Dona Bay Watershed Management Plan

Technical Memorandums

Prepared by:

Kimley-Horn and Associates, Inc.

Southwest Florida Water Management District

SARASOTA COUNTY

DONA BAY
WATERSHED MANAGEMENT PLAN

Final Report Appendices
Technical Memorandums
January 2007
(Revised April 2007)

Prepared By:

Kimley-Horn & Associates, Inc.
2601 Cattleman Road, Suite 500
Sarasota, Florida 34232

In Cooperation with:

Integrated Water Resources
Post, Buckley, Schuh & Jernigan
Biological Research Associates, Ltd
Earth Balance
Mote Marine Laboratory
University of South Florida
Southwest Florida Water Management District

Prepared For:

Sarasota County Government
Contract No. 2005-483
Environmental Service Business Center
Integrated Water Resources
1001 Sarasota Center Boulevard
Sarasota, Florida 34240

LIST OF TECHNICAL MEMORANDUMS

NATURAL SYSTEMS

TM 4.1.1.1	-	DATA COLLECTION AND REVIEW (PBSJ) GIS MAPPING OF SHORELINE DRAFT MONITORING PLAN
TM 4.1.1.2	-	DATA COLLECTION AND REVIEW (BRA)
TM 4.1.2	-	DEVELOPMENT OF NATURAL SYSTEM WATER BUDGET
TM 4.1.3.1	-	DATA ANALYSIS (PBSJ)
TM 4.1.3.2	-	DATA ANALYSIS (BRA)
TM 4.1.4	-	EVALUATION OF RESTORATION/ENHANCEMENT VALUE
TM 4.1.5	-	ALTERNATIVE IMPACT ANALYSIS (BRA)
MOTE MARINE	-	SALINITY TARGETS FOR WATERSHED MANAGEMENT IN DONA AND ROBERTS BAYS AND THEIR TRIBUTARIES

WATER SUPPLY

TM 4.2.1	-	WATER QUALITY ANALYSIS AND WATER TREATMENT OPTIONS ANALYSIS
TM 4.2.2	-	WATER QUANTITY | WATER BUDGET APPROACH
TM 4.2.3	-	WATER QUANTITY | FLOW DIVERSION APPROACH
TM 4.2.4.1	-	EVALUATION OF SURFACE STORAGE (Venice Minerals Site)
TM 4.2.4.2	-	EVALUATION OF SURFACE STORAGE (Albritton Site)
TM 4.2.4.3	-	EVALUATION OF SUBSURFACE STORAGE
TM 4.2.5	-	DETERMINATION OF SURFACE WATER TREATMENT PLANT LOCATION
TM 4.2.7	-	DEVELOPMENT OF PHASING PLAN
TM 4.2.8	-	WATER SUPPLY WATERSHED PROTECTION PLAN (DRAFT)

WATER QUALITY

TM 4.3.1	-	DATA COLLECTION AND REVIEW
TM 4.3.2	-	DATA ANALYSIS
TM 4.3.3	-	ALTERNATIVE IMPACT ANALYSIS

FLOOD PROTECTION

TM 4.4.1	-	INCLUSION OF WATERSHED CONNECTIONS
TM 4.4.2	-	CONTINUE MODEL VALIDATION
TM 4.4.3	-	REGIONAL STORMWATER FEASIBILITY STUDY
TM 4.4.4	-	DEVELOPMENT OF SCS SOIL CONSERVATION PLAN OVERLAYFOR PINELANDS AREA
TM 4.4.5	-	ALTERNATIVE IMPACT ANALYSIS

Chapter 3 – Natural Systems Appendices

Photo of Southern Coastal Watershed
Myakka River State Park

TM 4.1.1.1 – DATA COLLECTION AND REVIEW (PBSJ) GIS MAPPING OF SHORELINE DRAFT MONITORING PLAN

1.0 BACKGROUND

Sarasota County in cooperation with the Peace River Manasota Regional Water Supply Authority and the Southwest Florida Water Management District (SWFWMD) are currently completing the necessary, pre-requisite data collection and analysis as well as the comprehensive watershed management plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), Earth Balance, and Mote Marine Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the SWFWMD, to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan; and Sarasota County's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay watershed that will address the following general objectives:

1. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
2. Provide a more natural freshwater flow regime pattern for the Dona Bay watershed.
3. Protect existing and future property owners from flood damage.
4. Protect existing water quality.
5. Develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

This Technical Memorandum has been prepared by PBS&J to present a summary of efforts to develop GIS maps and data comparisons for existing and historical shoreline habitats of Dona and Roberts Bays (from Blackburn Bay to northern Lemon Bay). Also, this Technical Memorandum summarizes efforts to produce a draft Monitoring Plan for Dona Bay. These efforts are consistent with Task 4.1.1 of the DBWMP contract.

2.0 INTRODUCTION

This effort is part of the overall Natural Systems efforts defined in Task 4.1 of the DBWMP. Specifically, it included related natural systems evaluations and an assessment of potential restoration/enhancement opportunities for Dona Bay and its watershed. Since the intent of the project is to consider alternatives for watershed restoration/enhancement of the Dona Bay watershed and its associated estuary, PBS&J was tasked with developing GIS-based maps of existing and historical shoreline habitats of Dona Bay (not including the freshwater portions), and the development of a draft monitoring plan.

The size of the historical Dona Bay watershed has been greatly expanded, resulting in the diversion of significantly larger volumes freshwater being discharged to Dona Bay. Various watershed/hydrologic restoration scenarios are being considered to “re-balance” and create a more natural water budget. The re-balanced water budget would closer reflect pre-diversion conditions and restore more natural seasonal salinity regimes in the estuary. It is planned that water use and retention efforts will reduce the volume of freshwater discharging to Dona Bay restoring a more historical condition. Therefore, a draft Monitoring Plan for Dona Bay has been developed to quantify the benefits to the estuary, by monitoring improvements (i.e. nearing a more historical, pre-altered condition) to water quality and populations of the selected biological indicators.

3.0 DEVELOPMENT OF GIS-BASED MAPS OF EXISTING AND HISTORICAL SHORELINE HABITATS

The GIS-based mapping efforts for shoreline features included the production of the following maps: 1) a map of vegetation types along the shoreline using 2004 aerial photography groundtruthed and revised (if necessary) in 2006, 2) a map of shoreline features produced using 2004 aerial photography groundtruthed and revised (if necessary) in 2006, and 3) a map of shoreline features photointerpreted uing aerial photography from 1948.

For the vegetation map, the following vegetation types were mapped:

- Shorelines dominated by Australian Pines
- Shorelines dominated by Brazilian Peppers
- Shorelines dominated by Black Needle Rush
- Shorelines dominated by Leather Fern
- Shorelines dominated by various mangrove species
- Shorelines dominated by mangroves interspersed with various exotic vegetation
- Shorelines dominated by Cordgrass (Spartina alterniflora)
- Shorelines dominated by upland vegetation (and not Australian Pines)
- Shorelines dominated by other vegetation (e.g., landscaping features); and
- Shorelines with no vegetation

Field crews surveyed the entire stretch of shoreline, from Blackburn Bay to northern Lemon Bay, and also the extent of Shakett Creek up to the structure on Cow Pen Slough and Curry Creek. Using GPS, created maps and aerial photography, site survey information was relayed to a GIS specialist, who used this information to create GIS-based maps of these features. Results are displayed in Figure 1.

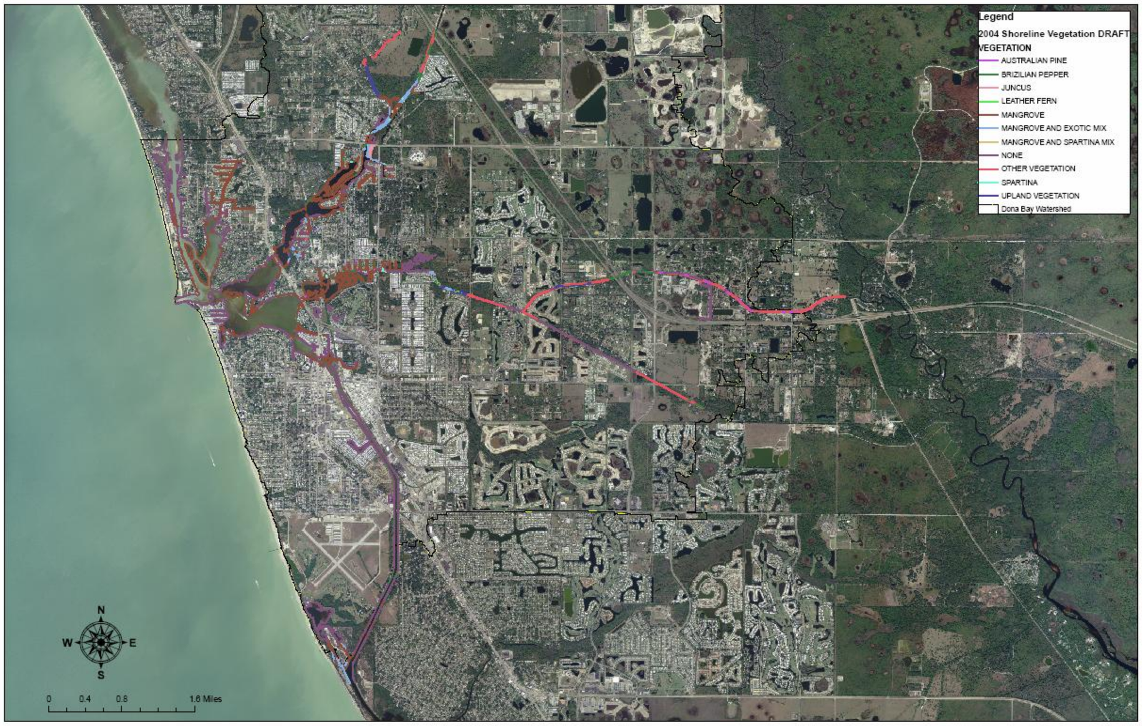


Figure 1 – 2004 Shoreline Vegetation Map

The dominant shoreline vegetation feature, unfortunately, is that of no vegetation at all. The shorelines of most residential neighborhoods are mostly hardened, with seawalls and/or rip rap as the major feature. However, the spoil island located just north of Venice Island has a fairly healthy shoreline of mixed mangroves and Spartina sp., as does much of the shoreline of both Dona and Roberts Bays in those areas located east of U.S. 41. In the farther upstream portions of Curry Creek / Blackburn Canal, there is a considerable amount of shoreline dominated by Black Needle Rush (Juncus roemerianus).

For the shoreline features map, the following shoreline types were mapped:

- Beach
- Cleared land
- Fringing deep wetlands
- Fringing patchy wetlands
- Exposed banks
- Rip rap
- Seawalls
- Upland shorelines

As in the vegetation maps, field crews surveyed the entire stretch of shoreline, from Blackburn Bay to northern Lemon Bay, and also the extent of Shakett Creek up to the structure on the Cow Pen Canal and Curry Creek. Using GPS, created maps and aerial photography, site survey information was relayed to a GIS specialist, who created the GIS-based maps of these features. Results are displayed in Figure 2.

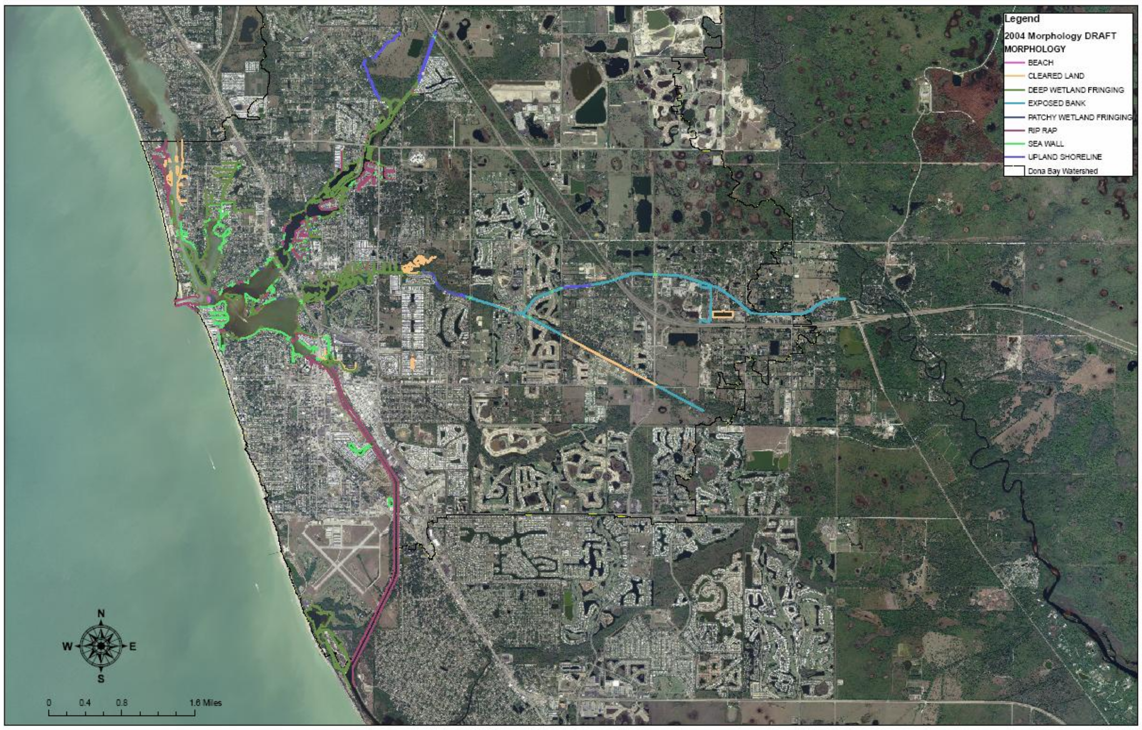


Figure 2 - 2004 Shoreline Features Map

In the areas closest to Venice Inlet, the dominant shoreline type is either rip rap or seawalls. For the most part, seawalls are the dominant shoreline feature for the residential neighborhoods, while rip rap is the dominant shoreline feature along both the inlet itself, and also along the Intracoastal Waterway. Most of the mangrove shorelines noted in Figure 1 are here classified as “fringing deep wetlands” rather than “fringing patchy wetlands.” This indicates that these wetland areas (mostly mangroves or mangroves and Spartina mixed together) have the potential to perform the expected wetland functions of providing habitat for fish and wildlife and also treating surface water runoff from immediately adjacent uplands. These wetland areas are mostly located east of U.S. 41.

For the 1948 shoreline features mapping effort, there was obviously no ground-truthing involved. For this reason, and also because of the reduced quality of the aerial photography for this time period, fewer shoreline features could be differentiated. The categories of “cleared land” and “exposed bank” were not mapped. Results are displayed in Figure 3.

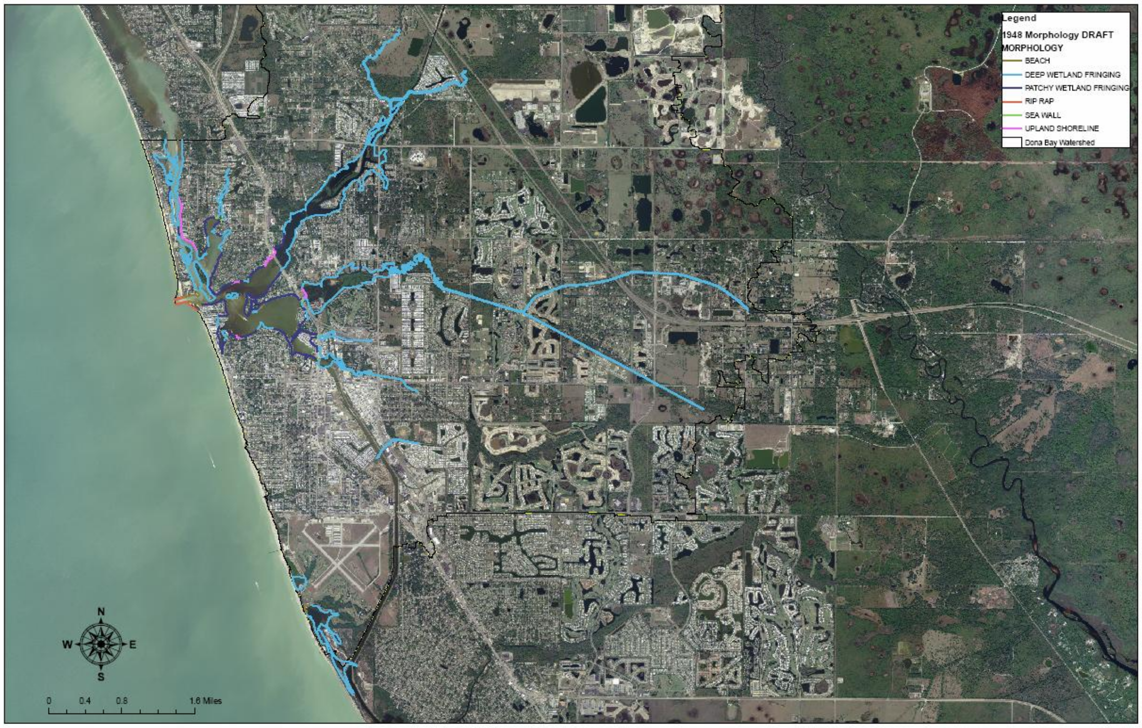


Figure 3 - 1948 Shoreline Features Map

In 1948, the dominant shoreline feature was that of a fringing deep wetland – most probably a shoreline dominated by mangroves. While rip rap was in place in the area of Venice Inlet, most of the areas now dominated by residential neighborhoods with seawalls was instead dominated by either deep or patchy fringing wetland.

Upon comparing the 1948 with 2004 shoreline features, it can be seen that major changes have occurred (Figure 4).

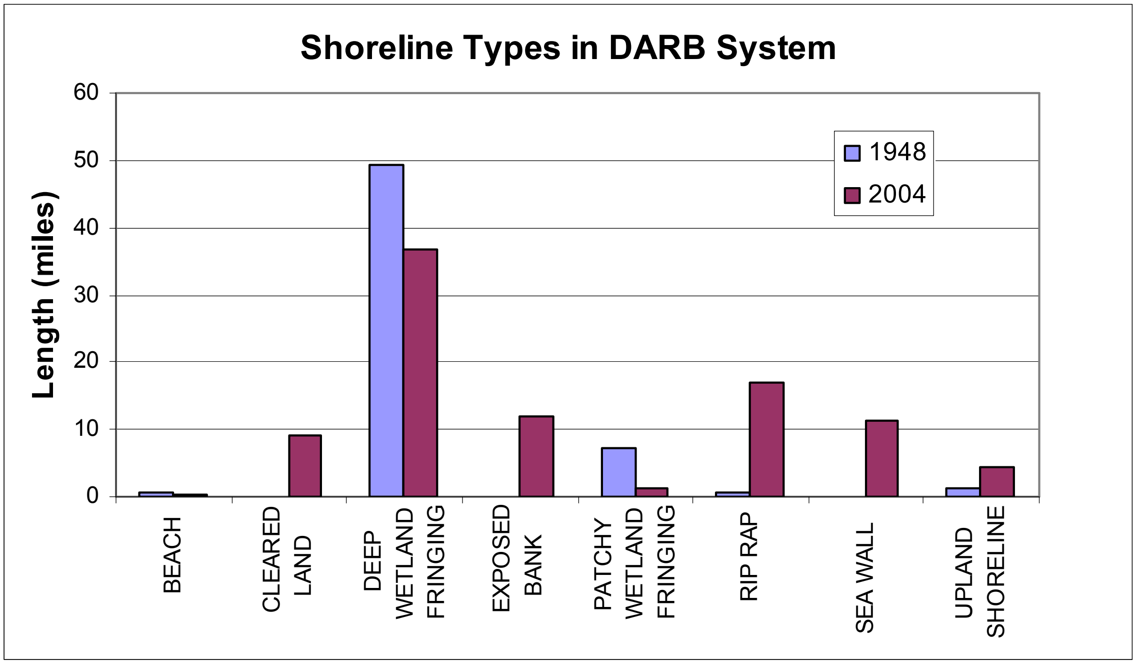


Figure 4 – Comparison of 1948 vs. 2004 Shoreline Features

The actual shoreline length in the DARB system has increased substantially, from 59.4 miles in 1948 to 91.8 miles in 2004, primarily due to the construction of canals for residential development and also the construction of the Intracoastal Waterway. However, most of this increase has been due to increases in the categories of rip rap and seawall. For the more "valuable" shoreline features (ecologically speaking) there have been reductions. The greatest loss of valuable shoreline, in terms of length of shoreline, was that of a loss of fringing deep wetlands. The greatest loss of valuable shoreline, in terms of a percent decline, was that of a loss in fringing patchy wetlands, which were mostly restricted to areas west of U.S. 41 in 1948.

4.0 DEVELOPMENT OF THE DRAFT MONITORING PLAN

An iterative multi-step process was used to develop a useful and effective monitoring plan for the Dona Bay system (Dona Bay, Shakett Creek and Cow Pen Slough). The step by step process is listed below, and then described in more detail:

1. Research the history of the Dona Bay watershed to understand how the current extent of the watershed and inflows related to the historic more "natural" state.
2. Review the current sampling that occurs in the Dona Bay watershed, and gather information on the results of that sampling to better understand the current state of Dona Bay.
3. Review the purpose, function, and elements of two HBMPs currently active in nearby estuaries.

4. Discuss the elements of these existing HBMPs that would be most effective in monitoring changes in Dona Bay. Further, discuss possible new elements, or modifications of existing elements, that would be uniquely effective in a Dona Bay Monitoring Plan.
5. Discuss some salinity/flow models that were run on data from Dona Bay, relative to distribution of sampling in Dona Bay for a Monitoring Plan.
6. Draft a Monitoring Plan for Dona Bay.

A study conducted by Mote Marine Lab (1975) and a more recent study by the Sarasota County Government (SCG, 2005) were critical documents for reviewing the history of the Dona Bay Watershed. Used together, these two documents provided an overview of the current and historical state of Dona Bay, and the extent of the Dona Bay watershed.

Much of the current sampling in Dona Bay is undertaken by the SCG. However a variety of other groups, including the United States Geological Survey (USGS), SWFWMD, and Mote Marine Laboratory (Mote), have ongoing, or recently completed sampling programs in Dona Bay. Many elements of these sampling programs were adopted for the draft Monitoring Plan for Dona Bay. Ongoing sampling efforts in the Dona Bay watershed include monitoring of water quality, oyster populations and seagrass beds.

Two active HBMPs (on the Peace River and Alafia River/ Tampa Bypass Canal) were reviewed. These described the rationale upon which the selected sampling regimes were initiated. Many facets of these programs were applicable to a draft Monitoring Plan for Dona Bay. However, one large difference between these HBMPs and the draft Monitoring Plan for Dona Bay is the actual geographic size of the water bodies. Dona Bay is much smaller than any of these other water bodies. Thus, it was proposed that the extent of sampling for the draft Monitoring Plan for Dona Bay be reduced, both to avoid redundancy in sampling, and to avoid disturbing the system through high levels of sampling activity.

While fish and benthic sampling are integral pieces of other monitoring plans and programs, it was decided that biotic sampling in Dona Bay should focus upon seagrass and oyster populations. Sampling of those populations already exists, and those particular organisms have been very well received as indicators of overall health in Dona Bay. It was clearly necessary that water quality monitoring via both grab samples, and continuous recorders should continue. After a series of discussions, an agreement on the extent and distribution of sampling was reached and an efficient and effective strategy was proposed. This strategy is outlined in the draft Monitoring Plan for Dona Bay. The sampling effort proposed is based upon sampling regimes already in place. It was also decided that it would be useful to compare the oyster and seagrass populations of Dona Bay with corresponding populations in Lyons Bay. The Lyons Bay watershed has not been altered to the same extent as the Dona Bay watershed. As a result, the oyster and seagrass populations of Lyons Bay have been found to be generally healthier than those of Dona Bay. Also, salinity has been found to be consistently higher and less variable in Lyons Bay than in Dona Bay.

Salinity versus flow relationships were created for use in another task of this project. These salinity flow models will be used to distribute continuous recorders (specific conductivity, dissolved oxygen, etc.). In this way the continuous recorders can be placed in areas that are should be most benefited by restoration of freshwater inflows from the Cow Pen Canal diversion. In conjunction with grab samples distributed via a random stratified schema, these continuous recorders should provide a satisfactory overview of changes in Dona Bay water quality characteristics relative to freshwater inflows.

Finally, the draft Monitoring Plan for Dona Bay was written, reviewed and edited by a number of staff with experience in planning and executing monitoring plans. It was widely accepted that the watershed/hydrologic restoration activites proposed are likely to improve water quality in Dona Bay, and are also likely to improve the health of oyster and seagrass populations in Dona Bay.

TM 4.1.1.2 – DATA COLLECTION AND REVIEW (BRA)

1.0 BACKGROUND

Sarasota County, in cooperation with the Peace River Manasota Regional Water Supply Authority and the Southwest Florida Water Management District (SWFWMD), are currently completing the necessary, pre-requisite data collection and analysis as well as the comprehensive watershed management plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), EarthBalance, and Mote Marine Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the SWFWMD, to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan, and the Sarasota County's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay watershed that will address the following general objectives:

1. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
2. Provide a more natural freshwater flow regime pattern for the Dona Bay watershed.
3. Protect existing and future property owners from flood damage.
4. Protect existing water quality.
5. Develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

This Technical Memorandum has been prepared by BRA to describe the procedures used to access literature and data, sources of acquired data, and all appropriate metadata and documentation, consistent with Task 4.1.1 of the DBWMP contract.

2.0 CURRENT STUDIES

BRA assessed numerous data files to evaluate the natural systems within the Dona Bay watershed, with a focus on four sites: (1) Albritton, (2) West Pinelands, (3) Myakka Connector, and (4) Venice Minerals. All literature and digital files listed below were compiled from Sarasota County and multiple public agencies. The data received from Sarasota County was either downloaded from the FTP site managed by Mr. Mike Jones or hand-delivered by Mr. Jones if the files were too large. The GIS layers were obtained directly from the cited public agencies.

- 1948 Historical Aerials (Sarasota County)
- 2004 Aerials (Sarasota County)
- Soils Map (USDA)
- *Soil Survey of Sarasota County, Florida* (1957, 1991) (USDA)

- 1995, 1999 Land Use (SWFWMD)
- 1847 GLO Survey Plats (Sarasota County)
- ESLPP Land Acquisition Plans (Sarasota County)
- LIDAR data (Sarasota County)
- Pinelands permits (SWFWMD, FDEP, ACOE, Sarasota County)
- *Sarasota County Old Cow Pen Slough Rehydration Area Slough Restoration 11th Semi-Annual Monitoring Report, June 2002* (PBS&J)
- Wading bird layer (FFWCC)
- Bald Eagle Nest Location layer (FFWCC)
- Scrub-jay layer (Sarasota County)
- Quadrangle Map (USGS)
- *Sarasota County Comprehensive Land Management Plan* (Sarasota County)
- *Manatee County Watershed Protection Plan* (Manatee County)
- *Cow Pen Slough Water Quality Monitoring Study: To determine the water quality within Cow Pen Slough as a potential irrigation or drinking water resource, September 2004* (Sarasota County)
- Fox Creek permits (SWFWMD)
- Comprehensive Water Management Program Boundaries (SWFWMD)
- *Dona and Robert's Bay Second Annual Watershed and Estuary Analysis, 2004* (Sarasota County)

USDA = United Stated Department of Agriculture
SWFWMD = Southwest Florida Water Management District
FDEP = Florida Department of Environmental Protection
ACOE = Army Corps of Engineers
PBS&J = Post, Buckley, Schuh & Jernigan
FFWCC = Florida Fish and Wildlife Conservation Commission
USGS = United States Geological Survey

TM 4.1.2 – DEVELOPMENT OF NATURAL SYSTEM WATER BUDGET

1.0 BACKGROUND

Sarasota County in cooperation with the Peace River Manasota Regional Water Supply Authority and SWFWMD are currently completing the necessary, pre-requisite data collection and analysis as well as comprehensive watershed management plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), Earth Balance, and Mote Marin Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the Southwest Florida Water Management District (SWFWMD), to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan; and SCG's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay watershed that will address the following general objectives:

a. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
b. Provide a more natural freshwater flow regime pattern for the Dona Bay watershed.
c. Protect existing and future property owners from flood damage.
d. Protect existing water quality.
e. Develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

This Technical Memorandum has been prepared by KHA, consistent with Task 4.1.2 of the DBWMP contract. The Deer Prairie watershed is considered a representative natural watershed in Sarasota County and Southwest Florida. A water budget analysis of historical hydrologic data collected in the Deer Prairie watershed has been conducted to estimate a representative natural watershed.

2.0 DESCRIPTION OF THE DEER PRAIRIE CREEK WATERSHED

The Deer Prairie watershed is located within the Myakka River watershed and contains 24,016.6 acres. It extends over portions of both Sarasota and Manatee Counties. The majority of the watershed is located within Sarasota County (15,872.7 acres) and of this portion of the watershed; approximately 86% (20,666.1 acres) is currently under public ownership. To determine the Deer Prairie watershed boundary, several information sources were reviewed. The western and southern boundaries are as defined by Sarasota County's adopted study for the lower Myakka River watershed. The northern and eastern boundaries were determined from SWFWMD 1-foot contour maps, 2004 aerials, and the Big Slough watershed study being conducted by SWFWMD and the City of North Port.

Figure 1 presents a map of the Deer Prairie watershed. **Figure 2** presents a map of the Deer Prairie watershed with the current publicly owned lands identified.

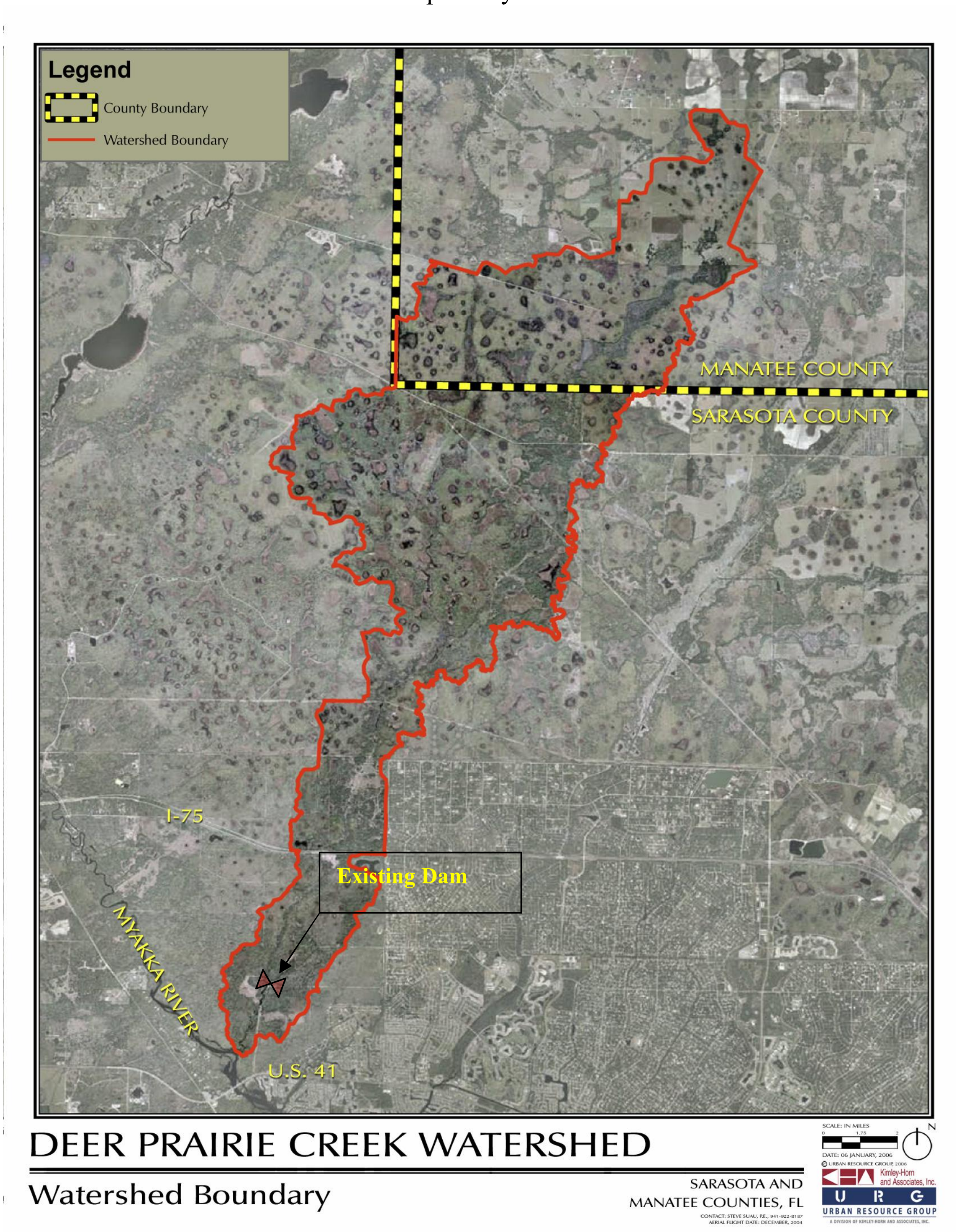


Figure 1 – Deer Prairie Watershed

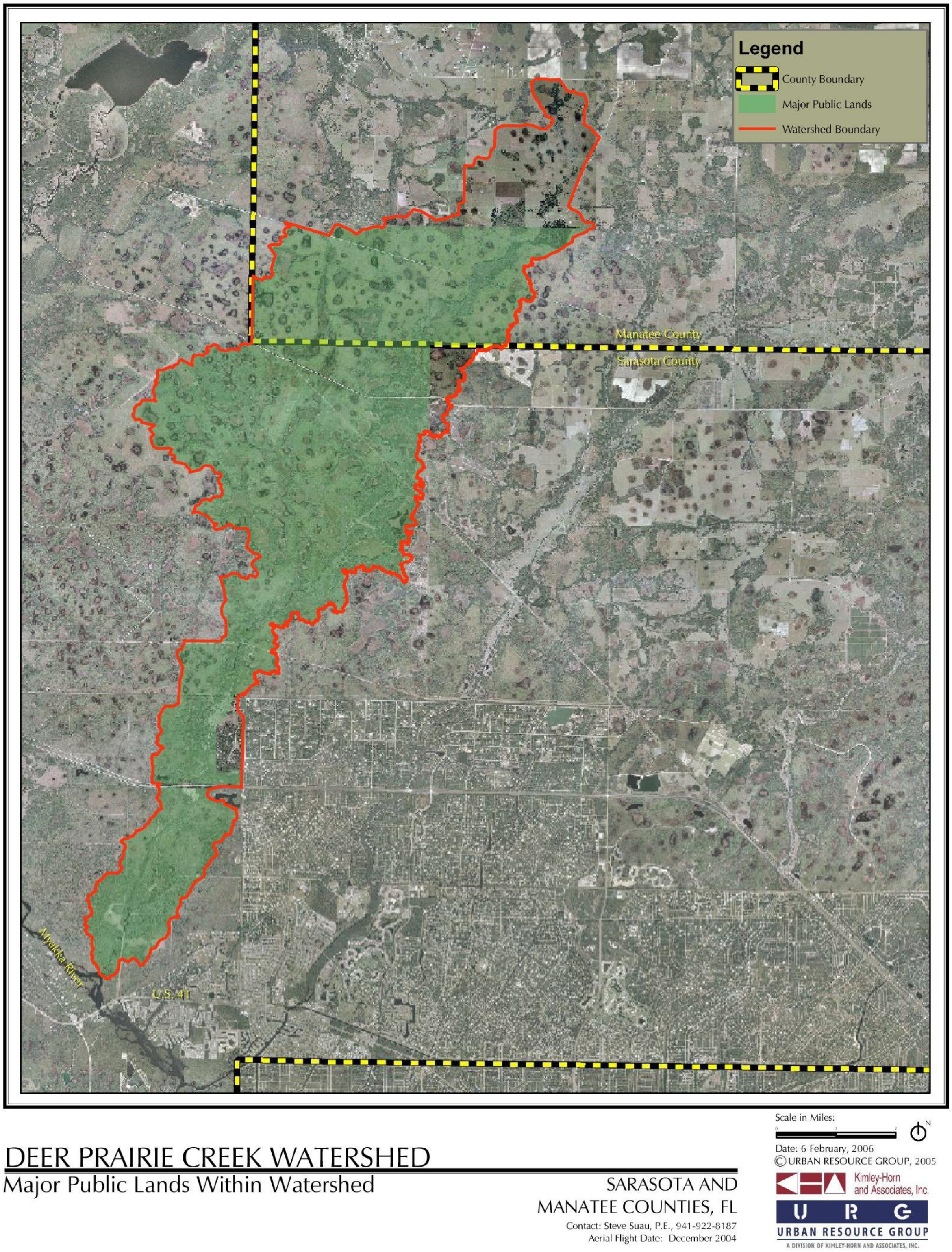


Figure 2 – Publicly Owned Lands within the Deer Prairie Watershed

The Deer Prairie watershed drains from north to south. Historical slough systems within the watershed ultimately drain to the historical Deer Prairie. The Deer Prairie watershed is one of the most natural watersheds in Sarasota County with relatively limited man-made alterations. These limited alterations include a man-made dam in the lower portion of the watershed that was constructed in the 1950's (refer to **Figure 3**). This dam is still in place and it has a crest elevation of 3.31 (National Geodetic Vertical Datum – NGVD 1929), it essentially acts as a salinity barrier. It is estimated that this dam impounds approximately 8.25 acres of surface water. This dam probably effects localized low flows, but has a minimal affect on normal and high flows from the Deer Prairie watershed.

Figure 3 – Deer Prairie Creek Dam

Other alterations include the construction of a bridge crossing associated with I-75 and two (2) Florida Power and Light (FPL) crossings. In addition, a man-made ditch was constructed through much of the historical wetland slough area to facilitate more efficient drainage. This drainage work was directed and tied into the historical Deer Prairie creek, located in the southern portion of the watershed. However, this ditch was not a pronounced drainage work and was probably constructed to facilitate mosquito control and cattle ranching, which appears to have been the predominant land use in the watershed prior to public ownership. Much of the man-made drainage ditch within the publicly owned lands portion of the Deer Prairie watershed has been backfilled under a joint effort by Sarasota County, SWFWMD, and the Charlotte Harbor National Estuary Program (CHNEP). The first phase of this effort was completed in summer of 2001 and the second phase was completed in the spring of 2002. This project has helped to further restore much of this watershed to its natural, even historical, condition. Removal of the Deer Prairie creek dam would further restore Deer Prairie watershed by restoring a more historical water budget from this watershed to Charlotte Harbor. It would also provide for the historical upstream migration of saline and brackish dependent species. The relatively natural condition of the Deer Prairie watershed and the availability of historical rainfall and stream flow data ($\pm$ 25 years) collected upstream of the salinity dam provides a unique opportunity to analyze a rainfall-runoff conversion process for a relatively natural watershed. This information could be very helpful as a basis for hydrologic restoration and establishing natural system water budget targets in other altered watersheds such as those associated with Dona Bay and Roberts Bay.

3.0 RAINFALL

Several sources of daily rainfall in the vicinity of the Deer Prairie Creek watershed were reviewed to compile monthly rainfall totals for the period of stream flow record (April, 1981 to present). A list of these sources and their respective periods of record are identified in **Table 1** below:

Site Identification	Period of Record	Operation Entity
ARMS (numerous stations)	January, 1993 to present	Sarasota County
Site 194 (Myakka River)	April, 1981 to present	NOAA
Site 269 (Big Slough)	April, 1981 through August, 1993	NOAA
Site 336 (Deer Prairie)	April, 1981 through December, 2004	NOAA
Site 355 (Big Slough)	April, 1981 through October, 1990	NOAA
Site 409 (Myakka River)	July, 1992 to present	NOAA
Site 417 (Deer Prairie)	July, 1992 to present	NOAA
Site 516 (Big Slough)	January, 2000 to present	NOAA
Site 543 (Big Slough)	September, 2000 to present	NOAA
Myakka River Watershed	April, 1981 to present	SWFWMD Report

Table 1 – Rainfall Stations Reviewed

Figure 4 identifies the locations of the National Oceanic & Atmospheric Administration (NOAA) rainfall monitoring sites located within the vicinity of the Deer Prairie watershed.

Data from Site 336 provided the most complete rainfall record for the Deer Prairie watershed flow period of record (April 1981 to the present). Because of its location in the Deer Prairie watershed, rainfall from this site was used exclusively from April 1981 through March 1991; and July 1991 through December 1992. Since Site 336 appeared to be having reporting problems in April, May and the early part of June of 1991 rainfall data from Site 194 was used for these three (3) months.

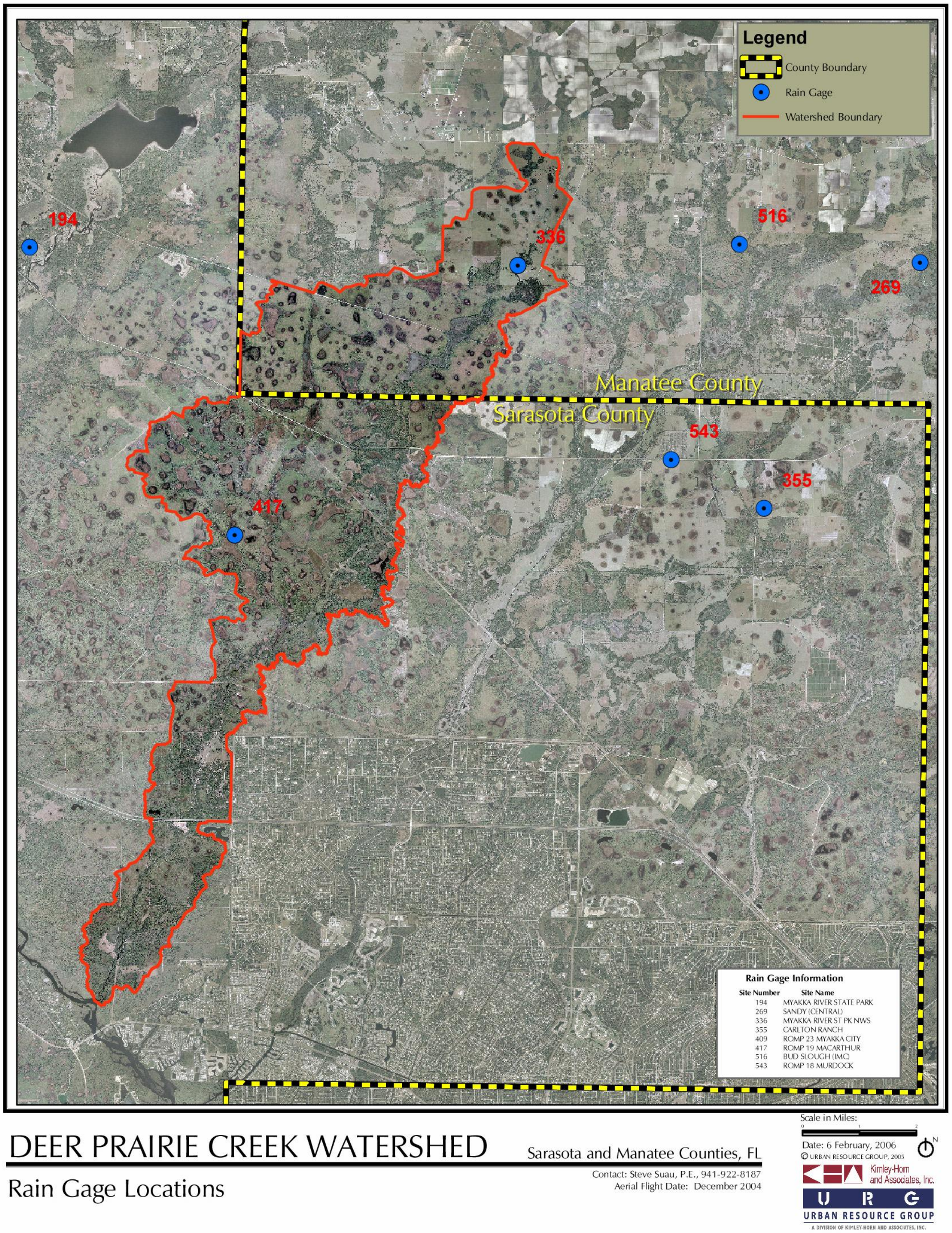


Figure 4 – NOAA Rainfall Station Locations

From January 1993 to present, Sarasota County Government (SCG) has rainfall measurements at up to 12 locations in the vicinity of their Deer Prairie Creek watershed. These sites are part of a radio telemetry network of stations known as the Automated Rainfall Monitoring System (ARMS). Jeffrey Banner of SCG Environmental Services manages the ARMS system, and provided average monthly rainfall totals from these rainfall monitoring sites located in the vicinity of the Deer Prairie Creek watershed.

The ARMS data provided by SCG was averaged with Sites 336 and 417, as available and used to reflect monthly rainfall from January 1993 through December 2005. A summary of rainfall data employed for the Deer Prairie water budget analysis is presented in **Table 2**.

Period	Data Base Used
April, 1981 through March, 1991	Site 336
April, 1991 through June, 1991	Site 194
July, 1991 through December, 1992	Site 336
January, 1993 through December, 2005	ARMS, Site 417, Site 336

Table 2 – Rainfall Data for Deer Prairie

4.0 RUNOFF

Hydrologic flow data from four (4) sites in the Deer Prairie Creek watershed from April 1 1981 through December 2005 were reviewed and analyzed to determine monthly runoff volumes. The site identification, dates of operation, entity responsible for operation, and contributing area are inventoried on **Table 3**. SCG ARMS site DPS-2 and USGS site 02299120 are located at approximately the same location but during different periods of record. All flow monitoring sites are presented on **Figure 5**.

Site Identification	Period of Record	Operation Entity	Contributing Area
02299160	04/01/81 through 09/30/92	USGS	20,017.4 acres
02299120	10/01/93 through 01/29/03	USGS	19,227.7 acres
02299060	10/01/93 through 01/27/03	USGS	6,577.5 acres
DPS-2	06/04/04 to 12/31/05 (1)	Sarasota County	19,227.7 acres

(1) Data from August 18, 2004 through October 11, 2004 not reported.

Table 3 – Stream Flow Stations in the Deer Prairie Creek Watershed

The downstream extent of the contributing area at each gage was determined using subbasin delineations provided by SCG for the portion of the Deer Prairie Creek watershed located in Sarasota County. The upstream extent of the contributing area at each gage is based upon the overall watershed boundary.

