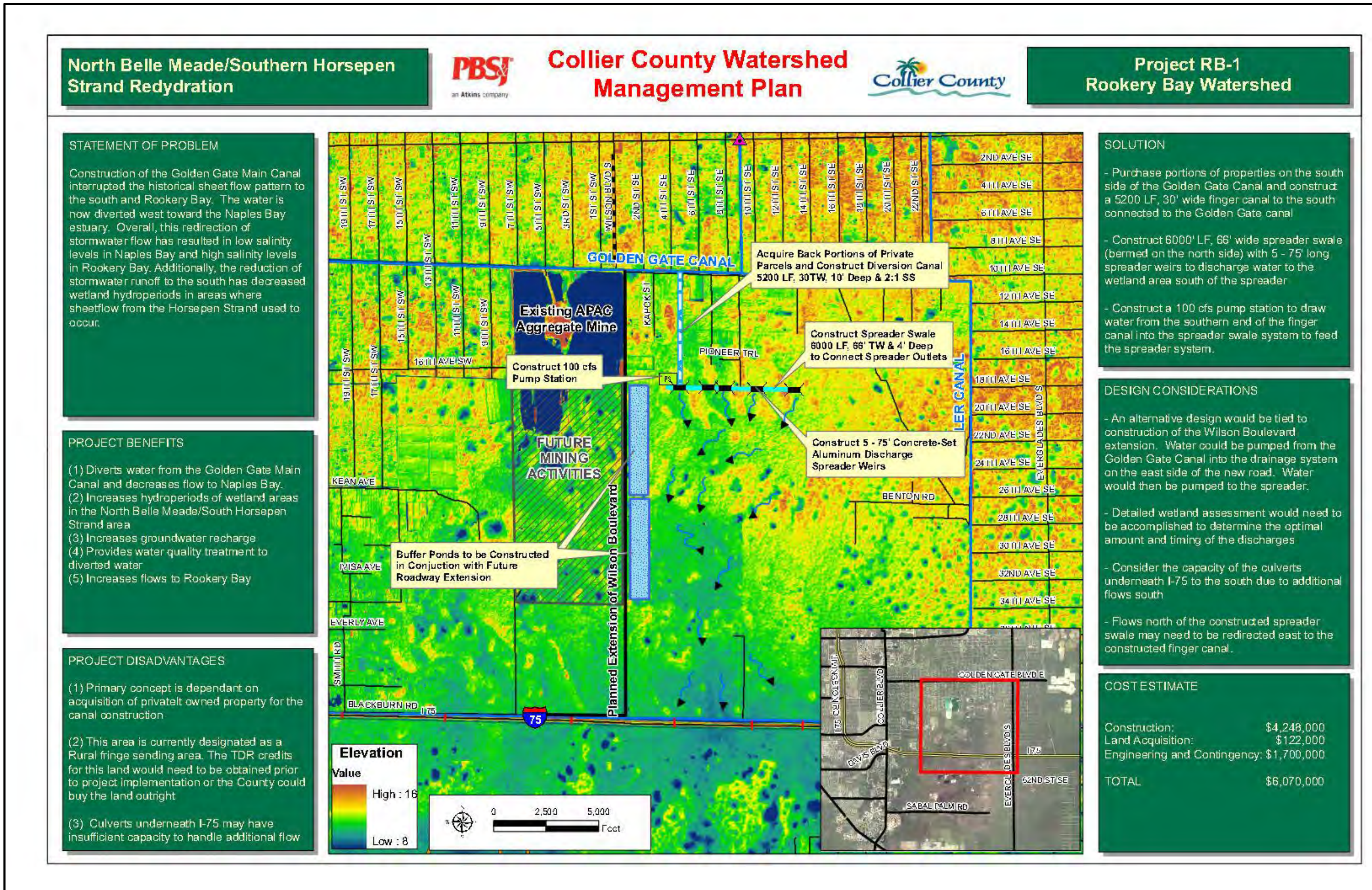

Figure 8-2 North Belle Meade Rehydration Concept from the CCWMP (Figure from CCWMP Report, Atkins/PBS&J, 2011)

8.3. Six L's Masterplan

As discussed in **Section 5.5**, the Six L's agricultural lands area lies in a strategic location, in terms of the historic flow-way for Rookery Bay. As part of the primary phase of the CCCWIP, described in **Chapter 6**, flow-ways would be re-established through the area to the extent possible and coordinated with the current land owners. These flow-ways would likely need to be constructed in coordination with the current agricultural activities (tomato farming) that exist today. If/when the properties transition to residential development in the future, further engineering and design will likely be required to develop a long-term and overall "Masterplan" for the area. This would involve augmenting or expanding the flow-ways constructed during the CCCWIP to incorporate discharges from the new development if and when that transition occurs in the future.

9. Project Costs, Schedule & Implementation

9.1. Planning-Level Opinion of Probable Costs

The preliminary opinion of probable construction costs for the projects described in **Chapter 6** and presented in **Appendix A** is presented in **Table 9-1**. These estimates are based on best available information for quantities and unit prices for the year 2016, and are equivalent to a 15% design. Sources include; current Florida Department of Transportation tabulated costs for item average unit cost, local bid tabs for similar projects in Collier County and throughout SFWMD and SWFWMD. Costs for any property acquisition (if needed) are not included. Costs include 2% for Maintenance of Traffic (MOT), 10% for Mobilization and a 30% contingency.

Additional costs are presented in the overall CCCWIP project cost estimate including, a more detailed project development (5%), design/plans preparations (10%), permitting (5%) and mitigation (5%). An estimated cost is also included for monitoring and SCADA telemetry systems. Considering that this project has a ten-year planning horizon (approximate) for completion of construction, a cost escalation factor of 23% (3% per year compounded over 7 years) has been included. Also included in the overall cost, is funding for other minor project that may be necessary or beneficial to enhance the system and for the future phase projects; North Belle Meade Flow-way and the Six L's Masterplan. **Table 9-1** presents a planning-level opinion of probable costs for the implementation of the CCCWIP.

More detailed breakdown of construction cost estimates are presented in **Appendix B**.

Table 9-1 Planning-Level Opinion of Probable Costs

Project Element	Estimated Cost
Project Area A	$5,1000,000
Project Area B	$1,400,000
Project Area C	$4,620,000
Project Area D	$160,000
Project Area E	$7,610,000
Construction Cost (Areas A-E) Total	$**18,890,000**
Project Development	$950,000
Design/Engineering (10%)	$1,890,000
Permitting (5%)	$950,000
Mitigation (5%)	$950,000
Monitoring and SCADA Telemetry Systems	$1,000,000
Additional Minor Projects	$1,000,000
North Belle Meade Preliminary Engineering	$1,000,000
Six L's Area Future Masterplan	$1,000,000
Cost Escalation over 7 years (3% per year)	$4,350,000
Total	$**32,000,000**

9.2. 10-Year Project Implementation Schedule

Collier County understands that implementing the CCCWIP project will take time and planning but the preliminary work that has been accomplished as part of this report has laid the necessary ground work and provides the foundation for successful project in the future. Considering the magnitude of the project, in terms of engineering, designing, permitting, and the planning and funding strategies that that need to be accomplished, a 10-year project schedule is the goal for project completion. **Table 9-2** below presents the desired overall project schedule for implementation of the CCCWIP.

Table 9-2 Project Implementation Schedule

CCCWIP Project Phase	Year									
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Project Development										
Design										
Construction										
Permitting										

10. Funding Sources and Strategies

10.1. Introduction

This section provides an overview of various funding sources potentially applicable to the Collier County Comprehensive Watershed Management Plan (CCCWMP). In addition, an overall funding strategy for the implementation of the Watershed Management Plan is recommended.

10.2. Deepwater Horizon Oil Spill Funding Sources

While the 2010 Deepwater Horizon oil spill was a disaster for the coastal communities and living resources of the Gulf States, the resulting legal settlements with the responsible parties (Transocean and BP) have created unprecedented funding streams to effect meaningful and sustainable improvements to the ecology and economy of the Florida Gulf coast. These settlements include:

- RESTORE Act funded by Clean Water Act penalties;
- Natural Resource Damages (NRD) funded by Oil Pollution Act penalties;
- National Fish and Wildlife Foundation (NFWF) Gulf Environmental Benefit Fund funded by criminal penalties; and
- State and local economic claims.

10.2.1. Clean Water Act (CWA) and Natural Resource Damages (NRD)

In 2014, Transocean agreed to pay $1 billion to settle pending Clean Water Act penalties. These funds were deposited in the Gulf Coast Restoration Trust Fund, and beginning in 2015, a portion of these funds was subsequently allocated to Gulf Coast counties and parishes under the RESTORE Act Direct Component. Collier County's 2015 allocation under this disbursement was $982,660.

In July 2015, BP announced a tentative comprehensive $20.8 billion settlement with the U.S. Justice Department as well as the five Gulf States that would resolve pending Oil Pollution Act and Clean Water Act penalties as well as state and local economic claims. The final Consent Decree was signed on April 4, 2016, settling all remaining claims. **Table 10-1** below shows the final breakdown of the Transocean and BP legal settlements by the various components for the State of Florida.

Table 10-1 Breakdown of Transocean and BP Legal Settlements for the State of Florida

Component	Dollars
RESTORE Act Direct Component (Pot 1)	$373,000,000
RESTORE Act Spill Impact Component (Pot 3)	$293,000,000
RESTORE Act Centers of Excellence (Pot 5)	$27,000,000
Natural Resource Damages	$680,000,000
Economic Damages	$2,000,000,000
Total	**$3,373,000,000**

It should be noted that, compared to the other four Gulf States, a much greater proportion of the total Florida settlement ($2 billion) is dedicated to economic damages. Nonetheless, the RESTORE Act and NRD components of the Florida settlement earmark approximately $1,373,000,000 for environmental restoration and related monitoring and research. Furthermore, it should be noted that up to 20 percent (approximately $320,000,000) of the RESTORE Act Council Selected Component (Pot 2) could also be spent on Florida projects. Therefore, the final Transocean and BP settlements could generate up to $1,693,000,000 environmental restoration in Florida over the next 15 years.