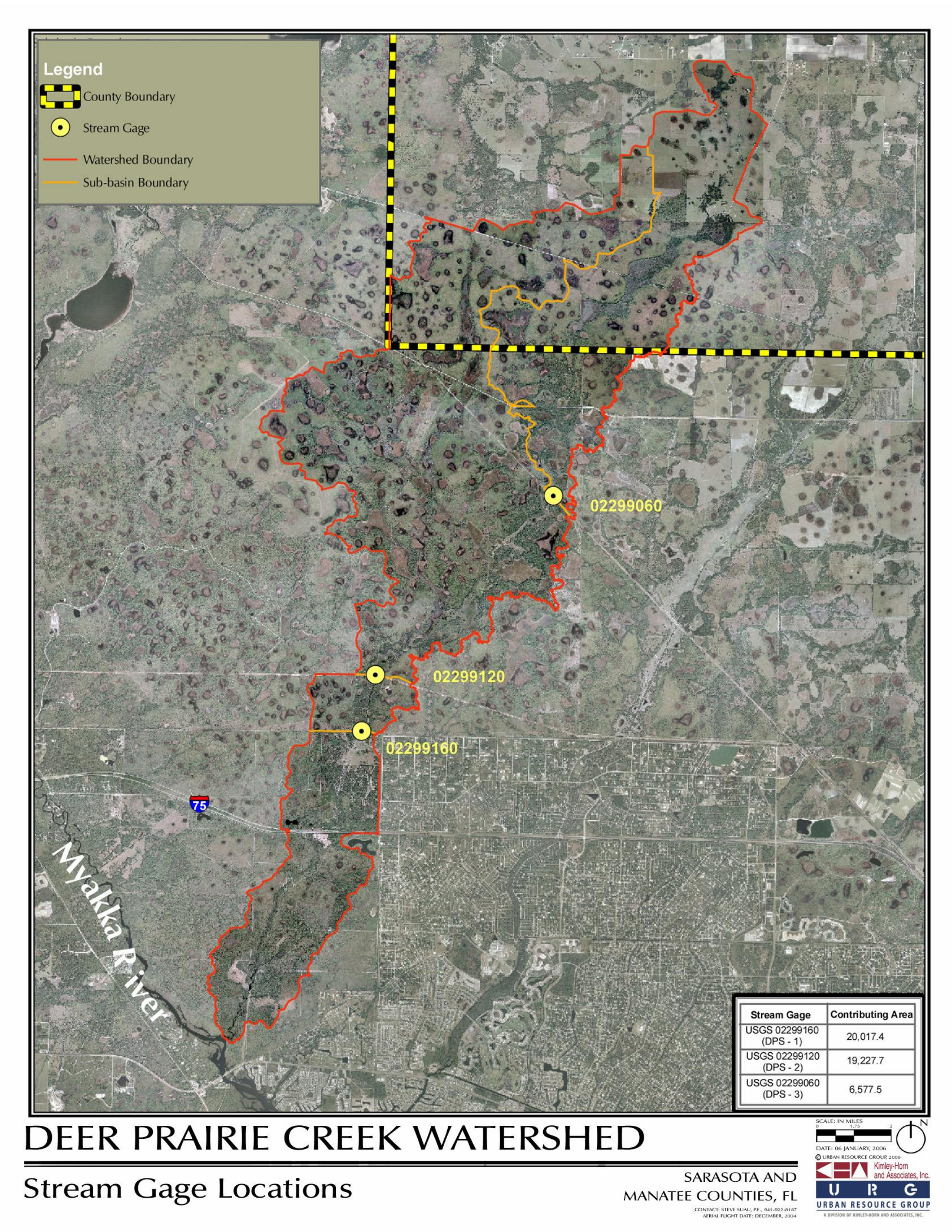


Figure 5 – Stream Gage Station Locations

From **Figure 5**, it can be seen that Site 02299120 is located downstream of Site 02299060. Therefore, flows measured at Site 02299120 include those from Site 02299060. A comparison of measured runoff volumes at these 2 sites indicated that with a couple of exceptions, Site 02299120 consistently reported higher volumes. In light of this comparison, and since the period of record for these two (2) sites is the same, it was decided to use data from Site 02299120 as indicative of the Deer Prairie watershed. **Table 4** provides a summary of stream flow data used for the Deer Prairie Creek water budget analysis.

Period	**Data Base Used**
April 1981 through September 1992	Site 02299160
October 1993 through December 2002	Site 02299120
June 2004 through December 2005	ARMS, Site DPS-2

Table 4 – Stream Flow Data for Deer Prairie

Through a separate contract with SCG, John Coffin with Hydrologic Data, Inc. is developing stage-discharge rating curves at DPS-2 and provided summary tables of flows for the ARMS stage data collected at this monitoring site. For the purpose of this analysis, KHA has relied upon the hourly data collected and provided by SCG and VHB.

Computation of hourly and monthly runoff volumes – Once flows were determined for the entire data base record, runoff volumes (in inches) were computed by averaging hourly flows, converting it to acre-inches, and dividing them by the contributing area in acres. Monthly runoff volumes were computed as the sum of the hourly runoff volumes for each month.

5.0 MONTHLY WATER BUDGET ANALYSES

Table 5 and **Table 6** summarize the monthly rainfall and runoff volumes in inches, respectively, during the study period. Cells highlighted in red correspond to periods with no or incomplete runoff records.

RAINFALL	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1981	0.66	5.88	1.53	0.00	1.91	15.77	8.17	19.85	5.96	1.78	4.87	1.19	
1982	2.06	2.67	6.62	5.05	2.81	15.61	13.24	11.73	11.98	3.24	0.69	1.02	76.72
1983	2.71	9.55	7.81	2.72	1.99	9.33	11.89	7.41	11.67	2.66	4.42	8.20	80.36
1984	1.00	2.44	5.41	3.31	4.29	2.87	15.47	7.29	4.19	2.76	2.36	0.36	51.75
1985	0.81	0.97	2.80	2.09	0.23	5.58	7.46	9.10	9.59	1.91	3.08	0.41	44.03
1986	1.79	1.66	4.40	0.97	1.94	7.53	5.58	7.09	2.40	5.92	1.31	3.53	44.12
1987	4.96	2.54	12.88	0.02	5.57	7.63	9.90	9.51	8.16	4.41	4.12	0.19	69.89
1988	4.49	2.41	5.17	1.66	2.63	3.20	8.67	15.62	11.47	2.14	3.43	1.21	62.10
1989	2.83	0.23	1.02	0.73	1.26	7.68	9.61	5.58	6.89	3.96	1.87	4.23	45.89
1990	0.17	3.67	1.68	0.96	3.57	7.89	10.34	7.20	2.74	5.90	0.88	0.55	45.55
1991	5.42	2.40	4.38	2.70	11.62	7.85	11.04	3.44	3.76	2.35	0.03	0.10	55.09
1992	1.12	4.55	2.85	3.19	0.80	26.16	3.47	10.51	4.48	2.75	0.84	0.80	
1993	7.63	2.85	4.53	6.51	2.62	3.39	5.02	6.83	4.31	5.43	0.24	0.75	
1994	3.67	0.76	2.19	3.08	0.31	8.87	11.33	9.03	13.26	5.15	1.08	1.85	60.58
1995	2.88	1.73	1.20	3.64	0.56	17.53	16.06	13.00	10.49	9.06	1.25	1.31	78.70
1996	3.85	1.09	4.81	2.00	5.87	5.24	4.81	7.30	4.44	4.02	0.23	1.91	45.56
1997	1.72	0.98	2.41	8.22	3.16	5.20	11.22	6.67	11.33	3.53	6.34	9.49	70.26
1998	4.86	7.49	9.80	0.09	2.44	4.57	9.40	8.60	9.30	2.47	4.13	1.01	64.16
1999	4.66	0.03	1.58	0.60	2.38	9.69	7.95	12.78	7.56	5.43	0.67	2.18	55.51
2000	2.72	0.54	2.20	1.99	0.48	10.39	7.41	11.03	7.96	0.49	0.92	1.01	47.14
2001	0.32	0.01	7.42	0.20	1.72	11.71	15.54	6.40	15.28	2.68	0.05	0.56	61.89
2002	2.39	5.24	0.32	2.61	2.78	8.34	7.22	10.97	4.26	2.94	4.40	5.63	57.09
2003	0.82	1.28	2.25	3.89	3.82	17.93	7.23	15.78	9.95	0.93	1.05	4.79	
2004	2.24	4.25	0.79	2.66	0.63	8.51	12.03	13.95	7.17	2.14	1.52	2.96	
2005	2.70	1.91	5.97	3.04	5.13	16.19	9.50	5.21	2.94	7.65	3.14	1.02	64.40
Average	**2.72**	**2.52**	**4.42**	**2.22**	**2.88**	**9.71**	**9.88**	**9.33**	**7.73**	**3.90**	**2.22**	**2.20**	**59.75**

Table 5 – Summary of Monthly Rainfall (in inches) for Deer Prairie Watershed

RUNOFF	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1981				0.00	0.00	0.08	0.14	3.79	3.90	0.33	0.08	0.01	
1982	0.01	0.00	0.03	0.07	0.01	3.70	4.67	2.79	2.42	4.90	0.31	0.04	18.95
1983	0.03	2.01	5.07	1.16	0.04	0.31	1.59	2.35	6.30	1.77	0.60	2.12	23.34
1984	1.04	0.37	1.44	0.69	0.07	0.03	0.16	0.63	0.07	0.03	0.01	0.00	4.53
1985	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.40	1.59	0.20	0.09	0.02	2.33
1986	0.01	0.01	0.06	0.01	0.00	0.22	0.42	0.68	2.49	0.49	0.61	0.63	5.65
1987	3.00	0.39	1.46	3.23	0.20	0.11	1.11	1.42	0.83	0.50	0.22	0.14	12.60
1988	0.11	0.19	0.77	0.35	0.13	0.03	0.02	0.13	7.52	0.23	0.10	0.06	9.65
1989	0.04	0.02	0.04	0.00	0.00	0.00	0.09	0.84	0.74	0.29	0.07	0.09	2.22
1990	0.13	0.06	0.02	0.00	0.00	0.13	0.12	0.10	0.01	0.05	0.00	0.00	0.63
1991	0.01	0.01	0.04	0.16	1.43	1.70	4.53	2.63	0.26	0.28	0.06	0.00	11.11
1992	0.00	0.00	0.00	0.01	0.00	4.03	4.40	3.53	2.25				
1993										0.19	0.34	0.04	
1994	0.05	0.02	0.01	0.01	0.00	0.04	1.39	3.60	8.32	4.46	0.86	0.28	19.05
1995	0.23	0.13	0.07	0.01	0.00	2.20	7.27	9.79	8.09	8.13	1.56	0.10	37.58
1996	0.45	0.11	0.05	0.03	0.04	0.12	0.05	0.74	0.13	1.00	0.04	0.02	2.78
1997	0.02	0.01	0.05	0.21	0.16	0.02	1.33	2.86	1.76	2.75	3.05	6.82	19.03
1998	4.48	4.38	6.08	1.00	0.01	0.00	0.06	0.84	2.50	1.67	1.25	0.29	22.55
1999	0.25	0.13	0.03	0.00	0.00	0.11	1.39	3.90	2.99	3.65	0.18	0.06	12.70
2000	0.03	0.02	0.00	0.00	0.00	0.01	0.10	3.15	2.74	0.77	0.04	0.00	6.87
2001	0.06	0.05	0.01	0.00	0.00	0.03	0.20	6.30	5.48	1.53	0.08	0.00	13.74
2002	0.00	0.00	0.00	0.00	0.00	0.00	4.74	5.95	7.79	0.55	0.17	0.00	19.20
2003													
2004						0.00	0.54				0.10	0.01	
2005	0.08	0.02	0.60	0.46	0.04	7.84	4.00	1.77	0.41	0.67	0.49	0.22	16.59
Average	**0.48**	**0.38**	**0.75**	**0.34**	**0.10**	**0.90**	**1.67**	**2.65**	**3.12**	**1.57**	**0.45**	**0.48**	**12.86**

Table 6 – Summary of Monthly Runoff (in inches) for Deer Prairie Watershed

Using average monthly rainfall and runoff presented in Tables 5 and 6, average monthly water budgets were developed for the Deer Prairie Creek watershed and are presented in **Table 7**. Monthly rainfall in the Myakka River watershed during the study period (as reported by the SWFWMD), the ratio of monthly runoff to monthly rainfall, and evapotransiration plus change in storage are also provided in **Table 7**.

During the flow period of study, the annual rainfall within the Deer Prairie watershed averaged over 3 inches more than the annual rainfall reported by SWFWMD in the Myakka River watershed, as a whole.

DEER PRAIRIE WATER BUDGET					
	1	2	3	4	5
	Annual Average	Average Monthly	Average Monthly	R/P	Average Monthly
MONTH	RAINFALL	RAINFALL	RUNOFF		ET + STORAGE
	(in inches)	(in inches)	(in inches)		(in inches)
January	2.46	2.72	0.48	0.18	2.24
February	2.55	2.52	0.38	0.15	2.14
March	4.14	4.42	0.75	0.17	3.67
April	2.36	2.22	0.34	0.15	1.88
May	2.91	2.88	0.10	0.03	2.79
June	9.28	9.71	0.90	0.09	8.81
July	8.93	9.88	1.67	0.17	8.21
August	8.46	9.33	2.65	0.28	6.69
September	7.41	7.73	3.12	0.40	4.61
October	3.51	3.90	1.57	0.40	2.34
November	2.07	2.22	0.45	0.20	1.77
December	2.19	2.20	0.48	0.22	1.73
TOTAL	56.27	**59.75**	**12.86**	0.22	46.89

Table 7 – Deer Prairie Water Budget

Where:

1 = Mean Annual Rainfall for the Myakka River Watershed (SWFWMD)
2 = Average Rainfall for Deer Prairie Watershed (1981 to Present)
3 = Average Runoff from Deer Prairie Watershed (1981 to Present)
4 = Average Runoff divided by Rainfall (Column 3 divided by Column 2)
5 = Evapotranspiration plus Change in Storage (Column 2 minus Column 3)

Figure 6 presents a comparison of average monthly rainfall and runoff volumes between April 1981 and December 2005 for the Deer Prairie watershed.

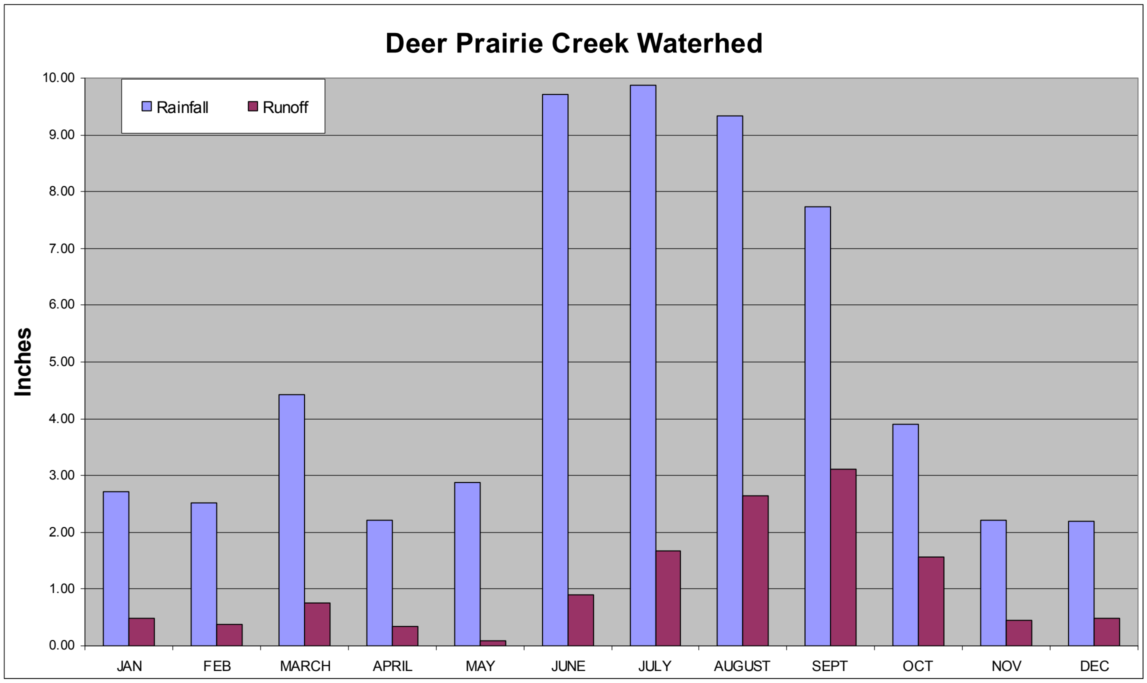


Figure 6 – Deer Prairie Watershed Average Monthly Runoff Conversion

Rainfall and runoff totals for each month for the period of record were plotted to determine if a reliable relationship existed. The results of these plots are provided in **Figure 7** through **Figure 18**. **Table 8** provides a summary of the equations developed for the monthly rainfall/runoff data and the "R" squared value for each equation.

As indicated in **Table 8**, only two months (May and December) resulted in "reliable" best fit equations correlating rainfall to runoff. In fact with 'R" squared values over 0.90, the rainfall/runoff equations for these two months should be quite reliable. However, the rainfall/runoff best fit equations for all other months resulted in "R" squared values under 0.70, with most being under 0.50.

A review of rainfall/runoff data in monthly increments indicated numerous instances where either the rainfall or runoff caused by rainfall, "bleeded" over from the preceding month. Therefore, it was concluded that segmenting water budgets into monthly partitions is too discrete an increment.

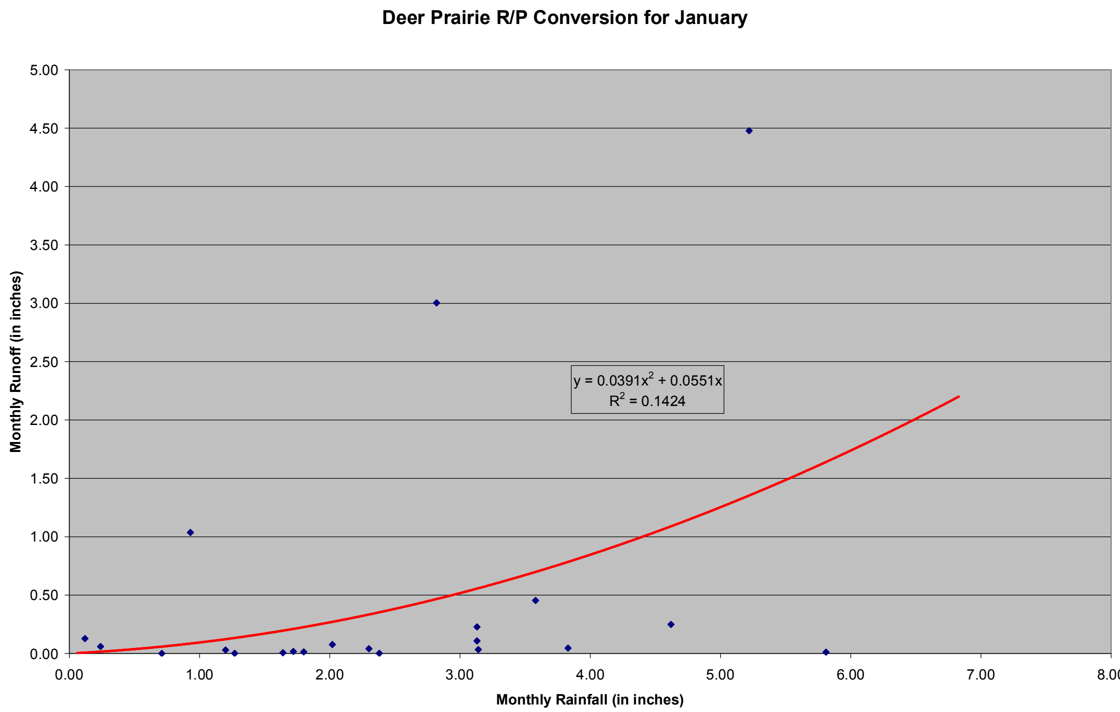


Figure 7 – Deer Prairie Watershed, Runoff vs. Rainfall for January

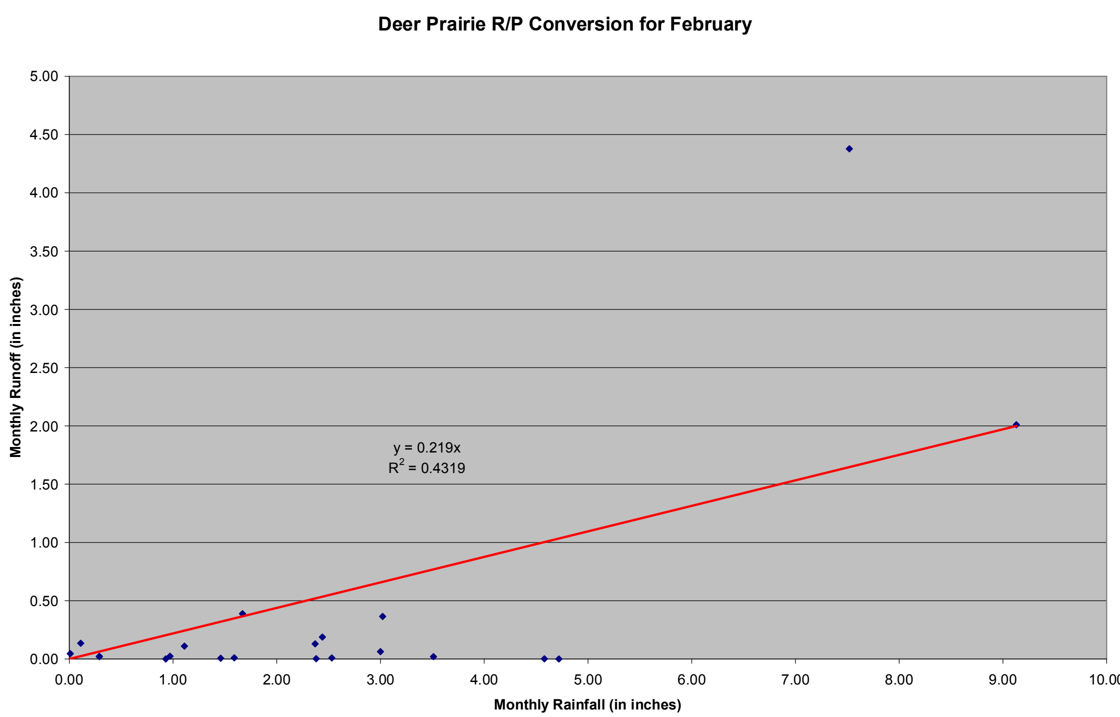


Figure 8 – Deer Prairie Watershed, Rainfall vs. Runoff for February

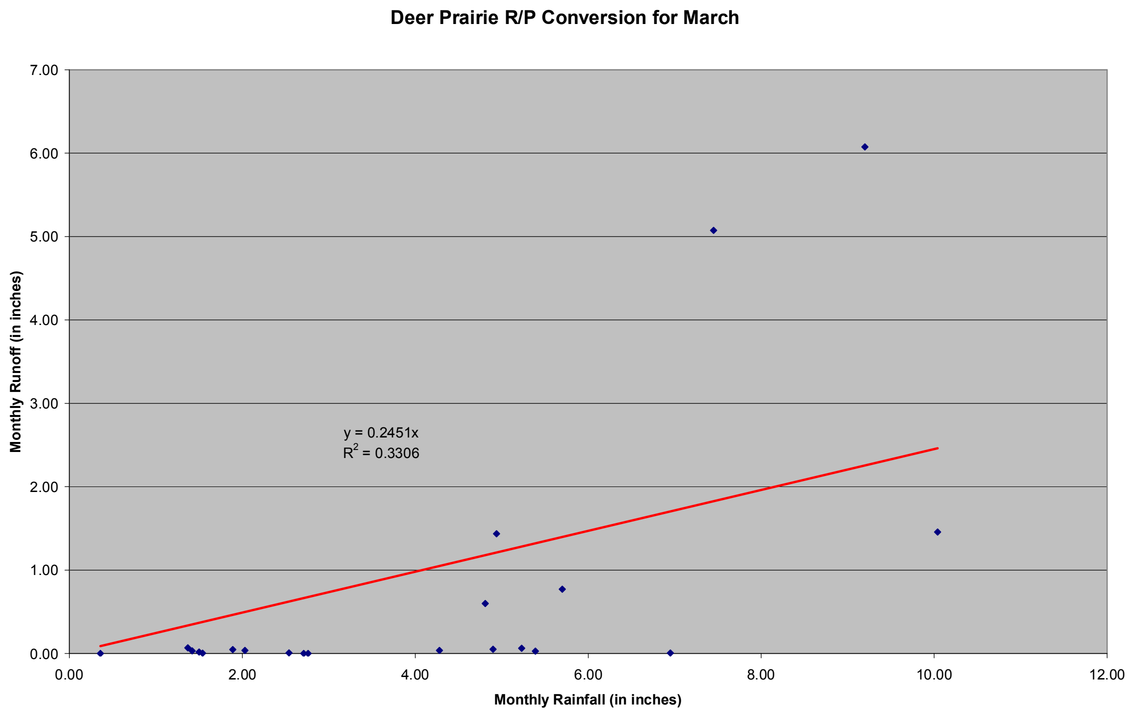


Figure 9 – Deer Prairie Watershed, Rainfall vs. Runoff for March

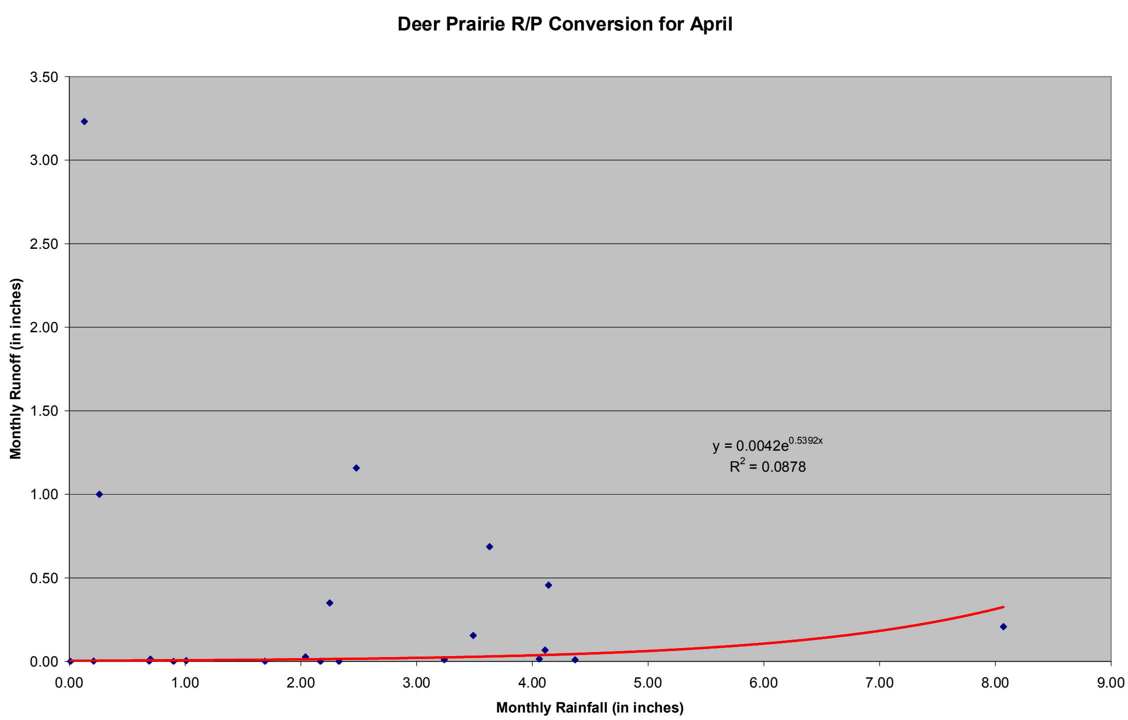


Figure 10 – Deer Prairie Watershed, Rainfall vs. Runoff for April

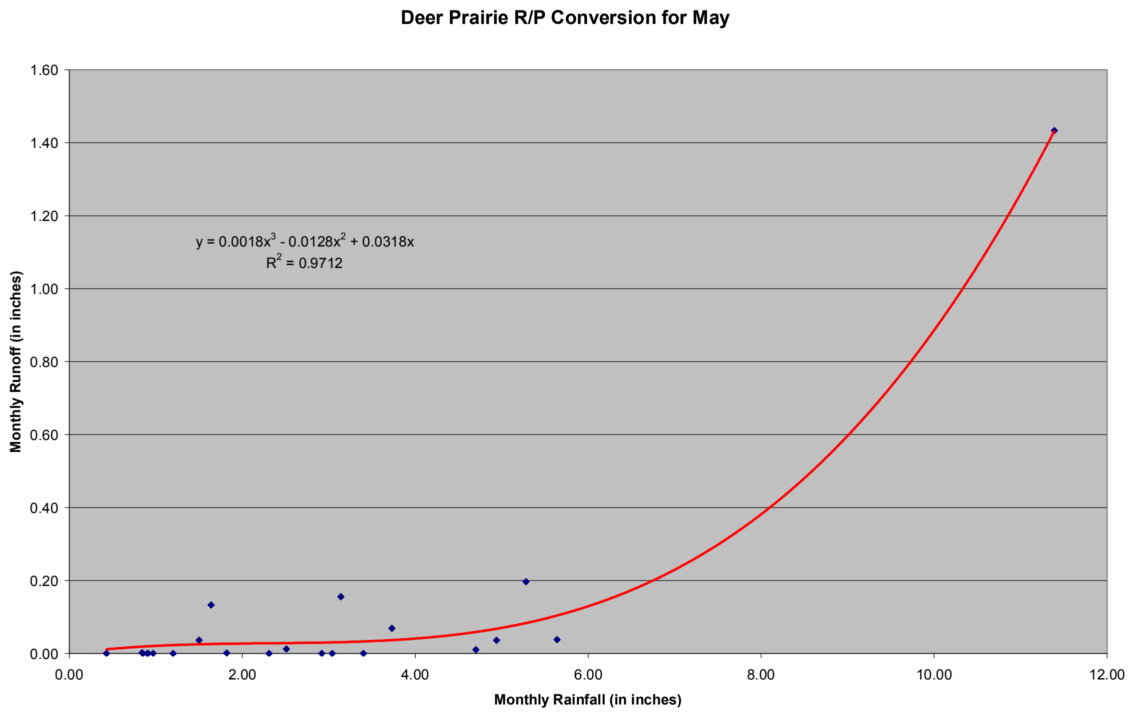


Figure 11 – Deer Prairie Watershed, Rainfall vs. Runoff for May

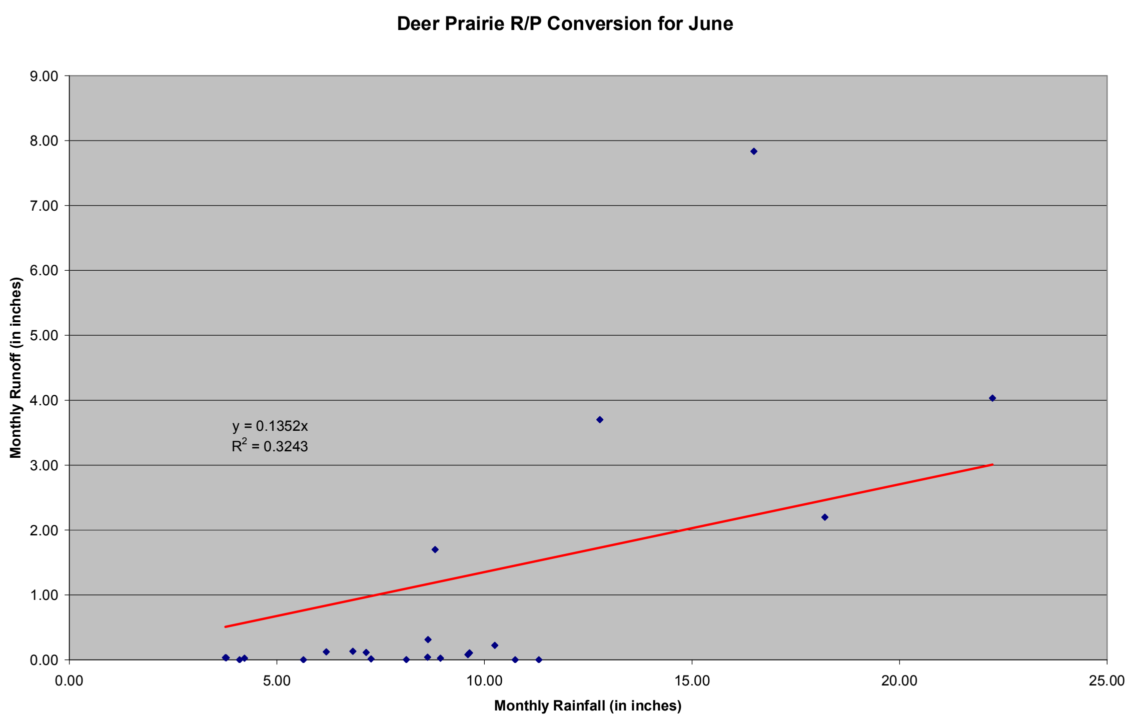


Figure 12 – Deer Prairie Watershed, Rainfall vs. Runoff for June

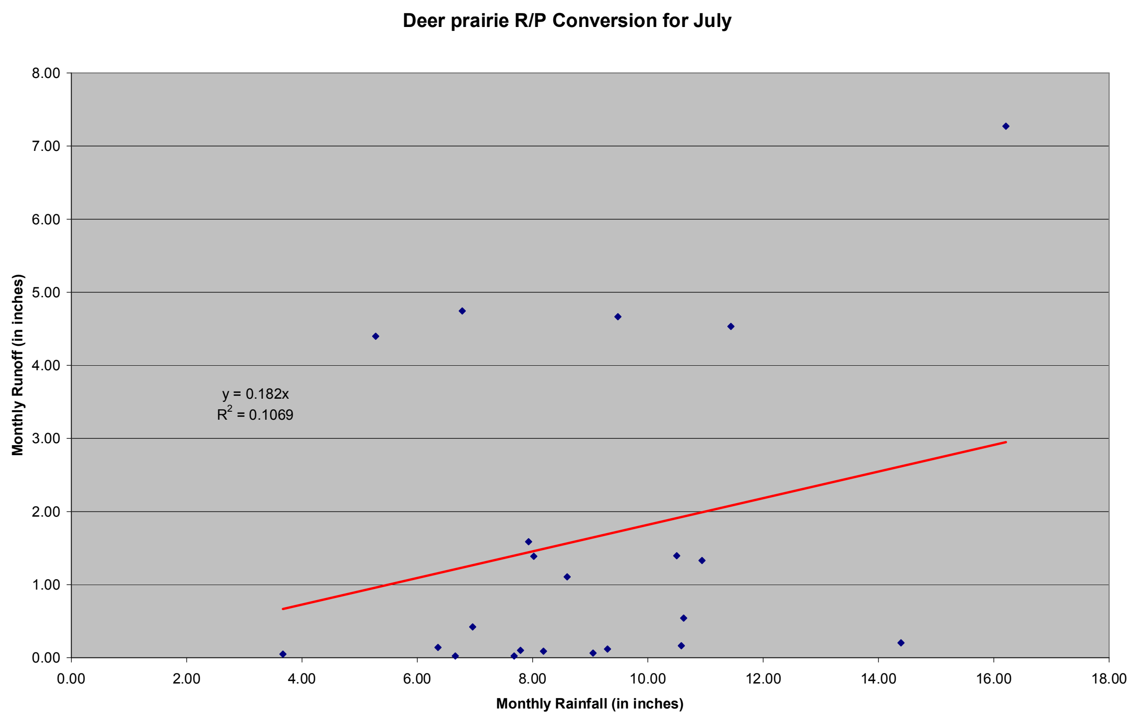


Figure 13 – Deer Prairie Watershed, Rainfall vs. Runoff for July

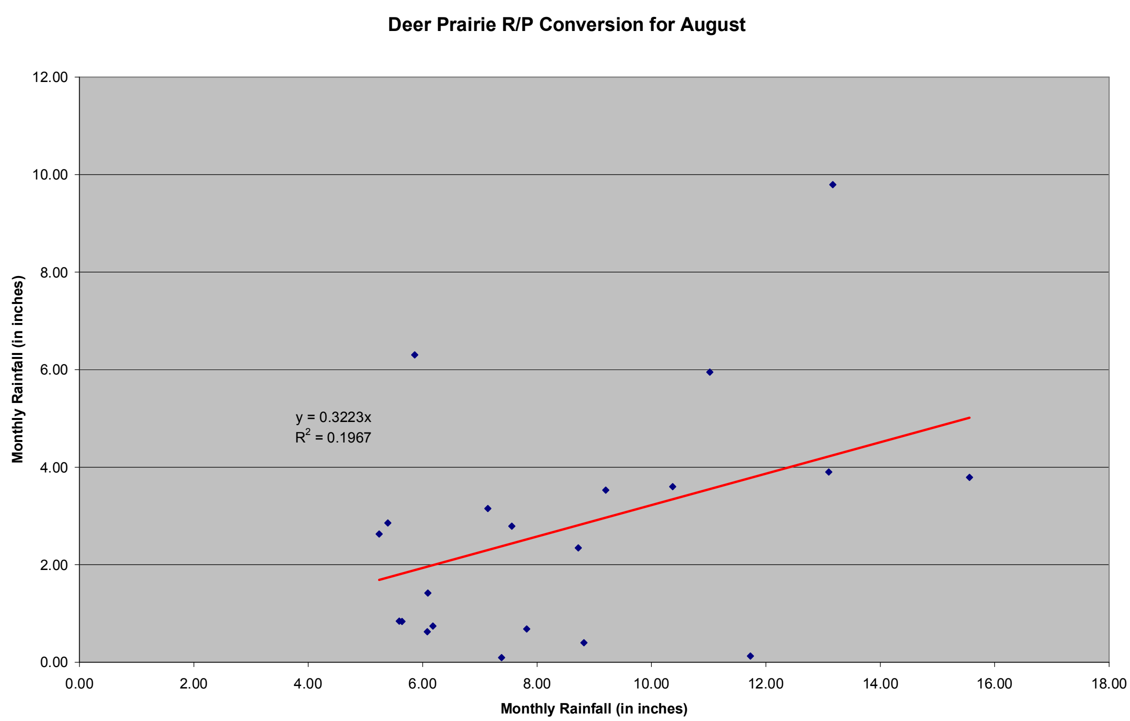


Figure 14 – Deer Prairie Watershed, Rainfall vs. Runoff for August

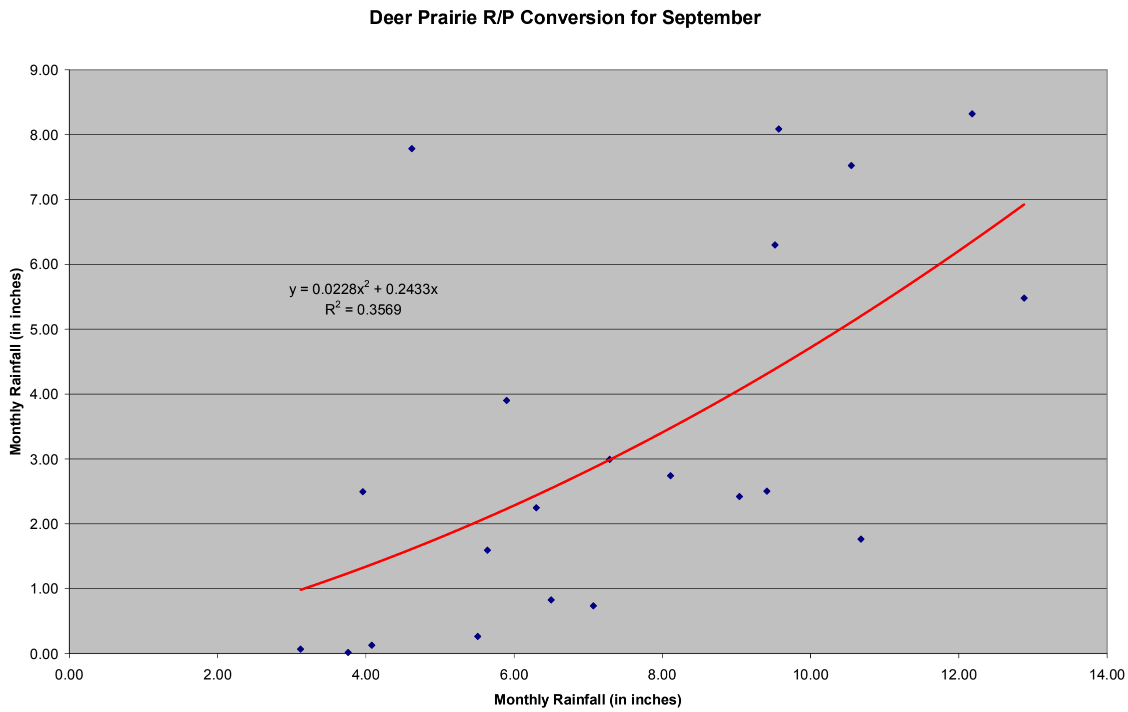


Figure 15 – Deer Prairie Watershed, Rainfall vs. Runoff for September

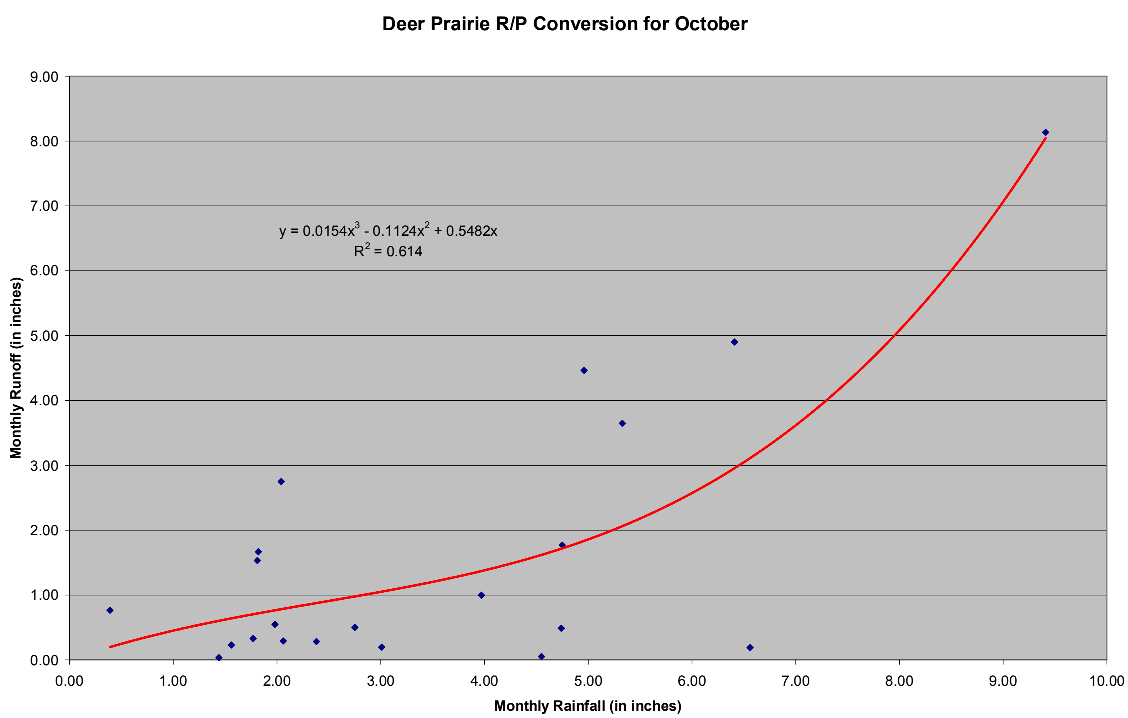


Figure 16 – Deer Prairie Watershed, Rainfall vs. Runoff for October

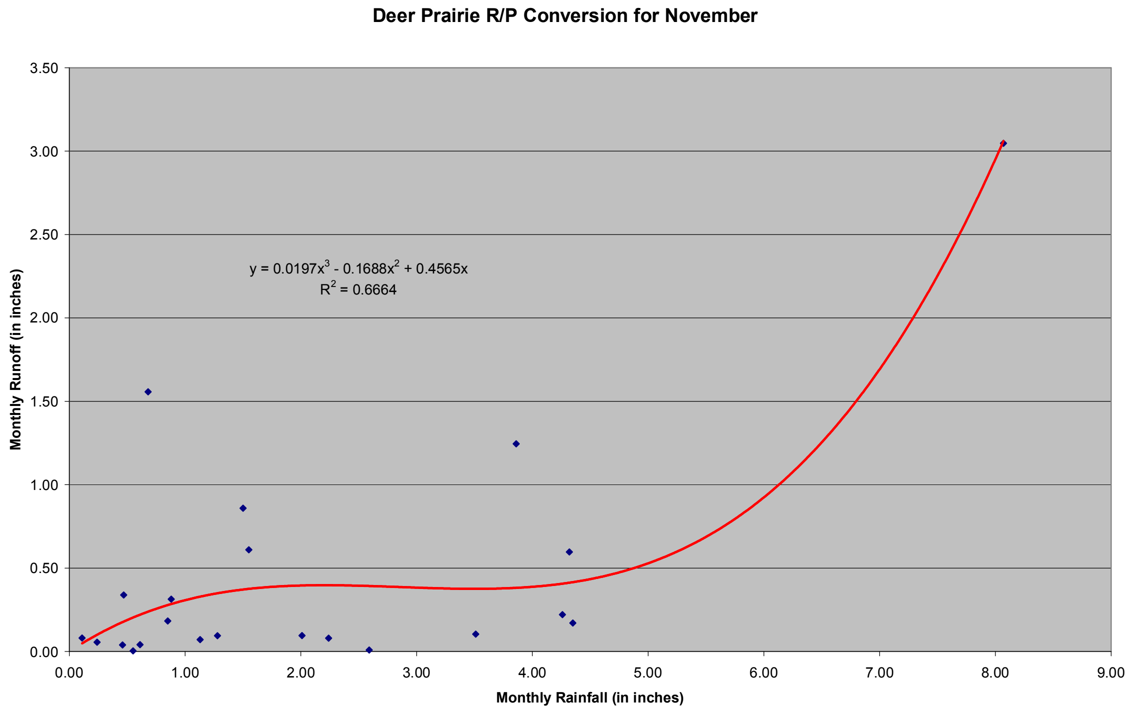


Figure 17 – Deer Prairie Watershed, Rainfall vs. Runoff for November

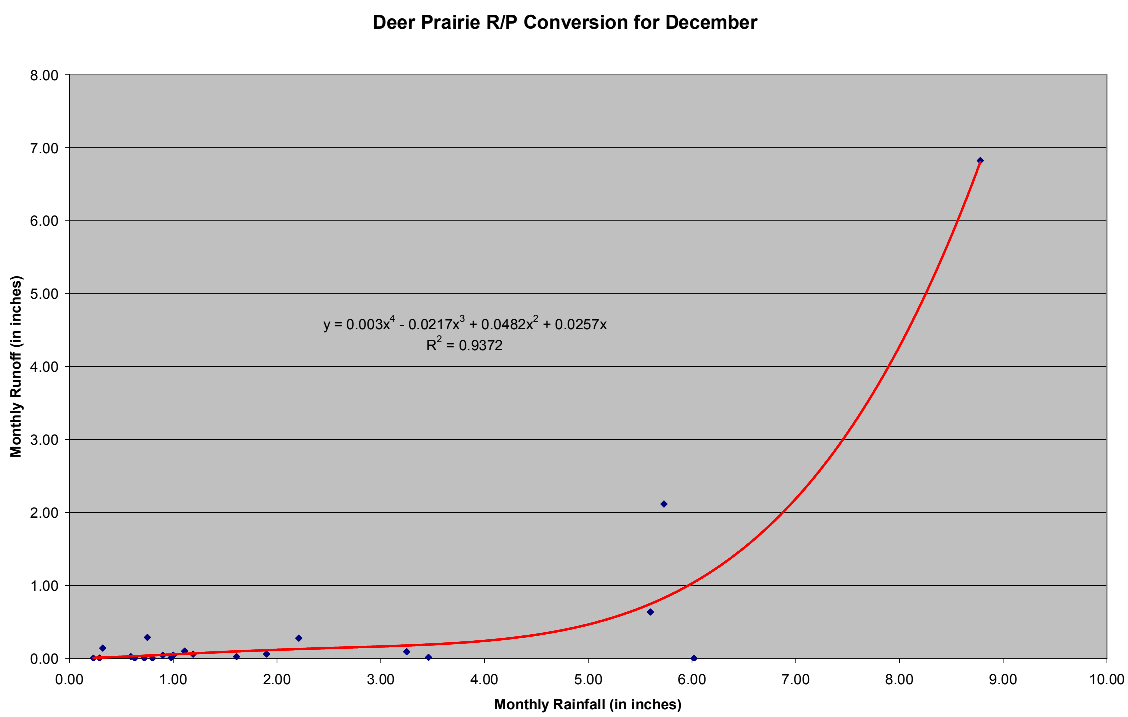


Figure 18 – Deer Prairie Watershed, Rainfall vs. Runoff for December

Month	Equation	R "squared"
January	y = 0.0391x2 + 0.0551x	R2 = 0.1424
February	y = 0.219x	R2 = 0.4319
March	y = 0.2451x	R2 = 0.3306
April	y = 0.0042e0.5392x	R2 = 0.0878
May	y = 0.0018x3 - 0.0128x2 + 0.0318x	R2 = 0.9712
June	y = 0.1352x	R2 = 0.3243
July	y = 0.182x	R2 = 0.1069
August	y = 0.3223x	R2 = 0.1967
September	y = 0.0228x2 + 0.2433x	R2 = 0.3569
October	y = 0.0154x3 - 0.1124x2 + 0.5482x	R2 = 0.614
November	y = 0.0197x3 - 0.1688x2 + 0.4565x	R2 = 0.6664
December	y = 0.003x4 - 0.0227x3 + 0.0482x2 + 0.0257x	R2 = 0.9372

Table 8 – Deer Prairie Watershed, Monthly Rainfall vs. Runoff Equations

6.0 SEASONAL BLOCK ANALYSIS

As indicated, due to the periodic occurrence of rainfall and/or runoff "bleeding" over from one month to the next, it was not possible to develop conclusive predictive relationships between rainfall and runoff on a month to month basis. Therefore, it may be concluded that "seasonal" rainfall and runoff cycles do not necessarily coincide with the narrow level of discretion coinciding to ±30 day periods defined the calendar months. On the other hand, developing water budgets based upon an annual basis spans too broad a period of time to be meaningful.

Pursuant to Additional Services No. 3, the recent seasonal "block" period used by the Southwest Florida Water Management District for the *Proposed Minimum Flows and Levels for the Upper Segment of the Myakka River, from Myakka City to SR 72* was considered to define the rainfall and runoff relationship for the Deer Prairie data base. The 3 seasonal blocks considered are defined as follows:

BLOCK 1 – April 20th through June 24th
BLOCK 2 – October 28th through April 19th
BLOCK 3 – June 25th through October 27th

The results of the seasonal "block" analyses for the Deer Prairie study period are provided in **Table 9** through **Table 11**. **Figure 19** through **Figure 21** present plots of rainfall and runoff for each of the seasonal blocks. **Table 12** presents the best fit runoff/rainfall equations for each seasonal block. These equations consistently resulted in an "R" squared greater than 0.80.

Block 1	Rainfall	Runoff
1981	15.31	0.03
1982	20.80	2.77
1983	6.79	0.35
1984	7.14	0.19
1985	6.20	0.00
1986	8.59	0.09
1987	11.79	0.46
1988	7.23	0.25
1989	7.86	0.00
1990	9.36	0.12
1991	16.22	2.90
1992	7.42	0.01
1994	10.76	0.04
1995	20.55	0.27
1996	11.54	0.13
1997	13.03	0.36
1998	4.73	0.05
1999	11.85	0.05
2000	7.54	0.00
2001	10.73	0.00
2002	8.95	0.00
2005	23.99	7.33
Average	**11.29**	**0.70**

Table 9

Block 2	Rainfall	Runoff
1981	19.59	0.18
1982	24.40	8.64
1983	24.69	6.21
1984	10.17	0.02
1985	12.50	0.23
1986	26.89	9.21
1987	16.64	1.73
1988	9.22	0.27
1989	12.58	0.40
1990	13.63	0.19
1991	10.74	0.09
1993	9.69	0.54
1994	12.12	1.72
1995	14.54	2.74
1996	9.91	0.16
1997	41.28	25.80
1998	11.59	2.03
1999	10.72	0.43
2000	9.60	0.13
2001	11.70	0.25
2004	16.40	1.27
Average	**15.65**	**2.96**

Table 10

Block 3	Rainfall	Runoff
1981	37.11	8.21
1982	41.70	15.62
1983	38.26	12.05
1984	28.46	0.89
1985	27.82	2.20
1986	20.46	4.15
1987	33.39	3.84
1988	37.90	7.90
1989	27.35	1.94
1990	28.28	0.29
1991	25.51	7.95
1994	37.36	17.65
1995	49.55	34.78
1996	21.53	1.92
1997	34.01	8.69
1998	33.29	4.99
1999	30.58	11.91
2000	30.83	13.50
2001	43.23	18.96
2002	28.73	5.69
2005	29.19	7.18
Average	**32.60**	**9.06**

Table 11

As indicated in **Table 9** and **Figure 19**, rainfall between April 20 and June 24 generally varied between 5 and 15 inches, but in 2005 received a high of almost 24 inches. Runoff in seasonal block 1 typically was less than 0.5 inches, with a high of 7.33 inches in 2005.

Relative to seasonal block 2, **Table 10** and **Figure 20** indicate that rainfall between October 28 and April 19 generally varied between 9 and 25 inches, but with a high in the 1997 el-nino year of over 41 inches. Runoff in seasonal block 2 typically was less than 3.5 inches, with a high of 25.80 inches in 1997.

Finally, **Table 11** and **Figure 21** indicate that rainfall between June 25 and October 27 generally varied between 20 and 40 inches, with a high of almost 50 inches occurring in 1995. Runoff in seasonal block 3 typically was less than 20 inches, with a high of 34.78 inches in 1995.

In conclusion, the seasonal block analysis resulted in a marked improvement over the monthly analysis in the ability to predict runoff, given rainfall.

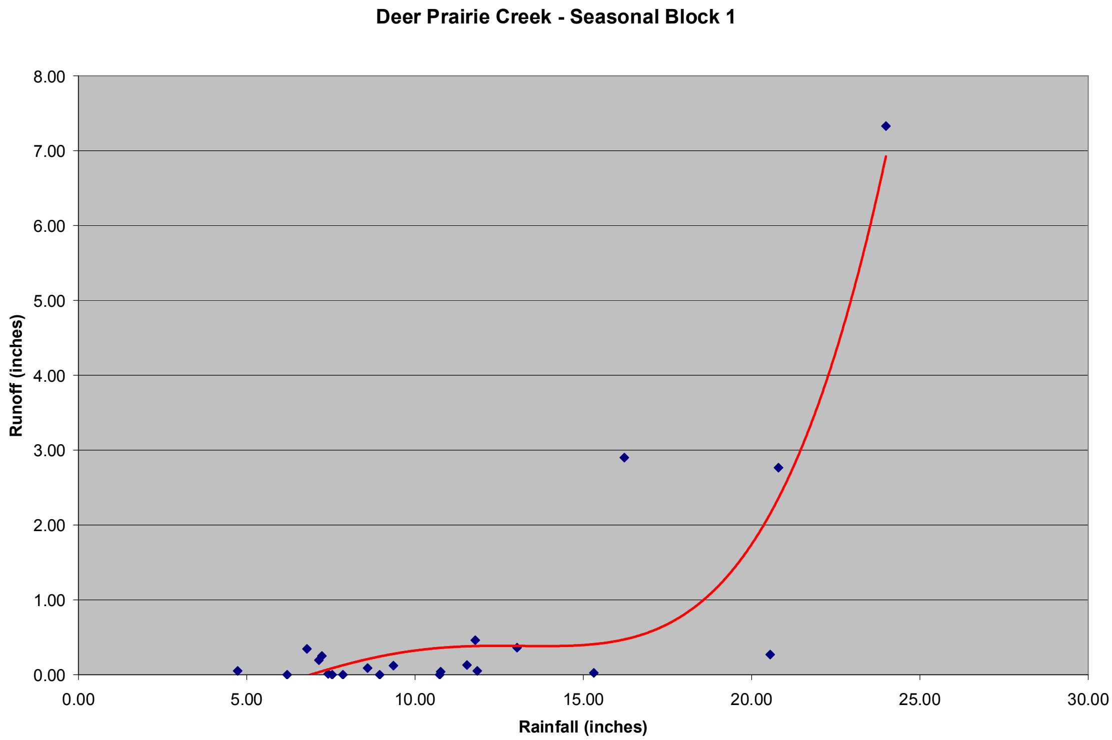


Figure 19 – Deer Prairie Watershed, Seasonal Block 1 Runoff vs. Rainfall

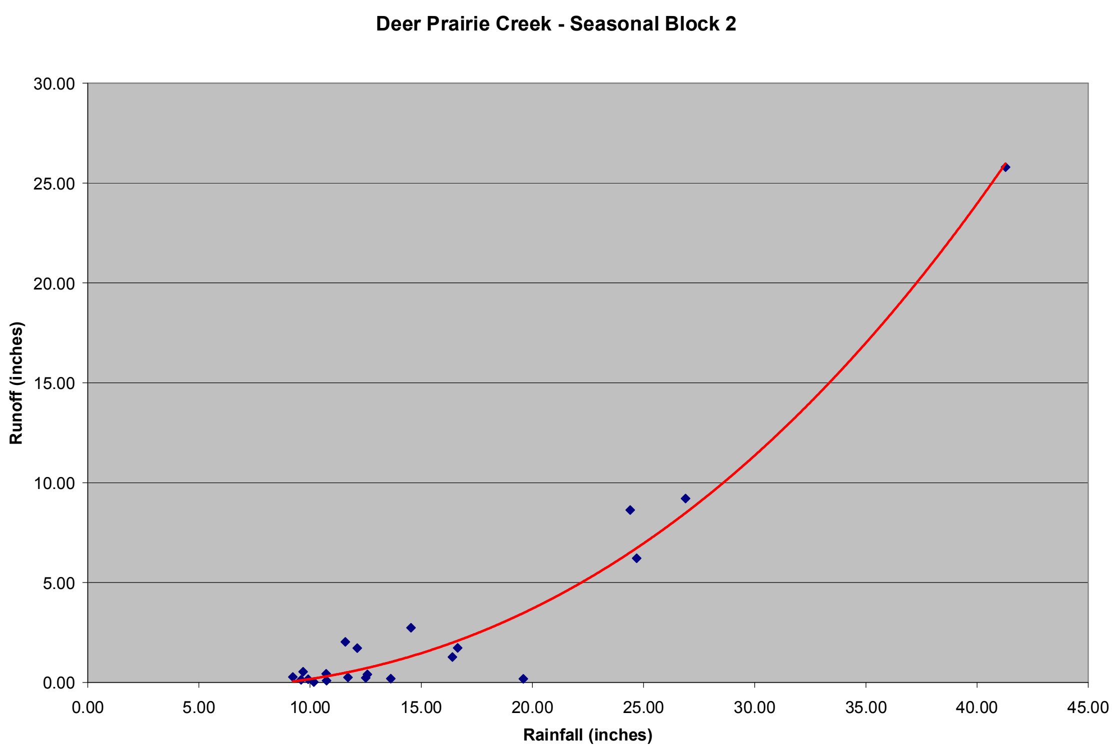


Figure 20 – Deer Prairie Watershed, Seasonal Block 2 Runoff vs. Rainfall

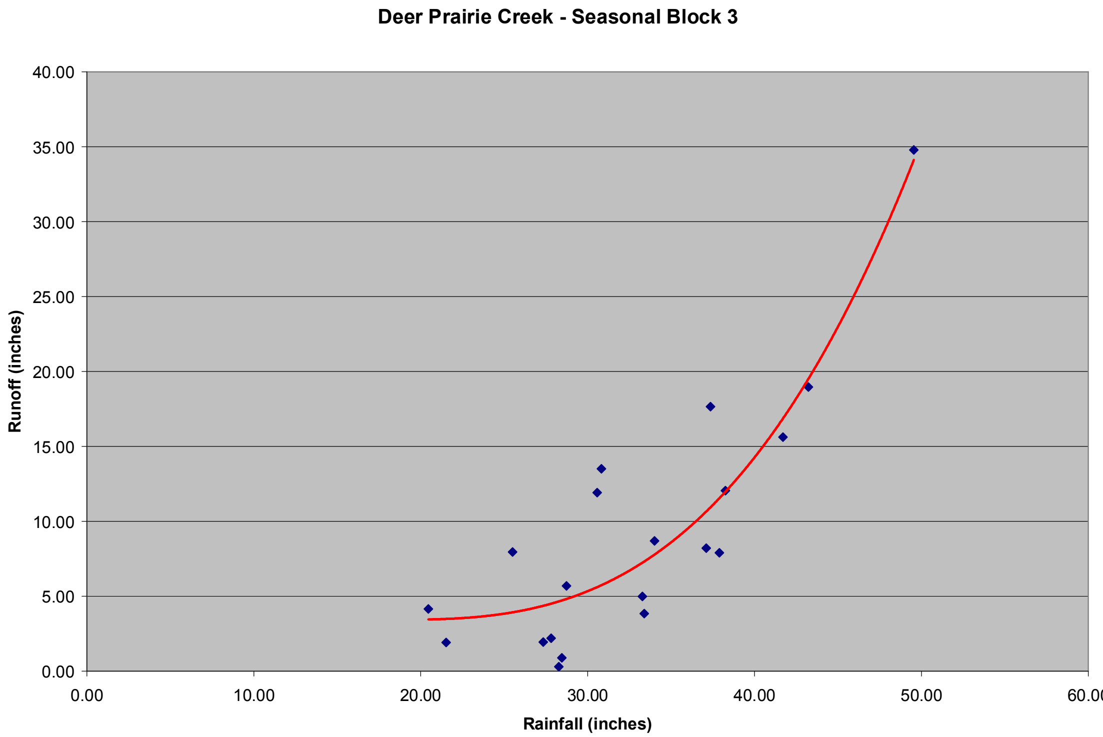


Figure 21 – Deer Prairie Watershed, Seasonal Block 3 Runoff vs. Rainfall

Seasonal Block	Equation	R "squared"
1	y = 0.000210132x4 - 0.0081255x3 + 0.10215x2 - 0.387x	R2 = 0.82
2	y = 0.0001323x3 + 0.01278x2 - 0.124x	R2 = 0.97
3	y = 0.0008651x3 - 0.04269x2 + 0.68x	R2 = 0.81

Table 12 - Deer Prairie Watershed, Seasonal Block Rainfall vs. Runoff Equations

7.0 ESTIMATION OF NATURAL WATER BUDGETS FOR THE HISTORICAL DONA BAY AND ROBERTS BAY WATERSHEDS

A comparison of the historic watershed areas for the Deer Prairie Creek watershed (upstream of USGS Gage location 02299160) and those for Dona Bay and Roberts Bay are presented in **Table 13**. Located within the same latitude range, the hydrologic setting of the historical Deer Prairie, Dona Bay, and Roberts Bay watersheds are also relatively similar in terms of soil types and dispersion, percent wetlands, topography and rainfall patterns. However, it is recognized that present day conditions for both the historical Dona Bay and Roberts Bay watersheds have been modified with coastal development and artificial drainage.

Watershed	**Area (acres)**
Deer Prairie	20,017.4
Dona Bay	10,064.6
Roberts Bay	9,700.3

Table 13 – Comparison of Historic Watersheds

The seasonal block equations developed relating rainfall to runoff in the relatively natural Deer Prairie Creek watershed were used to predict runoff to Dona and Roberts Bays from their respective historical watershed areas. Historical, daily rainfall from NOAA site 336 and dating back to 1944 was used with the seasonal block equations to predict the resulting seasonal runoff totals in inches/acre. This unit volume was then multiplied by the corresponding historical watershed areas to estimate the theoretical natural watershed runoff volumes, in acre-feet for the Dona Bay and Roberts Bay watersheds.

The results of the analyses for Dona Bay and Roberts Bay based upon a seasonal basis are presented graphically on **Figure 22** and **Figure 23**, respectively. **Figure 24** and **Figure 25** present the same results based upon a cumulative basis. These analyses are believed to be a reasonable representation of the amount of freshwater runoff based upon the historical areas and natural hydrologic setting for the Dona Bay and Roberts Bay watersheds, respectively.

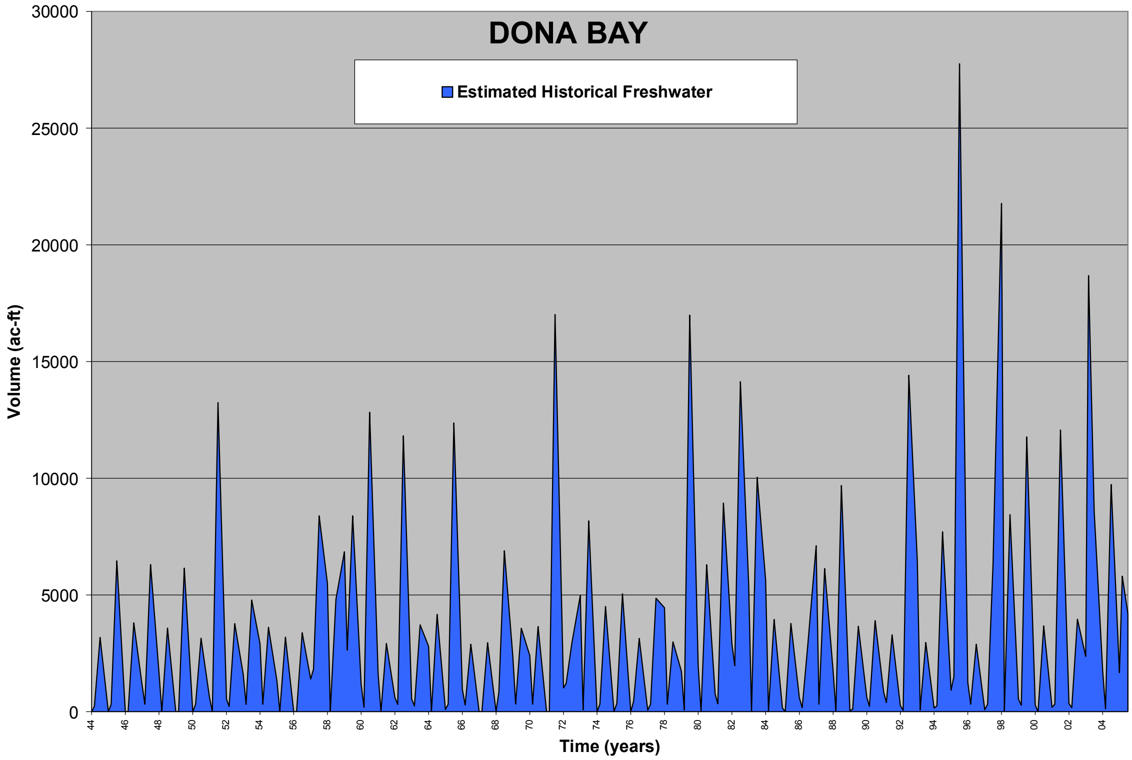


Figure 22 – Historical runoff to Dona Bay based upon seasonal block equations

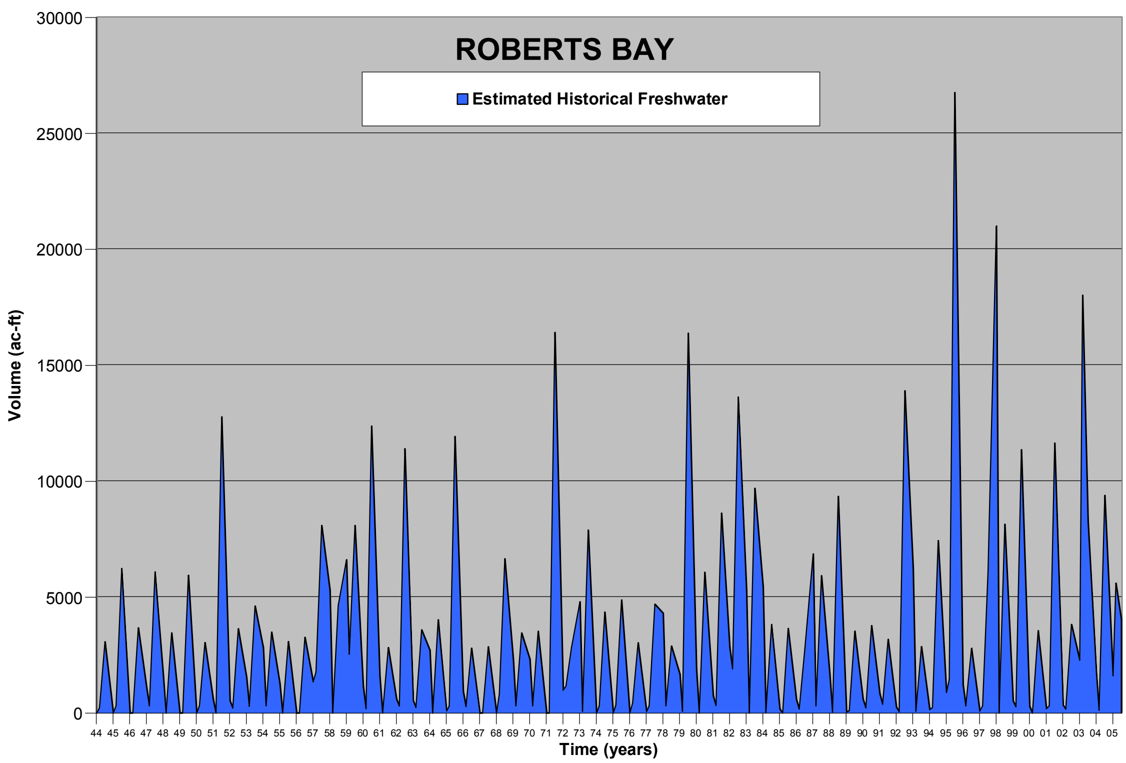


Figure 23 – Historical runoff to Roberts Bay based upon seasonal block equations

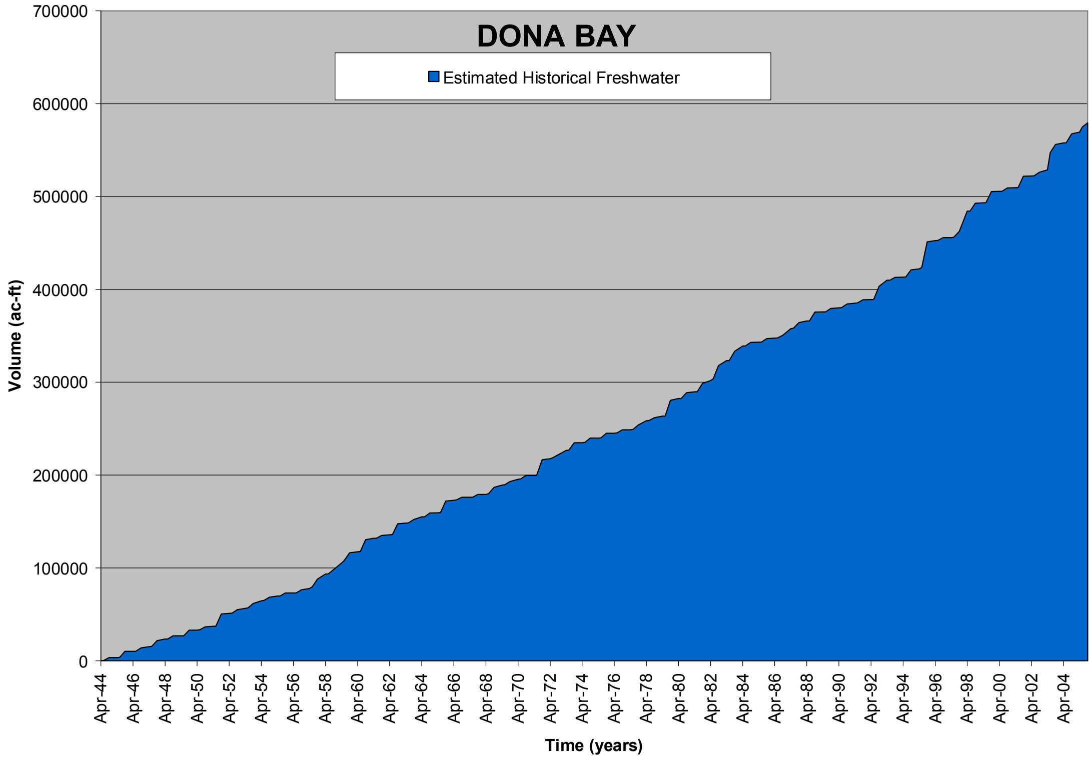


Figure 24 – Cumulative runoff to Dona Bay based upon seasonal block equations

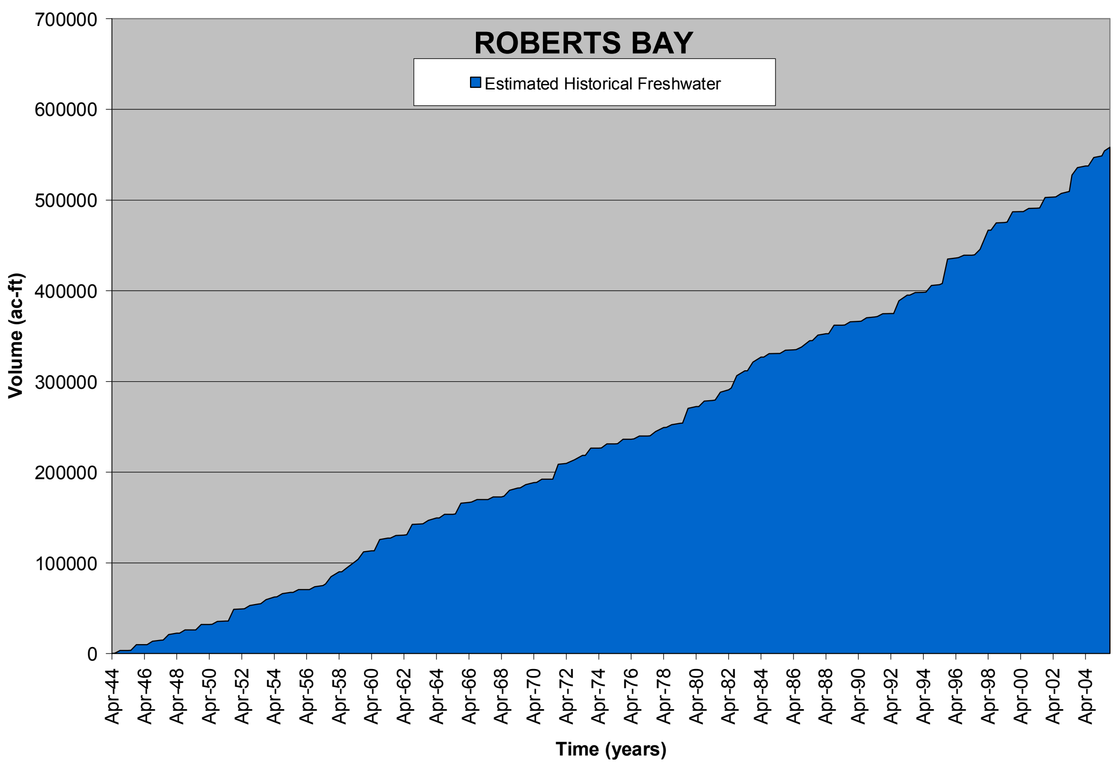


Figure 25 – Cumulative runoff to Roberts Bay based upon seasonal block equations

8.0 PRE & POST RESTORATION ANALYSIS OF DEER PRAIRIE WATERSHED

SCG requested that a comparison be made between runoff volumes prior to, and following the filling of the drainage ditch that drained portions of the sloughs in the Deer Prairie watershed. **Figure 26** compares average monthly runoff volumes for the period of record prior to the restoration of Deer Prairie Slough (April 1981 through June 2001) and since the restoration (July 2001 to present). Although this comparison indicates that there may be a trend that the watershed may be more dynamic since the restoration was completed (lower volumes in the dry season and higher volumes in the wet season), it should be noted that the post-restoration data base is based upon only 2 to 3 data points. This data set is not large enough to make a meaningful comparison. However, continued monitoring over several years is recommended to confirm if such a trend indeed exists.

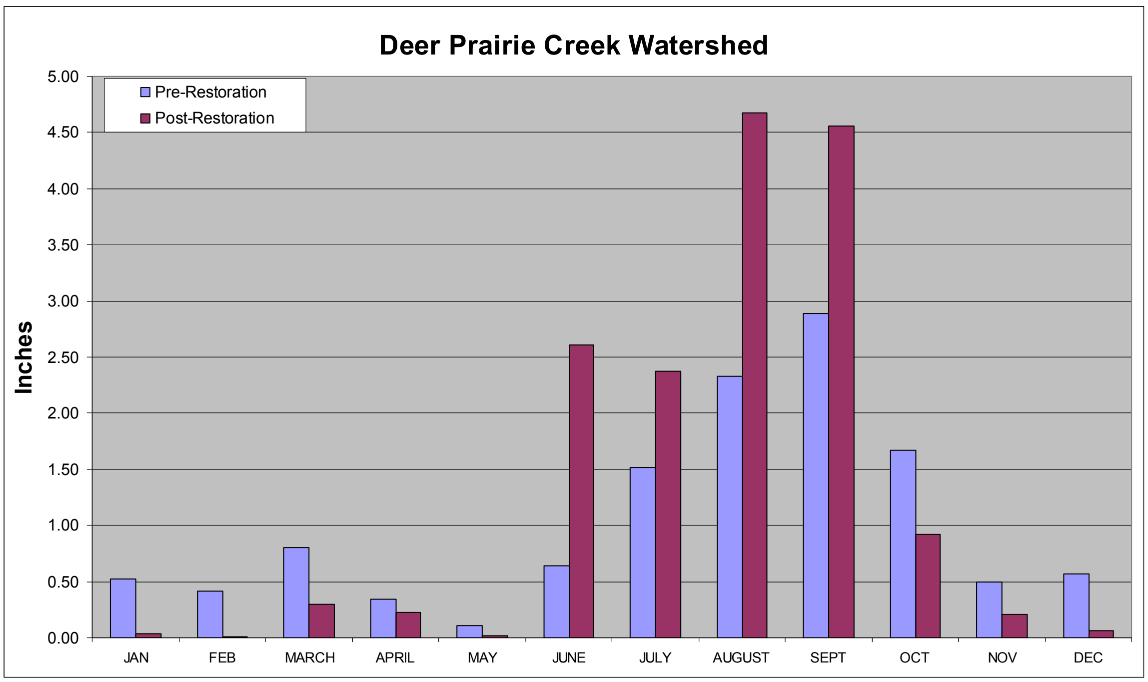


Figure 26 – Deer Prairie Watershed Comparison of Pre and Post-Restoration Runoff

This page intentionally left blank

TM 4.1.3.1 – DATA ANALYSIS (PBSJ)

1.0 BACKGROUND

Sarasota County in cooperation with the Peace River Manasota Regional Water Supply Authority and the Southwest Florida Water Management District (SWFWMD) are currently completing the necessary, pre-requisite data collection and analysis as well as the comprehensive watershed management plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), Earth Balance, and Mote Marine Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the SWFWMD, to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan; and Sarasota County's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay watershed that will address the following general objectives:

a. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
b. Provide a more natural freshwater flow regime pattern for the Dona Bay watershed.
c. Protect existing and future property owners from flood damage.
d. Protect existing water quality.
e. Develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

This Technical Memorandum has been prepared by PBS&J to present a summary of efforts to develop an analysis of flow data based on an Indicators of Hyrdrologic Alteration (IHA) approach. The IHA is used to develop statistical descriptions of stream flow variables, and to compare seasonal and annual variability in stream flow parameters with other, perhaps more natural systems. This Technical Memorandum summarizes efforts to produce an IHA for Deer Prairie Creek, the Cow Pen Canal, and the Blackburn Canal, consistent with Task 4.1.3 of the DBWMP contract.

2.0 INTRODUCTION

This effort is part of the overall Natural Systems efforts defined in Task 4.1 of the DBWMP. Specifically, it included related natural systems evaluations and an assessment of potential restoration/enhancement opportunities for Dona Bay and its watershed. Since the intent of the project is to consider alternatives for watershed restoration/enhancement of the Dona Bay watershed and its hydrologic regimes, PBS&J was tasked with calculating various IHA parameters for Deer Prairie Creek, the Cow Pen Canal, and the Blackburn Canal. Deer Prairie Slough is considered a “reference” stream of sorts, as it has a much less developed watershed, and does not display the dramatic watershed alterations (e.g., enlarged watershed, deeply channelized stream channel), as do both the Dona and Roberts Bay watersheds.

As part of this task, hydrologic indicators of associated with the Dona Bay watershed were compared with those from the relatively not-impacted Deer Prairie Creek watershed. In addition, a range of variability analysis was also used to provide the basis for additional comparisons between pre- and post-project development conditions.

3.0 INDICATORS OF HYDROLOGIC ALTERATION

The Indicators of Hydrologic Alteration (IHA) program, developed by Richter et al. in 1996, was used to calculate the values of the 12 indicators listed in Table 1. The IHA program has a built-in utility that conducts the calculations using discharge gage data in USGS format. The analysis was conducted separately for the dry and wet seasons to assess seasonal differences. The data for the Cow Pen Canal was that developed as part of this project using the watershed area draining to the USGS station 02299721 and the flows calculated using the Myakka River transferred equations described in Technical Memorandum 4.2.2 – Water Quantity | Water Budget Approach.

Data for Deer Prairie was available from USGS station 02299160 for the period 1981 through 1992. That information was supplemented with data from USGS station 02299120 for the period 1993 through 2003. Data from the two stations were combined due to the stations' close proximity. The extended data provided a better representation of flow conditions over time. Calculated values of several IHA parameters are shown in Table 1.

As the flow data is dependent on the size of the watershed, IHA flow parameters were normalized to represent unit-area basis (flows in cfs were converted to inches per year) to allow for more direct comparisons. Results are shown in Table 2.

IHA results indicate that the 1-day, 3-day, and 7-day minimum flows during both the wet and dry season in Deer Prairie are zero, whereas minimum flows for Cow Pen Canal are all above zero. Therefore, baseflows are much smaller in natural Deer Prairie Creek watershed than in the man-made Cow Pen Canal. In addition, as other parameters do not show significant differences between the two watersheds, it can be concluded that hydrologic impacts have both reduced storage capacity in the watershed and drained the water table, thus creating, or increasing base flows.

It should be noted that, per the IHA methodology, a value of zero for minimum flows simply indicate that the median of the annual 1-day, 3-day, and 7-day minimums is zero. That is also the case for the number-of-zero-days statistic. During the period of record, approximately three percent of the time (in days) no flow was recorded in the Cow Pen Canal.

	USGS Stations 02299160 and 02299120 Deer Prairie (1981 to 2003)		USGS Station 02299721 Cow Pen Canal (1936 to 2006)	
IHA Parameters	**Season 1 (10/1 - 5/31)**	**Season 2 (6/1 - 9/30)**	**Season 1 (10/1 - 5/31)**	**Season 2 (6/1 - 9/30)**
1-day minimum (cfs)	0	0	0.43	0.47
3-day minimum (cfs)	0	0	0.38	0.48
7-day minimum (cfs)	0	0.0007143	0.3843	0.5043
30-day minimum (cfs)	0.01433	0.9867	0.492	2.476
90-day minimum (cfs)	0.2909	27.78	1.033	15.66
1-day maximum (cfs)	60	228	187.5	327.6
3-day maximum (cfs)	57.83	222.2	181.5	321.6
7-day maximum (cfs)	51.5	187.3	143	302.3
30-day maximum (cfs)	26.61	105.7	70.47	164.7
90-day maximum (cfs)	13.82	62.5	58.91	85.43
Number of zero days	27	11.5	0	0
Base flow (cfs)	0	0.000003944	0.01694	0.009184
Date of minimum	105.5	153	139	157
Date of maximum	276.5	240.5	278	238

Table 1 - Summary of the Indicators of Hydrologic Alteration Analysis

IHA Parameters	USGS Stations 02299160 and 02299120 Deer Prairie (1981 to 2003) [a]		USGS Station 02299721 Cow Pen Canal (1936 to 2006) [b]	
	Season 1 (10/1 - 5/31)	Season 2 (6/1 - 9/30)	Season 1 (10/1 - 5/31)	Season 2 (6/1 - 9/30)
1-day minimum (in/yr)	0	0	0.10	0.11
3-day minimum (in/yr)	0.00	0.00	0.09	0.12
7-day minimum (in/yr)	0.00	0.00	0.09	0.12
30-day minimum (in/yr)	0.01	0.45	0.12	0.60
90-day minimum (in/yr)	0.13	12.55	0.25	3.80
1-day maximum (in/yr)	27.11	103.03	45.45	79.41
3-day maximum (in/yr)	26.13	100.41	44.00	77.96
7-day maximum (in/yr)	23.27	84.64	34.66	73.28
30-day maximum (in/yr)	12.02	47.76	17.08	39.92
90-day maximum (in/yr)	6.24	28.24	14.28	20.71
Number of zero days	12.20	5.20	0	0
Base flow (in/yr)	0.00	0.000003944	0.01694	0.009184
Date of minimum	105.5	153	139	157
Date of maximum	276.5	240.5	278	238

[a] Contributing area of 30.04 mi^2,
[b] Contributing area of 56 mi^2

Table 2 - Summary of the Indicators of Hydrologic Alteration Analysis Results Normalized by Watershed Size

4.0 RANGE OF VARIABILITY ANALYSIS

A range of variability analysis of the data was conducted by developing curves that represent the data percentile distribution of flows at both Deer Prairie (USGS Station 02299160) and Cow Pen Canal (at the upstream water level control structure). Figure 1 shows the normalized percentile distribution of flows using the data described previously. Consistent with the IHA analysis, the main flow differences between the two watersheds occur during low flow conditions, namely those below the median value. Comparisons of normalized flow values at selected percentiles are shown in Table 3. Results indicate that he ratio of Cow Pen Canal flows to Deer Prairie flows range from 3.0 to 14.8 for values below median. The ratios at the median and above are much closer to 1. It can be concluded that the hydrologic impacts are associated primarily with low flows, which in turn are associated with the dry season. Excess flows into Dona Bay in the dry season are also due to increases in the size of the watershed.

Percentile	Cow Pen Canal Flow 1956 – 2006 (in/year)	Deer Prairie Flow 1981- 2003 (in/year)	Flow Ratio (CPS / DP)
4	0.09	0.01	9.5
18	0.27	0.02	14.8
25	0.27	0.10	2.7
35	1.37	0.45	3.0
50	1.48	1.27	1.2
75	7.65	9.94	0.8
90	23.64	42.02	0.6

Table 3 – Comparison of Normalized Flows

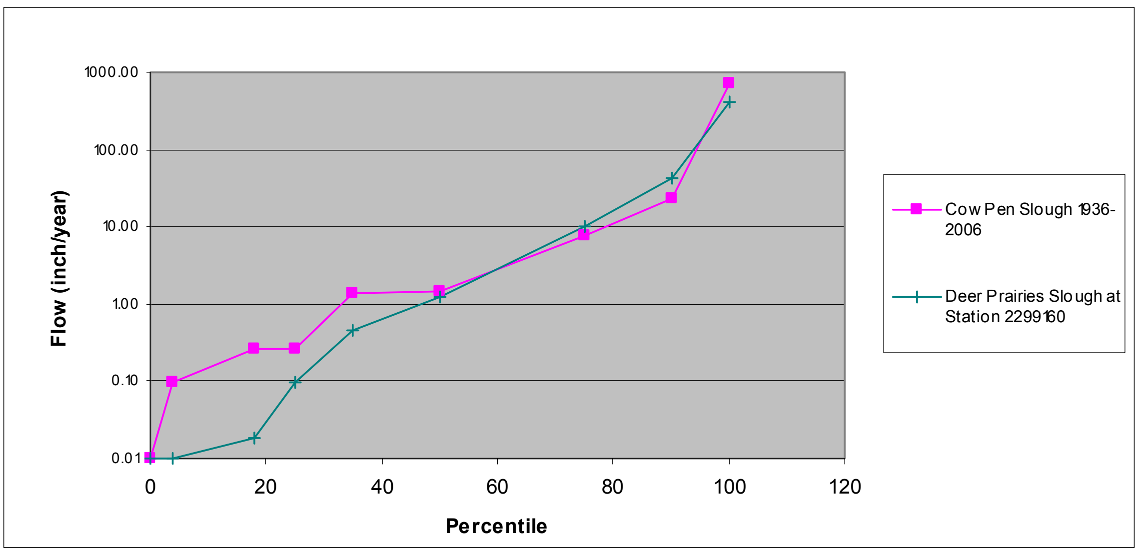


Figure 1 - Comparison of Flow Variability for Cow Pen Canal and Deer Prairie

This page intentionally left blank

TM 4.1.3.2 – DATA ANALYSIS (BRA)

1.0 BACKGROUND

Sarasota County, in cooperation with the Peace River Manasota Regional Water Supply Authority and the Southwest Florida Water Management District (SWFWMD), are currently completing the necessary, pre-requisite data collection and analysis as well as the Comprehensive Watershed Management Plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), EarthBalance, and Mote Marine Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the SWFWMD, to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan, and the Sarasota County's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay watershed that will address the following general objectives:

a. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
b. Provide a more natural freshwater flow regime pattern for the Dona Bay watershed.
c. Protect existing and future property owners from flood damage.
d. Protect existing water quality.
e. Develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

This Technical Memorandum has been prepared by BRA to summarize the hydrologic modifications of the Dona Bay watershed, the extensive field assessments, the results of the GIS exercises, and the results of the UMAM analyses, consistent with Task 4.1.3 of the DBWMP contract.

2.0 CURRENT STUDIES

2.1 Introduction

Alterations to the historical Dona Bay watershed have resulted in significant impacts such as the diversion of historical watershed areas, conversion of native habitats for agricultural, residential and commercial development, ditching of wetlands, and excavation, and filling of historical wetland and slough systems have dramatically altered hydrologic flow regimes. These activities have affected the functions and values of historical wetlands such as water filtration, attenuation of flood waters, and wildlife habitat. These activities have also significantly increase freshwater runoff to Dona Bay, which has adversely affected the historical estuarine values and functions.

Historically, the Dona Bay watershed included approximately 10,000 acres, consisting primarily of native upland habitats such as pine flatwoods, cabbage palm hammocks and wetlands. Most significantly, the original Cow Pen Slough was, primarily, a wetland conveyance system to the Myakka River and consisted of large, slow flowing marshes, ultimately discharging downstream to the Myakka River.

Conversion of historical landscapes, primarily for conversion to agricultural uses such as improved pastures, citrus and row crops as well as the excavation of the historical Cow Pen Slough by a series of deeply incised canals with spoil piles, has efficiently drained and significantly altered the character, function and values of historical wetlands. Additionally, the diversion of a significant portion of the Myakka River watershed into the Dona Bay watershed has dramatically increased fresh water flows to Dona Bay.

2.1.1 Watershed Background

The current Southwest Florida Water Management District (SWFWMD) land use database was used to calculate the difference in the land use types between the 2005 Dona Bay watershed and the 1948 limits of the watershed, as summarized in Table 1. The current watershed is approximately five times the size of the historical watershed due to the construction of Cow Pen Canal.

FLUCFCS Code	Description	2005 Acreage	1948 Acreage
1100	Residential Low Density	3294.1	549.5
1200	Residential Medium Density	1240.0	959.7
1300	Residential High Density	347.4	307.6
1400	Commercial and Services	160.7	109.5
1500	Industrial	84.5	84.5
1600	Extractive	729.6	478.1
1700	Institutional	112.6	51.4
1800	Recreational	777.9	336
1900	Open Land	2146.1	235.3
2100	Cropland and Pastureland	11266.1	1895.5
2140	Row Crops	905.7	19.2
2200	Tree Crops	1573.5	156.8
2300	Feeding operations	2.3	0
2400	Nurseries and Vineyards	110.5	9.8
2500	Specialty Farms	52.3	23.2
2600	Other Open Lands	236.7	0
3100	Herbaceous	83.9	0
3200	Shrub and Brushland	3649.1	502.1
3300	Mixed Rangeland	158.3	0
4100	Upland Conifer Forest	213.9	0
4110	Pine Flatwoods	6829.6	1449.7
4200	Upland Harwood Forests Pt 1	6.6	0
4340	Hardwood Conifer Mixed	1358.1	249.9
4400	Tree Plantations	379.4	0
5100	Streams and Waterways	153.2	57.9
5200	Lakes	349.0	58.3
5300	Lakes and Reservoirs	887.4	379.1
5400	Bays and Estuaries	153.3	153.3
6100	Wetland Hardwood Forests	12.5	0
6110	Bay Swamps	2.3	0
6120	Mangrove Swamps	19.9	19.9
6150	Stream and lake Swamps (bottomland)	2763.1	68.4
6200	Wetland Conifer Forests	45.9	34.9
6210	Cypress Swamp	81.4	3.3
6300	Wetland Forested Mixed	338.1	128.1
6410	Freshwater Marshes	4794.6	647.6
6420	Saltwater Marshes	32.4	32.4
6430	Wet Prairies	1149.0	240.6
6440	Emergent Aquatic Vegetation	85.0	32.6
7400	Disturbed Land	6.3	4.5
8100	Transportation	220.9	220.9
8200	Communications	2.7	2.7
8300	Utilities	768.9	32.5
	Total	**47,584.8**	**9,534.8**

Table 1 - Land Use Changes within the Dona Bay Watershed

2.1.2 Sarasota County-Owned Parcels

Historical aerial photography (1948) and the *Soil Survey of Sarasota County* (1957) were used to evaluate the historical land uses of four (4) Sarasota County owned parcels (Albritton, West Pinelands, the Myakka Connector, and Venice Minerals) within the Dona Bay watershed (Exhibit 1). The limits and types of historical land uses were determined by vegetative signatures and soil characteristics, which were interpreted and were digitized. The historical land uses were quantified and compared to the existing land uses. Table 1 summarizes the combined change (all four properties) in land use over the last 60 years.

The current and historical environmental features of the four (4) parcels were evaluated as identified in Figure 1. The evaluation included current wetland delineations and habitat assessments, approximation of historical wetland limits, upland habitat assessments, preliminary wildlife surveys, existing hydroperiod determinations, estimates of historical wetland wet season water levels, Uniform Mitigation Assessment Methodology (UMAM) assessments, and U.S. Army Corps of Engineers (COE) datasheets. Historical aerials and soil surveys were used to compare past land use to the existing onsite conditions. Finally, mitigation alternatives for each parcel were ranked based on an environmental cost-benefit analysis. Technical Memorandum 4.1.1.2– DATA COLLECTION AND REVIEW (BRA) summarizes this effort.

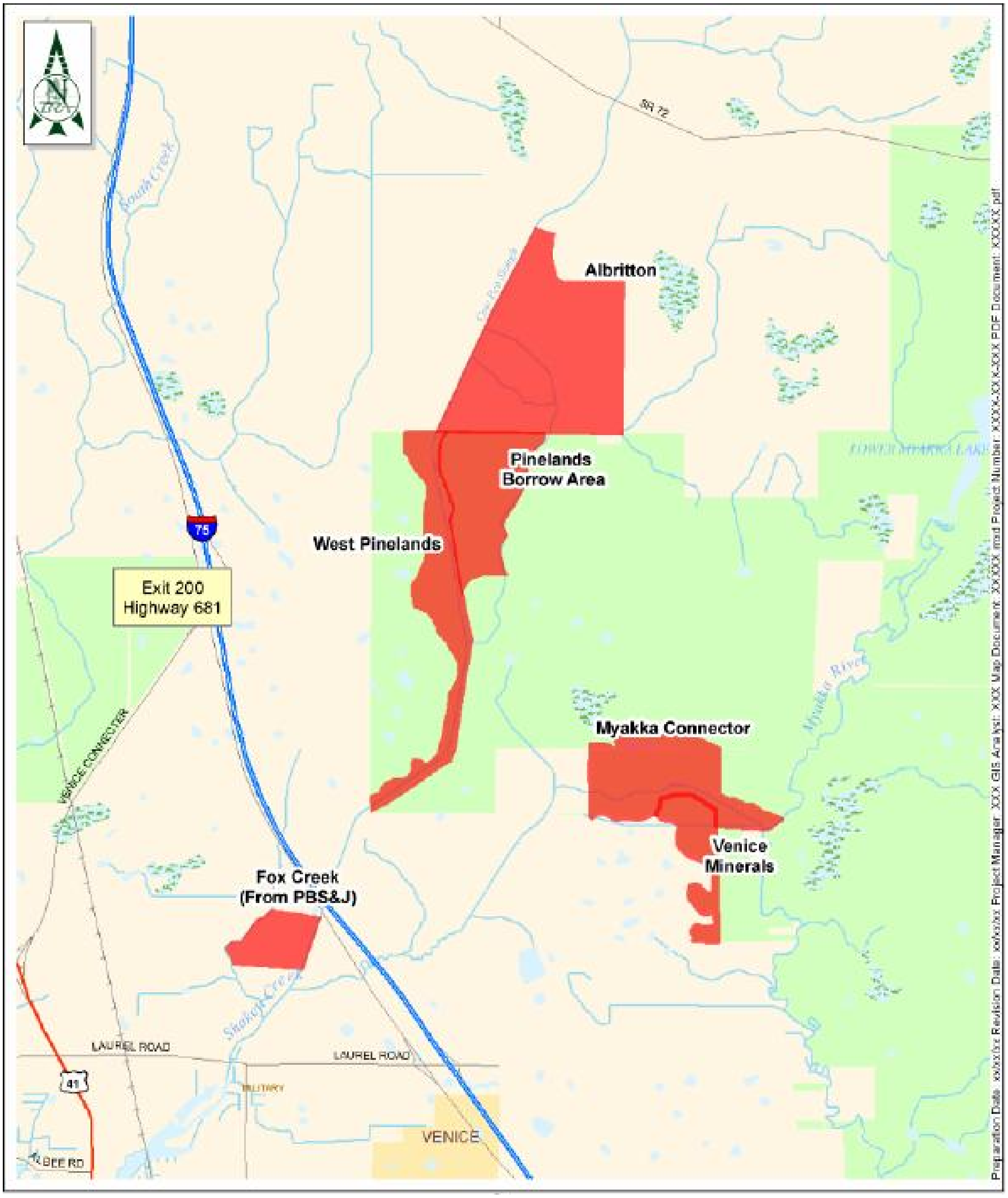


Figure 1 – Locations of Evaluation Areas

FLUCFCS	1948 (Acres)	2005 (Acres)	Change (Acres)
211 Improved Pasture	0.00	66.1	+66.1
212 Unimproved Pasture	0.00	98.1	+98.1
221 Orange Groves	0.00	652.1	+652.1
260 Other Open Lands	0.00	4.9	+4.9
320 Shrub and Brushland	0.00	0.5	+0.5
3201 Wax Myrtle Shrub	0.00	13.8	+13.8
411 Pine Flatwoods	528.1	275.8	-252.3
4111 Pine and Cabbage Palm	8.7	0.00	-8.7
427 Live Oak	0.00	161.7	+161.7
428 Cabbage Palm	89.9	52.9	-37.0
4281 Cabbage Palm and Pine	27.7	0.00	-27.7
434 Hardwood Conifer Mix	17.0	281.3	+264.3
5101 Channelized Waterway	0.00	43.4	+43.4
505 Ditches	0.00	3.7	+3.7
512 Ditches	0.00	27.4	+27.4
534 Agricultural Impoundments	0.00	13.0	+13.0
535 Excavated Areas	0.00	0.1	+0.1
560 Slough Waters	0.00	4.4	+4.4
616 Inland Sloughs	102.6	25.0	-77.6
617 Mixed Wetland Hardwood	0.00	9.2	+9.2
619 Brazilian Pepper	0.00	0.7	+0.7
631 Wetland Shrub	0.00	9.3	+9.3
6311 Buttonbush	0.00	7.7	+7.7
6312 Disturbed Wetland Shrub	0.00	7.3	+7.3
641 Freshwater Marsh	836	166.1	-669.9
6411 Excavated Freshwater Marsh	0.00	0.3	+0.3
643 Wet Prairies	378.1	3.2	-374.9
743 Spoil Areas	0.00	7.9	+7.9
8140 Roads and Highways	0.00	0.2	+0.2
8144 Roads	0.00	11.4	-11.4
8145 Graded & Drained Road	0.00	26.6	+26.6
832 Electrical Transmission Lines	0.00	14.3	+14.3
Total Uplands	**671.4**	**1659.9**	**+988.5**
Total Wetlands/OSW	**1316.7**	**328.7**	**-988.0**

Table 2 – 1948/2005 Land Use Comparison of County Owned Parcels (Albritton, West Pinelands, Myakka Connector, and Venice Minerals)

2.2 Albritton Site

2.2.1 Introduction

The Albritton parcel is located in Sections 27, 33 and 34, Township 37 South, Range 19 East, totals 1000 acres, and is within the SWFWMD Southern Coastal drainage basin and the Sarasota County Dona Bay watershed. The upland and wetland habitats onsite were evaluated during fieldwork conducted over several months in 2005. The parcel is currently being excavated for landfill cover and includes a large orange grove with a hammock system bisecting the property.