10.2.2. Gulf Environmental Benefit Fund

The Gulf Environmental Benefit Fund was established in early 2013 as a result of two plea agreements resolving the criminal cases against BP and Transocean after the Deepwater Horizon oil spill. The agreements direct a total of $2.544 billion to NFWF over a five-year period. The funds are to be used to support projects that remedy harm to natural resources (e.g., habitats, species) where there has been injury to, or destruction of, loss of, or loss of use of those resources resulting from the oil spill (http://www.nfwf.org/gulf/Pages/home.aspx). Projects are expected to occur within reasonable proximity to where the impacts occurred, as appropriate. Consistent with the terms of the plea agreements, funding priorities include, but are not limited to, projects that contribute significantly to the following natural resource outcomes:

- Restore and maintain the ecological functions of landscape-scale coastal habitats, including barrier islands, beaches and coastal marshes, and ensure their viability and resilience against existing and future threats;
- Restore and maintain the ecological integrity of priority coastal bays and estuaries; and
- Replenish and protect living resources including oysters, red snapper and other reef fish, Gulf Coast bird populations, sea turtles and marine mammals.

The State of Florida received a $356,000,000 Gulf Environmental Benefit Fund grant from NFWF in 2013 to develop a "Restoration Strategy" and to implement identified priority projects. The Florida Fish & Wildlife Conservation Commission (FWC) is the implementing entity within Florida, and is currently conducting a planning program to identify, evaluate, and prioritize various projects, programs and activities that address NFWF programmatic goals as well as the targeted natural resource outcomes. The Florida "Restoration Strategy" document is expected to be complete in 2017, with project implementation to follow.

10.3. Program Coordination

At this time, multiple planning processes are underway to identify, evaluate, prioritize, and implement projects that address the programmatic goals and criteria of the respective programs. These processes include the following:

- County development and implementation of Multi-Year Implementation Plans (RESTORE Act Direct Component – Pot 1);
- Restoration Council development of the annual Funded Priorities List (RESTORE Act Council Directed Component – Pot 2).
- Gulf Consortium development of the Florida State Expenditure Plan (RESTORE Act Spill Impact Component – Pot 3);
- Florida Institute of Oceanography development of the Gulf Research Plan (RESTORE Act Centers of Excellence – Pot 5); and
- Federal and State (Florida Department of Environmental Protection) trustees implementation of the Florida Natural Resource Damage Assessment (NRDA) and associated restoration and remediation projects.

In addition to these ongoing coastal planning processes, the Florida Gulf Coast Water Management District's and National Estuary Programs have also turned their focus to Gulf restoration, and are exploring ways they can leverage their existing respective funding sources with the Deepwater Horizon related funding streams. For example, both the Northwest Florida Water Management District and the Suwannee River Water Management District will be utilizing grant funds from NFWF to update their Surface Water Improvement and

Management (SWIM) Plans for priority water bodies in their respective districts, and to identify and prioritize projects that contribute to the NFWF mission. In addition, the South Florida Water Management District will be updating the Naples Bay SWIM Plan, and monies from the District Cooperative Funding Program will be available for project funding.

While these coastal planning processes all have their own unique statutory focus, there is the potential for a significant amount of duplication and overlap among them. For example, a living shoreline project that crosses two county boundaries could be identified as a priority project in those county's Multi-Year Implementation Plans, in the Florida State Expenditure Plan, in the Council's Funded Priority List, and in the NRDA trustee's phased program. Including the same or similar projects in multiple coastal restoration plans could potentially lead to confusion and the potential squandering of limited financial resources. Therefore, to ensure the success of the Restoration Strategy project it will be critical to:

- Effectively communicate and coordinate with other ongoing Florida coastal restoration planning processes;
- Minimize the duplication and overlap among these processes; and
- Leverage and optimize the use of all available funding streams to effect meaningful and sustainable improvements to the ecology of the Florida Gulf coast.

If Florida coastal restoration planning efforts are well coordinated, there should be no duplication and overlap of same or similar projects in the various plans. Furthermore, it should be possible to cross-link the most ecologically significant projects in such a way as to optimize available funding sources across project phases. For instance, in the living shoreline project example discussed above, Phase 1 (project engineering design and permitting) could be funded using RESTORE Act Direct Component funds, Phase 2 (construction) could be funded under the State Expenditure Plan, and Phase 3 (success monitoring) could be funded under the Gulf Environmental Benefit Fund. The key point here is that the success of Florida Gulf coast restoration efforts in general will be dependent on the effective coordination amongst and communication between the various ongoing coastal planning efforts, and it will be incumbent upon all recipient governmental units to maintain situational awareness of the status of these efforts in order to optimize their funding opportunities.

10.4. Recommended Funding Strategy

As discussed above, there are many timely opportunities for the funding of the Collier County Comprehensive Watershed Management Plan (CCCWMP). What follows are recommended elements of an overall funding strategy.

1. **Propose the CCCWMP as Collier County's priority project for inclusion in the State Expenditure Plan (SEP).** Collier County is projected to receive approximately $12.7 million under the RESTORE Act Spill Impact Component (Pot 3), all of which could be applied to the CCCWMP. The process for SEP initial project nominations will be conducted during the summer of 2016.

2. **Identify the NRD Water Quality component as a leveraged funding source.** A total of $330 million has been set aside in Florida's NRD Water Quality component, and these funds are eligible for use throughout the entire Florida Gulf coast, not just the panhandle counties. Since the CCCWMP project is clearly water quality focused, there is strong justification for requesting leveraged funds to augment Collier County's Pot 3 allocation for its SEP project.

3. **Continue to coordinate with the FDEP with regard to inclusion of the CCCWMP in the next Funded Priorities List (FPL).** The Restoration Council is expected to open the next FPL window during the fall of 2016, and the FDEP is currently in the process of evaluating and prioritizing projects to be submitted as part of Florida's funding request. It is expected that the next suite of Florida FPL projects will be focused in peninsular Florida to provide geographic balance, so the timing is critical.

4. **Dedicate a portion of Collier County's Direct Component funds to serve as matching funds for CCCWMP implementation.** Project proposals that include matching funds from existing county funding sources are more likely to receive leveraged funds from other non-secured sources, and more likely to be ranked higher for inclusion in future FPLs.

5. **Consult with the FWC with regard to inclusion of the CCCWMP in the Florida Restoration Strategy.** Although Gulf Environmental Benefit Fund monies will be spent primarily in panhandle Florida counties that received direct environmental impacts from the oil spill, a portion of the funds will be dedicated to peninsular Florida to offset impacts to fish, shellfish and other coastal migratory species. The CCCWMP will clearly provide benefits to these wildlife guilds, and thus should be eligible for NFWF funding.

6. **Consult with the South Florida Water Management District with regard to the update of the Naples Bay SWIM Plan.** As required by statute, SWIM Plans must be periodically updated and must identify priority projects. The CCCWMP should be recognized by the District as well as well as other stakeholders such as the Rookery Bay National Estuarine Research Reserve as a high priority restoration project.

Finally, although not related to Florida's Gulf restoration efforts, there have been recent changes in Florida regulatory programs that allow for alternatives to onsite stormwater treatment systems to meet water quality treatment requirements for new development. In 2012, the Florida legislature passed HB 559 which included direction to the water management districts and FDEP to "…allow alternatives to onsite treatment, including, *but not limited to* (emphasis added) regional stormwater treatment systems." Upon the Governor's signature, this provision was enacted into law as Section 373.413(6), Florida Statutes (F.S.). Additionally, Section 5.1 of the Southwest Florida Water Management District (SWFWMD) ERP Basis of Review (BOR) states that "The applicant may also provide reasonable assurance of compliance with state water quality standards by the use of alternative methods that will provide treatment *equivalent* (emphasis added) to systems designed using the criteria specified in this section." Because this provision allows for hydrologic restoration projects to serve as alternatives to typical stormwater treatment, it may be possible for Collier County to obtain mitigation and water quality treatment "credits" for future infrastructure projects through the implementation of the Comprehensive Watershed Management Plan.

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Appendix A. CCCWIP Conceptual Plan Set

CONCEPTUAL PLANS FOR THE

COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

Collier County

GROWTH MANAGEMENT DEPARTMENT
CAPITAL PROJECT PLANNING, IMPACT FEES, AND PROGRAM MANAGEMENT
COLLIER COUNTY, FLORIDA

PROJECT AREA MAP
N.T.S.

BOARD OF COUNTY COMMISSIONERS

DONNA FIALA	DISTRICT NO. 1
GEORGIA A. HILLER, ESQ.	DISTRICT NO. 2
TOM HENNING	DISTRICT NO. 3
PENNY TAYLOR	DISTRICT NO. 4
TIM NANCE	DISTRICT NO. 5

OWNER ADDRESS:

STORMWATER MANAGEMENT SECTION
2685 HORSESHOE DRIVE SOUTH, STE. 103
NAPLES, FL 34104
(239) 252-5342

GARY MCALPIN, P.E.
DIRECTOR OF COASTAL ZONE MANAGEMENT

ATKINS PROJECT No. 100046576
COLLIER COUNTY PROJECT No. 325-51144

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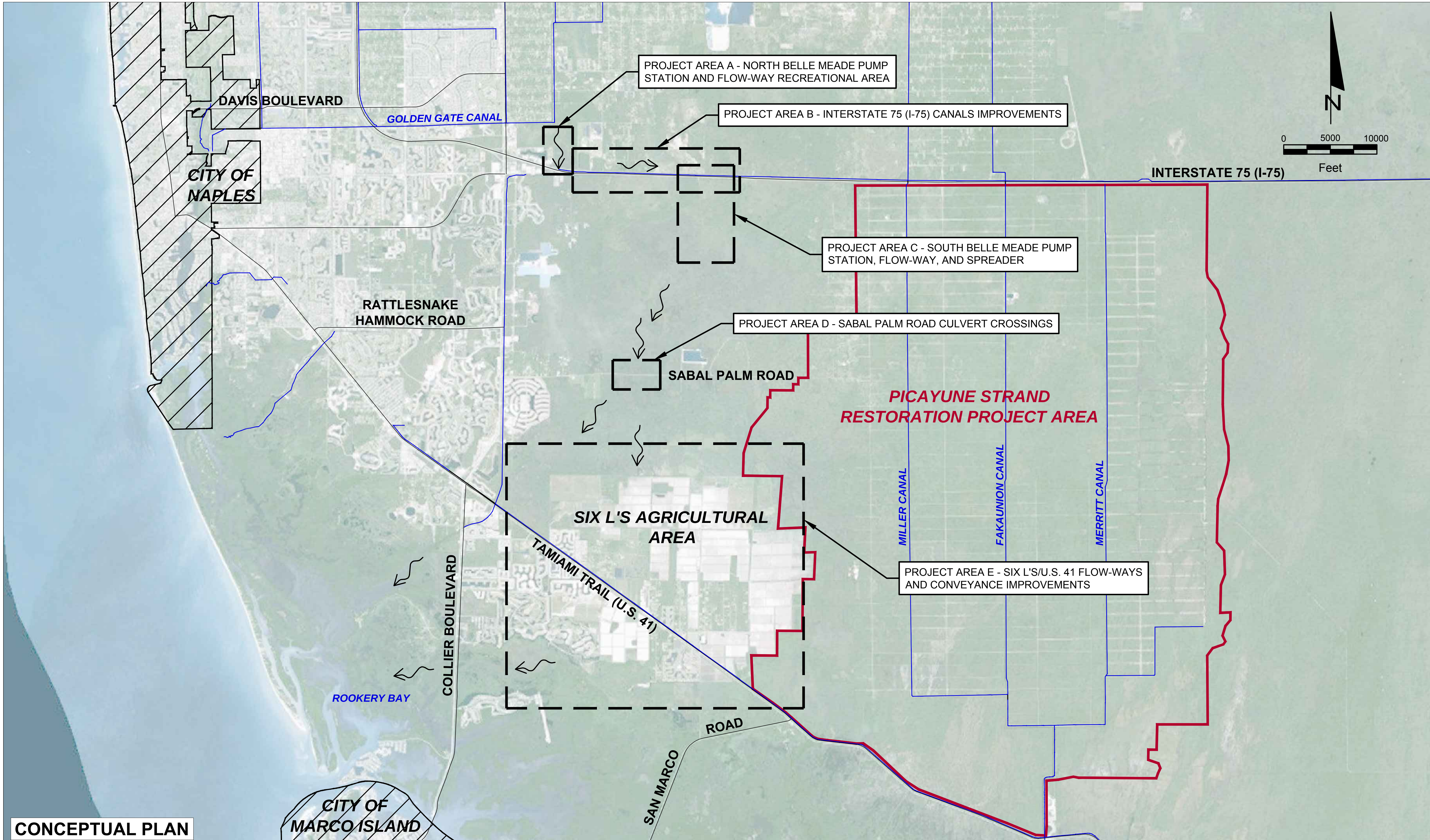
PREPARED BY:

ATKINS
CONSULTING ENGINEER
4030 W. BOY SCOUT BLVD., SUITE 700
TAMPA, FLORIDA 33607
TEL. (813) 282-7275
FAX (813) 282-9767
FBPR CERTIFICATE OF AUTHORIZATION NO. 24

MARK D. ERWIN, P.E.
FLORIDA PROFESSIONAL ENGINEER
NO. 65600

ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN REDUCED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.



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CLIENT: Collier County

PROJECT: COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE: KEY SHEET

ORIGINAL 09/2016
REVISIONS:
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

MARK D. ERWIN
FLORIDA P.E. NO. 65600

JOB NO. 100046576
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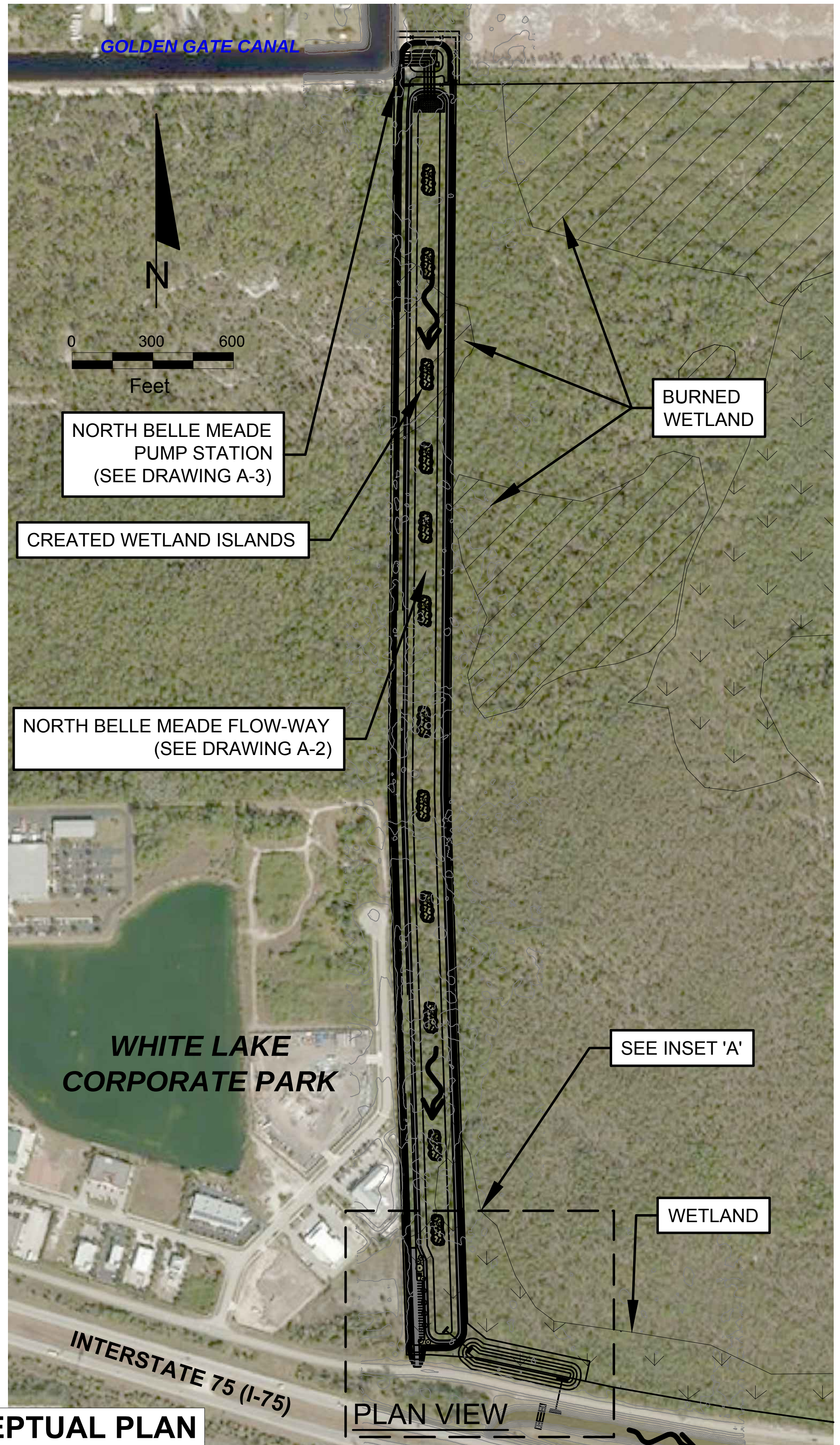
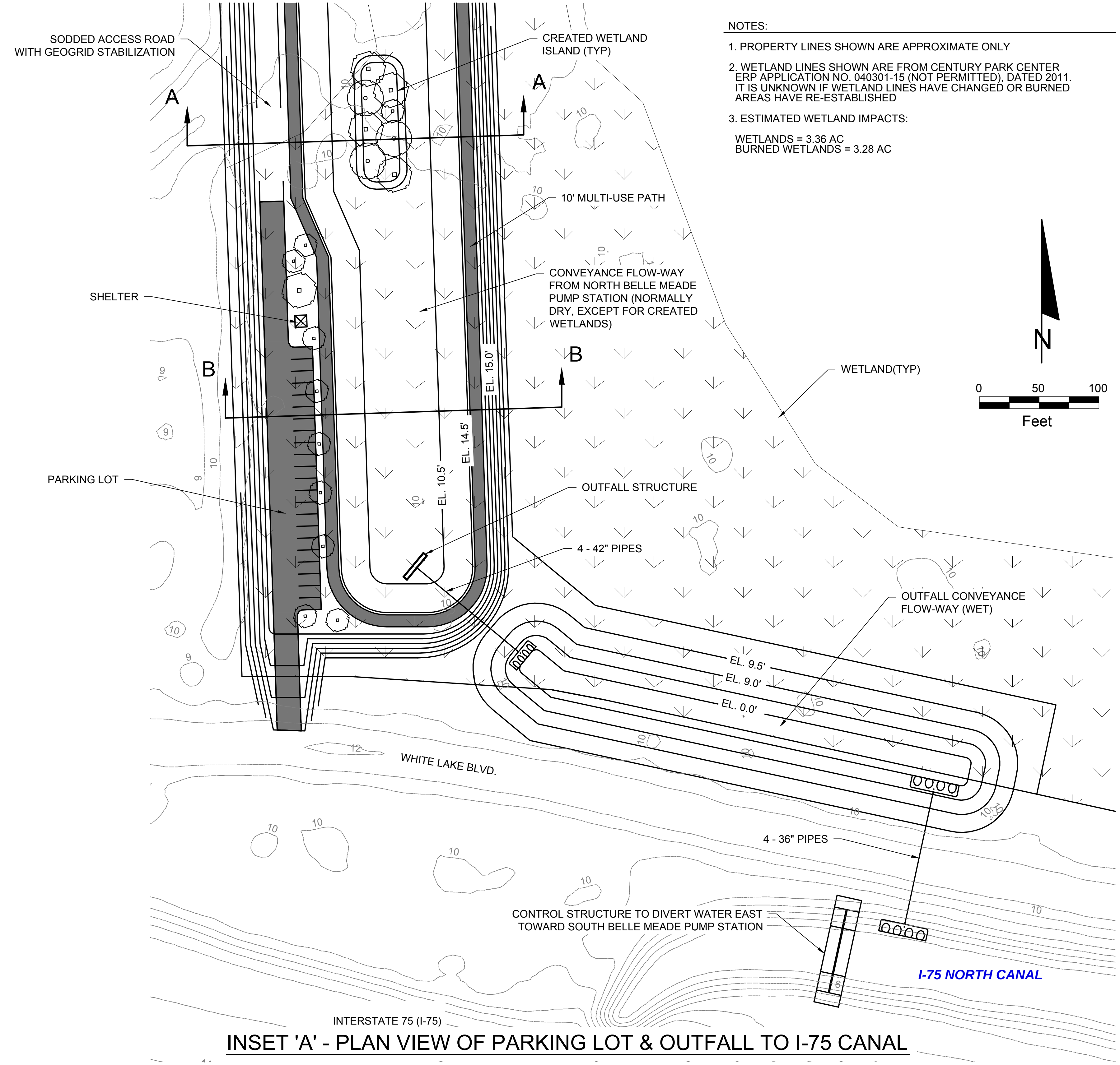