2.2.2 Historical Land Use

Historically, the Albritton property consisted primarily of a large freshwater marsh that served as a significant floodplain (Exhibit 2). Due to significant drainage activities, the large freshwater marsh (FLUCFCS 641) transitioned into wet prairies (FLUCFCS 643) and smaller, more distinct freshwater marshes. The uplands were located on the southern and eastern extents of the site and consisted primarily of pine flatwoods (FLUCFCS 411), cabbage palm (FLUCFCS 428), and a combination of the two (FLUCFCS 4281). Currently, the agricultural practices, including an orange grove, improved pasture and an extensive ditch network, have converted 633.2 acres of wetlands to uplands (Table 3). The remaining native habitat consists primarily of live oak (*Quercus laurifolia*), (FLUCFCS 427), a species that prefers drier substrate and probably thrived in the drained conditions, and 82.3 acres of highly disturbed freshwater marshes and wet prairies.

FLUCFCS	1948 (Acres)	2005 (Acres)	Change (Acres)
211 Improved Pasture	0.0	66.4	+66.4
221 Orange Groves	0.0	652.1	+652.1
260 Other Open Lands	0.0	4.9	+4.9
411 Pine Flatwoods	176.7	0.0	-176.7
427 Live Oak	0.0	101.2	+101.2
428 Cabbage Palm	79.0	21.9	-57.1
4281 Cabbage Palm and Pine	27.7	0.0	-27.7
434 Hardwood Conifer Mix	0.0	63.1	+63.1
5101 Channelized Waterway	0.0	13.4	+13.4
512 Ditches	0.0	27.4	+27.4
534 Agricultural Impoundments	0.0	13.0	+13.0
535 Excavated Areas	0.0	0.1	+0.1
619 Brazilian Pepper	0.0	0.7	+0.7
641 Freshwater Marsh	530.3	24.4	-505.9
6411 Excavated Freshwater Marsh	0.0	0.3	+0.3
643 Wet Prairies	185.4	3.2	-182.2
743 Spoil Areas	0.0	7.9	+7.9
8140 Roads and Highways	0.0	0.2	+0.2
Total Uplands	**283.4**	**917.7**	**+634.3**
Total Wetlands/OSW	**715.7**	**82.5**	**-633.2**
Total Acreage	**999.1**	**1000.2**	

Table 3 - 1948 vs. 2005 Land Uses for Albritton Site

2.3 West Pinelands

2.3.1 Introduction

The West Pinelands site is located in Sections 4, 9 and 16, Township 38 South, Range 19 East and totals 393.6 acres within the SWFWMD Southern Coastal drainage basin and the Sarasota County Dona Bay watershed. The upland and wetland habitats onsite were evaluated during fieldwork conducted over several months in 2005. Beginning in the early 1900's and continuing into the 1970's, the historical Cow Pen Slough system was drained and diverted from the Myakka River watershed to Dona Bay. One result was the drainage of the associated riparian wetland system. The West Pinelands site area of study is located both east and west of this canal.

2.3.2 Historical Land Use

The 1948 aerial (Exhibit 3) depicts the area of evaluation as the historical Cow Pen Slough consisting primarily of freshwater marsh (FLUCFCS 641) and wet prairies (FLUCFCS 643). The limited uplands consisted of islands of cabbage palm (FLUCFCS 428) and hardwood-conifer mixed forests (FLUCFCS 434). The floodplain was bordered by pine flatwoods to the west. The draining and diversion of the original Cow Pen Slough has severely altered and marginalized the hydrology of the surrounding wetlands by severely depressing the water table. The wetlands are highly degraded and at least 220 acres of wetlands have been converted to uplands, primarily unimproved pasture, roads, and hardwood-conifer mixed forests (Table 4).

FLUCFCS	1948 (Acres)	2005 (Acres)	Change (Acres)
212 Unimproved Pasture	0.00	98.1	+98.1
411 Pine Flatwoods	50.3	19.3	-31.0
4111 Pine and Cabbage Palm	8.7	0.00	-8.7
428 Cabbage Palm	7.6	14.3	+6.7
434 Hardwood Conifer Mix	17.0	145.1	+128.1
5101 Channelized Waterway	0.00	30.0	+30.0
617 Mixed Wetland Hardwood	0.00	2.1	+2.1
6311 Buttonbush	0.00	7.2	+7.2
641 Freshwater Marsh	215.8	50.6	-165.2
643 Wet Prairies	95.3	0.00	-95.3
8144 Roads	0.00	11.4	+11.4
8145 Graded & Drained Roads	0.00	15.5	+15.5
Total Uplands	**83.6**	**303.7**	**+220.1**
Total Wetlands/OSW	**311.1**	**89.9**	**-221.2**
Total Acreage	**394.7**	**393.6**	

Table 4 - 1948 vs. 2005 Land Uses for the West Pinelands Site

2.4 Myakka Connector

2.4.1 Introduction

The Myakka Connector site is located in Sections 13, 14, 15, 22, 23 and 24, Township 38S, Range 19E and totals 440.5 acres within the SWFWMD and Sarasota County Myakka River watershed. The onsite wetlands, and much of the current extent of uplands, were historically part of a much larger slough system that flowed from the northwest to the Myakka River. The majority of this slough encompassed an area of land larger than the remaining wetland fragments as evidenced by the current and historical *Soil Surveys of Sarasota County* (1991, 1957). Hydric soils located within this larger area include Bradenton fine sand, Delray fine sand, depressional, Felda fine sand, depressional, Felda and Pompano fine sand, frequently flooded, Floridana and Gator soils, depressional, Holopaw fine sand, depressional, Malabar fine sand, Pineda fine Sand, Pompano fine sand, depressional, and Pople fine sand. There were pockets of upland soils, typically within the pine flatwoods, over areas mapped as Eau Gallie and Myakka fine sands.

Relatively undisturbed lands surround the Myakka Connector site to the east, west and north, although Venice Minerals is located adjacent to this parcel to the south. The Myakka River abuts the property to the east, with no barriers separating the Myakka Connector site, thus allowing for easy wildlife access. In addition, the east banks of the Myakka River along this section of the river are protected lands. The property's connection to the historical Cow Pen Slough has been severely reduced due to the creation of the Cow Pen Canal and the berm at the southern end of the Pinelands Reserve.

2.4.2 Historical Land Use

The 1948 aerial (Exhibit 4) indicates that the aerial extent of the Myakka Connector is still situated between the Dona Bay watershed and the Myakka River watershed. In fact, flood analyses indicate that during extreme events, it is likely to move waters between watersheds. The drainage and diversion of the historical Cow Pen Slough effectively increased the size of the Dona Bay watershed, and, therefore, altered the hydrology of the slough through the Myakka Connector site. In 1948, approximately 258 acres of the property within the study area were wetlands and 182 acres were uplands, almost exclusively pine flatwoods. The diversion of the water from the site over the last 50 years has converted approximately 171 acres of wetlands to uplands (Table 5). The increase in extant uplands consists primarily of live oak (*Quercus virginiana)* and hardwood-conifer mixed forests as the decrease in the hydrologic regime has allowed for the succession of species more tolerant of drier conditions.

FLUCFCS	1948 (Acres)	2005 (Acres)	Change (Acres)
320 Shrub and Brushland	0.0	0.5	+0.5
411 Pine Flatwoods	179.1	183.4	+4.3
427 Live Oak	0.0	60.5	+60.5
428 Cabbage Palm	3.3	16.7	+13.4
434 Hardwood Conifer Mix	0.0	73.1	+73.1
560 Slough Waters	0.0	4.4	+4.4
616 Inland Sloughs	102.6	25.0	-77.6
617 Mixed Wetland Hardwood	0.0	7.1	+7.1
631 Wetland Shrub	0.0	2.9	+2.9
6312 Disturbed Wetland Shrub	0.0	6.3	+6.3
641 Freshwater Marsh	66.2	41.1	-25.1
643 Wet Prairie	89.3	0.0	-89.3
8145 Graded & Drained Road	0.0	8.4	+8.4
832 Electrical Transmission Lines	0.0	11.1	+11.1
Total Uplands	**182.4**	**353.7**	**+170.6**
Total Wetlands/OSW	**258.1**	**86.8**	**-171.3**
Total	**440.5**	**440.5**	

Table 5 - 1948 vs. 2005 Land Uses for Myakka Connector Site

2.5 Venice Minerals

2.5.1 Introduction

The Venice Minerals site is located in Sections 14 and 23, Township 38 South, Range 19 East, totals 154.4 acres, and is within the SWFWMD and Sarasota County Myakka River watershed. It is located directly south of the Myakka Connector, west of the FPL Easement and north of Venetian Golf & River Club. The site has historically been used as wetland mitigation for the adjacent sand and shell mining operation to the west. The upland and wetland habitats onsite were evaluated during fieldwork conducted over several months in 2005.

2.5.2 Historical Land Use

The historical condition of the Venice Minerals site, as indicated in the 1948 aerial (Exhibit 5), consisted of pine flatwoods (FLUCFCS 411) and freshwater marshes (FLUCFCS 641), with a small section of wet prairie (FLUCFCS 643) connecting two freshwater marshes. Several separate primitive roads traverse the property. The sole uplands on the property, pine flatwoods, totaled 122.0 acres and the wetlands totaled 31.8 acres. In its current (2005/2006) condition, 31.4 acres of the historical uplands have been converted to wetlands for mitigation purposes (Table 6). In addition 14.7 acres of pine flatwoods have been converted to a wax myrtle shrub mitigation area that surrounds the three northernmost wetlands.

FLUCFCS	1948 (Acres)	2005 (Acres)	Change (Acres)
3201 Wax Myrtle Shrub	0.00	13.8	+13.8
411 Pine Flatwoods	122.0	73.1	-48.9
505 Ditches	0.00	3.7	+3.7
631 Wetland Shrub	0.00	6.4	+6.4
6311 Buttonbush	0.00	0.5	+0.5
6312 Disturbed Wetland Shrub	0.00	1.0	+1.0
641 Freshwater Marsh	23.7	50.0	+26.3
643 Wet Prairies	8.1	0.00	-8.1
8145 Graded & Drained Road	0.00	2.7	+2.7
832 Electrical Transmission Lines	0.00	3.2	+3.2
Total Uplands	**122.0**	**92.8**	**-29.2**
Total Wetlands/OSW	**31.8**	**61.6**	**+29.8**
Total Acreage	**153.8**	**154.4**	

Table 6 - 1948 vs. 2005 Land Uses for Venice Minerals

3.0 DATA EVALUATION

3.1 Albritton Current Land Use

A land use map (Exhibit 6) was created by BRA based on the *Florida Land Use, Cover and Forms Classification System* (FLUCFCS) (Florida Department of Transportation, 1999). Descriptions of each habitat type are provided below. All provided upland acreages are approximate as they are based on aerial interpretation and not surveyed habitat delineations. A preliminary wildlife survey, including pedestrian and vehicular transects, was also conducted and the results follow the habitat assessments. Uplands account for 917.4 acres or 91.8% of the site.

3.1.1 Uplands

Improved Pasture (FLUCFCS 211; 66.4 acres)

Approximately 66.1 acres or 6% consists of improved pasture located in the southwest portion of the project area. These areas occur between the existing orange groves and the remaining natural habitat at the southern project boundary. The dominant vegetation is bahia grass (*Paspalum notatum*) with some scattered dogfennel (*Eupatorium capillifolium*) and cabbage palm (*Sabal palmetto*). Currently the grass is thick from lack of grazing or mowing. Several small swales occur within this area, though no change of vegetation exists between the swales and the surrounding pasture.

Alterations to these areas were initiated in the 1950's when the first of numerous ditches were excavated in order to drain the large slough system that was once located in this area (Exhibit 2). The excavated channel located just west of the subject parcel is called Cow Pen Canal, which was historically excavated from an extensive marsh/slough system. These pastures were created as the slough was drained and agricultural management and maintenance began. Currently the improved pastures are mostly devoid of native vegetation, except for scattered cabbage palms and other opportunistic ruderal species.

The areas primarily identified as improved pasture were mapped over historical Pompano fine sand and some Charlotte fine sand, based on the 1957 *Soil Survey of Sarasota County, Florida*. Both of these soils are associated with wet prairie systems and associated water-tolerant woody species such as slash pine *(Pinus elliottii)*, cabbage palm, and water oak *(Quercus nigra).*

Orange Groves (FLUCFCS 221; 652.1 acres)

Approximately 688.4 acres, or 68.8%, are currently managed as citrus groves, with the majority of the crop being orange trees, with some grapefruit and tangerines as well. The Cow Pen Slough floodplain historically encompassed much of the area that is now actively managed as citrus groves. The first of numerous ditches were initially excavated in the 1950's in order to drain Cow Pen Slough. Currently, a well-established network of dirt roads and ditches surround and bisect the groves.

The large majority of the citrus groves, particularly to the west, are mapped historically as Pamlico peaty muck, Delray Fine Sand, Delray mucky fine sand, and Pompano fine sand (1957 *Soil Survey of Sarasota County, Florida*). Current soils, based on the 1991 *Soil Survey of Sarasota County, Florida*, are mapped as Delray fine sand, depressional, Floridana and Gator soils, depressional, Gator muck, and Holopaw fine sand, depressional. The current soils in the eastern groves consist of US Hydric Soil Types, with the dominant soil being Adamsville fine sand based on the 1957 *Soil Survey of Sarasota County, Florida*, which are typically pine flatwoods. The 1991 *Soil Survey* identifies the eastern groves as Eau Gallie and Myakka fine sands and Pineda fine sand with several remnant marshes.

Other Open Lands <Rural> (FLUCFCS 260; 4.9 acres)

A few scattered patches of mixed shrubby areas cover about 4.9 acres, or 0.5%. These areas are typically found immediately adjacent to ditches, in areas that have been drained. Mainly shrubs or herbaceous species are present, with individual trees located periodically. Typical species present include dogfennel, caesarweed (*Urena lobata*), some Brazilian pepper (*Schinus terebinthifolius*), and broomgrass (*Andropogon* sp.).

These areas identified as Other Open Lands were wetland areas, as observed on the 1948 aerial imagery (Exhibit 2), prior to the active agricultural maintenance which affected the hydrology of these areas. The mapped soils based on the 1991 *Soil Survey of Sarasota County, Florida* for these areas are Delray fine sand, depressional and Holopaw fine sand, depressional, both hydric soils. Field evaluations confirmed some indicators that show a recent history as a wetland, but sufficient evidence was not present to delineate these areas as wetlands under current delineation methodologies. Restoration of these areas would be possible with adequate hydration to restore the hydric soils and to ultimately produce an area capable of sustaining hydrophytic vegetation long-term.

Live Oak (Potential Mesic Hammock) (FLUCFCS 427; 101.2 acres)

These areas surround the herbaceous wetlands and total ±101.2 acres, or 10.2%. These areas have been identified as potentially meeting Sarasota County requirements for "mesic hammock" designation, a county regulated upland habitat. These areas have not been field verified by Sarasota County Resource Protection Services. Typical species include live oak (*Quercus virginiana*), laurel oak cabbage palm, caesarweed, beautyberry (*Callicarpa americana*), wild coffee (*Psychotria nervosa* and *P. sulzneri*), and several vines, including muscadine grape (*Vitis* sp.) and greenbriar (*Smilax* spp.).

The live oak hammocks occur predominantly over areas mapped as Bradenton fine sand based on the *Soil Survey of Sarasota County, Florida* (1991), though some areas are over mapped Holopaw fine sand, depressional or Pineda fine sand. In the 1948 aerial imagery, much of this area appears to consist of mesic/upland hammock, with some distinct areas contained within the slough system as marsh. These hammock areas represent much of the native habitat as was present in 1948, and provide excellent opportunities for the preservation of wildlife habitat between and around the wetlands.

Cabbage Palm (FLUCFCS 428; 21.9 acres)

Cabbage palm is the dominant canopy species in these areas, with typical understory species including small cabbage palm, scattered beautyberry, wild coffee, and caesarweed. The cabbage palm areas are found in the same landscape positions as the live oak areas, with the main difference being the dominant canopy species. Cabbage palm hammocks are found primarily over Bradenton fine sand, and were historically found within these same areas, as evidenced by the 1948 aerial imagery.

Hardwood-Conifer Mixed (FLUCFCS 434; 63.1 acres)

The dominant canopy species are slash pine and live oak. The dominant understory species is saw palmetto (*Serenoa repens*), with scattered cabbage palm. In the southern portion of the property, the areas identified as Hardwood-Conifer Mixed are fairly open, with large areas of bahia grass interspersed with the saw palmetto understory. These areas total ±63.1 acres, or 6.5%.

These areas are currently mapped as Eau Gallie and Myakka fine sand, Malabar fine sand, and Pineda fine sand. These areas were historically mapped as Adamsville fine sand, a pine flatwoods soil, and Charlotte fine sand, a wet prairie soil (1957 *Soil Survey of Sarasota County)*. Much of these areas were historically pine flatwoods where the oaks have apparently encroached as a consequence of fire suppression.

3.1.2 Wetlands

The jurisdictional wetland limits (per 62-340, *Florida Administrative Code*) were delineated and flagged by BRA ecologists and surveyed by PBS&J over several months in 2005. The wetland limits were verified by Ms. Jennifer Brunty of the SWFWMD, as documented in the enclosed 3 October 2005 letter (Exhibit 7). In addition, Mr. Mark Peterson of the COE attended a site visit on 20 January 2006 and determined that the entire site is not COE jurisdictional due to the conversion to the property to orange groves and the resultant ditching, berming, and pumping of water, which artificially controls the water table (Exhibit 8).

<u>Wetland 4 (FLUCFCS 6411/643; 0.76 acres)</u>
Wetland 4 (Exhibit 9) is a 0.76-acre disturbed freshwater marsh/wet prairie located east of the Cow Pen Canal. It has an excavated core and remnants of a vegetated fringe. The core is open water and supports no hydrophytic vegetation. Small, scattered, spoil piles are present at the edge of the excavated area. Typical vegetation on these spoil piles include dogfennel and several immature cabbage palms. The outer zone of the wetland is degraded due to inadequate hydrology, as evidenced by the species composition of these areas. Limited wetland vegetation, including sand cordgrass (*Spartina bakeri*), scattered soft rush (*Juncus effusus*), pennywort (*Hydrocotyle umbellata*) and coinwort (*Centella asiatica*), are contained in the remaining portions of the wetland.

This wetland is also connected to Wetland 5 through a ditch, which continues to the northwest and south. The immediately surrounding uplands are improved pasture with a mixed hardwood-conifer forest and cabbage palm/live oak hammocks 150 feet to the east and west. No native buffer remains adjacent to this wetland. Wetland functions include the storage of water; however, limited suitability exists as wildlife habitat. The only anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland include: Little Blue Heron *(Egretta caerulea),* White Ibis *(Eudocimus albus),* Snowy Egret *(Egretta thula)* [all state-listed, Species-of-Special-Concern (SSC)], and the Wood Stork *(Mycteria americana)* [state and federally-listed as Endangered (E)]. Wildlife observed in this wetland during the assessment includes a single alligator *(Alligator mississippiensis)* and significant damage from pig *(Sus scrofa)* rooting.

<u>Wetland 5 (FLUCFCS 6411/643; 0.43 acres)</u>
Similar to Wetland 4, Wetland 5 is a 0.43-acre disturbed freshwater marsh/wet prairie located east of the Cow Pen Canal. It has an excavated core and some remnants of a vegetated fringe. The core is open water and supports no hydrophytic vegetation. Small, scattered spoil piles are present at the edge of the excavated area (more prominent than in Wetland 4). Typical vegetative composition on these spoil piles include dogfennel and several small cabbage palms. The outer zone of wetland is degraded due to inadequate hydrology, as evidenced by the species composition of these areas. Limited wetland

vegetation, including sand cordgrass, scattered soft rush, pennywort and coinwort, are contained in the remaining portions of the wetland.

The immediately surrounding uplands are improved pasture with a mixed hardwood-conifer forest and cabbage palm/live oak hammocks 150 feet to the east and west. No native buffer remains adjacent to this wetland. Wetland functions include the storage of water; however, it has limited suitability as wildlife habitat. The only anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading Birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. The only wildlife observed in this wetland during the assessment was an alligator and evidence of feral pigs.

Wetland 7 (FLUCFCS 6411; 11.93 acres)

Wetland 7 is an 11.93-acre freshwater marsh, which has been highly disturbed by past land management practices. Currently, ditches run adjacent to its southern and northeastern boundaries, and another smaller ditch bisects the wetland. In addition, adjacent to the northwest corner of the wetland within its historical footprint is a fenced area with an isolated ditch system that drains into the wetland. This small area was used for growing unknown crops in a private garden for the previous landowner. The garden is currently fallow. The presence of these smaller ditches, combined with the larger nearby ditches, have sufficiently drained the wetland so that the current seasonal high water elevation is more than one (1) foot below the wetland edge.

An excavated core normally contains water year-round and species coverage including cattails (*Typha* spp.), primrose willow (*Ludwigia peruviana*), Carolina willow (*Salix caroliniana*), and some softrush. The next zone forms the majority of the central portion of the wetland, barring the excavated core, and typical species include soft rush, fire flag (*Thalia geniculata*), scattered buttonbush (*Cephalanthus occidentalis*), primrose willow, coinwort, and maidencane (*Panicum hemitomon*). The small, excavated core and ditch, which bisects the wetland, have affected the hydrology of this wetland and in turn, the outer zone of wetland is degraded due to inadequate hydrology as evidenced by the species composition of these areas and comparisons with historical aerials. The outer most zone contains broom grass (*Andropogon virginicus*), coinwort, maidencane, dogfennel, bahia grass, and occasional blackberry *(Rubus* sp.*).*

Cabbage palm and live oak hammocks, along with the small garden area along a portion of the western boundary, constitute the wetland buffer. Wetland functions include the storage and filtration of water and habitat for wildlife. Anticipated wildlife utilization includes amphibians and reptiles, wading birds, and small and medium mammals. Wading Birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. Pig rooting was present throughout the outer zones. Hawks were observed flying overhead and roosting in trees in the adjacent uplands. A pair of otters (*Lontra canadensis)* was observed at the southern end of the wetland traveling along the ditch.

Wetland 8 (FLUCFCS 641; 0.01 acres)

Wetland 8 is a 0.01-acre freshwater marsh, which is a remnant of a larger system. This small area is a depressional area immediately surrounded by open lands consisting of bahia grass and broomsedge. Beyond this area, live oak hammock surrounds the wetland to the north, south, and east. To the west are orange groves and a large drainage ditch, which ultimately drains to the Cow Pen Canal. This wetland has no zonation and has limited coverage by hydrophytic vegetation, including several small buttonbush, prairie iris (*Iris hexagona)*, and a few small clumps of sand cordgrass. Hydric soil indicators are mostly absent within this wetland. Water is retained after rain events, but due to the presence of the large ditch to the west, water levels recede quickly. Wetland functions currently include minimal wildlife habitat and storage of water. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading Birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. During the assessment many tadpoles were present in the pool of water.

Wetland 9 (FLUCFCS 641; 2.51 acres)

Wetland 9 is a 2.51-acre freshwater marsh. The core retains water year-round and hydrophytic vegetation coverage includes primrose willow, Carolina willow, and some fireflag. Typical species of the middle zone include soft rush, fireflag, scattered buttonbush, primrose willow, coinwort, and maidencane. The outer most zone contains broomsedge, soft rush, primrose willow, coinwort, maidencane, dogfennel, bahia grass, yellow-eyed grass (*Xyris* spp.), and scattered blackberry. The wetland is adjacent to ditches to the north and west, with associated spoil areas located on the wetland side of the ditch. Thus, impounding of water and, alternately, excessive draining are problems depending on rainfall. The wetland is immediately surrounded by live oak hammock to the east and south, by orange groves and a ditch to the west, and by a road and a ditch to the north. Wetland functions currently include storage and filtering of water and limited habitat for wildlife. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. No wildlife was observed in this wetland during the assessment.

Wetland 11 (FLUCFCS 641; 4.17 acres)

Wetland 11 is a 4.17-acre freshwater marsh. This wetland has well-defined zonation with fireflag in the core, pickerelweed (*Pontederia cordata*) and maidencane in the middle zone and sand cordgrass in the outer zone. Other species present in the outer zone include maidencane, pennywort, broomsedge, dogfennel, scattered buttonbush, bahia grass, immature slash pine and laurel oaks. Live oak and cabbage palm hammocks occur to the west and a mixed hardwood/conifer forest occurs to the east. This forested habitat continues to the north and south of the wetland, providing a wildlife corridor. There are large ditches within 200 feet to the east and within 400 feet to the west. Following rain events, water levels within this wetland are raised, but water is not retained due to the lowered water table caused by the surrounding ditch network. Wetland functions currently include storage and filtering of water and limited habitat for wildlife. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. Skeletons of a variety of animals were found on the wetland edge including: deer *(Odocoileus virginianus),* pig, coyote *(Canis latrans),* rabbit, and cow. These appear to have been transported to the location. No other evidence of wildlife utilization was observed.

Wetland 12 (FLUCFCS 643; 0.90 acres)

Wetland 12 is a 0.90-acre wet prairie. This wetland has moderate zonation and limited species diversity. The core area is comprised of soft rush and prairie iris. The outer zone is comprised of maidencane, buttonbush, broom grass, primrose willow, and coinwort. The transitional zone has caesarweed and bahia grass. A live oak hammock is located to the north, south, and west of the wetland and a mixed hardwood/conifer forest is located to the east. The forested habitat continues to the north and south on the subject parcel. This system has been hydraulically impacted by the presence of the ditches within 600 feet to the east and within 200 feet to the west, which have drawn down the water table. Wetland functions currently include storage and filtering of water and limited habitat for wildlife. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. No wildlife utilization was observed during this assessment.

Wetland 13 (FLUCFCS 643; 0.42 acres)

Wetland 13 is a 0.42-acre wet prairie and is a highly disturbed and drained system. A well-traveled vehicle path bisects this wetland. Typical vegetation present includes broomsedge, smartweed (*Polygonum punctatum*), swamp fern (*Blechnum serrulatum*), maidencane, bahia grass and coinwort. This system has been hydraulically impacted by the presence of the ditches 500 feet to the east and west, and 200 feet to the north, which have lowered the surficial water table. Immediately after rain events, this wetland holds water to its historical level. However, due to the water table impacts caused by the extensive network of ditches, water recedes quickly causing the lack of long-term water retention necessary for the long-term survival of this system. This wetland is surrounded by a live oak hammock to the north, south, and west and by mixed hardwood/conifer forest to the east. The forested habitat continues to the north and south on the subject parcel. Wetland functions currently include storage and filtering of water and limited habitat for wildlife. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. No wildlife utilization was observed during this assessment.

Wetland 14 (FLUCFCS 641; 2.72 acres)

Wetland 14 is a 2.72-acre freshwater marsh. The core of the wetland appears to have been excavated and is comprised of open water with cattails and smartweed. The middle zone contains large amounts of primrose willow, maidencane and smartweed. The outermost zone is marginal and several upland species are encroaching into the wetland, including greenbriar (*Smilax auriculata*), caesarweed, dogfennel, and broomsedge. Other species present include maidencane, coinwort and Brazilian pepper. Live oak and cabbage palm hammocks surround this wetland. The abutting forested habitat continues to the north and south on the subject parcel. This system has been hydraulically impacted due to excavation of the interior, which caused the unnatural pooling of water in the wetland, and the creation of the ditch immediately adjacent to the eastern wetland edge, which caused the drawing down of the water table. Wetland functions currently include storage and filtering of water and limited wildlife habitat. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. There was evidence of pig rooting around the wetland edge.

<u>Wetland 15 (FLUCFCS 619; 0.79 acres)</u>
Wetland 15 is a 0.79-acre exotic hardwood wetland, with no zonation. It is dominated by nuisance/exotic species including Brazilian pepper and primrose willow. Other species present in smaller quantities include pop ash (*Fraxinus caroliniana*), bitter orange (*Citrus aurantium*), Carolina willow, arrowhead (*Sagittaria* sp.), and fireflag. This wetland is surrounded by live oak and cabbage palm hammocks immediately to the north and farther south, which continue to the north and south on the subject parcel. In addition, other open lands are located immediately adjacent to the southern end of this wetland. This system has been hydraulically impacted by the presence of a ditch immediately to the west, which causes water table draw down. Wetland functions include storage and filtering of water and limited habitat for wildlife. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. Extensive pig rooting was observed.

<u>Wetland 16 (FLUCFCS 641; 0.03 acres)</u>
Wetland 16 is 0.03-acre freshwater marsh located east of the Cow Pen Canal. This small, isolated wetland has no zonation and is comprised of soft rush and broomsedge. Standing water was present during field investigations. It is surrounded by improved pasture with a mixed hardwood-conifer forest and live oak hammock about 150 feet to the east and west. The hydrology of this wetland has been impacted by the nearby ditches, rutting from pig rooting, and agricultural maintenance. Wetland functions currently include limited storage of water and limited suitability as wildlife habitat. Anticipated wildlife utilization is by amphibians and reptiles, wading birds, and small and medium mammals. Wading birds expected to utilize this wetland are listed below: Little Blue Heron, White Ibis, Snowy Egret, and the Wood Stork. During this field investigation utilization by pigs was evident.

3.1.3 Wildlife

A database search was conducted for listed species potentially occurring on the Albritton site (Exhibit 10). The wetlands onsite may be used for foraging and loafing by several species of wading birds, including the state-listed Little Blue Heron, White Ibis, Snowy Egret, and Wood Stork. All of which are state-listed Species of Special Concern (SSC), except for the Wood Stork, which is state and federally listed as Endangered. Some opportunity for the state-listed Threatened Florida Sandhill Crane (*Grus canadensis pratensis*) might exist for foraging and loafing within the improved pastures in the south, though no suitable nesting habitat occurs onsite. Although the wetlands do have the potential for wading bird utilization, the closest documented colony (#615118) is listed as being approximately 1200 meters (0.55 miles) from the eastern property boundary on Hawkins Ranch. Although no colonies containing Wood Stork occur within the vicinity of the project area, the project area does occur within the 18.6-mile Core Foraging Area (CFA) as defined in the draft *Standard Local Operating Procedures for Endangered Species (SLOPES) – Wood Storks* (28 June 2002) published by the U.S. Fish and Wildlife Service. Several Bald Eagle (*Haliaeetus leucocephalus*) nests are in the vicinity of this site, however the closest nest (SA035) documented is approximately 1500 meters (0.68 miles) from the southern property boundary on the Pinelands Reserve, which is significantly beyond the limits of any protection zones for the nests. Other wildlife searches included the Florida Scrub-jay (*Aphelocoma coerulescens*), which has no documented territories within a two-mile radius of the site.

In addition, marginal habitats do exist onsite for the federal and state listed Eastern indigo snake (*Drymarchon corais couperi*), and the state-listed SSC, the gopher tortoise (*Gopherus polyphemus*) (SSC). The Eastern indigo snake is a habitat generalist, which is found in a wide-range of habitats, though none were observed during fieldwork. Marginal habitat does exist for the gopher tortoise in the mixed hardwood-conifer forests, and potentially in the improved pastures or orange groves. Probabilities of gopher tortoise occurring onsite are low due to the heavily managed nature of the parcel, but surveys would be required to make a final statement on their presence or lack thereof. Wildlife observed during BRA's preliminary wildlife survey is documented in the specific land use/wetland descriptions above.

3.1.4 Uniform Mitigation Assessment Methodology

The UMAM, pursuant to Chapter 62-345 of the *Florida Administrative Code*, became effective for the State of Florida on 2 February 2004 and for the COE in Florida on 1 August 2005. UMAM is the sole methodology utilized to determine wetland quality and mitigation requirements in the State of Florida as it incorporates the wetland impact acreages and the quality of the wetland pre- and post-development to compute quantitative compensation acreage. The UMAM datasheets (are divided into Part I, a qualitative description of the assessment area, and Part II, a quantitative description of the assessment area. Scoring on a 0-10, whole-number basis, in Part II, is required for

Location/Landscape Support, Water Environment, and Community Structure indicators. A "0" score is given to an area that no longer performs any functions of a wetland and a "10" score is given to a wetland in an optimal natural condition. Location/Landscape Support is scored relative to the assessment area's ability to support fish and wildlife during a portion of their life cycle and its relationship to surrounding areas in terms of wildlife habitat connectivity and "water quality and quantity benefits". Per Chapter 62-345, the Water Environment scoring is based on "the quantity of water in an assessment area, including timing, frequency, depth, and duration of inundation or saturation, flow characteristics, and the quality of that water. . . its ability to perform certain functions and. . . benefit or adversely impact its capacity to support certain wildlife." Finally, the Community Structure score is based on the vegetative community structure and composition and its ability to support wildlife habitat. The UMAM sheets for each wetland are included as Exhibit 11.

3.2 West Pinelands Current Land Use

A FLUCFCS land use map (Exhibit 12) was created by BRA based on field evaluations by BRA ecologists, aerially mapped and digitized vegetative boundary lines, and GIS analysis. Descriptions of each habitat type are provided below. All provided acreages are approximate as they are based on aerial interpretation and not surveyed habitat delineations. A preliminary wildlife survey, including pedestrian and vehicle transects, was also conducted and the results follow the habitat assessments.

3.2.1 Uplands

The non-jurisdictional wetlands on the site total approximately 303.7 acres, or 77.2%, and include the Cow Pen Canal.

<u>Unimproved Pasture (FLUCFCS 212; 98.1 acres)</u>
The unimproved pasture is a remnant of the former agricultural activities on the site. These pastures of bahia grass and broomgrass provide the immediate upland buffer and transition zones to the wetland features previously described. Often the transition from upland to wetland is gradual which provides a diverse mesic community that is dominated by herbaceous species such as broomgrass, white top sedge, golden rod (*Solidago* sp.), and dogfennel. However, the hydrology does not appear significant to support wetland species outside of occasional flooding events. In addition, further investigation of sub-surface soils did not contain indicators specific to a hydric soil.

<u>Pine Flatwoods (FLUCFCS 411; 19.3 acres)</u>
The mixed forest (described below) gradually transitions into a pine flatwood that is dominated by slash pine in the tree stratum and saw palmetto in the understory. Although live oak remains in scattered locations throughout, the diversity of tree and shrub species diminishes.

Cabbage Palm (FLUCFCS 428; 14.3 acres)
This area is located in the center of the property and is dominated by cabbage palm with an understory of beautyberry and wild coffee. This land use type is located south of a portion of hardwood-conifer mixed forest and, together, they are the extant tree island in the middle of the historical Cow Pen Slough. The edge of this system was used to set historical Wet Season Water Levels (WSWL).

Hardwood-Conifer Mixed (FLUCFCS 434; 145.1 acres)
Uplands to the west of the Cow Pen Canal floodplain include a mixed conifer and hardwood forest (FLUCFCS 434), which is co-dominated by slash pine, live oak and laurel oak, with cabbage palm in the sub-canopy. Other species in the understory include saw palmetto, wax myrtle, gallberry (*Ilex glabra),* and yaupon holly (*Ilex vomitoria)*.

Channelized Waterway (FLUCFCS 5101; 30.0 acres
Cow Pen Canal runs from north to south and is present along the eastern boundary of the project area. This feature fragments the surrounding land use significantly. Spoil piles from the dredging of the canal line the banks on both sides. Upland ruderal species such as dogfennel and panic grasses (*Panicum* sp.) are prominent on the banks. Wading birds and a single American alligator (*Alligator mississippiensis)* were observed on the banks.

Roads (FLUCFCS 8144; 11.4 acres)
This land use type is inclusive of the portion of Knight's Trail that falls within the project boundary. This paved road runs approximately north-south and terminates at the landfill.

Graded and Drained Road (FLUCFCS 8145; 15.5 acres)
This area is the maintained, bermed road west of canal that originates at the bend of the Cow Pen Canal and continues south.

3.2.2 Wetlands

The wetlands contained within the following descriptions (Exhibit 13) were previously delineated and permitted in the COE permit No. 89IPI-90924 (1994) and Florida Department of Environmental Protection permit No. 581723073 (1990). As these delineations were not conducted under the current State of Florida rules governing wetland delineation methodology (62-340, *Florida Administrative Code*) and a significant amount of time has passed, BRA re-delineated all of wetland lines (utilizing aerial interpretation and groundtruthing) based on current conditions and methodology. However, these limits have not been surveyed or verified by either state or federal agencies.

WL-1 (FLUCFCS 641; 3.4 acres)
This small, depressional basin is a remnant of a former large wetland system that comprised the riparian buffer for the original Cow Pen Slough as depicted on the 1948 aerial photograph. Wetland 1 (WL 1) is located approximately 200 feet west of the

slough canal and is now an herbaceous wet prairie dominated by maidencane, smartweed, soft rush, pennywort, and carpet grass (*Axonopus affinis)*. Broomgrass and bahia grass are present along the fringe of the wetland.

The buffer adjacent to WL-1 consists of an upland open improved pasture dominated by bahia grass with isolated live oak trees and cabbage palm. This pasture grades into an extensive upland mixed forest dominated by live oak, saw palmetto, and slash pine.

The *Soil Survey of Sarasota County* (1991) indicates the soils for this wetland as Delray fine sand depressional, a County-listed hydric soil. The description for this soil type indicates that it is poorly drained, often found in depressions in flatwoods. Although the soil within WL-1 has been subjected to historical alteration by decades of drainage activities, this description is further supported by the field observation of soil saturation at surface. No wildlife activities were observed within the wetland at time of the field activities. However, the wetland provides adequate opportunity for wildlife habitat for foraging potential, floodwater attenuation, and sediment or nutrient filtration.

<u>WL-2 (FLUCFCS 643/641; 3.7 acres)</u>
Similar to WL-1, this wetland is also a remnant of the original Cow Pen Slough. The outer rim of this system is a wet prairie dominated by herbaceous species such as maidencane, yellow-eyed grass, Southern blueflag iris (*Iris virginica),* beakrush (*Rhynchospora* spp.) and sand cordgrass. The center of the wetland is a freshwater marsh that is inundated and dominated by emergent herbaceous species including soft rush, smartweed, spikerush, and dayflower (*Commelina diffusa).*

The buffer is an upland improved pasture dominated by bahia grass and broomgrass immediately adjacent to the wetland. This system grades into a large upland mixed forest dominated by live oak, cabbage palm, slash line, saw palmetto and wax myrtle (*Myrica cerifera)*. No indication of recent disturbance is present. However, indication of a non-recent fire event was noted in the upland mixed forest buffer.

Soils within this wetland are similar to those present in WL-1, and are also mapped as Delray Fine Sand Depressional in the *Soil Survey of Sarasota County* (1991). However, observations of the soils during the field event do not support this soil description. This discrepancy is most likely attributed to the alteration of soils from the canal construction several decades ago that resulted in the drainage of historical wetlands in the historical Cow Pen Slough system. However, the soil is sufficiently supporting hydrophytic vegetation as the hydrology to this system appears stable.

Anticipated wildlife utilization within the wetland and buffer system is high. Eagles could potentially utilize the area for foraging. This system can adequately support wading birds and also large and small mammals. Wildlife observations included a flock of swifts, as well as deer and feral pig tracks and trails.

WL-3 (FLUCFCS 643; 1.4 acres)

This wetland is located approximately 200 feet from the Cow Pen Canal. It is a wet prairie remnant of the larger system that comprised the riparian edge for the wetland-stream complex. The species within the wetland are diverse and true zonation is strong, and include maidencane, broomgrass and dogfennel near the edge of the fringe. The center is dominated by smartweed, Vasey's grass (*Paspalum urvillei)*, nutsedge (*Cyperus* sp), and umbrella sedge (*Fuirena pumila).* Other non-dominant species worthy of notation include sand cordgrass, beaksedge, southern blue flag iris, and bristly fox tail (*Setaria geniculata).*

The buffer immediately adjacent to WL-3 is an improved pasture, dominated by bahia grass, with occasional live oak and cabbage palm trees. The buffer rises slightly in elevation toward an extensive mixed oak and pine forest to the west. Cow Pen Canal is located approximately 150 feet to the east. Improved pasture adjacent to the canal provides the buffer to the north and south of the wetland. This upland pasture connects to the other wetlands along the riparian zone to the slough.

The hydrology of this system is marginal due to the former disturbance by drainage; however, it still retains a hydraulic connection to the Cow Pen Canal. The *Soil Survey of Sarasota County* (1991) mapped unit, Felda fine sand, is within the outer fringe of the WL-3, where as the Floridana and Gator depressional unit is located more toward the center of the system. The soils adequately support hydrophytic vegetation although encroachment by upland species was noted. Hydric indicators observed in the soils on site were weak due to the compromised hydrology.

Wildlife utilization within this wetland and surrounding buffer is high. Wild turkeys were observed, and deer and feral pig tracks bisect the system. Eagles, wading birds (SSC), small mammals, reptiles, and amphibians may utilize the wetland for foraging. Another function of the wetland is to provide floodwater attenuation and filtration of sediments in flooding scenario.

WL-4A & WL-4B (FLUCFCS 631/643; 7.2 + 31.0 acres)

This large wetland system is composed of two distinct plant communities, a buttonbush and pop ash swamp, WL 4A, and an emergent wet prairie, WL 4B. The first community, WL 4A, is dominated by buttonbush, with co-dominance shared by Carolina willow shrubs and pop ash saplings. This area is frequently inundated as depicted by water marks and stain lines on the bases of the shrubs. Few groundcover species were noted, but are dominated by maidencane, bushy broomsedge, and pennywort.

The second plant community, WL 4B, is a wet prairie consisting of emergent herbaceous species with a co-dominance of maidencane, bushy broomsedge, smartweed, and spiked beakrush. Other species contributing to the diversity include lance-leaf frogfruit (*Phyla lancifolia)*, iris (*Iris* sp), and white top sedge (*Dichromena colorata)*. Soils for wetland communities consisted of Delray Fine Sand mapped unit typically found in depressional basins according to the *Soil Survey of Sarasota County* (1991).

The wetland provides potential for foraging, nesting and cover for wildlife and anticipated utilization is high both in the system and the surrounding buffer. Observations include trails from deer and feral pigs, tracks of other small mammals, and songbirds. Potential utilization could include foraging by raptors and wading birds. The buffer for the wetland is an upland live oak, laurel oak and slash line forest with an understory of saw palmetto. This plant community grades into a relatively undisturbed pine flatwoods that shows indication of a non-recent fire event.

WL 5 (FLUCFCS 641; 0.8 acres)
This wetland is reduced from its former configuration due to disturbance from drainage by the construction of the Cow Pen Canal. The system is predominantly an herbaceous dominated freshwater marsh. Buttonbush is scattered throughout the marsh. Dominant vegetation includes herbaceous species such as maidencane, smartweed, carpet grass, spiked beakrush, caric sedges (*Carex* spp), and rosy camphor-weed (*Pluchea rosea).* Upland grass species are encroaching into the system.

Soils consist of Delray fine sand, a mapped unit typically found in depressional basins according to the *Soil Survey of Sarasota County* (1991). However, the wetland appears to adequately support hydrophytic vegetation thus sustaining the stability of the wetland.

No wildlife activities were observed within the wetland at time of the field activities. However, the wetland provides adequate opportunity for wildlife habitat for foraging potential, floodwater attenuation, and sediment or nutrient filtration.

WL 6 (FLUCFCS 641; 3.2 acres)
Similar to WL 5, this system is also a wet prairie located adjacent to the current Cow Pen Canal and disturbed native habitat. It was formerly included in the original meandering slough prior to the canal construction that resulted in an altered hydrology to this wetland. Dominant species include such grasses as maidencane, broomgrass, and carpet grass, along with ground cover species including spiked beakrush and lance leaf frogfruit, and buttonbush.

Soils within this wetland are mapped as Delray fine sand, which are typically found in depressional basins along slough systems according to the *Soil Survey of Sarasota County* (1991). The wetland appears to adequately support hydrophytic vegetation thus sustaining the stability of the wetland.

Wildlife activities observed within the wetland at the time of the field activities include feral pig rooting and trails. Wading birds are also assumed to utilize the wetland as it can provide adequate opportunity for wildlife habitat for foraging potential, floodwater attenuation, and sediment or nutrient filtration.

WL 7 (FLUCFCS 641; 0.6 acres)

Wetland 7 is a 0.6-acre freshwater marsh located approximately 50 feet west of Cow Pen Canal. This wetland was part of the original Cow Pen Slough, but was drained in the 1950's, which altered the hydrology, however, hydric soils still persist. This isolated, moderate quality wetland currently has no standing water and an unpaved access road is present on the eastern edge. Pine flatwoods and improved pasture surround this wetland to the north, south, and west.

Vegetation within this wetland has no obvious zonation and is primarily a monoculture of maidencane with some broomsedge. The upland adjacent to Wetland 7 consists of an improved pasture dominated by bahia grass with isolated live oak and cabbage palm trees. Beyond this area is an upland flatwood plant community consisting of saw palmetto and slash pine.

Wetland functions include small mammal feeding, water storage and filtration. The anticipated wildlife utilization is by wading birds, insects, amphibians, small reptiles and small/medium mammals. Wading birds expected to utilize this wetland are listed, these include: Little Blue Heron (SSC), White Ibis (SSC), Snowy Egret (SSC), and Wood stork (E). No evidence of wildlife was observed.

WL-8 (FLUCCS 641; 1.9 acres)

Wetland 8 is part of the historical Cow Pen Slough as depicted on the 1948 aerial photograph. Wetland 8 is located approximately 200 feet from the canal, west of the bermed, graded, and culverted access road. It is now an herbaceous marsh dominated by maidencane, smartweed, carpet grass, and bushy beardgrass (*Andropogon glomeratus)*. The wetland has little to no nuisance/exotic species intrusion, moderate diversity, and evidence of severe drainage. The buffer adjacent to WL-8 consists of mixed hardwoods, including live oak, slash pine, saw palmetto, and scattered cabbage palm.

The *Soil Survey of Sarasota County* (1991) indicates the soils for this wetland as Floridana and Gator soils, depressional, a county-listed hydric soil. The description for this soil type states that it is very poorly drained, found in depressions. Although the soil within WL-8 has been subjected to historical alteration by decades of drainage activities, this description is further supported by the field observation of soil saturation at surface.

No wildlife activities were observed within the wetland at time of the field activities, although a bobcat was seen on the adjacent road. The wetland provides adequate opportunity for wildlife habitat for foraging potential, floodwater attenuation, and sediment or nutrient filtration.

WL-9 (FLUCCS 641; 0.31 acres)

Similar to the other wetlands on the property, this wetland is a remnant of the original Cow Pen Slough. The wetland is a drained freshwater marsh dominated by herbaceous species such as maidencane, smartweed, frog fruit, broomsedge, and meadow beauty

(*Rhexia* spp.). The buffer is a mixed hardwood forest and pine flatwoods area contiguous to the buffers of the adjacent wetlands, including Wetlands 8 and 10.

Soils within this wetland are mapped as Felda fine sand depressional in the *Soil Survey of Sarasota County* (1991). The alteration of soils from the canal construction several decades ago has resulted in the drainage of historical wetlands in the original Cow Pen Slough system and the once-hydric soils are losing their hydric indicators. However, the soil is sufficiently supporting hydrophytic vegetation as the hydrology to this system appears stable.

The only anticipated wildlife utilization in this system is for wading birds, reptiles, and large and small mammals. A bobcat was observed adjacent to the wetland and pig rooting was evident throughout.

<u>WL-10 (FLUCCS 641; 1.7 acres)</u>
This wetland is located approximately 200 feet from the Cow Pen Canal and has been heavily affected by the construction of the canal and the berming of the access road. Wetland 10 is a freshwater marsh remnant of the larger system that comprised the riparian for the wetland-stream complex. The species within the wetland include maidencane, broomgrass, dogfennel, smartweed, and frog fruit. The alteration of the natural hydrology has allowed the encroachment of upland species such as dogfennel, as well as limited species diversity and a lack of zonation. The buffer south of the wetland is the transition between the mixed hardwood forest to the north and the pine flatwoods to the south.

The hydrology of this system is marginal due to drainage from the former disturbance; however, it still retains the hydrological connection to Cow Pen Canal. The *Soil Survey of Sarasota County* (1991) mapped unit is Floridana and Gator soils, depressional, a hydric soil. The soils adequately support hydrophytic vegetation although encroachment by upland species was noted. Hydric indicators observed in the soils on site were weak due to the compromised hydrology.

Wildlife utilization within this wetland and surrounding buffer is high. Feral pig rooting was prevalent throughout the wetland. Floodwater attenuation and filtration of sediments are possible functions of the wetland.

<u>WL-12 (FLUCSS 617/641; 2.6 acres)</u>
This large wetland system is composed of two distinct plant communities, a wetland hardwood swamp with a herbaceous marsh core. The outer community is dominated by buttonbush, cabbage palm, and laurel oak with little to no herbaceous understory. This area is frequently inundated as depicted by watermarks, stain lines, buttressing, and rooting on the bases of the trees.

The wetland core is a freshwater marsh consisting of herbaceous species with a co-dominance of maidencane, bushy beardgrass, smartweed, and beakrush. A natural, meandering waterway drains the adjacent pine flatwoods, particularly to the south, and funnels the water into the wetland core.

Soils consist of Felda fine sand, depressional; typically found in depressional basins according to the *Soil Survey of Sarasota County* (1991). The altered hydrology from the construction of Cow Pen Canal compromised the hydric characteristics of the soil. However, hydric characteristics such as high organic content (muck) at grade support hydrophytic vegetation thus sustaining the stability of the wetland.

The wetland provides foraging, nesting and cover for wildlife. Utilization is high both in the system and the surrounding buffer. Potential utilization could include foraging by raptors, wading birds, herptiles, and mammals.

3.2.3 Wildlife

A database search was conducted for listed species potentially occurring on or adjacent to the subject property (Exhibit 10). The wetlands onsite may be used for foraging by several species of wading birds, including the state-listed Little Blue Heron, White Ibis, Snowy Egret, and Wood Stork. All are state-listed SSC, except for the Wood Stork, which is state and federally listed as Endangered. Some opportunity for the state-listed Florida Sandhill Cranes might exist for foraging or nesting within the herbaceous wetlands in the south, though no nesting habitat was observed. Although the wetlands have high potential for wading bird utilization, the closest documented colony is identified approximately 0.75 miles to the northwest of the project limits. Although no colonies containing Wood Storks were found on the subject property, the project area occurs within two 18.6-mile CFA as defined in the draft *Standard Local Operating Procedures for Endangered Species (SLOPES) – Wood Storks* (28 June 2002) published by the U.S. Fish and Wildlife Service. Several Bald Eagles' nests are in the vicinity of this site; however the closest nest is documented on the Pinelands property to the southeast, well outside of the primary and secondary protection zones. Other wildlife searches included the Florida Scrub-jay, which has no documented territories within a two-mile radius of the site. No scrub-jays or suitable habitat were observed on or adjacent to the subject property.

Although site conditions are marginal, potential habitats exist onsite for the federally and state threatened Eastern indigo snake and the state-listed SSC, the gopher tortoise. The Eastern indigo snake is a habitat generalist, which is found in a wide-range of habitats. However, none were observed during fieldwork. Potential habitat for the gopher tortoise is located within the upland mixed hardwood-conifer forests adjacent to the Cow Pen Canal. Probabilities of gopher tortoises occurring onsite are low due to the heavily managed nature of the parcel, but formal surveys would be required to make a final statement on their presence or lack thereof. Wildlife observed during the preliminary wildlife survey is documented in the specific land use/wetland descriptions above.

3.2.4 Uniform Mitigation Assessment Methodology

The UMAM sheets for each West Pinelands wetland are included as Exhibit 14. COE datasheets are provided as Exhibit 15. These datasheets will be used by COE staff to assess each wetland during COE permitting.

3.3 Myakka Connector Current Land Use

The upland and wetland habitats onsite were evaluated during fieldwork conducted in December 2005. A land use map (Exhibit 16) was created based on the FLUCFCS. Descriptions of each habitat type are provided below. All provided acreages are approximate as they are based on aerial interpretation and not surveyed habitat delineations.

3.3.1 Uplands

<u>Shrub and Brushland (FLUCFCS 320; 0.5-acre)</u>
This area totals 0.1% of the property and is dominated by wax myrtle, with highly patchy sawgrass *(Cladium jamaicense).* The soils in the area are mapped as Pineda fine sand, but no indicators of hydrology or hydric soils were observed in the field.

<u>Pine Flatwoods (FLUCFCS 411; 183.4 acres)</u>
The majority of the site (41.6%) is mapped as pine flatwoods, with a dominant canopy of slash pine. Typical understory species include saw palmetto, gallberry, some wax myrtle, and scattered cabbage palm. The pine flatwoods include areas identified within the *Soil Survey of Sarasota County* (1991) as both hydric and non-hydric soils. In areas where the soils are mapped as hydric, the pine flatwoods appear slightly sparser in vegetation and a bit more open. Several fire breaks were created for maintenance within the last year separating the pine flatwoods into sections.

<u>Live Oak Hammock (FLUCFCS 427; 60.5 acres)</u>
This land use type constitutes 13.7% of the property, is located in areas that were part of the historical slough and are identified as hydric soils according to the *Soil Survey of Sarasota County (*1991). The live oak hammocks are typically located in the same landscape position as the cabbage palm hammocks, but dominant canopy species differ slightly. The live oak hammocks appear to have a vegetative composition consistent with the Sarasota County regulated mesic hammock, especially in areas towards the south. In the eastern portion of the parcel, the live oak hammock is located around the braided channel before it opens into the live oak and cabbage palm dominated wetland area identified as Wetland 8A.

Live oak dominates the canopy with variable understory vegetation, but typical species include cabbage palm, some scattered saw palmetto, beautyberry, wild coffee, broomsedge, St. John's Worts (*Hypericum* sp.), and Panicgrass (*Dichanthelium* sp.).

Cabbage Palm (FLUCFCS 428; 16.7 acres)
The cabbage palm hammocks generally define flowways, are found adjacent to the live oak hammocks and wetlands and total 3.8% of the site. One main area of cabbage palm hammock is the connection between Wetlands 6A and 8A, which has been slightly disturbed due to the construction of a fire break. These areas do not meet the definition of Sarasota County-regulated mesic hammock. Few species other than cabbage palms are found within these areas.

Hardwood Conifer Mixed (FLUCFCS 434; 73.1 acres)
This landuse type constitutes 16.6% of the property. The canopy in these areas is dominated by slash pine and live oak with cabbage palm in the mid-canopy. Saw palmetto is typical in the understory. The hardwood-conifer mixed areas are adjacent to the current slough area and on the north side of Wetlands 3A and 4A, where fires have been far less frequent than in the pine flatwoods. These areas are typically located in soils identified as Pineda fine sand (31) and partially within the historical slough limits, according to the *Soil Survey of Sarasota County* (1991).

Graded and Drained Roads (FLUCFCS 8145; 8.4 acres)
A graded and drained road (2% of the site area) originates from the FPL easement, west along the north side of Wetlands 2A, 3A and 4A. This road is raised on a gravel bed, and has swales on either side, which serves as a berm to impound water in the adjacent wetlands.

Electrical Power Transmissions Lines (FLUCFCS 832; 11.1 acres)
The FPL transmission lines are located north-south through the eastern portion of this parcel and total 2.5% of the site. There are several culverts located under the easement toward the south end of the parcel where the slough drains towards the Myakka River. However, sufficient culvert crossings under the easement appear to be lacking and water is impounded within Wetlands 7A and 8A. The FPL easement does not hinder wildlife movement, and the culverts do allow for movement of fish and other aquatic small wildlife.

3.3.2 Wetlands

Wetland 9A and portions of Wetlands 2A and 4A were previously delineated and permitted under COE permit No. 89IPI-90924 (1994) and Florida Department of Environmental Protection permit No. 581723073 (1990). As these delineations were not conducted under the current State of Florida rules governing wetland delineation methodology (62-340, *Florida Administrative Code*) and a significant amount of time has passed, BRA re-delineated all of wetland lines based on current conditions and methodology. However, the limits have not been verified by the federal, state or local agencies.

WL 1A (FLUCFCS 560; 12.4 acres)
Wetland 1A (Exhibit 17) is part of a slough system formed by waters draining east to the Myakka River. The area exists as a combination of pockets of vegetated forested wetland, two distinct flow-ways, and scattered upland islands. The wetland is vegetated with Carolina willow, pop ash, laurel oak, cabbage palm, carpetgrass, and pennywort. The two flow-ways consist of one defined non-vegetated, meandering flow-way and one defined non-vegetated linear flow-way. The linear flow-way appears to have been altered either by creation or enhancement of its historical condition by the channeling of water through culverts under the FPL easement. The upland islands consist of saw palmetto, cabbage palm, and laurel oak and are too small to delineate as separate land uses.

The *Soil Survey of Sarasota County* (1991) indicates the soils for this wetland as Felda and Pompano fine sands, frequently flooded, a state and federal hydric soil. The description for this mapping unit states that it is poorly drained and is often found in floodplains throughout the county. This description is further supported by the field observation of soil saturation at surface in the wetlands and inundation in the flow-ways. The upland islands contain non-hydric soils, however they are also mapped as Felda and Pompano fine sands, frequently flooded.

Wildlife observations include pig rooting, wallows and trails, a Little Blue Heron, a Great Blue Heron *(Ardea herodias),* a green anole *(Anolis carolineansis)*, Glossy Ibis *(Plegadis falcinellus)*, and a black racer *(Coluber constrictor).* The buffer immediately adjacent to WL-1A is dominated by pine flatwood species, including slash pine and saw palmetto, with laurel oak and cabbage palm also present. Overall, the quality of WL-1A is high.

WL 2A (FLUCFCS 641; 1.3 acres)
Wetland 2A is a small depressional area which has a small core dominated by a buttonbush and Carolina willow. Typical species within the outer transitional zone include maidencane, a small red maple, wax myrtle, *Iris* spp., smartweed, asters (*Aster* spp.), broomgrass, sand cordgrass, and beakrush. Saw palmetto forms a hard edge to this wetland system, with scattered cabbage palm and wax myrtle.

This wetland is connected to Wetland (5A) to the south via a small channel. Two (2) additional wetlands (Wetlands 6A and 7A) and the remnant of a third are all connected to Wetland 2A through a series of hammocks. Based on the current and historical soil surveys, the current extent of this series of wetlands is smaller than the historical extent, and smaller than the area mapped as Holopaw fine sand, depressional (022). The surrounding uplands are pine flatwoods except for the cabbage palm hammocks that link several of the wetlands together. Observed wildlife includes a Limpkin *(Aramus* *guarauna)* and a Red-Tailed Hawk *(Buteo jamaicensis).* Suitable habitat exists for wading birds, including the Little Blue Heron, White Ibis, Snowy Egret (all state-listed Species of Special Concern) and the state and federal listed Wood Stork.

WL 3A (FLUCFCS 641; 11.6 acres)
The northern portion of this wetland is shrubby, dominated by buttonbush with primrose willow and some cattails (*Typha* sp.). Just south of the buttonbush, there is a deepwater core dominated by spatterdock (*Nuphar lutea*), which is surrounded by a zone of pickerelweed. The southern portion of this wetland is freshwater marsh. The outer zone is dominated by maidencane, then St. John's wort, umbrella grass, lemon water-hyssop (*Bacopa monnieri*), blue flag, coinwort, smartweed, asters, pennywort, sand cordgrass, sawgrass, and scattered wax myrtle.

This is a large herbaceous system located in soils mapped as Floridana and Gator soils, depressional and Holopaw fine sand, depressional. Based on the soil surveys, this marsh was surrounded by a large swath of Felda fine sand, depressional that formed the main portion of the historical slough system which flowed through this area to the Myakka River. Currently the majority of the areas mapped as Felda fine sand, Depressional are pine flatwoods, dominated by slash pine, saw palmetto, and gallberry.

Wildlife species observed within this wetland include a Great Egret and Little Blue Heron. Potential exists for usage by other listed wading birds. The surrounding uplands consist of hardwood/conifer mixed and pine flatwoods. There are some areas south of this wetland which show some tendencies towards wet prairie, including some patchy grassy hydrophytic vegetation. In addition, a small stream which during the dry season, appears to double as a road in some places, connects this wetland south to Wetland 3B.

WL 4A (FLUCFCS 641; 22.5 acres)
This high quality, large herbaceous marsh is also part of the main portion of the historical slough which traversed through this parcel. The main portion of this marsh remains intact, but the surrounding habitats have transitioned to hardwood/conifer mixed and pine flatwoods. Dominant soils include Floridana and Gator soils, depressional (15) and Holopaw fine sand, depressional (22). No connections or flow-ways to or from this wetland were located. A graded and maintained road (FLUCFCS 8145) was constructed around the northern boundary of this wetland which impounds water within this system.

This marsh is dominated by two (2) distinct pickerelweed cores, with some scattered buttonbush and Carolina willow. The western portion contains some cattails and sawgrass, which are particularly dense along the wetland edge. Wax myrtle is found regularly along the eastern boundary. The remaining zones of this wetland system are herbaceous, including St John's Wort, yellow-eyed grass, jointed knotweed (*Eleocharis interstincta*), beakrush, bog button (*Lachnocaulon* sp.), asters, smartweed, broomgrass, musky mint (*Hyptis alata*), and umbrella grass.

This wetland contains suitable habitat for wading birds and small and medium mammals. Evidence of pig rooting was observed, and a red-shouldered hawk was observed perched on a slash pine snag in the marsh.

WL 5A (FLUCFCS 641; 1.6 acres)
This high quality wetland is a pop ash swamp with scattered Carolina willow and a freshwater marsh outer zone. Typical species found in the outer zone include sand cordgrass, beakrush, sawgrass, maidencane, rosy camphor-weed, smartweed, some wax myrtle, and a few buttonbush. Laurel oak, live oak and cabbage palm are located at the wetland edge, with some minor encroachment of oaks into the outer zone of the wetland. In addition, several bromeliads were identified in the live oaks, including *Tillandsia setacea*, *T. utriculata*, and *T. fasciculata*.

This wetland is part of a larger system which includes Wetlands 2A, 6A, and 7A. Historically these systems were all connected and formed a large interlinked wetland system. Those connections are currently limited to small flowways through uplands areas and cabbage palm hammocks. The remaining uplands surrounding this wetland are pine flatwoods.

Observed wildlife in this wetland include a Barred Owl *(Strix varia),* cormorant *(Phalacrocorax* spp.), robins *(Turdus migratorius),* and evidence of usage by white-tailed deer, pigs and small mammals. Potential wildlife using this wetland include several listed wading birds.

WL 6A (FLUCFCS 641; 1.0 acres)
Wetland 6A is high quality and part of the Wetland 2A, 5A, and 7A complex. The core is dominated by pop ash. No understory exists in the core of this wetland. The outer zone is freshwater marsh with typical species present including beakrush, iris, smartweed, maidencane, and sand cordgrass. Edge species include live oak, laurel oak and cabbage palm. The surrounding uplands are live oak/cabbage palm hammock and pine flatwoods. The live oak/cabbage palm hammocks provide connections to Wetlands 5A and 7A.

Evidence of pig rooting was found throughout all the hammocks and along the wetland edge. A water-filled gopher tortoise burrow was observed at the wetland edge that appeared to be inactive. In addition, the potential exists for use of this wetland by wading birds, though no suitable nesting habitat is present.

WL 7A (FLUCFCS 641; 1.3 acres)
This high quality wetland contains two distinct zones, an inner core dominated by pop ash with some buttonbush, and an herbaceous outer zone. Typical species in the outer zone include maidencane, sand cordgrass, yellow-eyed grass, saw grass, coinwort, and pennywort. At the wetland edge some wax myrtle was present. A single clump of Brazilian pepper was located within the wetland. The majority of the uplands are pine

flatwoods, with the exception of a live oak/cabbage palm dominated hammock that appears to provide a connection to Wetlands 5A and 6A.

This wetland is located within areas mapped as hydric soils. The hydrology of this system is healthy, however, it is adjacent to the FPL easement swale, which impounds water. At this location, there is a large open water area in the FPL swale that appears too deep to support any hydrophytic vegetation. An immature Bald Eagle was observed perched in the FPL easement adjacent to this wetland.

WL 8A (FLUCFCS 641; 14.0 acres)
This large, high quality wetland is the main fragment that comprised the historical slough that traversed this area flowing towards the Myakka River. There is a braided channel that starts at the eastern edge of Wetland 3B with widths varying from a few feet to more than 15-feet that flows east. The channel has clearly defined banks throughout much of this area. However, before reaching the FPL easement, the channel opens into this large, open wetland. Little wetland vegetation exists. Live oaks dominate the canopy, with cabbage palm more prevalent along the wetland edges. The understory is mostly open with no shrub layer and minimal herbaceous layer. Some herbaceous species are found on the tree hummocks, but generally vegetation is lacking. There are four (4) culverts that drain under the FPL and connect Wetland 8A to Wetland 1A. This wetland along its entire length is mapped over Holopaw fine sand, depressional soils, a listed hydric soil for both the state and federal level.

WL 9A (FLUCFCS 641; 7.7 acres)
Wetland 9A is a high quality, isolated system surrounded by pine flatwoods to the north and hardwood-conifer mixed to the south. This wetland appears to have been historically isolated, surrounded by Pineda fine sand, which are typically found in association with pine flatwoods, consistent with the current conditions. This wetland contains both a forested and shrub component. The dominant canopy species is pop ash. Additional species present within this system include wax myrtle, buttonbush, St. John's wort, yellow-eyed grass, lance-leaf arrowhead (*Sagittaria lancifolia*), sand cordgrass, some red maple, beakrush, pickerelweed, sawgrass, coinwort, lemon water-hyssop, umbrella grass, rosy camphorweed, and iris. This wetland receives water from the surrounding uplands discharging to the flow south and east. However, the road to the south and west of this wetland is raised and graded, which prohibits water from sheet flowing in its natural direction towards the Myakka River.

WL 1B (FLUCFCS 560; 1.7 acres)
Wetland 1B is abutting Wetland 1A to the west. A north-south primitive road divides the two wetlands, which causes impounding of water and temporary dispersement of the meandering flow-way. Both the flow-ways that are present in Wetland 1A are also present in Wetland 1B and the linear flow-way remains unchanged. The meandering flow-way of Wetland 1B, however, is a defined channel through pine flatwoods with no inclusion of upland islands. The channel was approximately 3-4 feet deep and 5-10 feet

wide. The flow-way is primarily non-vegetated, although pop ash, cabbage palm, Carolina willow, and buttonbush are scattered along the banks and periodic floodplain of the wetland.

The *Sarasota County Soil Survey* (1991) maps the soils for this wetland and its surrounding uplands as Felda and Pompano fine sands, frequently flooded, which was supported by field observation of soil inundation at surface. Wildlife observations include pig rooting, wallows and trails and wading birds. The buffer immediately adjacent to WL-1B is dominated by pine flatwood species, including slash pine and saw palmetto, with laurel oak and cabbage palm also present. Overall, the quality of WL-1B is high.

<u>WL-2B (FLUCCS 641; 6.3 acres)</u>
This depressional basin is within an historical slough complex that is the remnant of the former flow-way between the original Cow Pen Slough and the Myakka River as depicted on the 1948 aerial photograph. Wetland 2B (WL 2B) is located approximately 200 feet north of a manmade canal and currently exists as a shrub system dominated by buttonbush, wax myrtle, pop ash, carolina willow, and scattered laurel oak. The understory is comprised of smartweed, soft bulrush (*Scirpus* sp), pickerelweed, and bull paspalum grass (*Paspalum boscianum).* Maidencane and sand cord grass are present along the fringe of the wetland.

The buffer adjacent to WL-2B consists of a mesic cabbage palm hammock with isolated live oak trees and wild coffee shrubs in the understory. This mesic hammock is located to the north of the WL-2B with connection to WL-3B. An extensive pine flatwood area is present south and east of the wetland. St Andrew's cross (*Hypericum hypericoides)* and broomgrass are prevalent in the groundcover.

The *Soil Survey of Sarasota County* (1991) identifies the soils for this wetland as Delray fine sand depressional, a county-listed hydric soil. The description for this soil type states that it is poorly drained, often found in depressions within flatwoods. Although the soil within WL-2B has been subjected to historical alteration by decades of drainage activities, this description is further supported by the field observation of soil saturation at surface.

Wildlife activities were observed within the wetland at time of the field activities including foraging by an osprey and wading birds. In addition, deer tracks and other mammal trails were observed through the system. The wetland provides adequate opportunity for wildlife habitat for foraging potential, floodwater attenuation, and sediment or nutrient filtration.

<u>WL-3B (FLUCCS 643/641; 3.6 acres)</u>
Similar to WL-2B, this wetland is high quality and is a remnant of the former slough system. A drainage swale provides flow-through hydrology for this wetland and may be the remnant channel for the historical slough. A narrow herbaceous dominated inundated

swale connects two depressional basins. The two basins are freshwater marshes with distinct zonation of an inner core of buttonbush and carolina willow, and an intermediate zone of herbaceous species such as cattail (*Typha latifolia),* flatsedge, and lance leaf arrowhead. The outer rim of this system as well as the connecting swale is a wet prairie dominated by herbaceous species such as maidencane, Southern blueflag iris*,* bull paspalum and water-hyssop.

As described above, a mesic cabbage palm hammock buffer connects this system to WL-2B to the south. This system grades into a large upland mixed forest dominated by live oak, cabbage palm, slash pine, saw palmetto and wax myrtle. No indication of recent disturbance is present.

Soils within this wetland are similar to those present in WL-1, and are also mapped as Delray fine sand, depressional in the *Soil Survey of Sarasota County* (1991). Observations of the soils during the field event support this soil description. The soil is sufficiently supporting hydrophytic vegetation as the hydrology to this system appears stable.

Potential wildlife utilization within the wetland and buffer system is high. As discussed previously, no Bald Eagle nests are known to be within two (2) miles of the site; however, eagles could potentially utilize the area for foraging. This system can adequately support wading birds and also large and small mammals. Wildlife observations include deer and feral pig tracks and trails.

<u>WL 4B (FLUCFCS 641; 1.9 acres)</u>
Wetland 4B is a high quality wetland located in the southwestern portion of the Myakka Connector site. This wetland is connected to Wetland 3B via a small channel, which coincides with the mapped Delray fine sand, depressional soil series according to the *Soil Survey of Sarasota County* (1991). This wetland was part of the large, historic slough system that drained toward the Myakka River, and which is still present, though reduced in size. The immediate uplands around this wetland are live oak/cabbage palm hammock, surrounded by pine flatwoods. Species typical in this system include St. John's wort, wax myrtle, smartweed, beakrush, lemon water-hyssop, and Baldwin's spikerush. Several trees are located at wetland fringe including laurel oak, cabbage palm, and red maple. Potential wildlife usage is high including wading birds, amphibians, reptiles and small mammals.

<u>WL 5B (FLUCFCS 641; 0.2 acres)</u>
Wetland 5B is a small, moderate quality herbaceous wetland which transitions into a hydric-mesic hardwood swamp. Typical vegetation within this system includes wax myrtle, beakrush, Baldwin's spikerush, torpedo grass, bulrush, smartweed, maidencane, pennywort, watergrass (*Axonopus furcatus*), and dayflower with patchy cover by laurel oak, cabbage palm, American elm (*Ulmus americana*), and red maple. This wetland transitions into a cabbage palm hammock to the north, east and west, with pine flatwoods

to the south. Some Brazilian pepper was identified in the buffer at the edge of the wetland. A fire break is located immediately adjacent to the east and hinders the flow of water. Improved pastures are located within 50-feet to the west of this wetland across a fence, which is heavily grazed. A Snowy Egret was observed using this marsh. In addition, tracks were found for pigs, and several songbirds and a squirrel *(Scirpus* sp.) were sighted.

3.3.3 Wildlife

A database search was conducted for listed species potentially occurring on the Myakka Connector (Exhibit 10). The wetlands onsite may be used for foraging and loafing by several species of wading birds, including the state-listed Little Blue Heron, White Ibis, Snowy Egret, and Wood Stork. All are state-listed SSC, except for the Wood Stork, which is a state and federal endangered species. No suitable nesting habitat is found onsite. Limited opportunity exists for the state-listed Florida Sandhill Crane because of the closed canopy typical of most of this area. Although no colonies containing Wood Storks occur within the vicinity of the project area, the project area does occur within the 18.6-mile CFA of at least one (1) colony as defined in the draft *Standard Local Operating Procedures for Endangered Species (SLOPES) - Wood Storks* (28 June 2002) published by the U.S. Fish and Wildlife Service. No Bald Eagle nests are documented as occurring within one (1) mile of this site. However, a nest was observed in a slash pine, but it appeared to be unfinished (or old) and no eagles were seen to utilize it. Other wildlife searches included the Florida Scrub-jay, which has no documented territories within a two-mile radius of the site.

In addition, habitats do exist onsite for the federal and state threatened Eastern indigo snake and the state-listed gopher tortoise (SSC). The Eastern indigo snake is a habitat generalist, which is found in a wide-range of habitats, though none were observed during fieldwork. Sufficient habitat does exist for the gopher tortoise in the pine flatwoods and mixed hardwood-conifer forests. The water table in this area is relatively high, which may limit the ability of tortoises to use this area. Probabilities of gopher tortoises occurring onsite are moderate due to the presence of moderately suitable habitat, but surveys would be required to make a final statement on their presence or lack thereof. Wildlife observed during BRA's preliminary wildlife survey is documented in the specific land use/wetland descriptions above.

3.3.4 Uniform Mitigation Assessment Methodology

The UMAM sheets for each wetland within the Myakka Connector site are included as Exhibit 18. COE datasheets are provided as Exhibit 19. These datasheets will be used by COE staff to assess each wetland during COE permitting.

3.4 Venice Minerals Current Land Use

A land use map (Exhibit 20) was created by BRA based on the FLUCFCS. Descriptions of each habitat type are provided below. All provided acreages are approximate as they are based on aerial interpretation and not surveyed habitat delineations. A preliminary wildlife survey, including pedestrian and vehicle transects, was also conducted and the results follow the habitat assessments.

3.4.1 Uplands

Wax Myrtle Shrub (FLUCFCS 3201; 13.8 acres)
This land use area was permitted (ERP No. 458405.00 and EM No. 483) as a transitional wetland, however it now exists as an upland buffer area. The shrub layer is almost exclusively wax myrtle with an understory of broomsedge. No hydric soil indicators are present.

Pine Flatwoods (FLUCFCS 411; 73.1 acres)
The majority of the uplands onsite are mapped as pine flatwoods, with a dominant canopy of slash pine. Typical understory species include saw palmetto, gallberry, some wax myrtle, and grape vine.

Recharge Ditch (FLUCFCS 505; 3.7 acres)
A large ditch which surrounds the Venice Minerals mining operation was installed several decades ago and exists along the western boundary of the property. The ditch has severely drained the southern wetlands, however, the large mitigation area was designed to receive water from the ditch and direct it offsite to the east towards the Myakka River.

Roads and Highways (FLUCFCS 8145; 2.7 acres)
A graded and drained road follows the recharge ditch along the western extent of the property.

Electrical Power Transmissions Lines (FLUCFCS 832; 3.2 acres)
The FPL transmission lines run north-south through the eastern portion of this parcel. There are several culverts located under the easement toward the south end of the parcel where the slough drains towards the Myakka River. However, sufficient culvert crossings appear to be lacking, and the ditches on either side of the FPL easement berm water within the wetlands. The FPL easement does not hinder wildlife movement, and the culverts do allow for movement of fish and other aquatic wildlife.

3.4.2 Wetlands

WL 1A (FLUCFCS 641; 1.7 acres)
This small depressional basin is a mitigation site for previous impacts associated with Venice Minerals (Exhibit 23). The 1948 aerial does not indicate the existence of a wetland at the present location. The wetland is dominated by herbaceous species with

dominant zones relative to the depth of water within the inundation. The center of the system is dominated by pickerelweed and grassy arrowhead (*Sagittaria graminea).* Open water is present in the center of the wetland. An inner rim is present at the shallow inundation and consists of herbaceous emergent species dominated by maidencane grass and large-headed rush (*Juncus megacephalus*), with a ground cover of water hyssops and the invasive exotic alligatorweed (*Alternanthera philoxeroides).* A transitional fringe of wax myrtle surrounds the outer fringe of the basin.

Soils appear to have been disturbed and are in transition to developing more hydric indicators, characteristic of created wetland mitigation. The *Soil Survey of Sarasota County* (1991) maps the soils for this wetland as Malabar fine sand, a county-listed hydric soil. The description for the Malabar fine sand unit states that it is poorly drained, often found in poorly defined drainage ways and sloughs. This description is further supported by the field observation of soil saturation at surface.

Wildlife observations include wading birds, amphibians, songbirds and small fish. The buffer around the wetland is extensive; however, an active surface mine is within 500 feet. The system provides nesting and foraging habitat for wildlife. A known eagle nest (SA023) is located 2.5 miles south of the wetland, however, adjacent to the south side of Laurel Road. Although no eagles were observed during field activities, the wetland could be used for foraging habitat by eagles. With the exception of wading birds, no other listed species are known to be within this system or immediately adjacent lands. The hydrology appears stable and adequate to sustain healthy hydrophytic vegetation. The vegetation did not appear stressed and no recent disturbance was observed. Overall, the quality of WL 1A is high.

The buffer immediately adjacent to WL-1A consists of a mesic to upland dominated by wax myrtle, laurel oak*,* saltbush (*Baccharis halimifolia),* and saw palmetto. Ground cover consists of carpet grass and broomgrass. Soils consist of fine sand lacking hydric characteristics. This is further supported in the *Sarasota County Soil Survey* (1991) as they are identified as Pineda fine sand, a non-hydric soil unit.

<u>WL 2A (FLUCFCS 631/641; 5.1 acres)</u>
This depressional basin is shown on the 1948 aerial and therefore is assumed to be a natural system. It is dominated by shrubby vegetation such as wax myrtle, St. John's wort*,* gallberry*,* stagger-bush (*Lyonia lucida)*, with a ground cover of herbaceous species such chalky broomgrass *(Andropogon capillipes),* pipewort (*Eriocaulon compressum),* yellow-eyed grass and pink sundew (*Drosera capillaris).* Toward the center of the system where the inundation becomes significantly deeper, the zone of vegetation changes to that dominated by emergent herbaceous species including pickerelweed, grassy arrowhead and cattails (*Typha dominigensis).*

Soils within this wetland are indicated as Holopaw fine sand, a listed hydric soil for Sarasota County. It is described in the *Soil Survey of Sarasota County* (1991) as being a poorly drained soil found in depressions. Field observations support this description as hydric characteristics are present.

The buffer to the south of the system is fragmented by an elevated road and an associated ditch located within a disturbed upland scrub habitat. Active mining is within 200 feet to the south. However, there is extensive undisturbed buffer to the west, north and east that provides non-fragmented land tracts including wetlands, mesic and upland habitats. Immediately surrounding WL 2A is a mesic plant community that connects to WL 1A and WL 3A. The dominant vegetation is wax myrtle, laurel oak, live oak, and cabbage palm.

Wildlife utilization within the wetland and buffer system is high. As discussed previously, no Bald Eagle's nest is known to be within 2 miles of the site; however, eagles could potentially utilize the area for foraging. Wildlife observations included a Great Blue Heron, songbirds, as well as sign of White-tailed deer and wild pigs.

Overall quality of the WL 2A is considered moderate to high. The system appears stable with good species diversity, natural hydrology, and a minor presence of invasive nuisance or exotic species, and good wildlife usage potential. The buffer is extensive with the exception of the road and berm that represents the only disturbance to the system.

<u>WL 3A (FLUCFCS 631/641; 4.2 acres)</u>
Similar to WL 1A, this small depressional basin is a previously permitted mitigation site as it is not shown as a wetland on the 1948 aerial. This inundated system also has a deeper inner zone that is dominated by herbaceous emergent species such as pickerelweed and grassy arrowhead. Surrounding this inner core is a shrubby and herbaceous zone dominated by St. John's wort, sand cordgrass and cattails. Ground cover herbaceous vegetation includes Asian coinwort, pennywort and water hyssop. Wax myrtle, water primrose (*Ludwigia octovalvis),* and yellow-eyed grass are present along the outer transitional fringe ring along the edge.

The buffer of the wetland is predominantly a mesic plant community with wax myrtle and slash pine comprising the dominant vegetation in the tree and shrub strata. Ground cover is dominated by broomgrass and flat-topped goldenrod (*Euthamia minor).* The buffer to the west connects to WL-2A and to additional wetlands to the east. The buffer is extensive for several hundred feet in all directions with exception of the southeast where an access road is located less than 100 feet from the wetland edge. An active mine is to the south of the road.

Soils are mapped as Pineda fine sand, a soil that often includes hydric units within it. It is classified as a poorly drained soil that is found on low hammocks and in broad, poorly defined sloughs. Although it is not considered a hydric soil unit, some of the inclusions found within the unit are often hydric soils. Field observations indicate that the soils are in transition to hydric from the created mitigation site.

Wildlife utilization is similar to both WL 1A and WL 2A in that no nesting was observed; however, wading birds, amphibians, and small mammal tracks/scat were observed. Red-shouldered Hawks *(Buteo lineatus)* were observed during field activities. The presence of an eagle nest located approximately 2 miles to the south suggests this wetland system is potential foraging habitat. The overall quality of the wetland is high. The vegetation species diversity is good, however, the overall system is small. The hydrology of this mitigated site is stable, but soils are still in hydric development and indicate progress toward a healthy, sustainable wetland system.

<u>WL 1B (FLUCFCS 641; 31.9 acres)</u>
Wetland 1B is a created freshwater marsh characterized by broom grass, sand cordgrass, water pennywort, wax myrtle, maidencane, smartweed *(Polygonum densiflorum),* marsh fleabane, assorted sedges, jointed spikerush *(Eleocharis interstincta*), St John's wort, pickerelweed, duck potato, tufted foxtail (*Aloperius carolinianus*), laurel oak, water hyssop and dogfennel. Scattered cattails were also observed.

Overall, this wetland is diverse and does not appear to have significantly altered hydrology. In addition, this wetland is hydrologically connected to other on-site wetlands and is surrounded by a high quality upland buffer. Venice Minerals is located to the west and an FPL easement is located on the east. The remaining uplands however, are part of a continuous mix of habitats which continue to the Myakka River. This continuum provides good habitat for wildlife and allows free movement from the wetlands to the surrounding uplands. The upland areas on site are characterized by cabbage palm, gallberry, slash pine, saw palmetto and live oak. Based on the above observations, this would be rated as a high quality wetland.

No threatened or endangered species were observed during the surveys of the Venice Minerals site. However, a Bald Eagle nest is located less than 3 miles away. It does not appear that any Wood Stork nest within a 10 mile radius of the subject property. However, this property is within the 18.6-mile foraging radius of 2 nests. The upland areas on site are characterized by slash pine and thick saw palmetto. While the upland areas may be too dense to be ideal gopher tortoise habitat, gopher tortoises may be present onsite, but none was observed in the initial survey.

<u>WL 2B (FLUCFCS 641; 3.2 acres)</u>
Wetland 2B is a naturally occurring freshwater marsh characterized by sand cord grass, wax myrtle, maidencane, smartweed, marsh fleabane, assorted sedges, jointed spikerush, St John's wort, red root, pickerelweed, duck potato, water hyssop, coinwort, buttonbush, dogfennel. There is a buttonbush core and good zonation. There is no evidence of nuisance or exotic vegetation in this wetland.

Overall, this wetland is diverse and does not appear to have significantly altered hydrology. In addition, this wetland is hydrologically connected to other on-site wetlands and is surrounded by a high quality upland buffer. There is existing overland flow to Wetland 3B. Venice Minerals is located to the west and an FPL easement is located on the east. The remaining uplands however, are part of a continuous mix of habitats which continue to the Myakka River. This continuum provides good habitat for wildlife and allows free movement from the wetlands to the surrounding uplands. The upland areas on site are characterized by cabbage palm, gallberry, slash pine, saw palmetto, live oak, and laurel oak. Based on the above observations, this would be rated as a high quality wetland.

No threatened or endangered species were observed during the surveys of the Venice Minerals site. However, a Bald Eagle nest is located less than 3 miles away. It does not appear that any Wood Stork nest within a 10 mile radius of the subject property. However, this property is within the 18.6-mile foraging radius of 2 nests. The upland areas on site are characterized by slash pine and thick saw palmetto. While the upland areas may be too dense to be ideal gopher tortoise habitat, gopher tortoises may be present onsite. But, none were observed in the initial survey.

<u>WL 3B (FLUCFCS 641; 5.3 acres)</u>

Wetland 3B is a naturally occurring freshwater marsh characterized by broom grass, water pennywort, wax myrtle, maidencane, jointed spikerush, St John's wort, red root, duck potato. There is a small core dominated by fire flag, buttonbush, and pickerelweed. No evidence of nuisance or exotic vegetation was seen during the initial survey. This wetland is diverse and shows good zonation.

Overall, this wetland is diverse and does not appear to have significantly altered hydrology. In addition, this wetland is hydrologically connected to other on-site wetlands and is surrounded by a high quality upland buffer. There is existing overland flow to Wetland 2B. Venice Minerals is located to the west and an FPL easement is located on the east. The remaining uplands however, are part of a continuous mix of habitats which continue to the Myakka River. This continuum provides good habitat for wildlife and allows free movement from the wetlands to the surrounding uplands. The upland areas on site are characterized by cabbage palm, gallberry, slash pine, and saw palmetto. Based on the above observations, this would be rated as a high quality wetland.

No threatened or endangered species were observed during the surveys of the Venice Minerals site. However, a Bald Eagle nest is located less than 3 miles away. It does not appear that any Wood Stork nest within a 10 mile radius of the subject property. However, this property is within the 18.6-mile foraging radius of 2 nests. The upland areas on site are characterized by slash pine and thick saw palmetto. While the upland areas may be too dense to be ideal gopher tortoise habitat, gopher tortoises may be present onsite, but none were observed in the initial survey.

<u>WL 4B (FLUCFCS 631; 0.9 acres)</u>

Wetland 4B is a wetland scrub system characterized by sand cord grass*,* wax myrtle*,* maidencane*,* smartweed*,* jointed St John's wort*,* red root*,* floating hearts (*Nymphoides cordata*)*,* coinwort, water dropwort (*Oxypolis filiformis*) water pennywort*,* slash pine and assorted sedges. Patches of 15-ft punk tree (*Melaleuca quinquenervia)* were observed. No other signs of nuisance or exotic vegetation were noted during the survey. There was no well-defined core to this wetland.

Overall, this wetland is diverse and does not appear to have significantly altered hydrology. In addition, this wetland is hydrologically connected to other on-site wetlands and is surrounded by a high quality upland buffer. There is existing overland flow to Wetland 2B. The major concern in this wetland is the presence of *Melaleuca* and the potential for its spread. Venice Minerals is located to the west and an FPL easement is located on the east. The remaining uplands however, are part of a continuous mix of habitats which continue to the Myakka River. This continuum provides good habitat for wildlife and allows free movement from the wetlands to the surrounding uplands. The upland areas on site are characterized by cabbage palm*,* gallberry, slash pine, and saw palmetto. Based on the above observations, this would be rated as a high quality wetland.

No threatened or endangered species were observed during the surveys of the Venice Minerals site. However, a Bald Eagle nest is located less than 3 miles away. It does not appear that any Wood Stork nest within a 10 mile radius of the subject property. However, this property is within the 18.6-mile foraging radius of 2 nests. The upland areas on site are characterized by slash pine and thick saw palmetto. While the upland areas may be too dense to be ideal gopher tortoise habitat, gopher tortoises may be present onsite, but none were observed in the initial survey.

<u>WL 1C (FLUCFCS 641; 4.2 acres)</u>
Wetland 1C is a freshwater marsh located approximately 300 feet east of the mining operation within the Myakka River watershed. This moderate quality wetland has little standing water, is bisected by a road to the south, and, therefore, has no hydrologic connection to the offsite southern wetland. The remnant wetland to the south is isolated and offsite. The Venetian Golf and River Club is south of the road, and there is a swale between the road and the wetland. To the north, east and west of the wetland are pine flatwood areas.

This wetland has three distinct zones. The core of the wetland consists of buttonbush, maidencane, pickerelweed, broomsedge, and hemp vine. The middle zone consists of dogfennel, St. Johns wort, spike rush, broomsedge, and wax myrtle. The outer most zone consists of wax myrtle, broomsedge, dogfennel, slash pine, torpedograss and Brazilian pepper. The immediately surrounding uplands consist of a hard saw palmetto outer edge with scattered pine (*Pinus* spp.).

Wetland functions include small mammal feeding, water storage and filtration. The anticipated wildlife utilization is by wading birds, insects, amphibians, small reptiles and small/medium mammals. Wading birds expected to utilize this wetland are listed, these include: Little Blue Heron (SSC), White Ibis (SSC), Snowy Egret (SSC), and Wood stork (E). Evidence of wildlife observed were pig and raccoon tracks and pig wallows.

WL 2C (FLUCFCS 641; 0.5 acres)
Wetland 2C is a freshwater marsh located approximately 1200 feet east of the mining activities and is within the Myakka River watershed. (This moderate quality, remnant wetland has no standing water; it is connected to a ditch that runs parallel on the wetland's eastern edge. East of the ditch is the FPL easement. The majority of the wetland is east of the easement.) A culvert under the road connects the two portions of the wetland. The Venetian Golf and River Club subdivision is south of this wetland. To the north and west of this wetland are pine flatwood areas.

This wetland has no zonation. The vegetation that dominates this wetland is smartweed, sawgrass, sand cordgrass, buttonbush, redroot, wax myrtle, Carolina willow with a small amount of arrowhead and primrose willow. The surrounding uplands consist of saw palmetto and scattered pine to the west and north of the wetland, and a large ditch and dirt road to the east of the wetland.

This wetland is significantly more degraded than the other onsite wetlands. Functions include small mammal feeding, water storage and filtration. The anticipated wildlife utilization is by wading birds, insects, amphibians, small reptiles and small/medium mammals. Wading birds expected to utilize this wetland are listed, these include: Little Blue Heron (SSC), White Ibis (SSC), Snowy Egret (SSC), and Wood Stork (E). No evidence of wildlife was observed.

WL 3C (FLUCFCS 6311; 0.6 acres)
Wetland 3C is a disturbed shrub wetland located approximately 600 feet north and west of the mining activity and within the Myakka River watershed. This moderate quality wetland has a shallow swale on the western edge and has very little standing water. It has a cabbage palm hammock on the northwest corner which appears to be a historical flow way. To the east is an FPL easement, and about 1400 feet to the south is the Venetian Golf and River Club subdivision. This wetland has no hydrologic connection to the northwest wetland (WL 4C). To the north, south, east, and west are pine flatwood areas.

The zonation of this wetland is poor, but it appears to have two zones. The core of the wetland consists of popash, cattail, smartweed, hemp vine, dandelion (*Taraxacum* spp.), Carolina willow and Brazilian pepper. The outer zone consists of Brazilian pepper, wax myrtle, salt bush, musky mint, dogfennel, and sawgrass. The surrounding uplands consist of saw palmetto, scattered cabbage palm, and scattered pine to the north, south, east, and west of the wetland.

This wetland is similar to Wetland 1C in function, which includes small mammal feeding, water storage and filtration. The anticipated wildlife utilization is by wading birds, insects, amphibians, small reptiles and small/medium mammals. Wading birds expected to utilize this wetland are listed, including: Little Blue Heron (SSC), White Ibis (SSC), Snowy Egret (SSC), and Wood stork (E). Evidence of wildlife observed was pig rooting. Observed wildlife includes Bald Eagle, hawk and vulture flyovers, and apple snails were observed on the ground.

WL 4C (FLUCFCS 6311; 0.4 acres)
Wetland 4C is a disturbed shrub wetland located approximately 400 feet north and west of mining activity and within the Myakka River watershed. This moderate quality wetland has no standing water. It has a cabbage palm hammock on the southeast corner which appears to be a historical flow way. To the east is an FPL easement, and approximately 1600 feet to the south is the Venetian Golf and River Club subdivision. This wetland has no hydrologic connection to the southeast wetland (WL 3C). To the north, south, east, and west are pine flatwood areas.

The zonation of this wetland is poor, but appears to have two zones. The core of the wetland consists of popash, cattails, sand cordgrass and Carolina willow. The outer zone consists of dogfennel, wax myrtle, frog fruit, sugarcane (*Saccharum officinarum*), Brazilian pepper and plume grass (*Erianthus* spp.). The surrounding uplands consist of saw palmetto, scattered pine, and scattered cabbage palm to the north, south, east, and west of the wetland.

This wetland is similar to wetland 1C in function, which includes small mammal feeding, water storage and filtration. The anticipated wildlife utilization is by wading birds, insects, amphibians, small reptiles and small/medium mammals. Wading birds expected to utilize this wetland are listed, these include: Little Blue Heron (SSC), White Ibis (SSC), Snowy Egret (SSC), and Wood Stork (E). Evidence of wildlife included pig and raccoon tracks and pig wallows.

3.4.3 Wildlife

A database search was conducted for possible listed species present on the Venice Minerals site (Exhibit 10). Although the wetlands do have the potential for several species of wading bird utilization, the closest documented colony is over two miles away. The closest Bald Eagles' nest is approximately 6,000 feet to the north on the Pinelands property. The closest Florida Scrub-jay habitat appears to be approximately 2734 meters away. Other wildlife searches included the Wood Stork, which have does not have documented territories or colonies within a two-mile radius of the site. Wildlife observed during the preliminary wildlife survey is documented in the specific land use/wetland descriptions above.

3.4.4 Uniform Mitigation Assessment Methodology

The UMAM sheets for each Venice Minerals wetland are included as Exhibit 22. COE datasheets are provided as Exhibit 23. These datasheets will be used by COE staff to assess each wetland during COE permitting.

3.5 Mitigation Alternative Analysis

To assess potential mitigation scenarios within the Dona Bay watershed, the 1948 wetland limits were superimposed on the current 2005 wetland limits to graphically evaluate how each property has changed in the last 60 years (Exhibits 24-27). The acreages were used as a baseline to determine the cost and benefit of returning the site to its historical condition. TM 4.1.5 – Alternative Impact Analysis presents the summary of this effort for each of the four (4) properties.