CONCEPTUAL PLAN



NOTES:

1. PROPERTY LINES SHOWN ARE APPROXIMATE ONLY
2. WETLAND LINES SHOWN ARE FROM CENTURY PARK CENTER ERP APPLICATION NO. 040301-15 (NOT PERMITTED), DATED 2011. IT IS UNKNOWN IF WETLAND LINES HAVE CHANGED OR BURNED AREAS HAVE RE-ESTABLISHED
3. ESTIMATED WETLAND IMPACTS:

   WETLANDS = 3.36 AC
   BURNED WETLANDS = 3.28 AC

INSET 'A' - PLAN VIEW OF PARKING LOT & OUTFALL TO I-75 CANAL

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CLIENT: Collier County

PROJECT: COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE: NORTH BELLE MEADE PUMP STATION AND FLOW-WAY RECREATIONAL AREA PLAN

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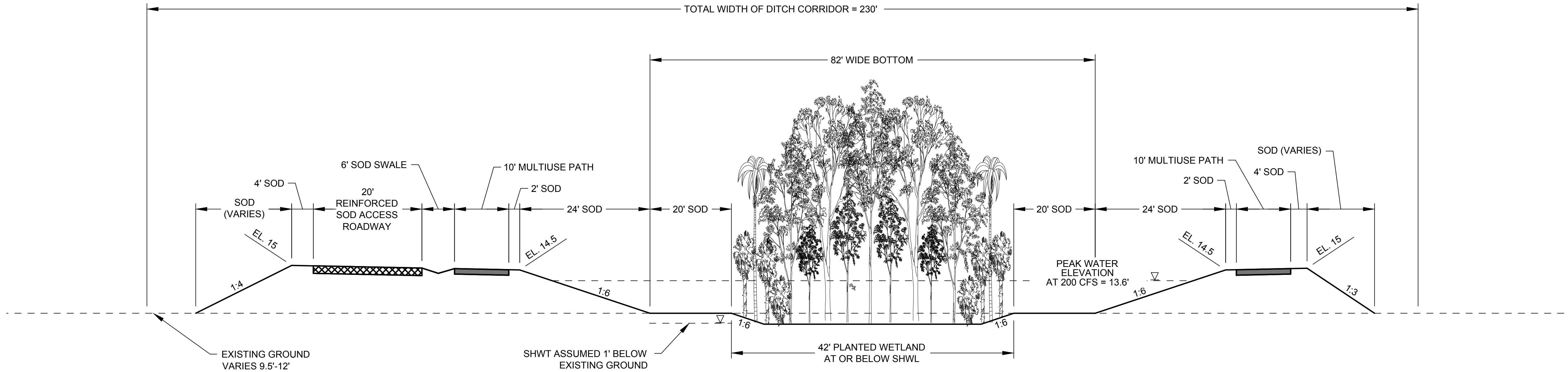

SECTION A-A OF NORTH BELLE MEADE FLOW-WAY

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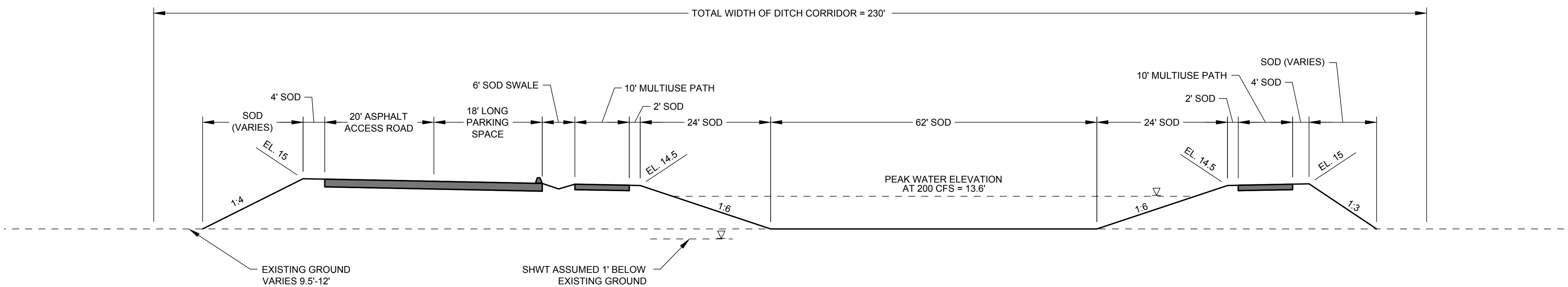

SECTION B-B OF NORTH BELLE MEADE FLOW-WAY

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CONCEPTUAL PLAN

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TITLE: NORTH BELLE MEADE FLOW-WAY RECREATIONAL AREA TYPICAL SECTIONS

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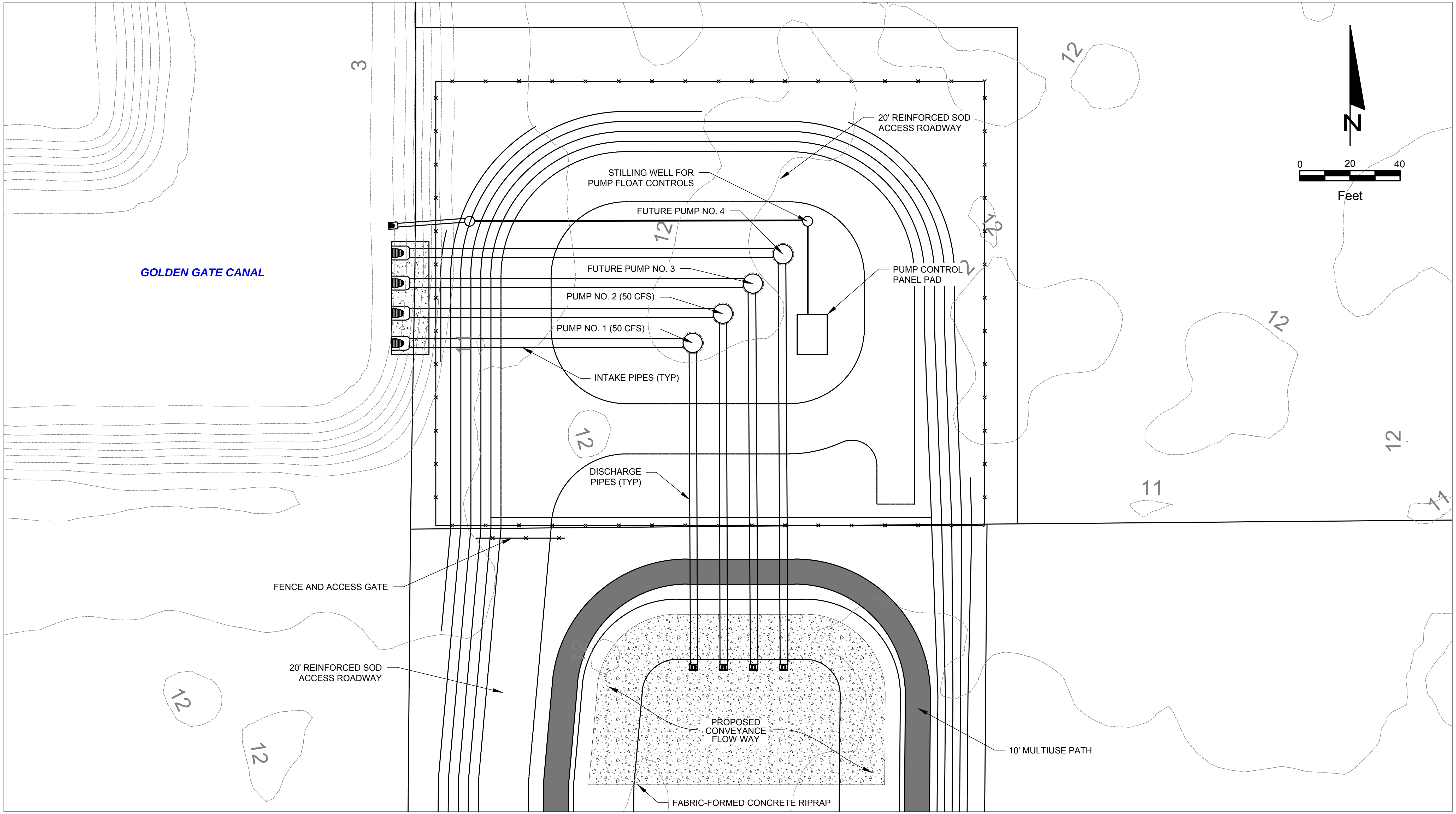

CONCEPTUAL PLAN

ATKINS
4030 W. Boy Scout Blvd., Suite 700
Tampa, Florida 33607
Tel. (813) 282-7275
Fax (813) 282-9767
WWW.ATKINS.COM
FBPE Certificate of Authorization No. 24

CLIENT: Collier County

PROJECT: COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE: NORTH BELLE MEADE PUMP STATION PLAN

ORIGINAL 09/2016
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MARK D. ERWIN
FLORIDA P.E. NO. 65600

JOB NO. 100046576
DRAWN CLT
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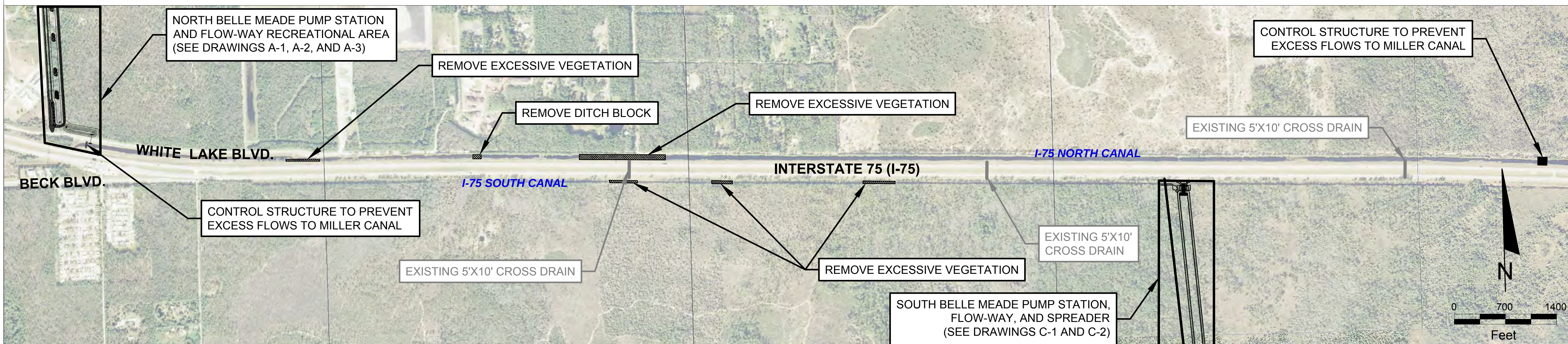

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CLIENT: Collier County

PROJECT: COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE: INTERSTATE 75 (I-75) CANALS IMPROVEMENTS PLAN

ORIGINAL 09/2016
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FLORIDA P.E. NO. 65600

JOB NO. 100046576
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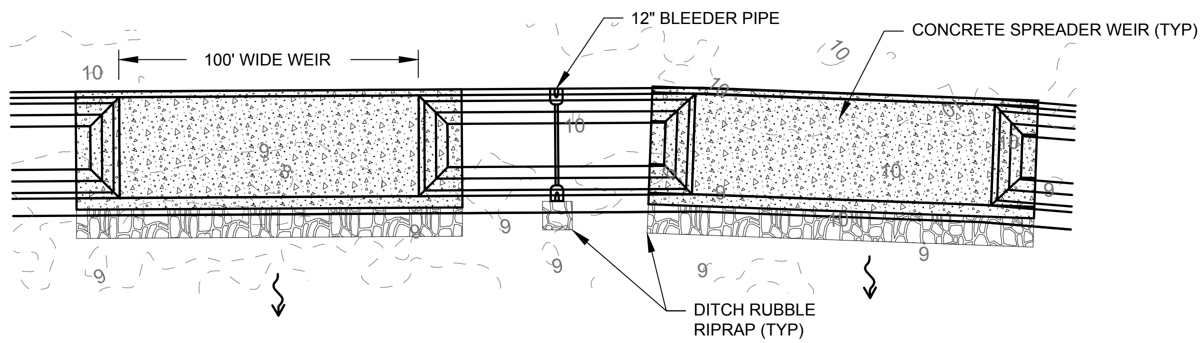

INSET 'A' - PLAN VIEW OF SPREADER SWALE WEIR

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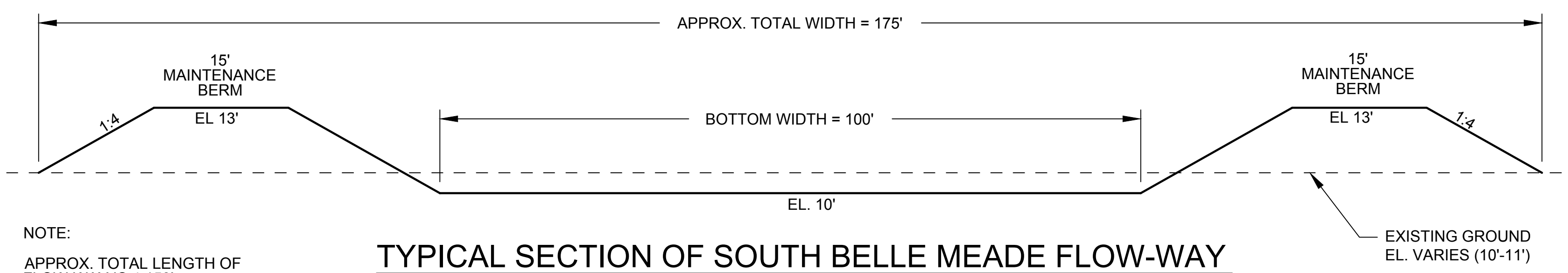

NOTE:

APPROX. TOTAL LENGTH OF FLOW-WAY IS 4,150'

TYPICAL SECTION OF SOUTH BELLE MEADE FLOW-WAY

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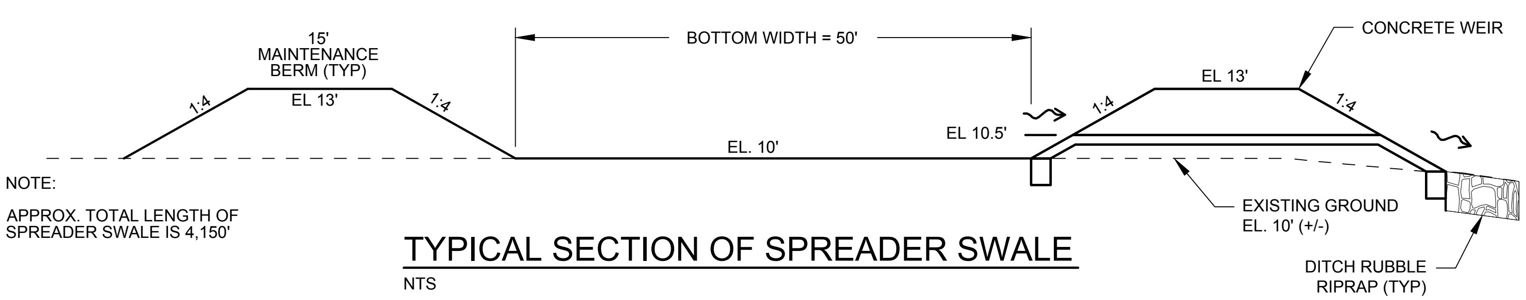

NOTE:

APPROX. TOTAL LENGTH OF SPREADER SWALE IS 4,150'

TYPICAL SECTION OF SPREADER SWALE

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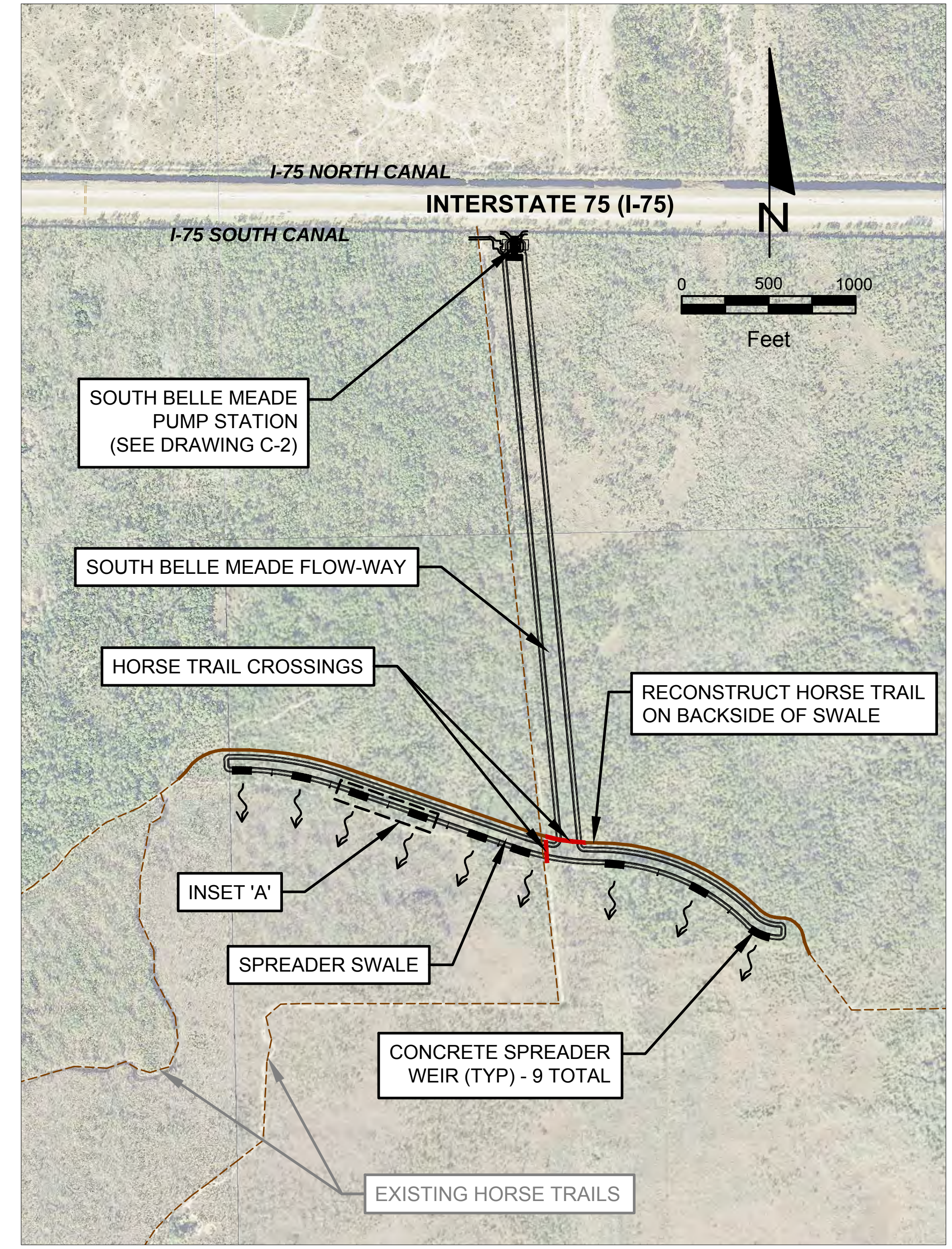

PLAN VIEW

CONCEPTUAL PLAN

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CLIENT: Collier County

PROJECT: COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE: SOUTH BELLE MEADE FLOW-WAY AND SPREADER PLAN AND TYPICAL SECTIONS