LIST OF EXHIBITS (previously provided and loaded onto the FTP site)

Exhibit 1: aerial_36x48_darb_r1
Exhibit 2: albritton_1948lu
Exhibit 3: cow_1948_lu_r3
Exhibit 4: gp_48_lu_r1
Exhibit 5: vm_48_lu_r1
Exhibit 6: alb_landuse_r2
Exhibit 7: Albritton 3 October 2005 SWFWMD JD Verification Letter
Exhibit 8: Albritton COE Letter
Exhibit 9: albritton_jd
Exhibit 10: dona_listed-basin_r2
Exhibit 11: Albritton UMAM sheets and Calculation Summary
Exhibit 12: cow_flucfcs_r3
Exhibit 13: cow_jd_r3
Exhibit 14: WP UMAM sheets and Calculation Summary
Exhibit 15: WP COE Datasheets
Exhibit 16: gp_fluc_r3
Exhibit 17: gp_jd_r3
Exhibit 18: MC UMAM sheets and Calculation Summary
Exhibit 19: MC COE Datasheets
Exhibit 20: vm_fluc_r1
Exhibit 21: vm_jd_r3
Exhibit 22: VM UMAM sheets and Calculation Summary
Exhibit 23: VM COE Datasheets
Exhibit 24: alb_enhance-restore
Exhibit 25: cow_enhance_restore_r3
Exhibit 26: gp_enhance_restore_r2
Exhibit 27: vm_enhance_restore

TM 4.1.4 - EVALUATION OF RESTORATION/ENHANCEMENT VALUE

1.0 BACKGROUND

Sarasota County, in cooperation with the Peace River Manasota Regional Water Supply Authority and Southwest Florida Water Management District (SWFWMD), is currently completing the pre-requisite data collection and analysis and comprehensive watershed management plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), EarthBalance®, and Mote Marine Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the SWFWMD, to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (NEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan, and SCG's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay Watershed that will address the following general objectives:

a. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
b. Provide a more natural freshwater flow regime pattern for the Dona Bay Watershed.
c. Protect existing and future property owners from flood damage.
d. Protect existing water quality.
e. Develop potential alternative surface water supply options that are consistent with and support other plan objectives.

This Technical Memorandum has been prepared by EarthBalance® to estimate the wetland and hammock mitigation credit potential and associated costs of three potential projects associated with the DBWMP, pursuant to Task 4.1.4 of the DBWMP contract. The purpose of the analysis is to determine if any of the potential projects would be appropriate as a mitigation bank and further, to determine the overall feasibility of establishing a mitigation bank in the Southern Coastal Basin.

2.0 INTRODUCTION

The Albritton site and the Cow Pen Slough corridor within public ownership (West Pinelands) may provide an opportunity to leverage habitat restoration value for private property habitat impacts within the Southern Coastal Basin. This task proposes to evaluate the feasibility of leveraging mitigation credits created by potential restoration and enhancement pursuant to state rules, and credits for upland mesic hammocks to satisfy local requirements. The work from this task will allow the County to consider the feasibility of such a mitigation proposal.

This task includes the following basic elements:

- Estimate ranges of credit for the three alternate mitigation projects using the State's Uniform Mitigation Assessment Methodology (UMAM) rule for wetlands and acreage ratios for uplands
- Provide recommendations to help optimize credit generation with preliminary cost estimates of restoration
- Evaluate the potential for establishing a wetland mitigation bank for the Southern Coastal Basin of SWFWMD

Specifically, EarthBalance® biologists have determined the feasibility, constraints, costs, and potential mitigation value of three potential projects: restoring and enhancing wetlands in the West Pinelands; and restoring and enhancing wetlands and preserving upland habitat associated with Albritton Reservoir Alternatives 2 and 3 (ARA2) and (ARA3). This report has been divided into four main sections that address the scope of work. The first three sections discuss the mitigation potential, costs, constraints/optimization, and recommended actions for each of the three potential mitigation projects. A final section addresses mitigation banking potential in the Southern Coastal Basin.

2.1 SCOPE OF WORK

EarthBalance® has collected data from the field and GIS databases that have been used to assess the mitigation value of the three potential mitigation designs determined as conceptually feasible by the project team. To determine mitigation feasibility and potential mitigation credits, the following tasks were completed.

<u>Research/ Field Preparation:</u>

- Acquire and review electronic versions of alternative mitigation parcels from the project team
- Research databases for GIS information on soils, wildlife, targeted lands, water quality, ownership, land use plans, and other relevant information for the targeted site(s) and the surrounding area
- Acquire and review aerial imagery including recent true color, 1996-2004 infrared, and historical aerial series
- Acquire and review site specific survey information for CPS control structures
- Obtain and review SWFWMD one-foot topography in digital form

Selected graphics from the GIS research are provided as Figures 1 through 4 at the end of this report. These provide a good general overview of the landscape setting where the three project areas are located.

<u>Field Work:</u>

- Perform field surveys of potential mitigation sites to review wetland extents and habitat maps prepared by the project team.
- Assess conditions of upland and wetland habitats with specific emphasis on impacts and their sources to determine feasible restoration measures
- Determine mitigation assessment area (AA) configuration
- Review baseline field datasheets for each AA to assist in the UMAM analysis
- Analyze field data and make comparisons with historic data and research findings

For each of the three potential mitigation areas, results of the field work are summarized in the Existing Conditions sections. Based on an analysis of the field work, a review of other project team information, and project team meetings, a conceptual work plan is described in the Mitigation Plan sections.

Preparing the UMAM analysis involved field data reduction and analysis of existing habitat conditions as well as the assessment of restoration needs within targeted mitigation areas. In addition, future uses of adjacent properties were assessed to determine compatibility of restoration activities. An understanding of current habitat impacts, achievable restoration goals, and future land use considerations was used to perform a UMAM analysis on each mitigation area to determine credit potential. The following is a breakdown of major task activities:

- Determine restoration needs of the three potential mitigation areas
- Assess the degree to which habitats can be reasonably restored given adjacent land uses and natural or man-made constraints
- Assess the current and future condition and uses of surrounding land
- Review the UMAM analysis of the current condition provided by the project team for all AAs
- Perform UMAM analysis on enhanced/restored/preserved condition of AAs
- Prepare draft UMAM scoring rationale text (datasheets not appropriate at this stage)
- Prepare UMAM credit potential tables for the three mitigation areas

The estimates of potential mitigation credits and a summary of scoring rationale are provided in the Potential Mitigation Credit Generation section for each potential mitigation project.

An estimate of the costs to achieve the potential mitigation credits is provided in the Estimated Mitigation Costs sections. The focus to this point is maximizing credit potential. By developing cost estimates of the restoration activities, cost/benefit analyses can be performed in future phases of the project. The following mitigation cost factors will be estimated and presented in tabular form:

- Environmental permitting
- Engineering
- Construction
- Restoration

- Bank-specific costs
- Long-term management

The cost estimates proposed are highly dependant on final design related data that is lacking at this point. The cost estimates are very preliminary and tend to be worst-case estimates that will require close scrutiny and refinement as the design proceeds. Avoiding uncertain estimates altogether was contemplated, but it was decided that providing preliminary estimates for review by the project team and County can serve as a starting point for cost refinement.

To summarize each project, sections on Constraints and Optimization as well as Recommended Actions are provided at the end of the discussion on each mitigation project.

In the final section of the report, Mitigation Banking Potential in the Southern Coastal Basin, variables such as credit demand, credit price, permitting considerations, and project phasing are addressed.

3.0 UMAM

The Uniform Mitigation Assessment Method (UMAM) is still a fairly new rule and is just now becoming more standardized in its application. Mathematically, the method is straightforward, but the concepts that drive the scoring of the individual factors can be complicated. Because UMAM is the driving force behind mitigation credit generation, an explanation of the rule and its implementation is summarized below.

UMAM provides a standardized procedure for assessing the functions provided by wetlands and the amount that those functions are reduced by a proposed impact, thereby quantifying the number of UMAM credits required to offset wetland losses. Similarly, the UMAM method is used to calculate the number of mitigation credits generated by mitigation activities such as wetland creation, enhancement, and restoration. The rule also allows the evaluation of uplands for mitigation credit based on the benefits provided to the fish and wildlife of the associated wetlands or other surface waters.

3.1 MECHANICS OF UMAM

UMAM is the mitigation assessment methodology adopted by the State in February 2004. In August 2005, the U.S. Army Corps of Engineers (USACOE) recognized UMAM as an accepted assessment methodology. Application of the UMAM methodology results in an overall wetland score between 0 and 1, with 1 representing full wetland function. Therefore, the overall wetland score can be thought of as a percentage of full function. In simplest terms, UMAM is used to quantify the change in the percentage of value that a wetland provides under either impact or mitigation scenarios. This change is then multiplied by the acreage of the wetland to yield the number of debits or credits. The remainder of this narrative pertains exclusively to the generation of mitigation credits.

The first step in determining the number of credits a mitigation area will yield is to define the assessment area (AA), which is an area of land that is sufficiently homogeneous in character, function, and mitigation benefits to be assessed as a single unit. The applicant describes the AA in detail in the Qualitative Characterization (Chapter 62-345.400, Florida Administrative Code [FAC]) on the Part 1 data form. This critical step provides a frame of reference that is used to identify the community target type of the AA, the wildlife species served by the AA, and the key wetland functions to those species. The AAs must be defined in acres, which are later multiplied by the percent improvement in wetland function to yield the number of mitigation credits generated.

To calculate the percent improvement in wetland function, the UMAM method must be performed on the "with mitigation" and "without mitigation" scenarios. The "with mitigation" scenario is based on the anticipated future condition of the AA with the mitigation plan in place. The "without mitigation" scenario is either the current condition, or, in the case of preservation, the reasonably expected outcome of not preserving the AA.

3.1.1 Scoring

The UMAM scoring methodology is based on a critique of three categories of wetland functions including Location and Landscape Support, Water Environment, and Community Structure. The three UMAM categories are scored on a scale of 0 to 10 based on indicators listed in subsection 62-345.500(6), FAC. The sum of the scores is then divided by 30, resulting in a numerical score between 0 and 1. For uplands, the Water Environment category is not assessed and the sum of the UMAM category scores is divided by 20. Upland AAs are scored based on the benefits provided to fish and wildlife of the associated wetlands or other surface waters. The scoring of each category is driven by how well each AA provides the functions that benefit the fish and wildlife described in the Part 1 data form.

The difference between the UMAM score with the mitigation or preservation plan in place, and the absence of the mitigation or preservation plan is the mitigation delta, or the raw change in the function that a wetland provides. The mitigation delta must then be modified to account for time-lag, risk, and in the case of preservation, a Preservation Adjustment Factor (PAF).

3.1.2 Preservation Adjustment Factor

The Preservation Adjustment Factor (PAF) scoring criteria listed in Chapter 62-345.500(3)(a), FAC, is a numerical score between 0 and 1, scored on one-tenth increments. A score of 0 represents no preservation value while a score of 1 represents maximum preservation value. The preservation AA's mitigation delta is multiplied by the PAF to yield an adjusted mitigation delta. The PAF scoring is based on the applicability and relative significance of the five criteria found in the rules that are paraphrased below.

(1) *Management techniques to promote natural ecological conditions such as fire patterns or the exclusion of invasive exotic species.*

Fire management is critical for a number of native Florida habitats including most upland and wetland habitats. Periodic fire events eliminate the overgrowth of brush and recycle nutrients. As a result of the proximity of development to many mitigation areas, fire management is not feasible. Alternatively, the use of mechanical brush reducing techniques can be successful. Fire management or a surrogate method must be appropriate in fire-dependant communities to optimal conditions.

Nuisance and exotic vegetation control is required at some level throughout Florida, particularly in the southern peninsula. Depending on baseline conditions and surrounding habitat, the level of control is variable but must be sufficient to maintain permit success criteria. Similarly, exotic animal species (such as feral hogs) can be problematic, and should be addressed under this criterion.

To optimally address this criterion, the mitigation project should be accompanied by an appropriate management plan that is enforceable and funded.

(2) *The ecological and hydrological relationship of habitats to be preserved.*

This criterion addresses the appropriateness and compatibility of preserved habitats and how they complement one another. Preservation of a wetland without sufficient surrounding or connected upland habitat can reduce the function of the wetland preserve. However, preservation of a narrow or disturbed pasture around a wetland perimeter may offer little value depending on adjacent upland land use. This criterion also addresses how sheetflow from wetlands or development affects wetland preserves and how wetlands are hydraulically connected.

To address this criterion, preserves should be designed with maximum connectivity between on-site preserves as well as connectivity to off-site preserves. Habitats to be preserved should complement one another.

(3) Th*e scarcity of the habitat provided and the degree to which listed species use the area.*

This criterion assesses the rarity of a habitat to be preserved and unique characteristics or functions that are provided. In general, preservation of common habitats should not be penalized substantially, but scarce habitats would typically be valued higher for preservation. This criterion encourages the applicant to preserve habitats that are scarce or that support listed species.

(4) *The proximity of the site to preserved land, land targeted for preservation, or significant natural resources habitats and the connections between them.*

The ability of a preserve to provide functions in the long term is critically dependant on its location. While some large preserves are somewhat "self-buffering", the value of all preserves is ultimately influenced by the ability of the site to support genetically viable wildlife populations. Migration of populations and gene pools to and from the preserve to adjacent preserves or ecological corridors must be considered when evaluating this criterion.

(5) *Extent and likelihood of adverse impacts if not preserved.*

The alternative use of the proposed preserve is often the most significant factor in determining preservation value. Habitats that are threatened by likely and significant degradation are valued highest, while habitats threatened by unlikely or minor degradation are valued lowest.

The PAF is scored by assessing how well the five criteria are met. Ideally, if all criteria are fully met, the proposed preserve would be worthy of a score of 1. Typically, a preserve cannot completely meet all criteria due to outside constraints (i.e., inability to perform prescribed burning) or the inherent properties of the preserve (i.e., habitat is in need of enhancement). There is no formal guidance on setting intermediate scores, but logically, the significance of the preserve's deficiencies should be assessed on a weighted basis. For example, if a preserve meets all criteria but is not rare, a slight deduction from a perfect score may be appropriate. However, if a proposed preserve is an island that cannot be expected to provide value to terrestrial species over the long term, a very low PAF may be assigned.

3.1.3 Time-Lag

UMAM also takes into account time-lag and risk, which modify the mitigation delta and have a profound effect on the number of mitigation credits generated. Time-lag is an estimate of the length of time between the initiation of the mitigation effort and the realization of the proposed improved condition ("with mitigation" scores). Time-lag and permit timeframes may be different. For example, permit success criteria may require 5 years of monitoring prior to release from monitoring requirements, however, the time-lag period may be 25 years for planted trees to attain the size and coverage necessary to support the proposed "with mitigation" scores.

Restored and enhanced habitats require time to develop hydric soils, microhabitats, and vegetative structure, but to some extent, time-lag can be altered. The use of innovative mitigation techniques or the implementation of an accelerated project schedule could reduce time-lag. Proposing optimal UMAM scores may require long periods of time, but reducing the proposed UMAM scores lowers expectations and reduces the time-lag. Pre-determined time-lag scores (t-factors) are provided in the UMAM rule based on the number of years between mitigation initiation and achievement of the proposed condition (e.g., reaching the "with mitigation" category scores).

There is typically no time-lag involved with preservation because credits are derived from preserving the parcel in its existing condition, and there is no time required for vegetative communities to develop or mature. However, if an immature habitat is proposed for preservation, a time-lag adjustment may be necessary, or alternatively, the "with preservation" scores could be lowered to reflect the existing immature state.

3.1.4 Risk

Risk is a measure of the uncertainty that the proposed condition (reflected in the with mitigation scores) will be achieved and maintained in the long term. Actually, most of the risk score pertains to the sustainability of the mitigation effort beyond the monitoring period required to prove success criteria are met. Mitigation projects that require long periods of time to reach maturity generally involve more risk than those that require shorter time periods.

Six factors specified in Chapter 62-345.600, FAC, including vulnerability to altered hydrologic conditions, vulnerability to sustainability of the desired vegetative community, vulnerability to exotic species, vulnerability to degraded water quality, and the vulnerability of the site to direct and secondary impacts, are analyzed to establish a numeric risk factor between 1 (no risk) and 3 (high risk) based on quarter point increments. Economically sound, innovative techniques can be used to minimize the risk score, however, some externally induced risk will typically remain, such as the threat of secondary impacts from adjacent development.

If no risk factors exist or all are nullified by project modifications, a perfect score of 1 would be appropriate. Similar to PAF scoring, the risk score should be calculated by determining how severely potential risk factors could affect the proposed mitigation. For example, if there is a significant threat of invasion by exotic species from an adjacent disturbed habitat, the risk score may be very high. However, proposing a perpetually funded management plan may significantly reduce the risk score.

Relative Functional Gain

The amount of mitigation credit generated per acre is defined as the Relative Functional Gain (RFG). The RFG is calculated by first determining the mitigation delta (or adjusted mitigation delta in the case of preservation), then dividing the delta by the product of the risk and time-lag. Therefore, the negative effects of high risk or a large t-factor have a compounding effect that reduces mitigation potential. Finally, to determine the potential mitigation credits provided by an AA, the RFG is multiplied by the acreage of the AA.

4.0 WEST PINELANDS

The West Pinelands parcel is a potential linear wetland enhancement and restoration parcel located on the western side of the historical Cow Pen Slough within County-owned lands. The parcel extends for approximately 3.3 miles and is approximately 277 acres. Historically, the parcel was comprised of deep, internal, herbaceous wetland zones and outer, shallow, wet prairie habitat fringed by pine flatwoods and oak hammock. Excavation of a canal through the slough system has lowered water tables resulting in the conversion of shallow wetland habitat to uplands and alteration of the hydroperiod of deeper wetland zones. The parcel is currently preserved and managed, which limits mitigation potential to the enhancement of existing wetlands and the restoration of former wetlands.

A preliminary mitigation plan map, credit estimates, and mitigation cost estimates for the West Pinelands project area are contained as Figure 5, Table 1 and Table 2, respectively at the end of this report..

4.1 WEST PINELANDS - EXISTING CONDITIONS

The entire project area is comprised of historic slough wetlands. The western wetlands and the deeper zones of the slough currently meet the jurisdictional wetland definition but have been altered by the effects of the adjacent canal. Existing wetland habitats are classified predominantly as herbaceous marsh, while there are small amounts of shrubby and forested wetland habitat. Remaining wetlands have highly organic soils, which allow surface waters to perch. However, water levels and hydroperiods are reduced compared to the historic condition, resulting in changes in vegetation composition and zonation and the invasion of nuisance and exotic species. Overall, these wetlands are quite different from the historic condition, but they are still viable wetland habitats. These wetlands are collectively referred to as wetland enhancement areas in the remainder of this section, although enhancement potential of the individual wetlands ranges from 0-12 percent (0-0.12 credits/acre).

Shallower wetland zones closer to the canal have been converted to upland habitats including unimproved pasture and a mix of pine and oak trees with a grassy understory. These habitats have primarily sandy soils, which allow water to percolate quickly to the lowered water table induced by the adjacent canal. In many areas, these former wetlands display evidence of a hydrophytic seed bank, as many wetland grasses and herbs are present in scattered patches. These habitats are collectively referred to as wetland restoration areas in the remainder of this section and have a potential restoration value of approximately 29 percent (0.29 credits/acre).

4.2 WEST PINELANDS - MITIGATION PLAN

In addition to the drawdown of the water table caused by the canal, surface water is shunted from the wetlands to the canal via control structures. Many of the control structures have become washed out or have rusted pipes that allow water to discharge at even lower elevations than the control elevations. In addition, there are 12 breaches in the canal that were created to allow high flows from the canal spill out into the floodplain. Though not created to facilitate discharge to the canal, 7 of the breaches have an invert elevation below the estimated historic wet season water level (WSWL), which allows water to quickly fall with the canal level. At 100 to 200 feet wide, these breaches allow substantial water conveyance of flood waters and prevent long-term ponding at the estimated historic WSWL.

Adding water pumped from the canal to the West Pinelands without changing breach elevations was considered. However, after reviewing topography relative to breach inverts, it appears that very little hydroperiod improvement could be gained. Obviously additional water would help the system, however gains would only be accomplished in the lowest elevations below the breaches. Most of these areas are existing wetlands that have been scored moderately high, therefore, there is little mitigation credit.

To restore historic wetlands, surface water overflow elevations must be raised. Raising the breaches should improve water storage in the wetlands. The control structures could also be raised or eliminated. Because the surrounding property to the west is owned by the County, it is assumed that the breaches can be araised without affecting upstream landowners. However, because flooding is a sensitive issue, it should be the first item considered in a more thorough feasibility study.

Repairing and raising control structure inverts alone will not likely completely restore wetland hydroperiods, but would cause some improvement. Raising all breaches and control structures may have a cumulative beneficial effect, but it is likely that the groundwater drawdown must be addressed to realize substantial hydroperiod improvement. Our experience confirms that groundwater drawdown near deeply incised drainage features substantially affects wetlands particularly early and late in the hydroperiod.

One way to reduce the groundwater drawdown is to construct a slurry wall along the entire 3.3-mile length of canal, however, this in intuitively cost prohibitive. Similarly, lowering all the wetlands in place (vertical relocation) would also be expensive. The project team has decided to explore the implementation of solar pumps to pump water from the canal to the West Pinelands. Several details regarding installation need to be addressed, but assuming that the pumps can be used to replace water lost to the canal to re-create a fairly normal hydroperiod, the project area has been designed and evaluated to determine the maximum credit potential. The following is a list of the major tasks needed to complete the mitigation plan:

- Raise or remove existing control structures.
- Adjust existing canal breaches up or down to increase water storage. Ideally the breaches would be re-established at or near the historic WSWL
- Construct a series of narrow earthen berms to maintain WSWL of restoration "cells."
- Perform initial herbicide treatment.
- Rely on seed bank regeneration in the wetland restoration areas. Supplemental planting of herbaceous wetland vegetation may be required.
- Install approximately eight 10,000-gallons/day solar pumps. Each requires six 56-inches x 26-inches solar panels.
- Perform active management of vegetation and hydroperiods through establishment.

4.3 WEST PINELANDS - POTENTIAL MITIGATION CREDIT

The summary UMAM credit analysis is provided in Table 1 at the end of this report. Baseline scores were provided by the project team. To determine mitigation credit potential, proposed "with mitigation" scores were determined for each enhancement and restoration area. Preservation value was not assessed as the project area is currently in County ownership.

Because these are potential future scores, and the site is very homogenous, a single "with mitigation" score was assigned to all wetland enhancement areas that reflects the proposed condition (i.e., all areas are proposed to have less than 5 percent exotic coverage, etc.). Similarly, the restoration area was assessed as a single assessment area (AA). By rule, baseline UMAM scores for wetland restoration AAs are zero (0).

Below is a summary of the West Pinelands UMAM analysis justification.

4.3.1 Location and Landscape Support

This category was scored fairly high (7-8) by the project team in the existing condition as the project area is situated on a large parcel of native, County-owned and managed land. Implementing the management plan would not alter the surrounding high-quality upland and wetland habitats significantly, though there could be some subtle improvement to hydrologic conditions and a corresponding improvement in natural vegetation communities. However, re-hydrating the slough would improve connectivity between wetland zones and would likely improve wildlife utilization of the adjacent uplands, which would improve the UMAM score to 8 in all cases. The site is proposed to be limited to an 8 because the canal is a substantial barrier that prevents the movement of many species to other managed lands to the east. In addition, surrounding lands to the north, west, and south of the County parcel are not managed native lands. These will likely be intensified with low-density development based on future land use. The future condition of the parcel is a large island that is somewhat self-buffering but yet not optimally connected to other natural habitats.

4.3.2 Water Environment

There are many challenges to restoring the natural hydroperiod of the slough system. Even if sufficient pumping could be used to offset percolation, the periodicity of the hydroperiod would be extremely difficult to mimic. In addition, the chemistry of the water pumped into the mitigation area would be different than water that would naturally flow into the system. The score for this category is limited to 8 for existing wetlands with organic soils, and 7 for sandy restoration areas that will be more challenging to re-hydrate in a natural pattern.

4.3.3 Community Structure

All areas would be managed to minimize nuisance and exotic cover to less than 5 percent. Vegetation in the existing wetlands would be expected to thrive in response to an increased hydroperiod. Typically, emergent species recruit well from the organic seed bank, and it is expected that a UMAM score of 8 is feasible. However, the restoration area has been converted to upland habitat for several decades, and while the seed bank is likely still there, it is typically less robust than in organic soils. Approximately half of the restoration area is expected to require supplemental planting. It is likely that maintaining a desirable hydroperiod in these shallow areas will be difficult, making the site susceptible to weedy and exotic invasion. Therefore, the potential UMAM score in the restoration AA is limited to 7.

4.3.4 Time-Lag

It is expected that the enhancement wetlands will respond well to an increased hydroperiod, and with management, will stabilize in three years. The restoration AA is expected to require more management but, with supplemental planting, should develop appropriate coverage within five years.

4.3.5 Risk

As the project is proposed as a mitigation bank, financial assurances to carry out long-term maintenance will be required, which eliminates many forms of risk. The site will also be required to be protected from any land-use changes (i.e., conservation easement). However, at this point, the vulnerability to alterations in hydrology and water quality are highly questionable.

There is low to moderate risk in enhancing the existing wetlands. The topography, soils, and mostly desirable vegetation are currently in place. It seems apparent that hydroperiods can be improved immediately by removing breaches, but that obtaining the prolonged historic water depths may prove challenging, therefore a moderate risk score of 1.5 is proposed.

Mimicking the historic hydroperiod appears to be extremely challenging in the shallow and sandy restoration areas. It seems that the pumps are fairly effective and reliable but research revealed that the solar pumps have low functionality and can only be turned on or off. Because the rate of percolation of water to the canal may be highly variable based on antecedent conditions (rainfall) and the difference between the water levels in the wetlands and canal (head), a variable pumping regime may be desirable. Without the ability to program the pumps, they would need to be turned on or off periodically. Possibly, pumps could somehow be linked remotely to a background wetland or local rainfall that could be used as a control to drive the pumping regime. Therefore a high risk factor (2.25) is proposed until these issues can be further addressed.

The current UMAM analysis yields a total of 54.11 UMAM credits. If the hydroperiods of all wetlands can be conclusively restored to the near-natural condition, the risk and category scores can be improved, which could increase the credit potential to as high as 80 credits.

4.4 WEST PINELANDS - ESTIMATED MITIGATION COSTS

Mitigation cost estimates for the West Pinelands are provided in Table 2 at the end of this report. The second page of the table provides the assumptions used to estimate costs. At this point, conservative estimates based on industry standards and project experience were used because many details are still unknown.

The site has been assessed as a potential mitigation bank, which includes costs specific to mitigation banks such as marketing/sales, legal/accounting, and funding the management trust. Also typical of mitigation banks, the estimated revenue generated from credit sales has been compared to the expenses on an annual basis and a net-present-value has been calculated for the income streams. This format allows a more comprehensive understanding of the timing of expenses and credit availability, and the calculation of net-present-value provides an overall understanding of project value. Again, the proposed expenses are only preliminary estimates at this point.

Overall project expenses for the 10-year project are estimated at approximately $3.8 million, or approximately $70,000 per credit. The most significant and uncertain cost factors are permitting, construction, and restoration. The hydrologic modeling required appears to be highly complex, making the ecological translation of the modeling into success criteria and mitigation credits similarly difficult. Modeling will also directly affect construction costs. The estimates for construction currently assume earthen breaches can simply be altered and allowed to stabilize. However, if modeling shows that significant hardened structures are required, the costs could increase dramatically. Restoration costs are a large cost factor. The proposed costs are based on the assumption that significant herbicide treatment would be required as wetland seed sources are re-established. These costs could be reduced depending on how the site responds. Conversely, if exotic and weedy species dominate, supplemental planting may be required. In addition, it is likely the pumps will need to be "programmed", which may require wiring, equipment, and technical time that have not been considered yet. These are only preliminary costs for consideration; however, it appears that the project is economically feasible at this early stage.

4.5 WEST PINELANDS - PROJECT CONSTRAINTS AND OPTIMIZATION

The major constraints with this project revolve around water issues. Perhaps most importantly, will the project adversely affect upstream or downstream users? The level of improvement attainable may be governed by outside constraints. Secondly, can solar pumps or any type of pumps be permitted? The SWFWMD does not typically embrace mechanical means such as pumps. Third, can the natural hydroperiod be mimicked? This will have a direct effect on project cost and credit generation. Preliminary engineering modeling could be used to more closely address these issues, and determine the hydrologic regime that is possible given on-site and off-site constraints.

Restoration costs can be optimized with careful active management. Allowing vegetative succession by weedy species instead of consistently treating all nuisance species with herbicide can actually improve results. However, immediately eradicating aggressive exotic species can reduce future management efforts. If the native seed bank is not responding, selective supplemental planting or seeding may improve vegetative establishment. The use of fire may help attain beneficial coverage.

Perhaps the project can be performed in phases, where initially all breaches are removed, and depending on the results, solar pumps could be added. Cost-benefit analyses could be used to determine how many credits the pumps could add and at what cost (time, complexity, and dollars). Alternatively, more efficient electric pumps could be considered as there is power nearby and the disturbed canal berm could be used to install necessary electric and automation wiring.

4.6 WEST PINELANDS - RECOMMENDED ACTIONS

The following are recommended actions to consider:

- Perform preliminary modeling to determine off-site impacts to identify what level of restoration is feasible
- Determine realistic permeability rates to more accurate estimate horizontal water loss
- Determine what effect structures alone would have on wetland hydroperiods
- Determine what additional credit pumps provide and at what cost
- Determine if electric pumps would be favorable to solar in terms of performance and cost
- Prepare a revised design(s) and perform more detailed cost estimating
- Consider phasing the project to reduce uncertainties

- Evaluate the project as a County project or ROMA and not a mitigation bank to determine cost and time savings

5.0 ALBRITTON RESERVOIR ALTERNATIVE 2

The Albritton Reservoir Alternative 2 (ARA2) mitigation project involves the preservation of substantial upland habitat and the enhancement and restoration of historic herbaceous wetlands that have been severely drained by the Albritton Grove ditch network. The surrounding grove was historically a large marsh that was part of the original Cow Pen Slough system.

Wetland hydroperiods are proposed to be restored by impounding water in a surrounding reservoir at the land surface in conjunction with the Alternative 2 Reservoir design. In addition to hydroperiod restoration, nuisance and exotic vegetation in the project area would be removed and maintained to generate mitigation credits. The project has also been assessed to determine potential mesic hammock credits. The project includes approximately 21 acres of wetland enhancement, 9 acres of wetland restoration, 80 acres of upland preservation, and 80 acres of potential mesic hammock for a total project size of approximately 190 acres in two separate areas.

A mitigation plan map, credit estimates, and mitigation cost estimates for the ARA2 mitigation project area are provided as Figure 6, Table 3, and Table 4, respectively at the end of this report.

5.1 ARA2 - EXISTING CONDITIONS

Upland habitat in the project area is comprised of generally good quality pine flatwoods, mixed pine-oak forest, and potential mesic oak hammock. The groundwater table in the project area has been significantly lowered, which has altered species composition and soil characteristics. Nuisance and exotic vegetation is moderate overall and generally limited to the understory, with occasional dense stands of Brazilian pepper along habitat edges.

Wetlands in the project area have also been significantly drained, causing the conversion of the outer zones in many areas to uplands and allowing the invasion of nuisance and exotic vegetation. Remaining wetland habitats suffer from a reduced hydroperiod and moderate to heavy invasion of undesirable vegetative species.

5.2 ARA2 - MITIGATION PLAN

The mitigation plan provided as Figure 6 at the end of this report is straightforward, and involves the preservation and restoration of native habitats. However, ensuring that the adjacent reservoir will maintain a natural hydroperiod in the project area could be complicated depending on pumping and storage regimes. At this point, however, it is assumed that hydroperiods will be restored to a high, though not optimal level by the construction of the adjacent reservoir. This is a conservative approach to avoid overestimating credit value in the event that reservoir levels can not be manipulated in a manner that promotes optimal hydroperiod maintenance.

No work effort or associated costs have been estimated to restore hydrology. It is assumed that this mitigation project would be completed in conjunction with reservoir construction. Therefore, all major earthmoving is assumed to be accomplished with the reservoir construction. Without the reservoir project, or an alternative effort that could restore the depressed groundwater table, the ARA2 mitigation project would not be possible as proposed. The following is a summary of the major tasks needed to complete the mitigation plan:

- Perform initial exotic removal/herbicide treatment in uplands and wetlands.
- Remove existing irrigation ditches.
- Plant supplemental herbaceous wetland vegetation in approximately 50 percent of the overall wetland restoration and enhancement areas. Rely on seed bank regeneration in remaining wetland habitat.
- Plant supplemental groundcover species in approximately 25 percent of upland and hammock habitat including habitat edges, road removal areas, and internal areas lacking beneficial coverage. Rely on seed bank regeneration in the balance of the uplands.

5.3 ARA2 - POTENTIAL MITIGATION CREDIT GENERATION

The summary UMAM credit analysis is provided in Table 3 at the end of this report. Baseline scores were provided by the project team. Preservation values for each AA were determined by assessing the difference in UMAM scores between the future "without preservation" and "with preservation" conditions. In addition, each AA was then assessed to determine if additional credit could be generated by enhancing the preserved condition. The following is a summary of the ARA2 UMAM analysis justification.

5.3.1 Preservation

Wetland restoration areas were not assessed for preservation value because they will be converted from uplands that score zero (0) by UMAM rule.

In the "with preservation" condition, assessed AAs are expected to be maintained in the current condition, therefore, baseline UMAM scores are used to estimate the "with preservation" condition. Preservation credits in this analysis have been determined by calculating the UMAM value of protecting the existing habitat by conservation easement or similar restrictive covenant.

Without preservation, location scores would be somewhat degraded in existing wetlands (enhancement areas) that are greater than 0.5 acre assuming the surrounding upland land use would be intensified through some form of development (housing, agriculture, mining). However, many of the wetlands are imbedded in potential mesic hammock, which can only be impacted by 25 percent per County rules. These areas would be less affected by development than wetlands in or near unprotected upland habitats. Development would also require surface water permitting; therefore, the water environment scores are expected to remain the same with and without preservation. Community structure would likely continue to degrade without management. Overall, existing wetlands would be moderately degraded without preservation primarily from upland land use intensification and a lack of management. However, other isolated wetlands that are less than 0.5 acre could be eliminated without mitigation, therefore, without preservation, these wetlands would score zero (0) in all categories. Wetland preservation values are moderate to high overall, but based on the small amount of acreage, only 1.04 credits could be generated as shown in Table 3 at the end of this report.

Upland habitats could be developed (i.e., excavated) without preservation and are not specifically regulated; therefore, without preservation, uplands would score zero (0) in all categories. With preservation, the existing native uplands would be protected, creating the opportunity for over 22 UMAM credits.

The preservation adjustment factor (PAF) for wetland enhancement areas was estimated to be in the middle range (0.5-0.6) based on the scoring criteria listed in Chapter 62-345.500(3)(a), FAC, which generally focus on habitat quality, ability to be managed, and the risk of degradation if not preserved. These wetlands are moderate quality, can be managed, and are at risk of moderate to extreme degradation if not preserved. The PAF for the UP-1 AA in the northern portion of the project was estimated at 0.8 because this habitat provides good wetland support and is at risk of extreme degradation. However, the southern uplands (UP-2) were assigned a PAF of 0.4 because though they are high quality at risk of extreme degradation, these uplands are not well associated with wetland habitats.

Mesic hammock habitat was not assessed with UMAM, but was assessed using a ratio to determine credit value. Because the County allows impacts to only 25 percent of mesic hammock habitat, the preservation of every 4 acres of functioning mesic hammock would yield a net increase of 1 acre of mesic hammock. Therefore, potential mesic hammock credits estimated at the bottom of Table 3 at the end of this report, are the acres of potential mesic hammock divided by four. It is assumed that one mesic hammock credit represents the ability to impact one acre of functioning mesic hammock.

5.3.2 Enhancement/Restoration

Because the "with mitigation" condition for all wetland enhancement areas is very similar, a single "with mitigation" score was assigned to all wetland enhancement areas. Similarly, all restoration areas were assessed as a single AA. By rule, baseline UMAM scores for wetland restoration AAs are zero (0). Enhancement credits shown in Table 3 at the end of this report have been determined by calculating the UMAM value of enhancing the "with preservation" condition after a conservation easement is in place.

5.3.3 Location and Landscape Support

In the "with mitigation" scenario, all enhancement and restoration areas are assigned a score of 7, which is similar to the existing condition scores (6-7). The existing surrounding low-quality habitat is comprised of an active orange grove, which will be converted to an open-water reservoir. The minimal improvement to location scores results from the synergistic effects of enhancement of the upland and wetland habitat to be preserved. The surrounding reservoir will provide little beneficial habitat though it will provide an adequate buffer.

The UP-1 AA location score is also improved slightly by enhancement activities, from a score of 5 to 6. The category score for this AA is slightly lower than the internal wetland habitats that it protects. The enhanced location score for the southern upland (UP-2) that is contiguous with County-owned land remains unchanged at 7.

5.3.4 Water Environment

In the "with mitigation" scenario, all wetland enhancement areas are assigned a score of 8, indicating that wetland hydrology is expected to function at a high level. This may be difficult to achieve adjacent to the reservoir. Wetland restoration areas are shallower and more susceptible to hydrologic alterations, therefore a slightly lower score (7) is proposed in this AA.

This category is not scored for uplands.

5.3.5 Community Structure

This category is expected to be improved by supplemental planting and regular maintenance activities in conjunction with improved hydrology. A conservative estimate of 8 is expected for wetland enhancement areas while a slightly lower score of 7 is expected in the fringing restoration areas.

Upland habitats can be improved by exotic removal, supplemental planting, and implementation of an aggressive management plan. The moderately degraded northern habitats are expected to improve from 5 to 9, while the more intact southern habitats could improve from 7 to 9.

5.3.6 Time-Lag

As there is some uncertainty as to how the wetland hydroperiods will be affected by the adjacent reservoir, a conservative estimate of five years is expected for enhanced and restored wetlands to reach the proposed condition. Upland areas should respond to enhancement activities within three years.

5.3.7 Risk

As with the West Pinelands project, hydrologic restoration is the critical component that affects risk as well as the physical UMAM category scores (water and vegetation) and time-lag. Enhancing or restoring existing or previous wetlands generally entails low risk because topography, soils, and seed sources are present. However, appropriate hydrology is the key component to sustainable mitigation. At this point, a moderate risk score of 1.75 has been assigned to enhancement areas, while a slightly higher score of 2.0 is assigned to the exterior restoration areas. Depending on the ultimate water level regime in the reservoir and the results of modeling, these risk scores could be adjusted up or down.

There is little risk associated with the enhancement of upland habitat, however, the value of the upland directly corresponds to the value of the wetland habitat it supports, therefore a higher than typical score of 1.5 is assigned.

Overall, the ARA2 project potentially generates 2.36 wetland enhancement credits and 9.22 upland enhancement credits. When added to the 23.41 preservation credits, the total credit potential is 37.83 UMAM credits. In addition, there is the potential to generate 19.96 mesic hammock credits. This is an estimate of credit potential of the habitat in the project area. However, the overall linear and disjunctive configuration of the mitigation areas combined with the atypical hydrologic design may not be desirable to the regulatory agencies.

5.4 ARA2 - ESTIMATED MITIGATION COSTS

Mitigation cost estimates are provided in Table 4 at the end of this report. The second page of the table provides the assumptions used to estimate costs.

Overall project expenses for the 7-year project are approximately $1.93 million, or approximately $51,000 per UMAM credit. Compared to the West Pinelands, UMAM credits associated with ARA2 are less than half as expensive. In addition, mesic hammock credits worth approximately $1 million would be created with this plan. Because one mesic hammock credit represents the ability to build on one acre of mesic hammock, it is assumed that a mesic hammock credit is worth the value of an acre of land. A reasonable estimate of the value of an acre of land in Sarasota County is $50,000, thus, an estimated credit value of $50,000. The value of 19.96 mesic hammock credits at $50,000 per credit is approximately $1 million. When combined with UMAM credits, the total potential credit value is approximately $5.4 million, at a cost of less than $2 million. While land costs have not been considered, this appears to be the most economically feasible project. However, agency reviewers may require that the design be modified into a single, well-connected project area.

Cost factors for this project are rather straightforward. Significant costs include planting and maintenance. With more detailed field studies and assurances of stable hydrology, these costs may be reduced.

5.5 ARA2 - PROJECT CONSTRAINTS AND OPTIMIZATION

This project is fairly simple, however, as with the West Pinelands project, the ability to restore natural hydrology is critical. If off-site impacts are caused by the project, it may be very difficult to re-hydrate wetlands sufficiently.

If it can be demonstrated that wetland hydroperiods will mimic natural conditions, it may be possible to improve credit generation slightly by reducing risk and time-lag scores. In addition, improving connectivity of the northern project area to the County-owned land to the south would improve the location category score and generate slightly more mitigation credit. In the current design, the northern project area does not support terrestrial species well.

5.6 ARA2 - RECOMMENDED ACTIONS

The following are recommended actions to consider:

- Perform preliminary modeling to determine if there are off-site impacts and the level to which hydrologic restoration is feasible
- Determine if operation of the reservoir will conflict with natural wetland hydroperiods
- Determine if the project can be configured with connectivity to other preserved lands
- Incorporate design changes from the project team and perform more detailed cost estimating
- Determine the UMAM credit potential of mesic hammock habitat
- Evaluate the project as a County project or ROMA and not a mitigation bank to determine cost and time savings given the small number of potential credits

6.0 ALBRITTON RESERVOIR ALTERNATIVE 3

The Albritton Reservoir Alternative 3 (ARA3) mitigation project involves the creation of a 104-acre marsh system in the southern portion of the Albritton site in conjunction with preservation and enhancement of upland habitat and the enhancement and restoration of historic herbaceous wetlands. As compared to the ARA2 project, this project area is more regular in shape and is well connected to County owned land. However, the ARA3 project is much more costly to construct and carries more project risk.

Wetland hydroperiods are proposed to be restored by impounding water in the surrounding reservoir and discharging it to the project wetlands in conjunction with the Alternative 3 Reservoir design. In addition to wetland creation and hydroperiod restoration, nuisance and exotic vegetation in the project area would be removed and maintained to generate mitigation credits. The project has also been assessed to determine potential mesic hammock credits. The project includes approximately 104 acres of wetland creation (and 12 acres of buffer sideslope), 15 acres of wetland enhancement, 31 acres of wetland restoration, 38 acres of upland preservation, and 63 acres of potential mesic hammock for a total project size of approximately 263 acres.

A mitigation plan map, credit estimates, and mitigation cost estimates for the ARA3 mitigation project area are provided as Figure 7, Table 5, and Table 6, respectively at the end of this report.

6.1 ARA3 - EXISTING CONDITIONS

Portions of the native ARA2 habitats described above are also part of the ARA3 project area. In addition, the ARA3 project area contains a 116-acre portion of active citrus grove that will be converted to wetland habitat. A 30-acre portion of the historic slough system that has been converted to improved pasture is also present in the southwest portion of the site. Both the grove and pasture were previously wetland habitats, though the restoration of the grove to wetland habitat is differentiated as wetland creation in this section.

6.2 ARA3 - MITIGATION PLAN

Similar to the ARA2 mitigation plan, the mitigation plan provided as Figure 7 at the end of this report involves the preservation and enhancement of generally native habitats. In addition, a historic portion of the slough that has been converted to pasture is proposed to be treated with herbicide, replanted, and re-hydrated in conjunction with the ARA3 reservoir project. A larger area of historic marsh that has been converted to citrus will be cleared, leveled, possibly excavated, and planted with herbaceous wetland vegetation. This area has been graded, bedded, and ditched substantially. It is unlikely that substantial amounts of soil will be removed from the grove as it was historically a deep marsh system and the water table must be raised above the historic land surface to maintain hydroperiods in the northeastern enhanced wetlands. At a minimum, substantial earthwork will be required to level and contour the creation area. Therefore, the construction cost estimate allows for the removal of up to 3 feet of soil, which should cover the cost of any combination of grading and hauling necessary to restore proper wetland elevations in the citrus grove.

Similar to ARA2, it is assumed that hydroperiods will be restored to a high, though not optimal level in all wetland habitats as a result of the adjacent reservoir project. This is a conservative approach to avoid overestimating credit value in the event that reservoir levels can not be manipulated in a manner that promotes optimal hydroperiod maintenance.

It is assumed that this mitigation project would be completed in conjunction with reservoir construction; therefore, all necessary infrastructure required to restore hydrology is assumed to be included in the reservoir design. Without the reservoir project, or an alternative effort that could restore the depressed groundwater table, the ARA3 mitigation project would not be possible as proposed. The following is a summary of the major tasks needed to complete the mitigation plan:

- Clear and grade the citrus grove to appropriate wetland elevations in the Marsh Creation (MC) area.
- Treat the improved pasture area (WR) with herbicide at least twice using large scale agricultural equipment; remove exotics in the remaining project area.
- Remove existing ditches and roads through native habitats
- Plant supplemental herbaceous wetland vegetation in approximately 50 percent of existing Wetlands 4, 5 and 7-9 in both restoration and enhancement portions. Rely on seed bank regeneration in remaining wetland habitat.
- Plant supplemental groundcover species in approximately 25 percent of upland and hammock habitat including habitat edges, road removal areas, and internal areas lacking beneficial coverage. Rely on seed bank regeneration in the balance of the uplands.
- Plant the entire marsh creation area (MC) and the western pasture restoration area (WR).
- Perform initial exotic removal/herbicide treatment in uplands and wetlands and maintain the site in perpetuity.

6.3 ARA3 - POTENTIAL MITIGATION CREDIT GENERATION

The summary UMAM credit analysis for ARA3 is provided in Table 5 at the end of this report. The UMAM analysis was very similar to analysis performed for the ARA2 project discussed above. Only the differences in the two analyses are discussed below.

6.3.1 Preservation

In the ARA3 design, the southern upland preserve area (UP-2) is well connected to wetland habitat. The improved association between the upland preserve and wetland habitats results in an increase of the PAF from 0.4 to 0.8 for this AA, which doubles the credits generated per acre of UP-2. All other preservation values were similar to the ARA2 analysis.

6.3.2 Enhancement/Restoration

Because the project area is regularly shaped and contiguous with County owned land, the location scores of all AAs in the “with mitigation” scenario are slightly higher than in the ARA2 design. This results in a slight increase in enhancement values.

The risk factors were also similar to those described in the ARA2 analysis, with the exception that risk for wetland creation in ARA3 was established at a high value (2.5). A high risk value is assigned because the grove soils have been heavily manipulated, it lacks a native seed source, and topography has been altered substantially. There is also some risk that hydrologic improvement will not meet expectations.

Overall, the ARA3 project could potentially generate 62.23 UMAM credits and 15.7 mesic hammock credits with a value of $7.9 million.

6.4 ARA3 - ESTIMATED MITIGATION COSTS

Mitigation cost estimates are provided in Table 6 at the end of this report. The second page of the table provides the assumptions used to estimate costs.

Overall project expenses for the 10-year project are estimated at $7 million, therefore, each UMAM credit is estimated to cost approximately $113,000 to create, which is similar to the West Pinelnads and double ARA2.

Significant costs include earthwork and planting. While the planting estimate is not likely to change substantially, the earthwork estimate is simply a placeholder at this point. The amount of soil to be removed (if any) and the level of effort needed to grade and re-contour the highly disturbed grove must be determined to refine the cost estimate. The cost estimate assumes that up to 3 feet of soil may be required to be removed from the grove, thus, the proposed estimate is likely a worst-case scenario.

6.5 ARA3 - PROJECT CONSTRAINTS AND OPTIMIZATION

Again, hydrologic restoration is the key to success. If off-site impacts can be avoided, and stable hydrology restored, the project may be feasible. Achieving appropriate hydrology would mean that only minimal excavation would be required, and construction costs could be lowered.

In the event that target hydrology cannot be met and excavation of the grove is required, the cost of excavation may be offset by the value of the fill material removed. This would likely reduce the number of credits somewhat, but the project could be feasible.

6.6 ARA3 - RECOMMENDED ACTIONS

The following are recommended actions to consider:

- Perform preliminary engineering modeling to determine if there are off-site impacts and the level to which hydrologic restoration is feasible.
- Determine if operation of the reservoir will conflict with natural wetland hydroperiods.