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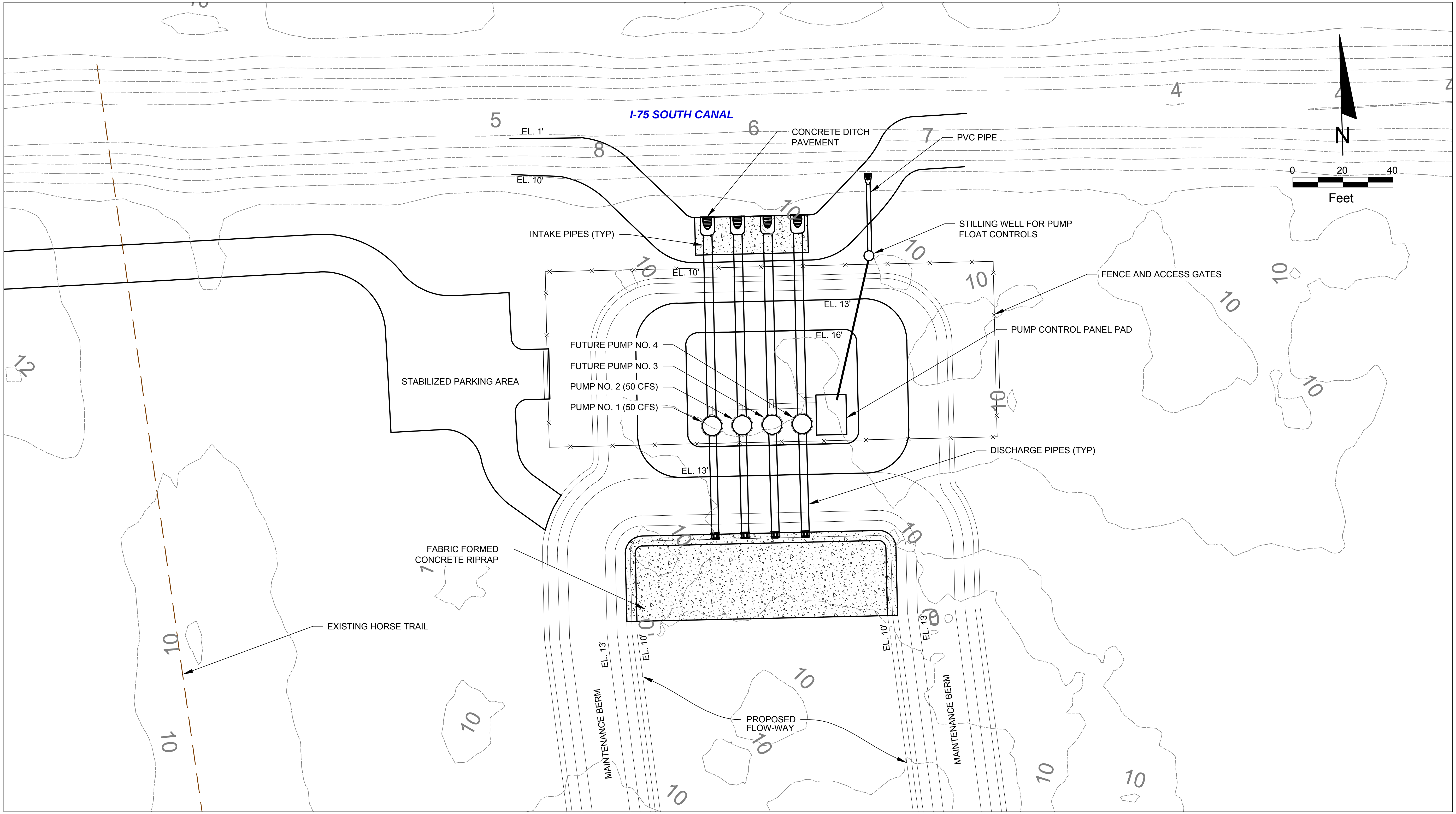

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TITLE: SOUTH BELLE MEADE PUMP STATION PLAN

ORIGINAL 09/2016
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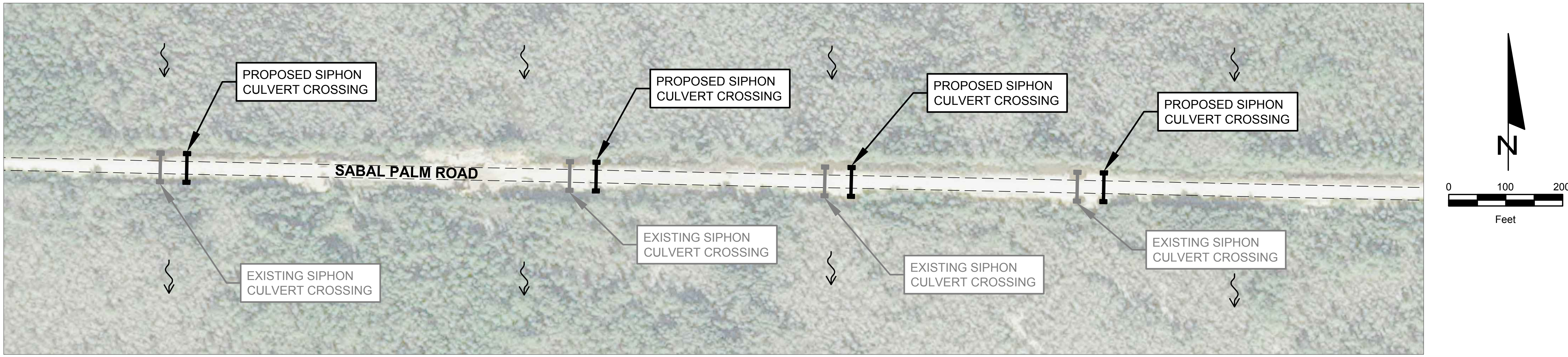

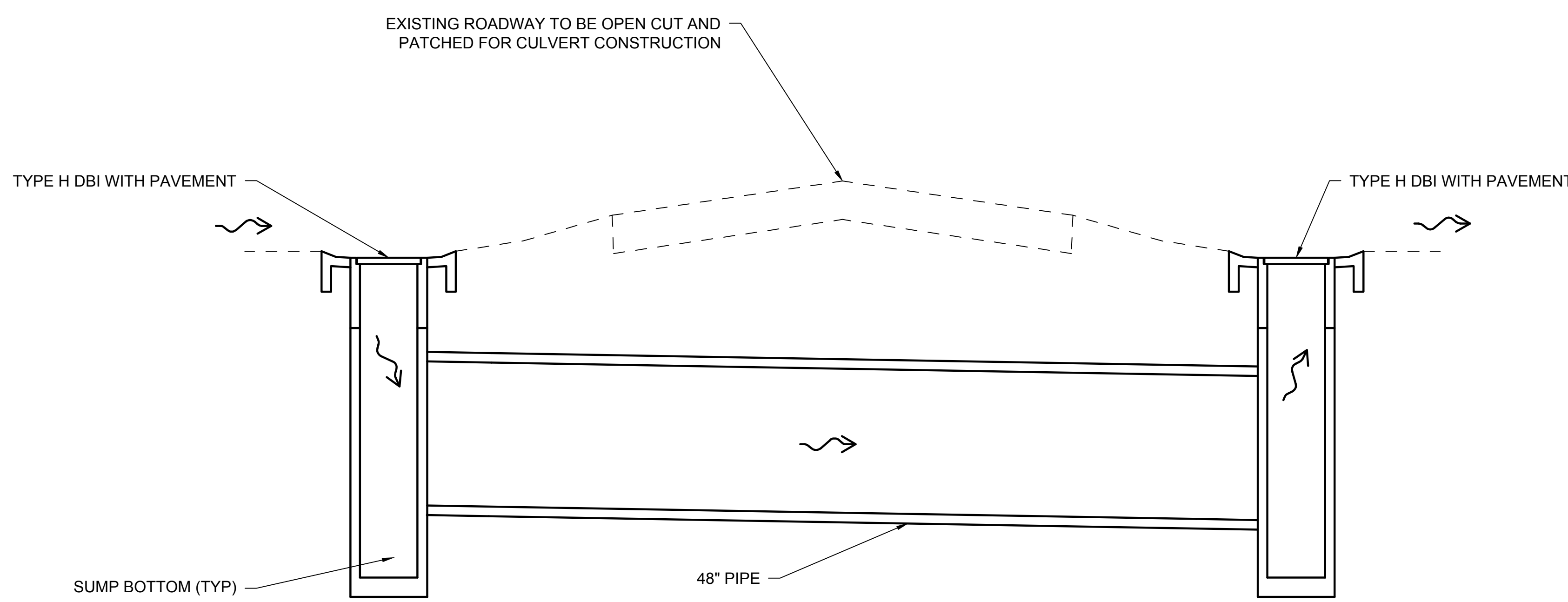

TYPICAL SECTION OF SIPHON CULVERT CROSSING

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CLIENT: Collier County

PROJECT: COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE: SABAL PALM ROAD CULVERT CROSSINGS

ORIGINAL 09/2016
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FLORIDA P.E. NO. 65600

JOB NO. 100046576
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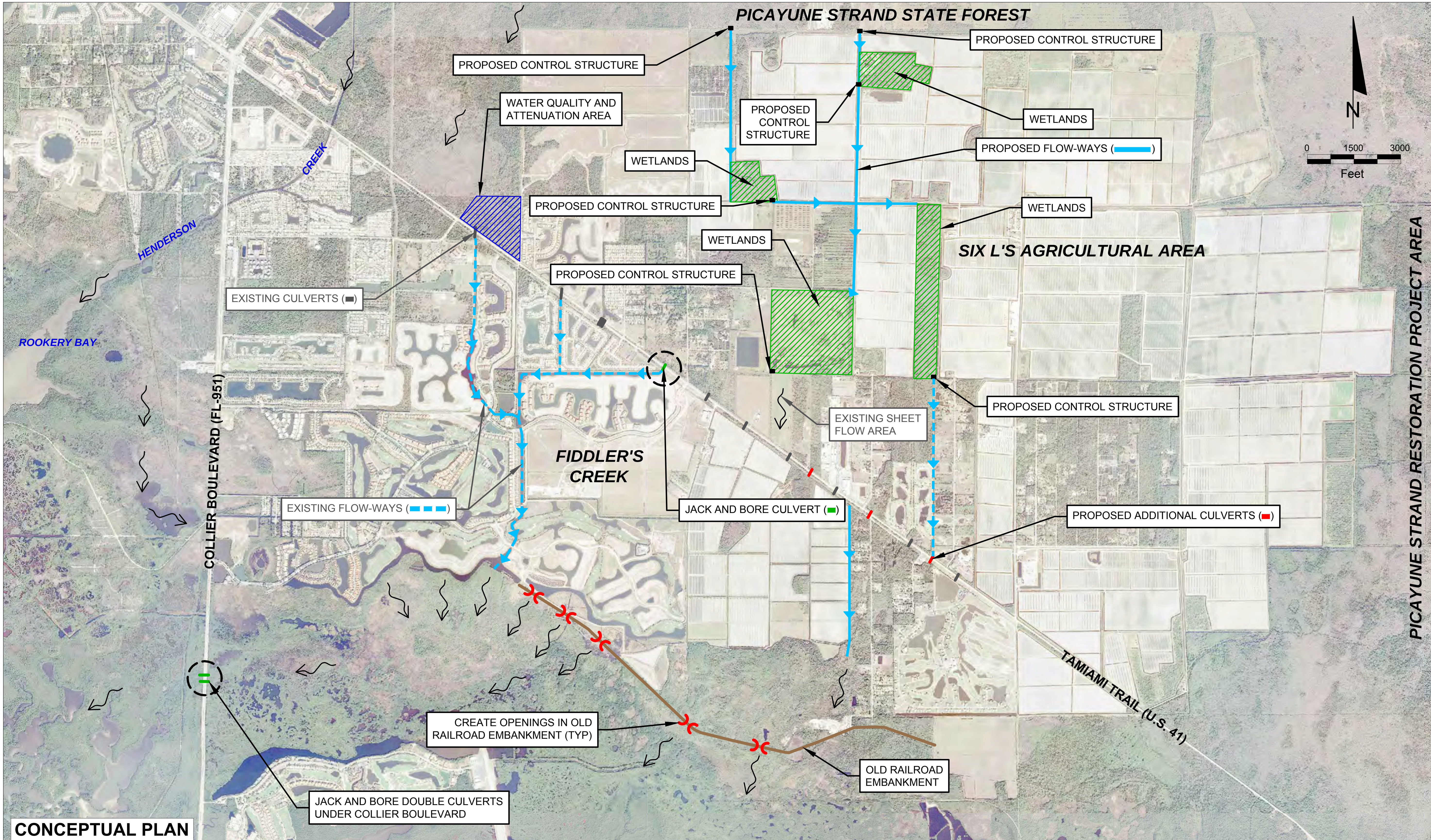

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CLIENT
Collier County

PROJECT
COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN

TITLE
SIX L'S/U.S. 41 FLOW-WAYS AND CONVEYANCE IMPROVEMENTS PLAN

ORIGINAL 09/2016
REVISIONS:
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MARK D. ERWIN
FLORIDA P.E. NO. 65600

JOB NO. 100046576
DRAWN CLT
PE MDE
CHECKED
QC

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Appendix B. Detailed Estimates of Construction Costs

ATKINS

COLLIER COUNTY COMPREHENSIVE WATERSHED IMPROVEMENT PLAN
ESTIMATE OF COST

Prepared By: CLT, PE
Checked By: MDE, PE

ITEM	PAY ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL AMOUNT
PROJECT AREA A - NORTH BELLE MEADE PUMP STATION AND FLOW-WAY RECREATIONAL AREA						
North Belle Meade Pump Station & Flow-way						
1	01-ELEC	Electrical Equipment - (control panel, site elec.)	1	LS	$75,000.00	$75,000
2	01-ENCL	VFD Package with NEMA 3R Enclosure	4	EA	$7,317.00	$29,268
3	01-PUMP	50 CFS Vertical Axial Flow Pump powered by 60hp, 1800 rpm Electric Motor.	2	EA	$55,274.00	$110,548
4	01-STRT	Freight to the jobsite, installation and start up service	1	EA	$20,648.13	$20,648
5	104-10-3	Sediment Barrier	11,300	LF	$1.50	$16,950
6	104-11	Floating Turbidity Barrier	200	LF	$10.50	$2,100
7	104-11-X	Turbidity Monitoring	1	LS	$5,000.00	$5,000
8	104-15	Soil Tracking Prevention Device	1	EA	$2,000.00	$2,000
9	110-1-1	Clearing and Grubbing	27	AC	$15,000.00	$405,000
10	120-5	Channel Excavation	8,248	CY	$30.50	$251,564
11	120-6	Embankment	72,165	CY	$10.50	$757,737
12	145-71	Reinforcement Grid for Soil Stabilization (Access Rd & Station Parking)	10,789	SY	$6.50	$70,129
13	160-4	Type B Stabilization	12,230	SY	$3.50	$42,805
14	285-709	Optional Base Group 09	12,230	SY	$15.00	$183,450
15	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C (220 lb/sy)	1,345	TN	$100.00	$134,530
16	337-7-43	ASPH CONC FC, TRAFFIC C, FC-12.5, PG 76-22 (165 lb/sy)	111	TN	$140.00	$15,538
17	400-1-25	Conc. Class I, Substructure (Electrical Pad)	4	CY	$580.00	$2,320
18	400-2-25	Conc. Class II, Substructure (Pump Support Slab)	12	CY	$667.00	$8,004
19	400-91	Dewatering (For Pump Cans)	4	EA	$20,000.00	$80,000
20	425-2-62	Manhole, P-8, >10'	1	EA	$5,000.00	$5,000
21	425-1-611	Inlets, Ditch Bottom, Type K	1	EA	$21,000.00	$21,000
22	430-174-112	Pipe Culvert, Round 12"	192	LF	$57.00	$10,944
23	430-175-136	Pipe Culvert, Round 36" (Discharge Piping, 36" PVC)	569	LF	$114.00	$64,866
24	430-175-142	Pipe Culvert, Round 42" (Intake Piping, PVC)	506	LF	$130.00	$65,780
25	430-175-142	Pipe Culvert, Round 42" (Outfall Pipes from ditch/pond)	440	LF	$130.00	$57,200
26	430-175-148	Pipe Culvert, Round 48" (Pipe from ditch to I-75 ditch)	460	LF	$160.00	$73,600
27	430-880-2	Flap Gates (36")	4	EA	$10,000.00	$40,000
28	430-982-140	Mitered End Sections, Round 42" CD	8	EA	$3,500.00	$28,000
29	430-982-141	Mitered End Sections, Round 48" CD	8	EA	$4,000.00	$32,000
30	430-984-140	Mitered End Sections, Round 42" SD (with bars)	4	EA	$6,000.00	$24,000
31	430-984-181	Mitered End Sections, Round 12" SD (with bars)	1	EA	$700.00	$700
32	455-133-1	Sheet Piling Steel, Temporary-Critical	9,000	SF	$12.50	$112,500
33	530-3-4	Riprap, Rubble, Ditch Lining (Pump Intake)	65	TN	$85.00	$5,525
34	530-74	Bedding Stone (Stabilized Parking Area - 8" Depth)	400	TN	$70.00	$28,006
35	530-7-4	Regular Excavation	8,476	CY	$5.00	$42,380
36	547-70-2	Riprap, Fabric-Formed Concrete, 10" Filter Points	826	SY	$104.00	$85,904
37	550-10-220	Fencing, Type B, 5.1-6.0', Standard	800	LF	$11.00	$8,800
38	550-60-224	Fence Gate, Type B, DBL 18.1-20' Opening	1	EA	$1,150.00	$1,150
39	570-1-2	Performace Turf (Sod) - North Canal and North Belle Meade Pump Station	114,769	SY	$2.50	$286,923
40	01-PLANT	Trees for planted wetlands (1.2 acres total)	524	EA	$50.00	$26,200
42		Electrical Service Connection	1	LS	$100,000.00	$100,000
43	01-LAND	Landscaping	1	LS	5%	$166,653
44	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$69,994
45		Mobilization (10%)	1	LS	10%	$349,972
46		Contingency (30%)	1	LS	30%	$1,175,906
Sub-total						***$5,095,600***
PROJECT AREA B - INTERSTATE 75 (I-75) CANALS IMPROVEMENTS						
I-75 Canal Excavations & Vegetation Removal						
47	110-1-1	Clearing and Grubbing (Inludes channel vegetation removal)	16	AC	$15,000.00	$240,000
48	120-5	Channel Excavation	11,054	CY	$30.50	$337,154
49	104-11	Floating Turbidity Barrier	1,780	LF	$10.50	$18,690
50	104-11-X	Turbidity Monitoring	1	LS	$5,000.00	$5,000
41	01-CANALW	Canal Weir	2	LS	$180,000.00	$360,000
51	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$19,217
52		Mobilization (10%)	1	LS	10%	$96,084
53		Contingency (30%)	1	LS	30%	$322,844
Sub-total						***$1,399,000***