- Estimate the amount of earthwork required based on preliminary engineering estimates.
- Evaluate the project as a County project or ROMA and not a mitigation bank to determine cost and time savings.

7.0 MITIGATION BANKING POTENTIAL IN THE SOUTHERN COASTAL BASIN

There is clear demand for a mitigation bank in the Southern Coastal Basin. For both the private and public sector, individuals and elected officials have pondered the lack of mitigation banking in the coastal basins. High land values are a deterrent making investors withstand years of negative cash flow before enough credits can be brought to the market to turn the tide. Perhaps the real issue is that credit prices have not caught up with land values. A credit price of possibly $200,000-300,000 is unheard of in Florida, but may be necessary in expensive coastal basins.

The preliminary cost estimates from the three projects demonstrate that the most complicated project (ARA3) that requires a large amount of earthwork and infrastructure is nearly twice as expensive (per credit generated) as the simplest project (ARA2) that restores and preserves native habitats. The West Pinelands project is very conceptual at this point, and at best it appears more costly than ARA2, and could approach the ARA3 costs if hardened structures are required. Land costs have not been included in the analyses therefore, true costs are not revealed. Even with land cost, simpler mitigation methods should be the most cost effective.

For the projects analyzed, only the ARA2 project appears economically feasible even without land costs. However, there are only a small number of credits (38) involved with that project and many uncertainties to resolve. The linear and disjunctive ARA2 project is not a typical mitigation bank design as currently designed. Perhaps with design alterations, and even with land costs included, this project could be feasible.

It appears that the West Pinelands project could be feasible as long as critical issues such as upstream flooding and SWFWMD approval of pumps can be satisfactorily addressed. However, if modeling shows that more complicated hardened structures are required, costs could rise substantially. This appears to be the most uncertain option, but still one worth pursuing.

At the proposed credit prices, the ARA3 project is not likely to be economically feasible, even if the conservatively estimated implementation costs were reduced substantially. A sensitivity test could shed light on this assumption.

Despite uncertainties and formidable costs, the County, because of its large land holdings, may be uniquely positioned to bring credits to the market, although possibly at a higher credit price than $115,000. With more precise cost estimates based on engineering design, it may be feasible to reduce costs without a substantial reduction in credits. This improvement, coupled with higher credit prices, may allow the development of an economically sound mitigation bank on existing County owned lands.

Another approach that may improve the economic feasibility of the projects would be to implement the mitigation activities in phases. This may increase the total time to generate credits, but it allows the reduction of project risk as active management is used to refine the project progressively. For example, phase 1 of the West Pinelands project could be raising the surface water discharge inverts into the canal and determining how the seed bank responds. Phase 2 could include supplemental pumping and planting.

In summary, the cost estimates proposed are very preliminary and assumptions are subject to engineering verification. We encourage the project team and the County to closely scrutinize and troubleshoot the analysis to determine how the projects can be refined.

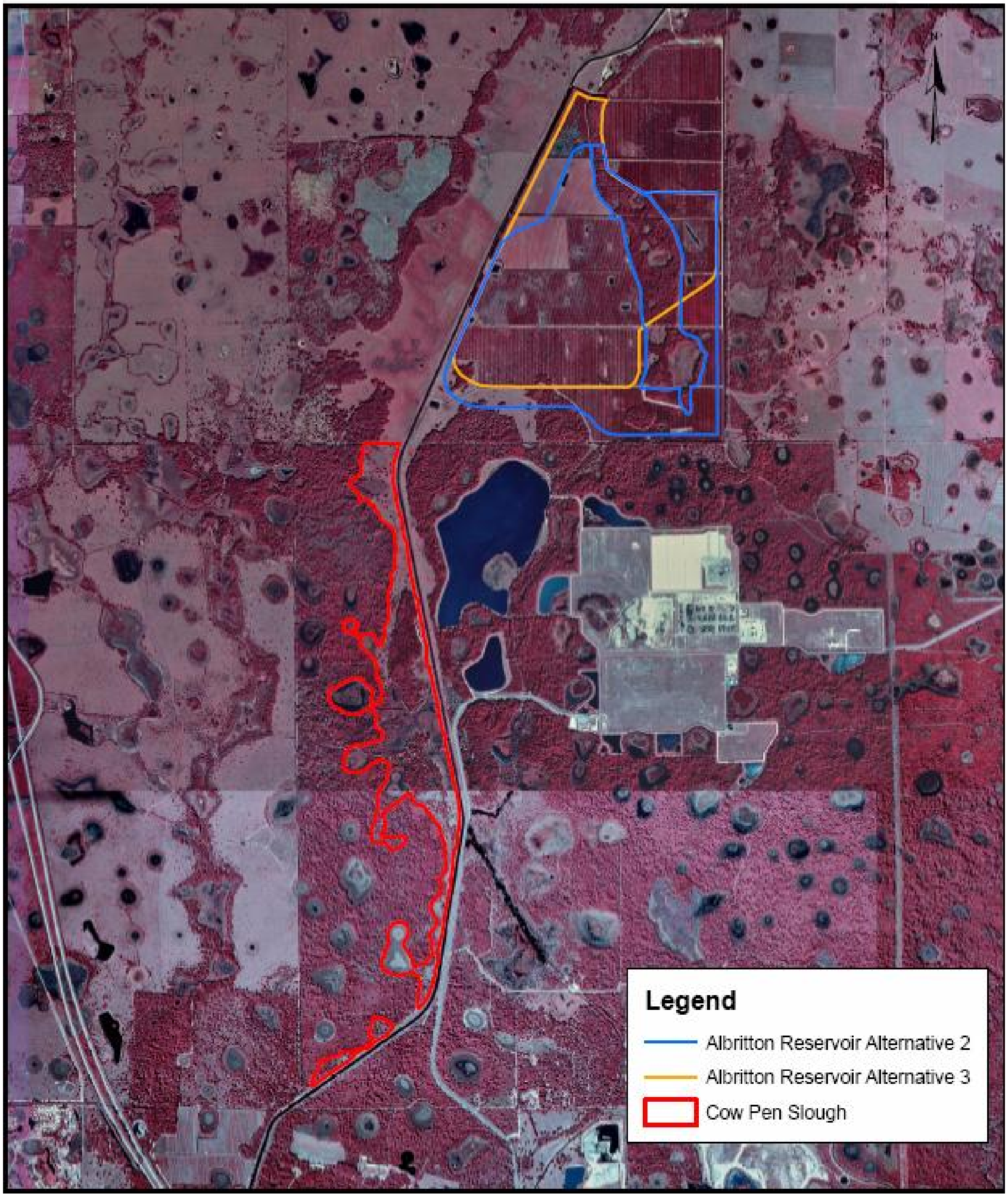


Figure 1 – Potential Mitigation Bank Sites

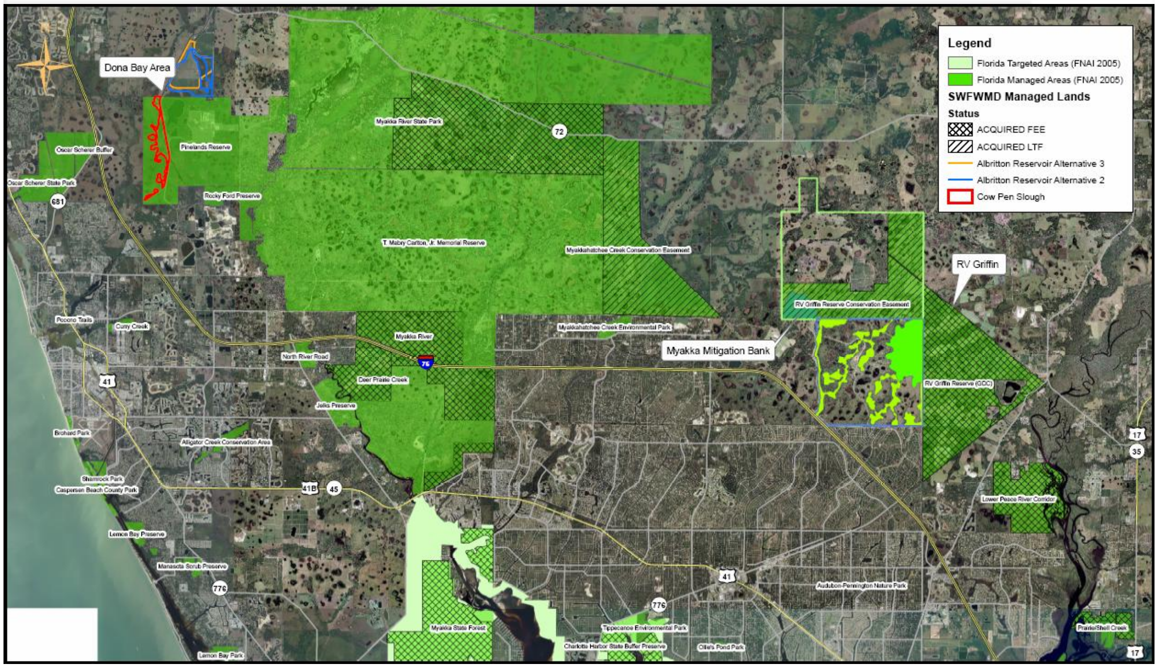


Figure 2 – Regional Preservation Lands

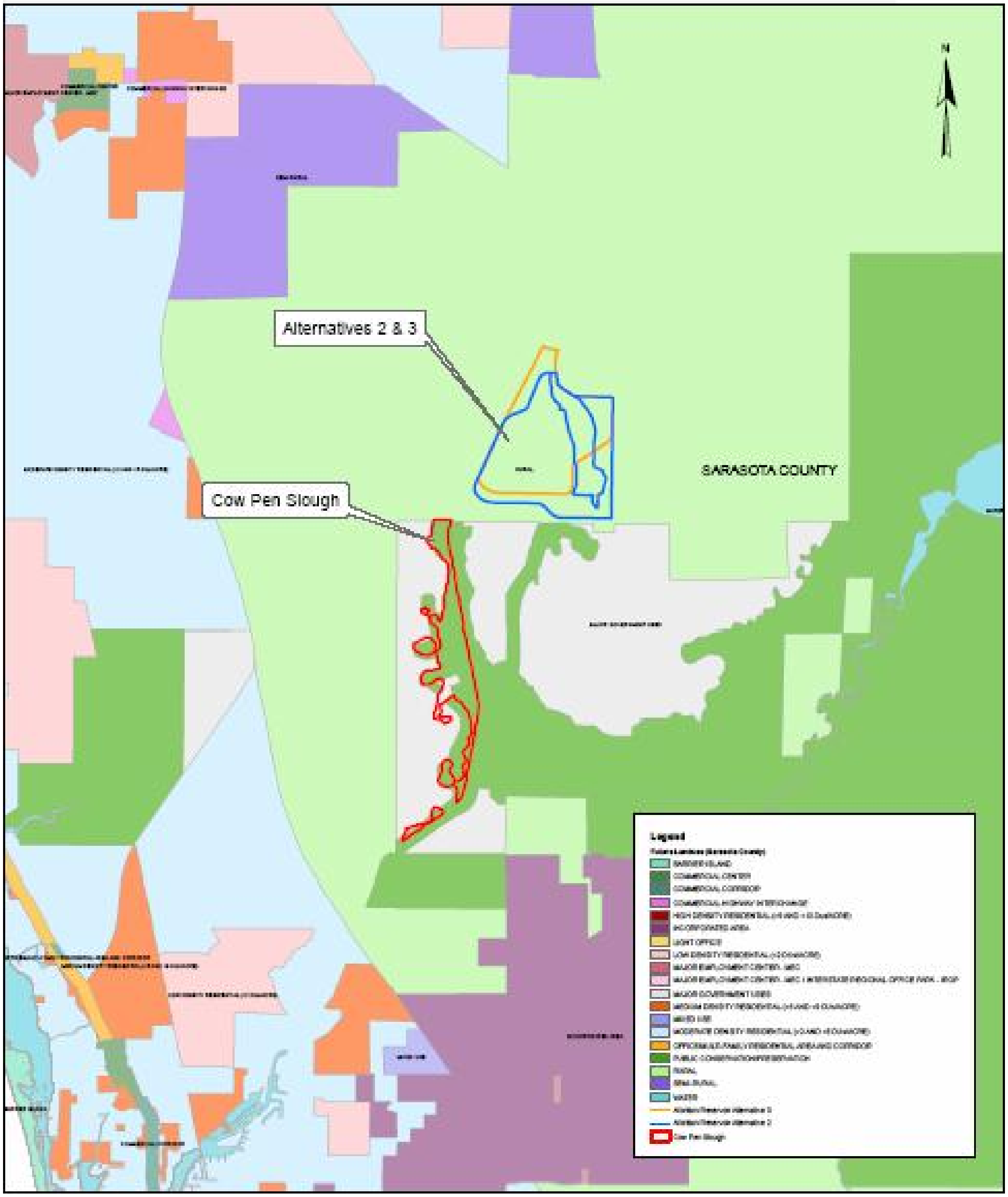


Figure 3 – Future Land Use Map

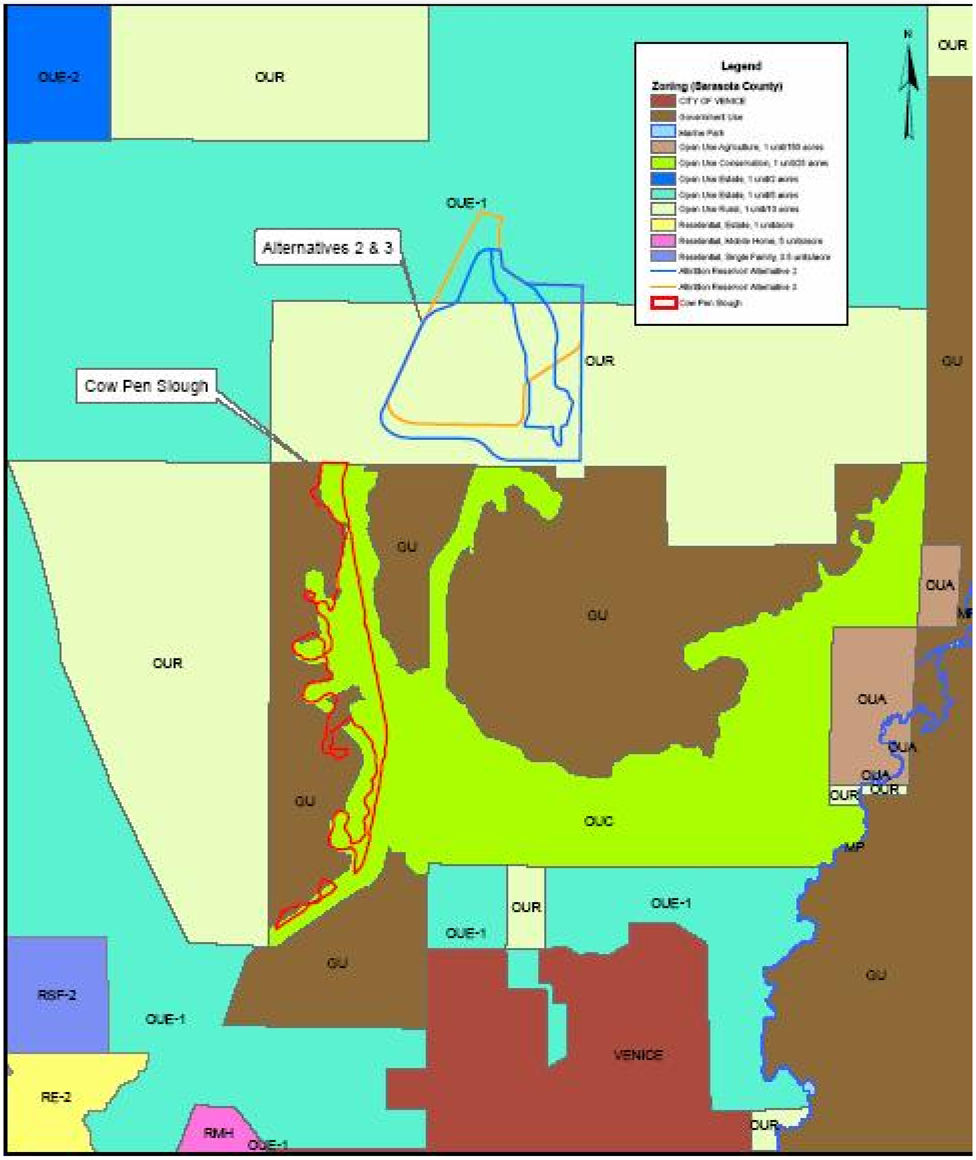


Figure 4 – Sarasota County Zoning

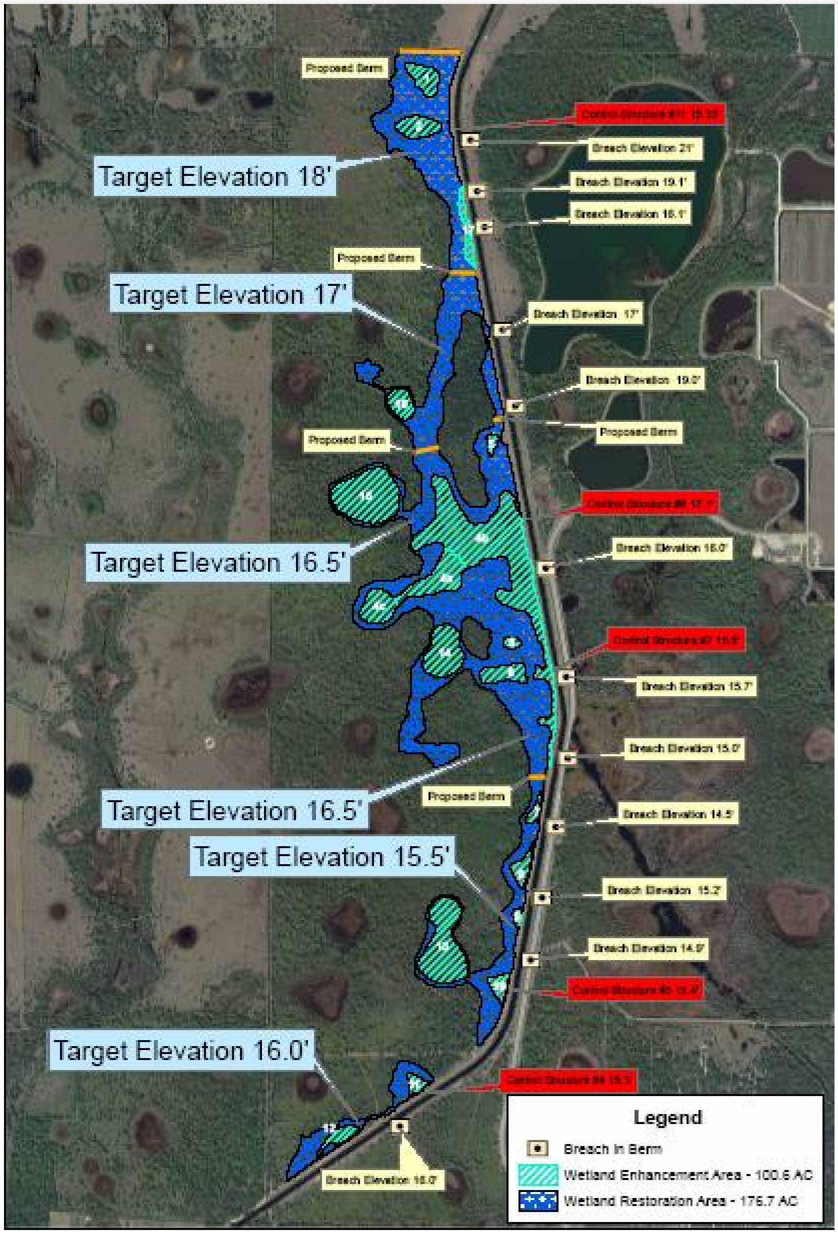


Figure 5 – West Pinelands Preliminary Mitigation Plan

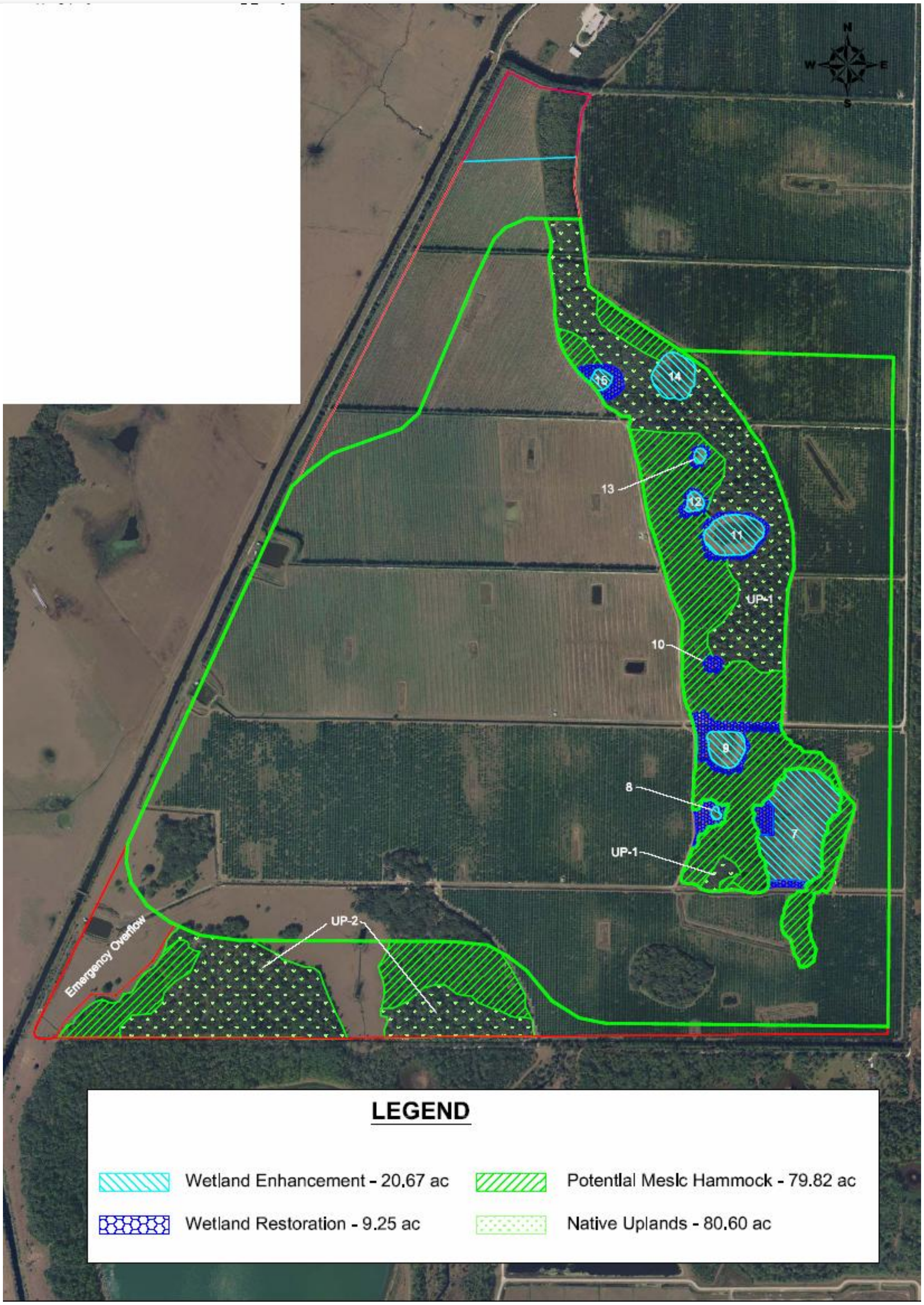


Figure 6 – Albritton Reservoir, Alternative 2 Mitigation Plan

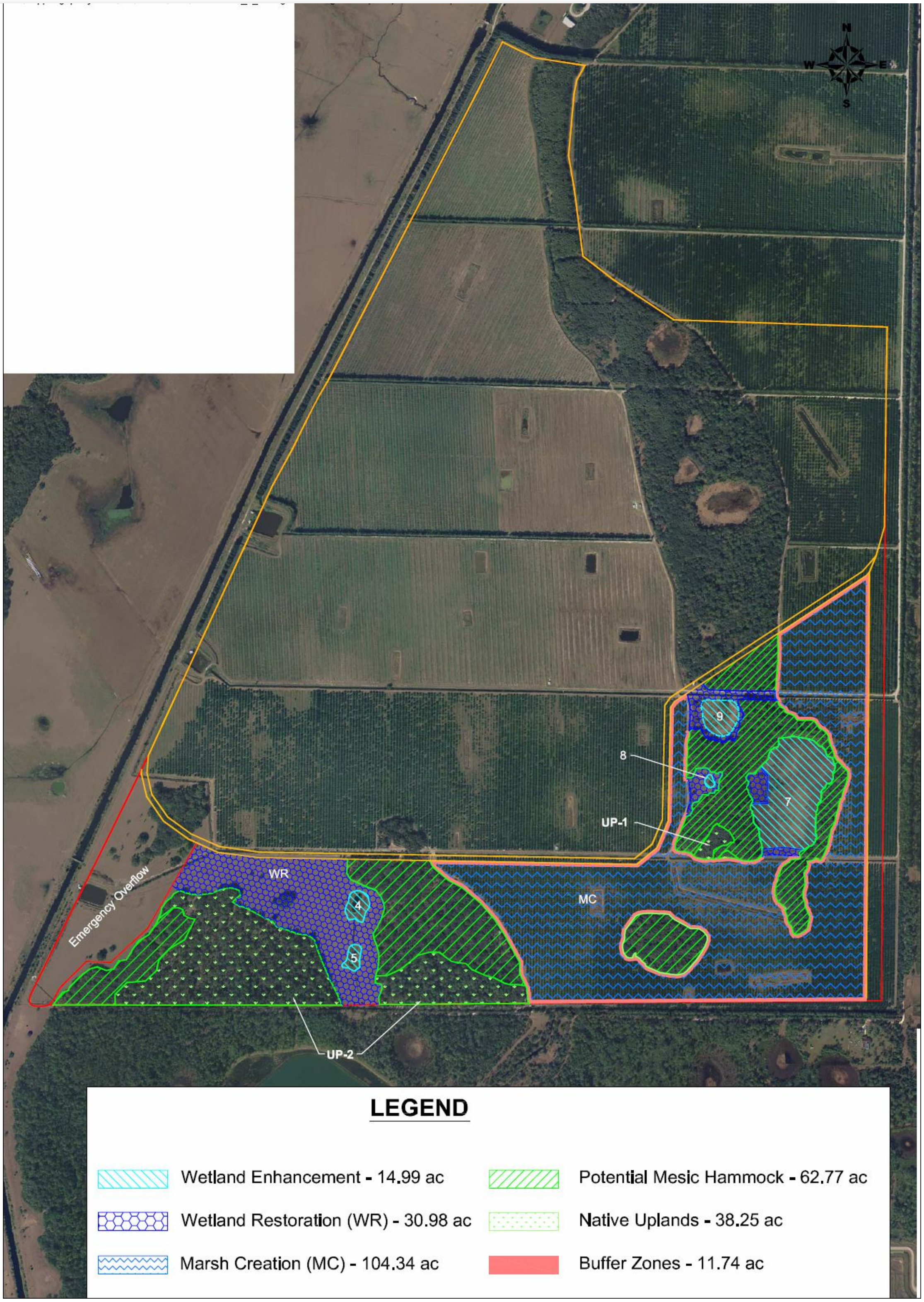


Figure 7 – Albritton Reservoir, Alternative 3 Mitigation Plan

ASSESSMENT AREA	MITIGATION AREA (acres)	SCORE: LOCATION AND LANDSCAPE BASE LINE	SCORE: LOCATION AND LANDSCAPE WITH MIT	SCORE: WATER ENVIRONMENT BASE LINE	SCORE: WATER ENVIRONMENT WITH MIT	SCORE: COMMUNITY STRUCTURE BASE LINE	SCORE: COMMUNITY STRUCTURE WITH MIT	BASELINE	WITH ENHANCEMENT	ENHANCEMENT DELTA	Time Lag	Risk	ENHANCEMENT RFG	ENHANCEMENT CREDIT
Wetland Enhancement														
Wetland 1	3.11	7	8	6	8	6	8	0.63	0.80	0.17	1.07	1.50	0.10	0.32
Wetland 2	3.32	7	8	6	8	6	8	0.63	0.80	0.17	1.07	1.50	0.10	0.34
Wetland 3	0.85	7	8	5	8	6	8	0.60	0.80	0.20	1.07	1.50	0.12	0.11
Wetland 4a	6.78	8	8	7	8	7	8	0.73	0.80	0.07	1.07	1.50	0.04	0.28
Wetland 4b	33.99	7	8	7	8	8	8	0.73	0.80	0.07	1.07	1.50	0.04	1.41
Wetland 4c	4.22	8	8	8	8	8	8	0.80	0.80	0.00	1.07	1.50	0.00	0.00
Wetland 5	0.72	8	8	8	8	7	8	0.77	0.80	0.03	1.07	1.50	0.02	0.01
Wetland 6	3.22	7	8	7	8	7	8	0.70	0.80	0.10	1.07	1.50	0.06	0.20
Wetland 7	0.87	7	8	5	8	6	8	0.60	0.80	0.20	1.07	1.50	0.12	0.11
Wetland 8	1.92	7	8	7	8	7	8	0.70	0.80	0.10	1.07	1.50	0.06	0.12
Wetland 9	0.60	7	8	7	8	7	8	0.70	0.80	0.10	1.07	1.50	0.06	0.04
Wetland 10	1.70	7	8	6	8	6	8	0.63	0.80	0.17	1.07	1.50	0.10	0.18
Wetland 11	1.25	7	8	7	8	6	8	0.67	0.80	0.13	1.07	1.50	0.08	0.10
Wetland 12	1.93	7	8	6	8	7	8	0.67	0.80	0.13	1.07	1.50	0.08	0.16
Wetland 13	11.88	8	8	8	8	8	8	0.80	0.80	0.00	1.07	1.50	0.00	0.00
Wetland 14	7.03	8	8	8	8	8	8	0.80	0.80	0.00	1.07	1.50	0.00	0.00
Wetland 15	12.48	8	8	8	8	8	8	0.80	0.80	0.00	1.07	1.50	0.00	0.00
Wetland 16	2.84	8	8	8	8	8	8	0.80	0.80	0.00	1.07	1.50	0.00	0.00
Wetland 17	1.94	7	8	6	8	6	8	0.63	0.80	0.17	1.07	1.50	0.10	0.20
Subtotal	100.65													3.59
Wetland Restoration														
Cow Pen Restoration	176.70	0	8	0	7	0	7	0.00	0.73	0.73	1.14	2.25	0.29	50.52
Total	**277.35**													**54.11**

Table 1 – West Pinelands, UMAM Credit Assessment

Note	Expenses	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Total
A	Project Management	$ 62,400	$ 62,400	$ 62,400									$ 187,200
B	Survey	$ 53,200	$ 53,200	$ 53,200									$ 159,600
C	Environmental Permitting	$ 150,000	$ 150,000	$ 150,000									$ 450,000
D	Environmental Oversigh			$ 91,800									$ 91,800
E	Engineering	$ 200,000	$ 100,000	$ 100,000									$ 400,000
F	As-Built Certification				$ 50,000								$ 50,000
G	Construction				$ 1,775,648								$ 1,775,648
H	Maintenance				$ 209,000	$ 129,600	$ 129,600	$ 129,600	$ 64,800	$ 64,800	$ 64,800	$ 64,800	$ 857,000
I	Planting				$ 320,710								$ 320,710
J	Miscellaneous Costs				$ 20,000								$ 20,000
K	Monitoring				$ 72,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 5,000	$ 5,000	$ 5,000	$ 231,000
L	Fencing and Security				$ 5,000								$ 5,000
M	Legal/Accounting	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 110,000
N	Management/Marketing	$ -	$ -	$ -	$ -	$ -	$ 28,900	$ 80,500	$ 80,500	$ 80,500	$ 80,500	$ 84,686	$ 435,586
O	Trust Fund Escrow	$ -	$ -	$ -	$ -	$ -	$ 77,185	$ 215,000	$ 215,000	$ 215,000	$ 215,000	$ 226,180	$ 1,163,365
P	Trustee Fees	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 22,000
	Subtotal	$ 477,600	$ 377,600	$ 469,400	$ 2,464,358	$ 177,600	$ 283,685	$ 473,100	$ 408,300	$ 377,300	$ 377,300	$ 392,666	$ 6,278,909
	Revenue												
Q	UMAM Credits Sold	0.00	0.00	0.00	0.00	0.00	3.59	10.00	10.00	10.00	10.00	10.52	54.11
R	UMAM Credit Price	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	
	UMAM Credit Gross Revenue	$ -	$ -	$ -	$ -	$ -	$ 412,850	$ 1,150,000	$ 1,150,000	$ 1,150,000	$ 1,150,000	$ 1,209,800	$ 6,222,650
	Total Net Revenue	$ (477,600)	$ (377,600)	$ (469,400)	$ (2,464,358)	$ (177,600)	$ 129,166	$ 676,900	$ 741,700	$ 772,700	$ 772,700	$ 817,134	$ (56,259)
	NPV	($1,025,411.63)											
	Discount Rate	7%											

Table 2- West Pinelands Pro Forma (Page 1)

A	Project Management	Management of all schedules, deliverables, billing, etc. Estimate based on a bill rate of $150/hour, 8 hours per week, Years 1 -3 through implementation = $150 x 8 hrs/week x 52 weeks = $62,400/year
B	Survey	Survey SHWL elevations, establish benchmarks, conservation easement description, as-builts. Estimate based on 75 field days @$1,500/day and 40 office days @$800/day plus expenses of $15,000. Total approx. $53,200 per year over first 3 years.
C	Environmental Permitting	Highly complex, approximately 3 years. Estimate $450,000 based on previous projects.
D	Environmental Oversight	Oversee weir installation, pump installation, culvert removal, berm construction, planting, and inspect erosion control. Biologist @$85/hour on site 6 hours/day through construction (180 day total) = $91,800
E	Engineering Design and Permitting	Highly complex surface and groundwater modeling, ensure no impact to adjacent lands, substantial ERP support, model water levels, canal drawdown, prove all wetland hydroperiods will be improved and maintained. Provide plan set and engineers report. Estimate $400,000.
F	As-Built Certification	Engineer's certification that creation area, berms, control structures, and ditch removal is performed correctly. Estimate $50,000.
G	Construction	1) Remove 5 structures @$3,000 each = $15,000. 2) Remove 35% of canal berm and install rock weir at SHWE. Earthmoving = 17,351ft. X 35% = (6,073 ft. x 85 ft. wide x 3 ft. high)/27 = 57,356 cy. x $4/cy. = $229,424. Rock weir = 6,073 ft. x $122/ft (based on recent similar project) = $740,906. 3.) Construct earthen berms to separate restoration cells = (1,892 ft. x 20 ft. wide x 2 ft. high)/27 = 2,803 cy x $6/cy. = $16,818. 4.) Purchase and install solar pumps. Horizontal water loss eto canal estimated at 1.8MGD based on average Kh of 4.65in./hr for the soil types. (4.65 in./hr./12 = 0.3875 ft./hr. x 1.5 ft deep x 17,424 ft. of canal = 10,128 cubic ft./hr. x 7.48 cubic ft./gallon = 75,757 gal./hr. x 24 = 1,818,179 gal day of loss.) Each $6,000 pump = 20,000 gal/day = approximately 91 pumps ($546,000). Installation of 8 solar panels for each well (requires crane, concrete setting, wiring) and digging wells $2,500 each = $227,500. Total = $1,775,648.
H	Maintenance	Maintenance of nuisance/exotic vegetation estimated at $2,700/crew day. Year 4 : Initial mechanical spray out of grasses $20,000, plus seven 10-day events ($209,000). Year 5-7: six 8-day events ($129,600). Year 8 and beyond: quarterly 6-day events ($64,800).
I	Planting	Assume supplemental planting required in 50% of restoration area (none in enhancement wetlands): 176.7 ac x 4,840 units @ $0.75/unit x 50%= $320,710.
J	Miscellaneous Costs	Monitoring wells (12@$1,500 = $18,000), transect markers ($2000) = $20,000
K	Monitoring	Semi-annual monitoring for 5 years, baseline and completion report in Year 4 for a total 12 events at $18,000/event. Year 4 = $48,000, Years 5-8 = $36,000. After success, $5,000/year.
L	Fencing and Security	Site currently fenced; fencing may require repair after construction and signage may be required by agencies. Estimate $5,000 as a placeholder.
M	Legal/Accounting	Legal review of conservation easement, title insurance, trust fund documents, federal legal documents, etc. Banking, expense tracking, government reporting. Estimate $10,000 per year average.
N	Management/Marketing	Promotion of credits, advertising, sales expenses, credit ledger adjustments, record keeping, agency reporting, etc. 7% of sales is typical.
O	Trust Fund Escrow	Annual maintenance, monitroing, and reporting estimated at $69,800/yr requiring escrow amount of $1,163,333 @6%. Paid from credit sales at $21,500 per credit.
P	Trustee Fees	Industry standard.
Q	Credits Sold	No preservation credits. Total of 3.59 enhancement credits available in Year 6. Remainder available by Year 8. When available, credit sales conservatively estimated at 10/year.
R	Credit Price	Herbaceous credit prices in adjacent basins are currently Braden River $100,000 and Myakka $90,000. Southern Coastal land values generally higher and credits will not be sold for several years. Assume credit price will be $115,000

Table 2- West Pinelands Pro Forma (Page 1)

ASSESSMENT AREA	MITIGATION AREA (acres)	SCORE: LOCATION AND LANDSCAPE				SCORE: WATER ENVIRONMENT				SCORE: COMMUNITY STRUCTURE				BASELINE	WITHOUT PRESERVATION	WITH PRESERVATION	PRESERVE DELTA	P - FACTOR	Time Lag	Risk	PRESERVATION RFG	PRESERVE CREDIT	WITH ENHANCEMENT	ENHANCEMENT DELTA	Time Lag	Risk	ENHANCEMENT RFG	ENHANCEMENT CREDIT	Total Potential Credits
		BASE LINE	W/O PRES	WITH PRES	WITH MIT	BASE LINE	W/O PRES	WITH PRES	WITH MIT	BASE LINE	W/O PRES	WITH PRES	WITH MIT																
Wetland Enhancement																													
Wetland 7	11.33	6	5	6	7	4	4	4	8	5	4	5	8	0.50	0.43	0.50	0.07	0.50	1.00	1.25	0.03	0.30	0.77	0.27	1.14	1.75	0.13	1.51	1.82
Wetland 8	0.16	6	0	6	7	4	0	4	8	4	0	4	8	0.47	0.00	0.47	0.47	0.60	1.00	1.25	0.22	0.04	0.77	0.30	1.14	1.75	0.15	0.02	0.06
Wetland 9	1.94	6	5	6	7	5	5	5	8	6	4	6	8	0.57	0.47	0.57	0.10	0.50	1.00	1.25	0.04	0.08	0.77	0.20	1.14	1.75	0.10	0.19	0.27
Wetland 11	3.26	7	4	7	7	7	7	7	8	7	4	7	8	0.70	0.50	0.70	0.20	0.50	1.00	1.25	0.08	0.26	0.77	0.07	1.14	1.75	0.03	0.11	0.37
Wetland 12	0.46	7	0	7	7	6	0	6	8	6	0	6	8	0.63	0.00	0.63	0.63	0.60	1.00	1.25	0.30	0.14	0.77	0.13	1.14	1.75	0.07	0.03	0.17
Wetland 13	0.24	7	0	7	7	6	0	6	8	6	0	6	8	0.63	0.00	0.63	0.63	0.60	1.00	1.25	0.30	0.07	0.77	0.13	1.14	1.75	0.07	0.02	0.09
Wetland 14	2.71	6	4	6	7	4	4	4	8	5	4	5	8	0.50	0.40	0.50	0.10	0.60	1.00	1.25	0.05	0.13	0.77	0.27	1.14	1.75	0.13	0.36	0.49
Wetland 15	0.57	6	4	6	7	4	4	4	8	2	2	2	8	0.40	0.33	0.40	0.07	0.60	1.00	1.25	0.03	0.02	0.77	0.37	1.14	1.75	0.18	0.10	0.12
Subtotal	20.67																					1.04						2.36	3.39
Wetland Restoration																													
Wetlands 7-13 and 15	9.25	0	0	0	7	0	0	0	7	0	0	0	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.70	1.14	2.00	0.31	2.84	2.84
Native Uplands																													
UP-1	44.96	5	0	5	6	NA	NA	NA	NA	5	0	5	9	0.50	0.00	0.50	0.50	0.80	1.00	1.25	0.32	14.39	0.75	0.25	1.07	1.50	0.16	7.00	21.39
UP-2	35.64	7	0	7	7	NA	NA	NA	NA	7	0	7	9	0.70	0.00	0.70	0.70	0.40	1.00	1.25	0.22	7.98	0.80	0.10	1.07	1.50	0.06	2.22	10.20
Subtotal	80.60																					22.37						9.22	31.59
Total UMAM	**110.52**																					**23.41**						**14.42**	**37.83**
Mesic Hammock	79.82																												19.96

Table 3 – Albritton, Alternative 2 UMAM Credit Assessment

Note	Expenses	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
A	Project Management	$ 31,200	$ 31,200	$ 31,200					$ 93,600
B	Survey	$ 11,000	$ 11,000	$ 11,000					$ 33,000
C	Environmental Permitting	$ 100,000	$ 100,000						$ 200,000
D	Environmental Oversight			$ 15,300					$ 15,300
E	Engineering	$ 40,000	$ 40,000						$ 80,000
F	As-Built Certification			$ 15,000					$ 15,000
G	Road Removal/Ditch Backfill			$ 36,000					$ 36,000
H	Maintenance			$ 108,000	$ 64,800	$ 43,200	$ 43,200	$ 43,200	$ 302,400
I	Planting			$ 263,730					$ 263,730
J	Miscellaneous Costs			$ 9,500					$ 9,500
K	Monitoring			$ 28,000	$ 14,000	$ 14,000	$ 14,000	$ 14,000	$ 84,000
L	Fencing and Security			$ 12,000					$ 12,000
M	Legal/Accounting	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 70,000
N	Management/Marketing	$ -	$ -	$ 80,500	$ 80,500	$ 40,250	$ 40,250	$ 63,032	$ 304,532
O	Trust Fund Escrow	$ -	$ -	$ 105,430	$ 105,430	$ 52,715	$ 52,715	$ 82,552	$ 398,842
P	Trustee Fees	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 14,000
	Subtotal	$ 194,200	$ 194,200	$ 727,660	$ 276,730	$ 162,165	$ 162,165	$ 214,783	$ 1,931,903
	Revenue								
Q	Credits Sold	0.00	0.00	10.00	10.00	5.00	5.00	7.83	37.83
R	Credit Price	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	
	Gross Revenue	$ -	$ -	$ 1,150,000	$ 1,150,000	$ 575,000	$ 575,000	$ 900,450	$ 4,350,450
	Total Net Revenue	$ (194,200)	$ (194,200)	$ 422,340	$ 873,270	$ 412,835	$ 412,835	$ 685,667	$ 2,418,547
	NPV	$1,656,285.49							
	Discount Rate	7%							

Table 4 – Albritton, Alternative 2 Pro Forma (Page 1)

A	Project Management	Management of all schedules, deliverables, billing, etc. Estimate based on a bill rate of $150/hour, 4 hours per week, Years 1 - 3 through implementation = $150 x 4 hrs/week x 52 weeks = $31,200/year
B	Survey	Survey SHWL elevations, establish benchmarks, conservation easement description, as-builts. Estimate based on 15 field days @$1,500/day and 10 office days @$800/day plus expenses of $2,500. Total approx. $33,000 over first 3 years.
C	Environmental Permitting	Low to moderate complexity, approximately 2 years. Estimate $200,000 based on previous projects.
D	Environmental Oversight	Oversee reservoir construction near wetlands, oversee road removal/ditch backfill, inspect erosion control. Biologist @$85/hour on site 6 hours/day intermittently through construction (30 days total) = $15, 300
E	Engineering Design and Permitting	Most issues resolved with reservoir design. Provide ERP support, model water levels, reservoir drawdown, prove wetland hydroperiods will be improved and maintained. Provide plan set and engineers report. Estimate $80,000.
F	As-Built Certification	Engineer's certification that ditching is removed and topography re-established at grade. Estimate $15,000.
G	Ditch Backfill/Grading	Push trails and spoil into ditch to create shallow spreader swales. Estimate based on previous projects. Excavator and bulldozer, $1,500 /day each x 12 days $36,000.
H	Maintenance	Maintenance of nuisance/exotic vegetation estimated at $2,700/crew day. Year 3 : Initial 10 days plus five 6-day events ($108,000). Year 4: six 4-day events ($64,800). Years 5-7: quarterly 4-day events ($43,200), Year 8 and beyond: quarterly 2-day events($21,600).
I	Planting	Assume supplemental planting required in 50% of wetland area (15 acres x 4,840 units x $0.75/unit = $54,450). Assume supplemental groundcover (10' on-center) required in 25% of uplands (40 acres x 436 units x $1 2= $209,280).
J	Miscellaneous Costs	Monitoring wells (6@$1,500), transect markers ($500) = $9,500.
K	Monitoring	Semi-annual monitoring for 5 years, baseline and completion report in Year 3 for a total 12 events at $7,000/event. Year 3 = $28,000, Years 4-7 = $14,000. $2,400/year after success.
L	Fencing and Security	Estimate based on industry standards at $2.00 per linear foot of perimeter. Security will likely be resolved with reservoir, but estimate 6,000 feet of perimeter on south and northeast sections as a placeholder ($12,000).
M	Legal/Accounting	Legal review of conservation easement, title insurance, trust fund documents, federal legal documents, etc. Banking, expense tracking, government reporting. Estimate $10,000 per year average.
N	Management/Marketing	Promotion of credits, advertising, sales expenses, credit ledger adjustments, record keeping, agency reporting, etc. 7% of sales is typical.
O	Trust Fund Escrow	Annual maintenance, monitoring, and reporting estimated at $24,000/yr requiring escrow amount of $400,000.@ 6%. Paid from credit sales at $10,574 per credit.
P	Trustee Fees	Industry standard.
Q	Credits Sold	Limited by available credits. Total of 23 preservation credits available in Years 3-4. Progressive success releases over following 3 years.
R	Credit Price	Herbaceous credit prices in adjacent basins are currently Braden River $100,000 and Myakka $90,000. Southern Coastal land values generally higher and credits will not be sold for several years. Assume credit price will be $115,000.