ITEM	PAY ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL AMOUNT
PROJECT AREA C - SOUTH BELLE MEADE PUMP STATION, FLOW-WAY, AND SPREADER						
South Belle Meade Pump Station, Flow-way, and Spreader						
54	01-PUMP	50 CFS Vertical Axial Flow Pump powered by 60hp, 1800 rpm Electric Motor.	2	EA	$55,274.00	$110,548
55	01-ENCL	VFD Package with NEMA 3R Enclosure	2	EA	$7,317.00	$14,634
56	01-STRT	Freight to the jobsite, installation and start up service	1	EA	$39,397.75	$39,398
57	01-ELEC	Electrical Equipment - (control panel, site elec.)	1	LS	$75,000.00	$75,000
58	400-1-25	Conc. Class I, Substructure (Electrical Pad)	4	CY	$580.00	$2,320
59	400-2-25	Conc. Class II, Substructure (Pump Support Slab)	12	CY	$667.00	$8,004
60	430-175-142	Pipe Culvert, Round 42" (Intake Piping, PVC)	320	LF	$130.00	$41,600
61	430-175-136	Pipe Culvert, Round 36" (Discharge Piping, 36" PVC)	200	LF	$114.00	$22,800
62	SPECIAL	5'X10' Reinforced Concrete Box Culvert	310	LF	$400.00	$124,000
63	430-880-2	Flap Gates (36")	4	EA	$10,000.00	$40,000
64	430-984-140	Mitered End Sections, Round 42" SD (with bars)	4	EA	$6,000.00	$24,000
65	430-984-181	Mitered End Sections, Round 12" SD (with bars)	1	EA	$700.00	$700
66	455-133-1	Sheet Piling Steel, Temporary-Critical	4,000	SF	$12.50	$50,000
67	524-1-29	Conc. Ditch Pavt, 4" Reinforced	410	SY	$83.00	$34,030
68	530-3-4	Riprap, Rubble, Ditch Lining (Pump Intake)	65	TN	$85.00	$5,525
69	550-10-220	Fencing, Type B, 5.1-6.0', Standard	480	LF	$11.00	$5,280
70	550-60-224	Fench Gate, Type B, DBL 18.1-20' Opening	2	EA	$1,150.00	$2,300
71	425-2-62	Manhole, P-8, >10'	1	EA	$5,000.00	$5,000
72	430-174-112	Pipe Culvert, Round 12"	100	LF	$57.00	$5,700
73	145-71	Reinforcement Grid for Soil Stabilization (Parking Area)	4,260	SY	$6.50	$27,690
74	530-74	Bedding Stone (Stabilized Parking Area - 8" Depth)	1,470	TN	$70.00	$102,879
75	120-1	Regular Excavation	9,244	CY	$5.00	$46,220
76	120-5	Channel Excavation	1,060	CY	$30.50	$32,330
77	120-6	Embankment	31,336	CY	$10.50	$329,028
78	524-1-2	Conc. Ditch Pavt, 4" Non Reinforced	406	SY	$63.50	$25,781
79	524-1-29	Conc. Ditch Pavt, 4" Reinforced	3,667	SY	$83.00	$304,361
80	530-3-4	Riprap, Rubble, Ditch Lining (Outfalls)	902	TN	$85.00	$76,670
81	110-1-1	Clearing and Grubbing (Pump Station & Spreader Swale)	29	AC	$15,000.00	$435,000
82	110-1-1	Clearing and Grubbing (Dirt Access Road)	6	AC	$15,000.00	$96,419
83		Dirt Access Road Compaction	31,111	SY	$20.00	$622,222
84	570-1-2	Performace Turf (Sod) - South Ditch and South Belle Meade Pump Station	47,768	SY	$2.50	$119,420
85	570-1-2	Performace Turf (Sod) - South Channel Bottom	52,973	SY	$2.50	$132,433
86	400-91	Dewatering (For Pump Cans)	4	EA	$20,000.00	$80,000
87	104-11	Floating Turbidity Barrier	250	LF	$10.50	$2,625
88	104-11-X	Turbidity Monitoring	1	LS	$5,000.00	$5,000
89	104-10-3	Sediment Barrier	11,600	LF	$1.50	$17,400
90		Electrical Service Connection	1	LS	$100,000.00	$100,000
91	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$63,326
92		Mobilization (10%)	1	LS	10%	$316,632
93		Contingency (30%)	1	LS	30%	$1,063,882
Sub-total						***$4,610,200***
PROJECT AREA D - SABAL PALM ROAD CULVERT CROSSINGS						
Sabal Palm Road Culvert Crossings						
94	110-1-1	Clearing and Grubbing	1	AC	$15,000.00	$15,000
95	160-4	Type B Stabilization	150	SY	$3.50	$525
96	285-709	Optional Base Group 09	150	SY	$15.00	$2,250
97	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C (220 lb/sy)	16.5	TN	$100.00	$1,650
98	337-7-43	ASPH CONC FC, TRAFFIC C, FC-12.5, PG 76-22 (165 lb/sy)	2	TN	$140.00	$280
99	425-1-585	Inlets, Ditch Bottom, Type H, <10'	8	EA	$7,000.00	$56,000
100	430-175-148	Pipe Culvert, Round 48"	160	LF	$160.00	$25,600
101	570-1-2	Performace Turf (Sod)	356	SY	$2.50	$890
102	104-10-3	Sediment Barrier	400	LF	$1.50	$600
103	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$5,000
104		Mobilization (10%)	1	LS	10%	$10,280
105		Contingency (30%)	1	LS	30%	$35,422
Sub-total						***$153,500***

ITEM	PAY ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL AMOUNT
PROJECT AREA E - SIX L'S / U.S. 41 FLOW-WAYS AND CONVEYANCE IMPROVEMENTS						
Tamiami Trail Conveyance Improvement (U.S. 41)						
106	110-1-1	Clearing and Grubbing	0.5	AC	$15,000.00	$7,500
107	430-185-148	Pipe Culvert, Round 48" (Jack and Bore)	70	LF	$800.00	$56,000
108	430-175-148	Pipe Culvert, Round 48"	80	LF	$160.00	$12,800
109	430-982-141	Mitered End Section, Round 48"	2	EA	$4,000.00	$8,000
110	570-1-2	Performace Turf (Sod)	556	SY	$2.50	$1,390
111	104-10-3	Sediment Barrier	100	LF	$1.50	$150
112	104-12	Staked Turbidity Barrier	200	LF	$7.00	$1,400
113	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$5,000
114		Mobilization (10%)	1	LS	10%	$8,724
115		Contingency (30%)	1	LS	30%	$30,289
		Sub-total				***$131,300***
Tamiami Trail Water Quality and Attenuation Area (U.S. 41)						
116	01-PUMP	10 CFS Vertical Axial Flow Pump Station	1	EA	$40,000.00	$40,000
117	110-1-1	Clearing and Grubbing	12	AC	$15,000.00	$180,000
118	120-1	Regular Excavation	10,400	CY	$5.00	$52,000
119	120-6	Embankment (New Berms)	12,500	CY	$10.50	$131,250
120	120-SPECIAL	Finish Grading	24,000	SY	$10.00	$240,000
121	104-10-3	Sediment Barrier	7,000	LF	$1.50	$10,500
122	104-12	Staked Turbidity Barrier	100	LF	$7.00	$700
123	400-2-25	Conc. Class II, Substructure (Pump Support Slab)	12	CY	$667.00	$8,004
124	550-10-220	Fencing, Type B, 5.1-6.0', Standard	150	LF	$11.00	$1,650
125	550-60-224	Fence Gate, Type B, DBL 18.1-20' Opening	1	EA	$1,150.00	$1,150
124	570-1-2	Performace Turf (Sod)	50,000	SY	$2.50	$125,000
125	SPECIAL	Concrete Spillways	3	EA	$11,000.00	$33,000
126	SPECIAL	Outfall Weir Structure	1	EA	$30,000.00	$30,000
127	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$17,065
128		Mobilization (10%)	1	LS	10%	$85,325
129		Contingency (30%)	1	LS	30%	$286,693
		Sub-total				***$1,242,300***
Old Railroad Embankment Removal (U.S. 41)						
130	110-1-1	Clearing and Grubbing	1	AC	$15,000.00	$15,000
131	120-1	Regular Excavation (Assumed RR = 12' top, 3' high, 1:3 SS)	700	CY	$5.00	$3,500
132	570-1-2	Performace Turf (Sod)	4,000	SY	$2.50	$10,000
133	104-10-3	Sediment Barrier	1,800	LF	$1.50	$2,700
134	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$5,000
135		Mobilization (10%)	1	LS	10%	$3,120
136		Contingency (30%)	1	LS	30%	$11,796
		Sub-total				***$51,100***
Collier Boulevard (FL-951) Conveyance Improvement						
137	110-1-1	Clearing and Grubbing	1	AC	$15,000.00	$15,000
138	430-185-148	Pipe Culvert, Round 48" (Jack and Bore)	200	LF	$800.00	$160,000
139	430-175-148	Pipe Culvert, Round 48"	160	LF	$160.00	$25,600
140	430-982-141	Mitered End Section, Round 48"	4	EA	$4,000.00	$16,000
141	570-1-2	Performace Turf (Sod)	1,112	SY	$2.50	$2,780
142	104-10-3	Sediment Barrier	200	LF	$1.50	$300
143	104-12	Staked Turbidity Barrier	400	LF	$7.00	$2,800
144	102-1	Maintenance of Traffic (MOT)	1	LS	2%	$5,000
145		Mobilization (10%)	1	LS	10%	$22,248
146		Contingency (30%)	1	LS	30%	$74,918
		Sub-total				***$324,600***

ITEM	PAY ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL AMOUNT
PROJECT AREA E - SIX L'S / U.S. 41 FLOW-WAYS AND CONVEYANCE IMPROVEMENTS (CONT'D.)						
6L's Agricultural Area Improvements						
147	104-10-3	Sediment Barrier	140,000	LF	$1.50	$210,000
148	104-11	Floating Turbidity Barrier	700	LF	$10.50	$7,350
149	104-11-X	Turbidity Monitoring	1	LS	$5,000.00	$5,000
150	110-1-1	Clearing and Grubbing	50	AC	$15,000.00	$750,000
151	120-1	Regular Excavation	7,580	CY	$5.00	$37,900
152	120-6	Embankment (New Berms)	14,710	CY	$10.50	$154,455
153	120-6	Embankment (Berm Plugs)	250	CY	$10.50	$2,625
154	120-SPECIAL	Finish Grading	27,800	SY	$10.00	$278,000
155	400-91	Dewatering (For Control Structures)	5	EA	$60,000.00	$300,000
156	425-158-9	Inlets, Ditch Bottom, Type H, Modify	10	EA	$7,500.00	$75,000
157	430-175-172	Pipe Culvert, Round 72" (Cross Drain, RCP)	400	LF	$500.00	$200,000
158	430-175-172	Pipe Culvert, Round 72" (Outfall, RCP)	500	LF	$500.00	$250,000
159	430-982-645	Mitered End Sections, Round 72" CD (with bars)	16	EA	$3,000.00	$48,000
160	455-133-2	Sheet Piling Steel, Temporary-Critical	6,000	SF	$12.50	$75,000
161	530-3-4	Riprap, Rubble, Bank and Shore (24", Cross Drains, Includes Filter Fabric)	260	TN	$85.00	$22,100
162	530-3-4	Riprap, Rubble, Bank and Shore (24", Outfalls, Includes Filter Fabric)	160	TN	$85.00	$13,600
163	530-74	Bedding Stone (8", Cross Drains, Includes Filter Fabric)	90	TN	$70.00	$6,300
164	530-74	Bedding Stone (8", Outfalls, Includes Filter Fabric)	55	TN	$70.00	$3,850
165	570-1-2	Performace Turf (Sod) - New Berms	27,550	SY	$2.50	$68,875
166	SPECIAL	Geotechnical Exploration and Berm Inspection	1	LS	$500,000.00	$500,000
167	SPECIAL	Berm Rehabilitation Allowance	1	LS	$500,000.00	$500,000
168	SPECIAL	Sluice Gates Weir Structures	2	EA	$204,000.00	$408,000
169	102-1	Maintenance of Traffic (MOT)	1	LS	5%	$195,803
170		Mobilization (10%)	1	LS	10%	$391,606
171		Contingency (30%)	1	LS	30%	$1,351,039
Sub-total						***$5,854,500***

Construction Cost Estimate Total (Project Areas A-E)	**$18,862,100**
Project Development (5%)	**$943,100**
Design/Engineering (10%)	**$1,886,200**
Permitting (5%)	**$943,100**
Mitigation (5%)	**$943,100**
Monitoring and Scada Telemetry Systems	**$1,000,000**
Additional Minor Projects	**$1,000,000**
North Belle Meade Preliminary Engineering	**$1,000,000**
Six L's Area Future Masterplan	**$1,000,000**
Cost Escalation compounded over 7 years (3% per year)	**$4,338,300**
Total Estimated Cost	**$31,916,000**

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