Table 4 – Albritton, Alternative 2 Pro Forma (Page 2)

ASSESSMENT AREA	MITIGATION AREA (acres)	SCORE: LOCATION AND LANDSCAPE				SCORE: WATER ENVIRONMENT				SCORE: COMMUNITY STRUCTURE				BASELINE	WITHOUT PRESERVATION	WITH PRESERVATION	PRESERVE DELTA	P - FACTOR	Time Lag	Risk	PRESERVATION RFG	PRESERVE CREDIT	WITH ENHANCEMENT	ENHANCEMENT DELTA	Time Lag	Risk	ENHANCEMENT RFG	ENHANCEMENT CREDIT	Total Potential Credits
		BASE LINE	W/O PRES	WITH PRES	WITH MIT	BASE LINE	W/O PRES	WITH PRES	WITH MIT	BASE LINE	W/O PRES	WITH PRES	WITH MIT																
Wetland Enhancement																													
Wetland 4	0.98	6	4	6	8	5	5	5	8	5	4	5	8	0.53	0.43	0.53	0.10	0.50	1.00	1.25	0.04	0.04	0.80	0.27	1.14	1.75	0.13	0.13	0.17
Wetland 5	0.58	6	4	6	8	5	5	5	8	5	4	5	8	0.53	0.43	0.53	0.10	0.60	1.00	1.25	0.05	0.03	0.80	0.27	1.14	1.75	0.13	0.08	0.11
Wetland 7	11.33	6	5	6	8	4	4	4	8	5	4	5	8	0.50	0.43	0.50	0.07	0.50	1.00	1.25	0.03	0.30	0.80	0.30	1.14	1.75	0.15	1.70	2.01
Wetland 8	0.16	6	0	6	8	4	0	4	8	4	0	4	8	0.47	0.00	0.47	0.47	0.60	1.00	1.25	0.22	0.04	0.80	0.33	1.14	1.75	0.17	0.03	0.06
Wetland 9	1.94	6	5	6	8	5	5	5	8	6	4	6	8	0.57	0.47	0.57	0.10	0.50	1.00	1.25	0.04	0.08	0.80	0.23	1.14	1.75	0.12	0.23	0.30
Subtotal	14.99																					0.48						2.17	2.65
Wetland Restoration																													
Wetlands 7-9 and WR	30.98	0	0	0	8	0	0	0	7	0	0	0	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.73	1.14	2.00	0.32	9.96	9.96
Wetland Creation																													
MC	104.34	0	0	0	7	0	0	0	7	0	0	0	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.70	1.14	2.50	0.25	25.63	25.63
Native Uplands																													
UP-1	1.33	5	0	5	8	NA	NA	NA	NA	5	0	5	9	0.50	0.00	0.50	0.50	0.80	1.00	1.25	0.32	0.43	0.85	0.35	1.07	1.50	0.22	0.29	0.72
UP-2	36.92	7	0	7	8	NA	NA	NA	NA	7	0	7	9	0.70	0.00	0.70	0.70	0.80	1.00	1.25	0.45	16.54	0.85	0.15	1.07	1.50	0.09	3.45	19.99
Buffer Zones	11.74	0	0	0	7	NA	NA	NA	NA	0	0	0	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.70	1.25	2.00	0.28	3.29	3.29
Subtotal	49.99																					16.97						7.03	23.99
Total UMAM	**200.30**																					**17.45**						**44.79**	**62.23**
Mesic Hammock	62.77																												15.69

Table 5 – Albritton, Alternative 3 UMAM Credit Assessment

Note	Expenses	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
A	Project Management	$ 46,800	$ 46,800	$ 46,800								$ 140,400
B	Survey	$ 32,000	$ 32,000	$ 32,000								$ 96,000
C	Environmental Permitting	$ 175,000	$ 175,000									$ 350,000
D	Environmental Oversight			$ 61,200								$ 61,200
E	Engineering	$ 100,000	$ 100,000									$ 200,000
F	As-Built Certification			$ 30,000								$ 30,000
G	Construction			$ 2,374,440								$ 2,374,440
H	Maintenance			$ 216,000	$ 129,600	$ 129,600	$ 129,600	$ 129,600	$ 64,800	$ 64,800	$ 64,800	$ 928,800
I	Planting			$ 881,060								$ 881,060
J	Miscellaneous Costs			$ 20,000								$ 20,000
K	Monitoring			$ 48,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 24,000	$ 3,000	$ 3,000	$ 174,000
L	Fencing and Security			$ 18,000								$ 18,000
M	Legal/Accounting	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 100,000
N	Management/Marketing	$ -	$ -	$ 80,500	$ 59,973	$ -	$ 30,107	$ 80,500	$ 80,500	$ 80,500	$ 88,872	$ 500,952
O	Trust Fund Escrow	$ -	$ -	$ 181,580	$ 135,277	$ -	$ 67,911	$ 181,580	$ 181,580	$ 181,580	$ 200,464	$ 1,129,972
P	Trustee Fees	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 20,000
	Subtotal	$ 365,800	$ 365,800	$ 4,001,580	$ 360,850	$ 165,600	$ 263,618	$ 427,680	$ 362,880	$ 341,880	$ 369,136	$ 7,024,824
	Revenue											
Q	UMAM Credits Sold	0.00	0.00	10.00	7.45	0.00	3.74	10.00	10.00	10.00	11.04	62.23
R	UMAM Credit Price	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000	
	UMAM Credit Gross Revenue	$ -	$ -	$ 1,150,000	$ 856,750	$ -	$ 430,100	$ 1,150,000	$ 1,150,000	$ 1,150,000	$ 1,269,600	$ 7,156,450
	Total Net Revenue	$ (365,800)	$ (365,800)	$(2,851,580)	$ 495,900	$ (165,600)	$ 166,482	$ 722,320	$ 787,120	$ 808,120	$ 900,464	$ 131,626
	NPV	($812,678.77)										
	Discount Rate	7%										

Table 6 – Albritton, Alternative 3 Pro Forma (Page 1)

A	Project Management	Management of all schedules, deliverables, billing, etc. Estimate based on a bill rate of $150/hour, 6 hours per week, Years 1 -3 through implementation = $150 x 6 hrs/week x 52 weeks = $46,800/year
B	Survey	Survey SHWL elevations, establish benchmarks, conservation easement description, as-builts. Estimate based on 45 field days @$1,500/day and 25 office days @$800/day plus expenses of $8,000. Total approx. $32,000 per year over first 3 years.
C	Environmental Permitting	Moderate complexity, approximately 2 years. Estimate $350,000 based on previous projects.
D	Environmental Oversight	Oversee wetland creation, sideslopes, road removal/ditch backfill, planting, and inspect erosion control. Biologist @$85/hour on site 8 hours/day through construction (90 days total) = $61,200
E	Engineering Design and Permitting	Design considered in reservoir permitting, provide ERP support, model water levels, reservoir drawdown, prove all wetland hydroperiods will be improved and maintained. Provide plan set and engineers report. Estimate $200,000.
F	As-Built Certification	Engineer's certification that creation area, berms, control structures, and ditch removal is performed correctly. Estimate $30,000.
G	Construction	1) Clear creation area (MC): 104 ac. X $1,500/ac. = $156,000. 2) Excavate MC avg. of 3 ft. = 104 ac. X 3 ft. = 503,360 cy. X $4/cy. = $2,013,440. 3) Dress sideslopes and transitional areas, back fill ditches = 30 days @ $1,500/day = $45,000. 4) Install discharge structures = 20 days @$3,000/day = $60,000. Hardened discharge structure budget $100,000.
H	Maintenance	Maintenance of nuisance/exotic vegetation estimated at $2,700/crew day. Year 3 : Eight 10-day events ($216,000). Year 4-7: six 8-day events ($129,600). Year 8 and beyond: quarterly 6-day events($64,800).
I	Planting	Assume supp. planting required in 50% of existing wetland area (12 ac x 4,840 units @ $0.75/unit = $43,560). Plant MC and WR (130ac.) = $471,900. Assume supp. groundcover (10' on-center) planted in 25% of uplands (25 ac. x 436 units x $12= $130,800). Plant buffer sideslope @ $20,000/ac. = $234,800.
J	Miscellaneous Costs	Monitoring wells (12@$1,500 = $18,000), transect markers ($2000) = $20,000
K	Monitoring	Semi-annual monitoring for 5 years, baseline and completion report in Year 3 for a total 12 events at $12,000/event. Year 3 = $48,000, Years 4-7 = $24,000. After success, $3,000/year.
L	Fencing and Security	Estimate based on industry standards at $2.00 per linear foot of perimeter. Security will likely be resolved with reservoir, but estimate 9,000 feet of perimeter on south and eas sections as a placeholder ($18,000).
M	Legal/Accounting	Legal review of conservation easement, title insurance, trust fund documents, federal legal documents, etc. Banking, expense tracking, government reporting. Estimate $10,000 per year average.
N	Management/Marketing	Promotion of credits, advertising, sales expenses, credit ledger adjustments, record keeping, agency reporting, etc. 7% of sales is typical.
O	Trust Fund Escrow	Annual maintenance, monitroing, and reporting estimated at $67,800/yr requiring escrow amount of $1,130,000 @6%. Paid from credit sales at $18,158 per credit.
P	Trustee Fees	Industry standard.
Q	Credits Sold	Limited by available credits. Total of 17.45 preservation credits available in Years 3-4. Progressive success releases in years 5-8. When available, credit sales conservatively estimated at 10/year.
R	Credit Price	Herbaceous credit prices in adjacent basins are currently Braden River $100,000 and Myakka $90,000. Southern Coastal land values generally higher and credits will not be sold for several years. Assume credit price will be $115,000.

Table 6 – Albritton, Alternative 3 Pro Forma (Page 2)

TM 4.1.5 – ALTERNATIVE IMPACT ANALYSIS (BRA)

1.0 BACKGROUND

Sarasota County, in cooperation with the Peace River Manasota Regional Water Supply Authority and the Southwest Florida Water Management District (SWFWMD), are currently completing the necessary, pre-requisite data collection and analysis as well as the Comprehensive Watershed Management Plan for the Dona Bay Watershed. Kimley-Horn and Associates, Inc. (KHA), PBS&J, Biological Research Associates (BRA), EarthBalance, and Mote Marine Laboratory have been contracted by Sarasota County Government (SCG), with funding assistance from the SWFWMD, to prepare the Dona Bay Watershed Management Plan (DBWMP).

This regional initiative promotes and furthers the implementation of the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation Management Plan, SWFWMD's Southern Coastal Watershed Comprehensive Watershed Management Plan, and the Sarasota County's Comprehensive Plan. Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan for the Dona Bay watershed that will address the following general objectives:

a. Provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay.
b. Provide a more natural freshwater flow regime pattern for the Dona Bay watershed.
c. Protect existing and future property owners from flood damage.
d. Protect existing water quality.
e. Develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

This Technical Memorandum has been prepared by BRA to rank and prioritize the assessed tracts based on project cost benefit and overall enhancement to water resources subsequent to restoration, to present a table comparing existing and proposed natural system conditions within the freshwater segment of the watershed, to summarize the natural system improvements or degradation that would occur as a result of implementing any of the alternatives, and to describe the permitting issues/constraints related to each alternative, consistent with Task 4.1.5 of the DBWMP contract.

2.0 ANALYSES

2.1 Introduction

BRA used the results of the extensive field and database evaluations to rank the mitigation alternatives for each of four (4) publicly-owned tracts included within the Dona Bay Watershed Plan [Albritton (AL), West Pinelands (WP), the Myakka Connector (MC), and Venice Minerals (VM)]. To assess potential mitigation scenarios and opportunities, the approximate, historical wetland limits were superimposed over the current wetland limits to graphically evaluate how their extent had changed in the last 60 years. The difference in the acreages was used as a baseline to determine the cost and benefit of restoring and/or enhancing the site to its historical condition to the extent practicable. Assuming that additional property will not have to be purchased, the cost per acre for wetland creation is estimated to be $60,000. The scoring/ranking of these alternatives assumes an appropriate hydrologic regime.

The rankings are based on a cost-benefit analysis of each alternative. For the **Environmental Cost Ranking**, a "low" ranking is based on the highest mitigation cost per acre; for the **Environmental Benefit Ranking**, a "low" ranking is for a lowest onsite environmental benefit; and for the **Environmental Overall Ranking**, a "low" ranking is the least desirable option. Table 1 is a ranking summary of all the tracts included within this evaluation.

Site	Alt.	Environmental Cost Ranking	Environmental Benefit Ranking	Environmental Overall Ranking	Notes
AL	1	Medium	low	medium	Impacts hammock
AL	2	Low	medium	low	Enhances most wetlands
AL	3	High	high	high	Impacts ½ hammock, restores 113 acres
AL	4	Medium	low	medium	Impacts hammock
WP	1	Medium	high	high	Enhances all wetlands, restores 221 acres
WP	2	Low	medium	low	Enhances all wetlands
WP	3	High	low	medium	Impacts all wetlands
MC	1	Medium	high	high	Enhances all wetlands, restores 171 acres
MC	2	Low	medium	low	Enhances all wetlands
MC	3	High	low	medium	No action
VM	1	Medium		high*	Impacts all wetlands
VM	2	Low		medium*	Impacts lowest quality wetlands
VM	3	High		low*	Preserves all wetlands

Table 1 - Environmental Cost-Benefit Analysis Ranking by Parcel
*Overall ranking based on KHA analysis, including water supply benefits

The remainder of this report is a detailed description of each alternative and the factors used in the cost and benefit analyses of each.

2.1.1 Albritton Site

The Albritton alternatives analysis is based on the four (4) alternatives provided by Post, Buckley, Schuh & Jernigan, Inc. (PBSJ):

- Alternative 1 (refer to Figure 1) proposes impact to all the onsite wetlands, except Wetlands 5 and 16, and 10.84 acres of wetland restoration.

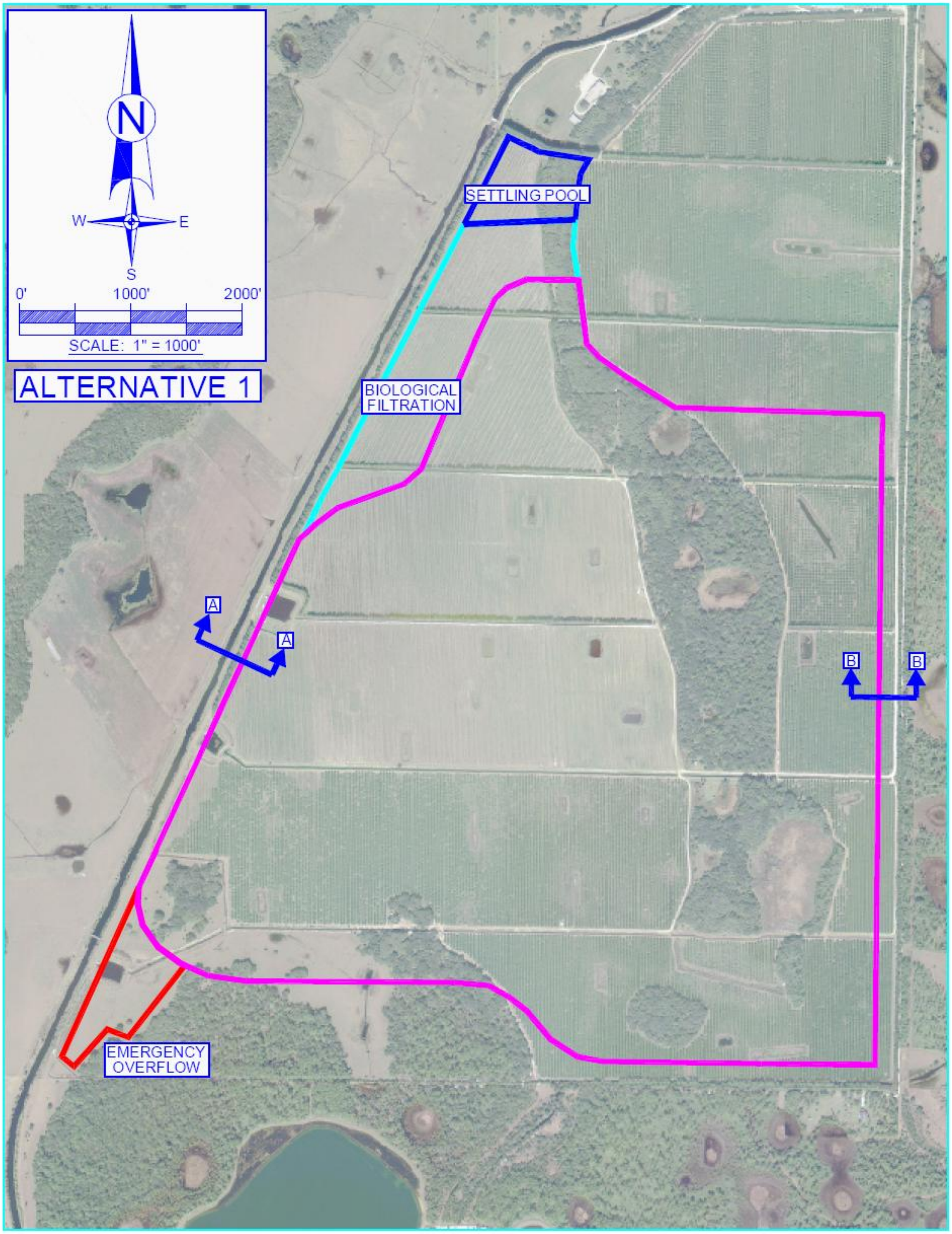


Figure 1 – Albritton, Alternative 1

- Alternative 2 (refer to Figure 2) proposes impacts to Wetland 4 only, enhancement to all the non-impacted wetlands, and the restoration of 10.84 acres of wetland along the southern property boundary.

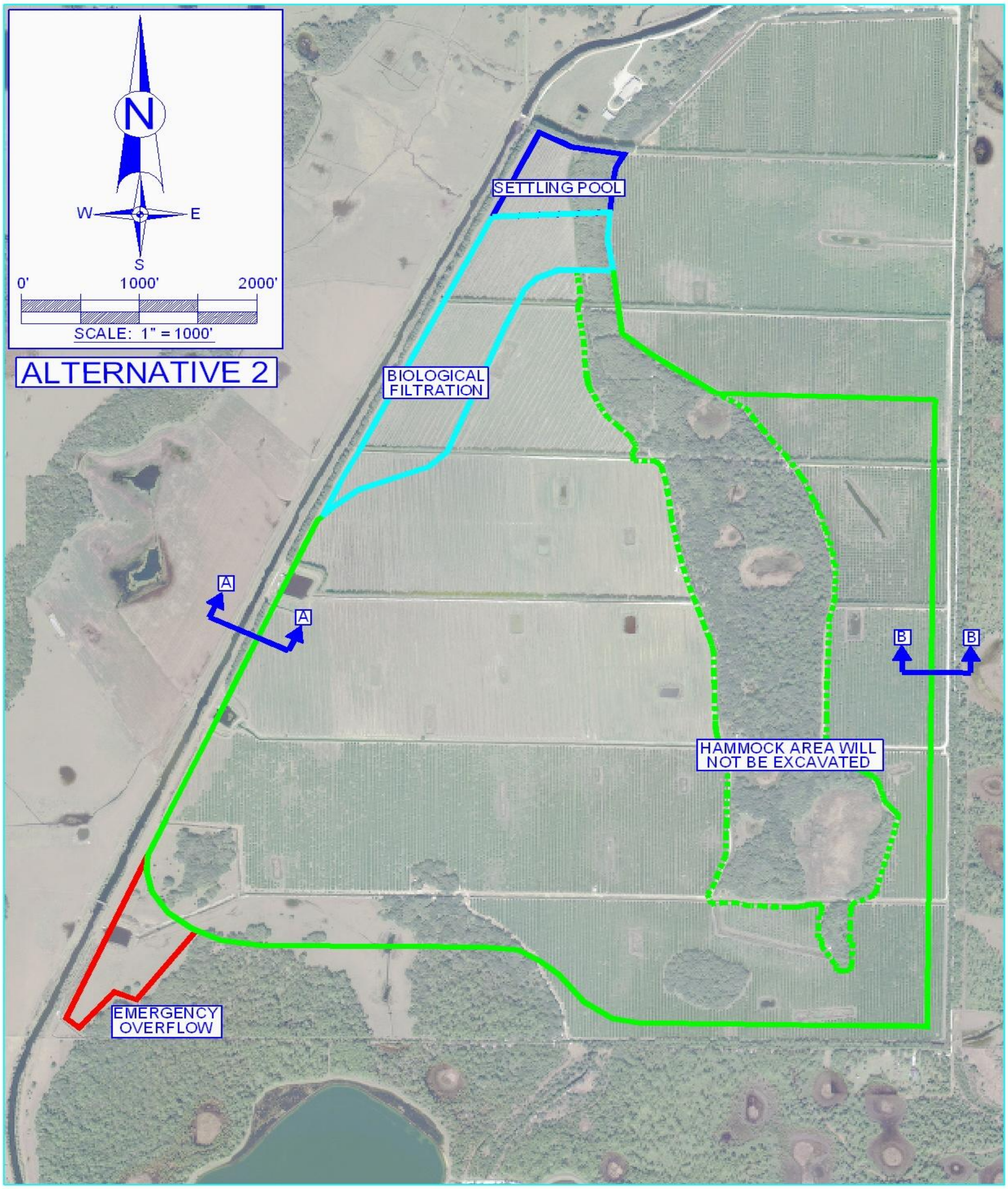


Figure 2 – Albritton, Alternative 2

- Alternative 3 (refer to Figure 3) proposes impact to Wetlands 11, 12, 13, 14 and 15, enhancement of Wetlands 4, 5, 7, 8, 9 and 16, and the restoration of 113.1 acres of wetland.

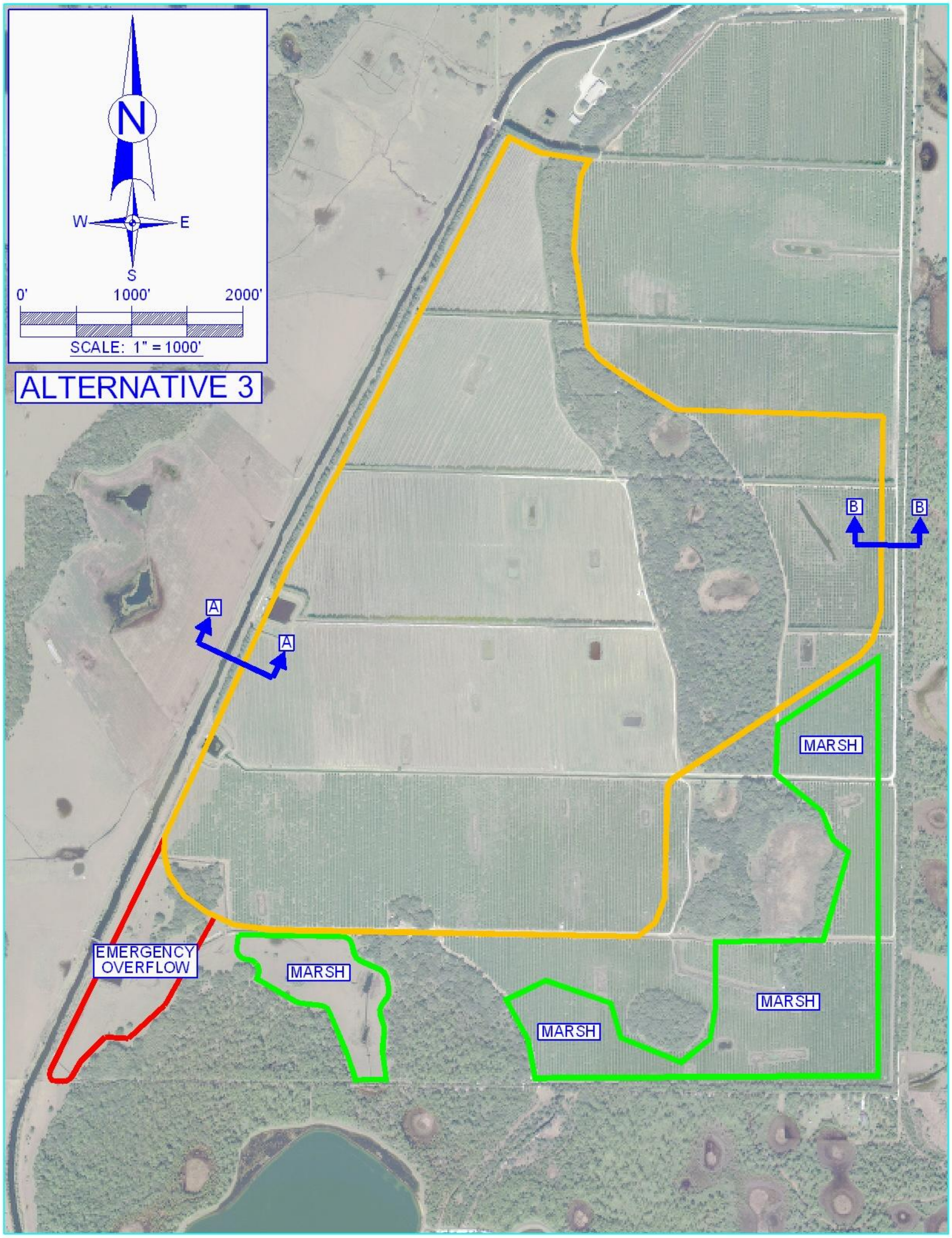


Figure 3 – Albritton, Alternative 3

- Alternative 4 (refer to Figure 4) is environmentally identical to Alternative 1.

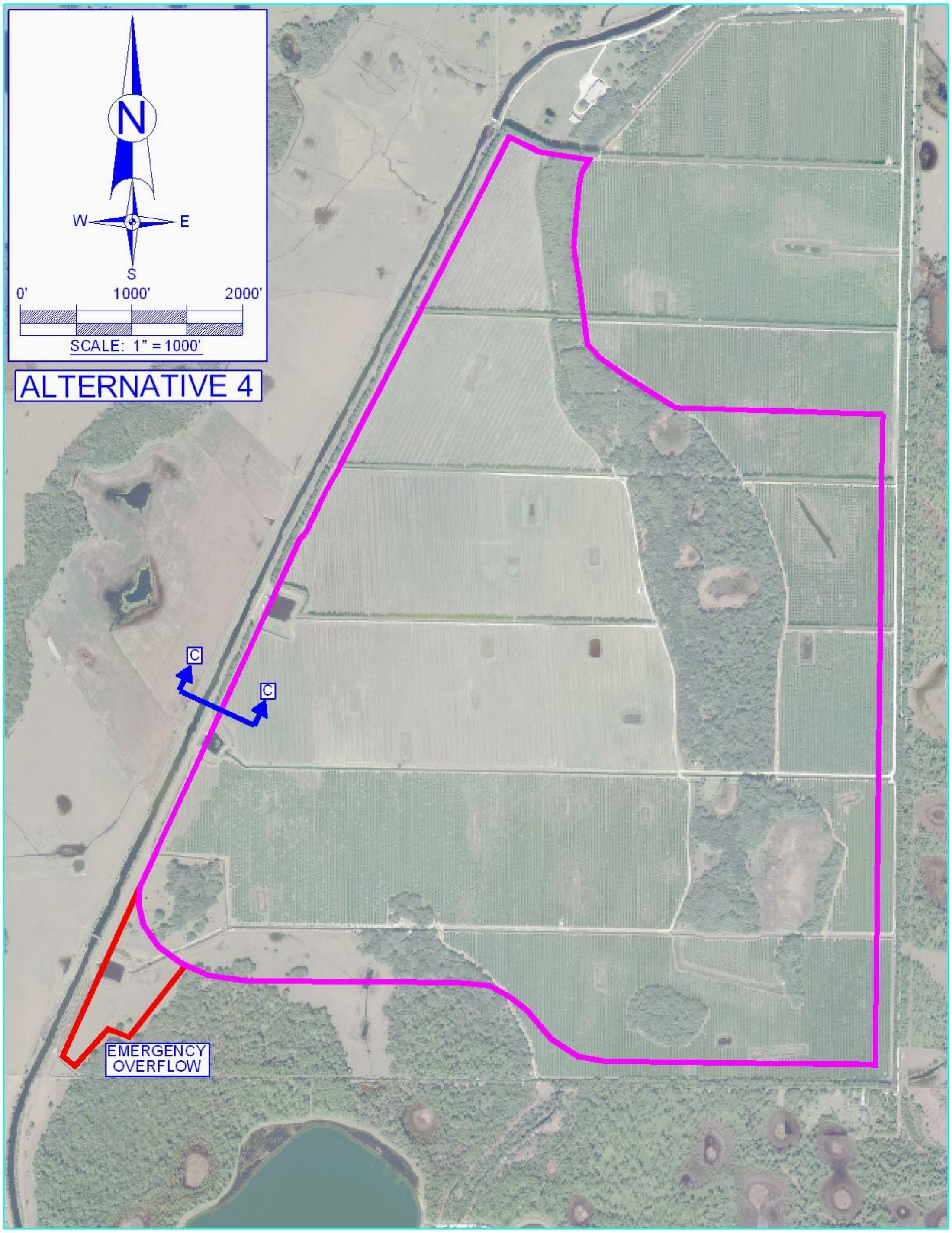


Figure 4 – Albritton, Alternative 4

Table 2 summarizes the environmental rankings associated with each alternative for the Albritton site.

Alt.	Alternative Detail	Environmental Cost Ranking	Environmental Benefit Ranking	Environmental Overall Ranking
1	Impact nine wetlands; restore 10.84 acres	medium ($226,177)	low	medium
2	Impact one wetland; enhance ten wetlands; restore 10.84 acres	low ($229,879)	medium	low
3	Impact five wetlands; enhance six wetlands; restore 113.1 acres	high ($166,434)	high	high
4	Impact nine wetlands; restore 10.84 acres	medium ($226,177)	low	medium

Table 2 - Albritton Alternatives Ranking

Based solely on the estimated cost of mitigation per unit of loss or gain (Environmental Cost), the alternatives would be ranked in the following order:

1. Alternative 3
2. Alternatives 1/4
3. Alternative 2

However, based solely on the Environmental Benefit associated with the functional gain, which could be banked and used as mitigation for future Sarasota County projects, achieved by each alternative, the alternatives be ranked as follows:

1. Alternative 3
2. Alternative 2
3. Alternatives 1/4

A final ranking was determined by using an equal weighting of Environmental Cost and Environmental Benefit as follows:

1. Alternative 3
2. Alternatives 1/4
3. Alternative 2

Wetland	Wetland Acreage	Functional Loss Units [1]	Functional Gain Units*	Alt 1	Alt 2	Alt 3	Alt 4
4	0.76	(0.40)	0.16	(0.40)	(0.40)	0.16	(0.40)
5	0.43	(0.23)	0.09	0.09	0.09	0.09	0.09
7	11.93	(5.97)	2.86	(5.97)	2.86	2.86	(5.97)
8	0.01	(0.01)	0.00	(0.01)	0.00	0.00	(0.01)
9	2.51	(1.42)	0.47	(1.42)	0.47	0.47	(1.42)
11	4.17	(2.92)	0.33	(2.92)	0.33	(2.92)	(2.92)
12	0.90	(0.57)	0.12	(0.57)	0.12	(0.57)	(0.57)
13	0.42	(0.27)	0.06	(0.27)	0.06	(0.27)	(0.27)
14	2.72	(1.36)	0.65	(1.36)	0.65	(1.36)	(1.36)
15	0.79	(0.32)	0.25	(0.32)	0.25	(0.32)	(0.32)
16	0.03	(0.01)	0.01	0.01	0.01	0.01	0.01
Wetland Restoration				4.63	4.63	48.26	4.63
Total (FL)[2] Or FG[3]		**(13.48)**		**(8.51)**	**9.07**	**46.41**	**(8.51)**
Total Est. Mitigation Acreage				19.79			19.79
Total Est. Cost**				$1,246,770+ $678,000= $1,924,770	$2,085,000	$7,724,400	$1,246,770+ $678,000= $1,924,770
Cost Per Functional Unit***				$226,177	$229,879	$166,434	$226,177

Table 3 – Albritton Site UMAM Functional Loss and Gain Units

* Based on projected UMAM scores of "8" for location/landscape, hydrology, and species composition for the value of the created mitigation area

**Total Estimated Cost = (restoration/enhancement acreage X $60,000)

***Cost per Functional Unit = Total Estimated Cost/Total FL or FG

[1] Total Functional Loss units if wetland is impacted in its entirety.

[2] Functional Loss

[3] Functional Gain

2.1.2 West Pinelands Site

The West Pinelands alternatives analysis is based upon the three (3) alternatives presented by BRA:

- Alternative 1 (refer to Figure 5) is an enhancement of all the current wetlands and the restoration of the historical floodplain limits (221.2 acres) within the project boundary.
- Alternative 2 (refer to Figure 5) is an enhancement of all the current wetlands.
- Alternative 3 is the impact to all onsite wetlands for floodplain storage.

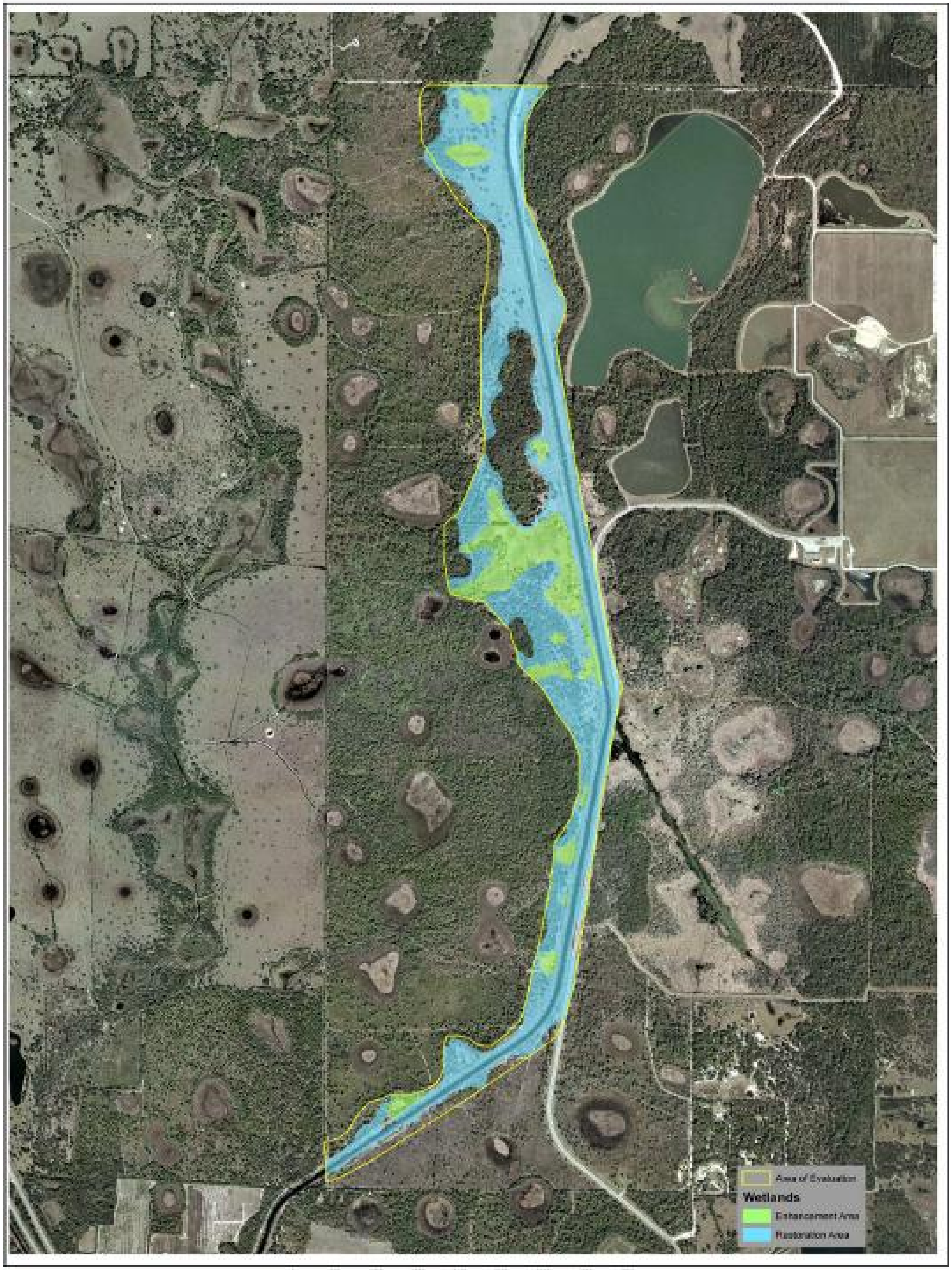


Figure 5 – West Pinelands, Alternatives 1 and 2

Table 4 summarizes the environmental rankings associated with each alternative for the West Pinelands site.

Alt.	Description	Environmental Cost Ranking	Environmental Benefit Ranking	Environmental Overall Ranking
1	Enhance all wetlands; restore 221.2 acres	medium ($170,589)	high	high
2	Enhance all wetlands	low ($799,674)	medium	low
3	Impact all wetlands	high ($146,465)	low	medium

Table 4 - West Pinelands Alternatives Ranking

Based solely on the estimated cost of mitigation per unit functional gain or loss (Environmental Cost), the alternatives would be ranked as follows:

1. Alternative 3
2. Alternative 1
3. Alternative 2

However, based solely on the Environmental Benefit associated with the functional gain, which could be banked and used for future Sarasota County projects, achieved by each alternative, the alternatives are ranked as follows:

1. Alternative 1
2. Alternative 2
3. Alternative 3

A final ranking was determined by using an equal weighting of Environmental Cost and Environmental Benefit as follows:

1. Alternative 1
2. Alternative 3
3. Alternative 2

Wetland	Wetland Acreage	Functional Loss Units[1]	Functional Gain Units*	Alt 1	Alt 2	Alt 3
1	3.40	(2.15)	0.45	0.45	0.45	(2.15)
2	3.70	(2.34)	0.49	0.49	0.49	(2.34)
3	1.40	(0.84)	0.22	0.22	0.22	(0.84)
4A	7.20	(5.28)	0.38	0.38	0.38	(5.28)
4B	31.00	(22.73)	1.65	1.65	1.65	(22.73)
5	0.80	(0.61)	0.02	0.02	0.02	(0.61)
6	3.20	(2.24)	0.26	0.26	0.26	(2.24)
7	0.60	(0.36)	0.10	0.10	0.10	(0.36)
8	1.90	(1.33)	0.15	0.15	0.15	(1.33)
9	0.31	(0.22)	0.02	0.02	0.02	(0.22)
10	1.70	(1.08)	0.23	0.23	0.23	(1.08)
12	3.10	(2.07)	0.33	0.33	0.33	(2.07)
Wetland Restoration			94.01	94.01		
Total (FL)[2] or FG[3]		**(41.25)**	**98.31**	**98.31**	**4.30**	**(41.25)**
Total BRA-estimated mitigation acreage*						95.9
Total BRA-estimated cost**				$16,770,600	$3,438,600	$6,041,700
Cost per Functional Unit***				$170,589	$799,674	$146,465

Table 5 - West Pinelands UMAM Functional Loss and Gain Units

* Based on projected UMAM scores of "8" for location/landscape, hydrology, and species composition for the value of the created mitigation area

**Total Estimated Cost = (restoration/enhancement acreage X $60,000)

***Cost per Functional Unit = Total Estimated Cost/Total FL or FG

[1] Total Functional Loss units if wetland is impacted in its entirety.

[2] Functional Loss

[3] Functional Gain

2.1.3 Myakka Connector

The Myakka Connector alternatives analysis is based upon the three (3) alternatives as follows:

- Alternative 1 (refer to Figure 6) is an enhancement of all the current wetlands and the restoration of the historical floodway limits (171.3 acres) within the project boundary. The estimated cost of enhancement/restoration is $20,000 per acre as no planting or grading is proposed, only restoration of hydrology and minimal nuisance/exotic species removal.
- Alternative 2 (refer to Figure 6) is an enhancement of all the current wetlands.
- Alternative 3 is no action.

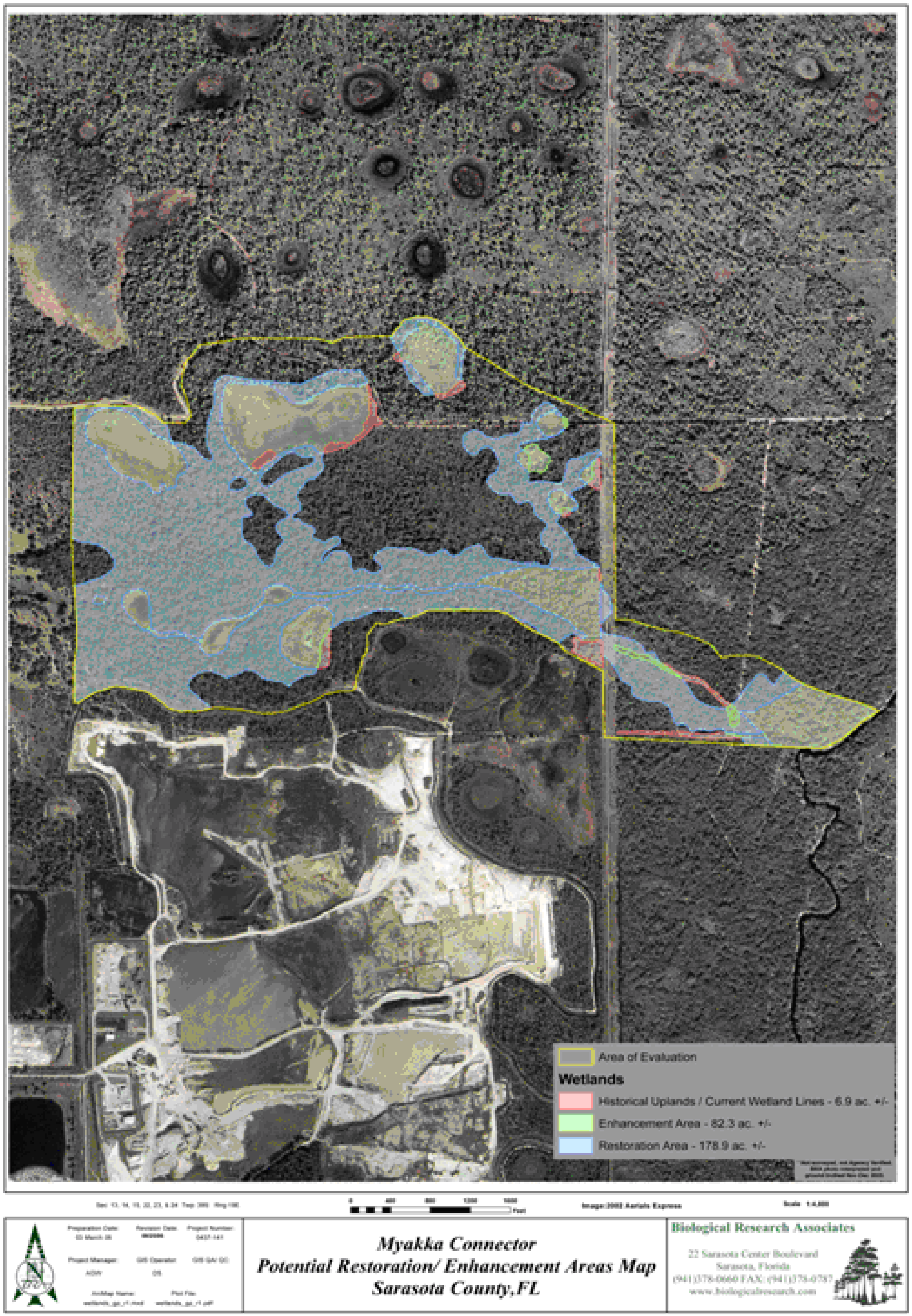


Figure 6 – Myakka Connector, Alternatives 1 and 2

Table 6 summarizes the environmental rankings associated with each alternative for the Myakka Connector site.

Alt.	Alternative Detail	Environmental Cost Ranking	Environmental Benefit Ranking	Environmental Overall Ranking
1	Enhance all wetlands; restore 171.3 acres	medium ($59,652)	high	high
2	Enhance all wetlands	low ($392,118)	medium	low
3	No action	high ($0)	low	medium

Table 6 – Myakka Connector Alternatives Ranking

Based solely on the estimated cost of mitigation per unit functional gain or loss (Environmental Cost), the alternatives would be ranked as follows:

1. Alternative 3
2. Alternative 1
3. Alternative 2

However, based solely on the Environmental Benefit associated with the functional gain, which could be banked and used for future Sarasota County projects, achieved by each alternative, the alternatives are ranked as follows:

1. Alternative 1
2. Alternative 2
3. Alternative 3

A final ranking was determined by using an equal weighting of Environmental Cost and Environmental Benefit and is provided as follows:

1. Alternative 1
2. Alternative 3
3. Alternative 2

Wetland	Wetland Acreage	Functional Loss Units[1]	Functional Gain Units*	Alt 1	Alt 2
1A	12.37	(0.72)	0.33	0.33	0.33
2A	1.30	(1.08)	0.07	0.07	0.07
3A	11.60	(9.67)	0.62	0.62	0.62
4A	22.50	(18.75)	1.20	1.20	1.20
5A	1.60	(1.33)	0.09	0.09	0.09
6A	0.40	(0.33)	0.02	0.02	0.02
7A	1.30	(1.04)	0.10	0.10	0.10
8A	14.00	(11.67)	0.75	0.75	0.75
9A	1.80	(1.56)	0.05	0.05	0.05
1B	7.20	(6.24)	0.19	0.19	0.19
2B	6.30	(5.04)	0.50	0.50	0.50
3B	3.60	(2.88)	0.29	0.29	0.29
4B	1.90	(1.52)	0.15	0.15	0.15
5B	0.20	(0.14)	0.03	0.03	0.03
Wetland Restoration			81.90	81.90	
Total (FL)[2] or FG[3]		**(61.97)**	**86.29**	**86.29**	**4.39**
Total BRA-estimated mitigation acreage*					
Total BRA-estimated cost**				$5,147,400	$1,721,400
Cost per Functional Unit***				$59,652	$392,118

Table 7 – Myakka Connector, UMAM Functional Loss and Gain Units

* Based on projected UMAM scores of "9" for location/landscape, hydrology, and species composition for the value of the created mitigation area

**Total Estimated Cost = (restoration/enhancement acreage X $60,000)

***Cost per Functional Unit = Total Estimated Cost/Total FL or FG

[1] Total Functional Loss units if wetland is impacted in its entirety.

[2] Functional Loss

[3] Functional Gain

2.1.4 Venice Minerals Site

The Venice Minerals alternatives analysis is based on the three (3) impact alternatives provided by KHA:

- Alternative 1 (refer to Figure 7) proposes to impact all of the onsite wetlands.

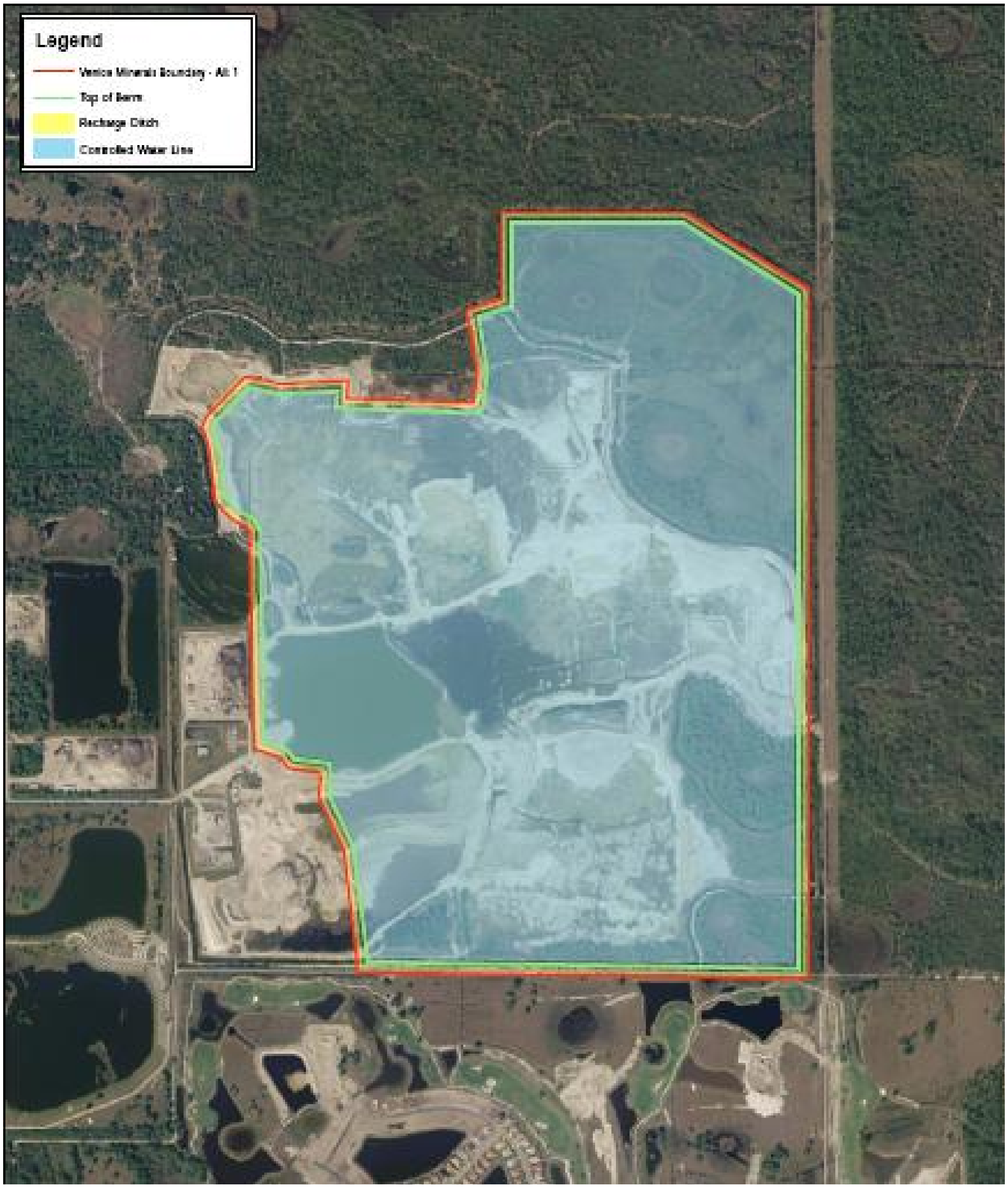
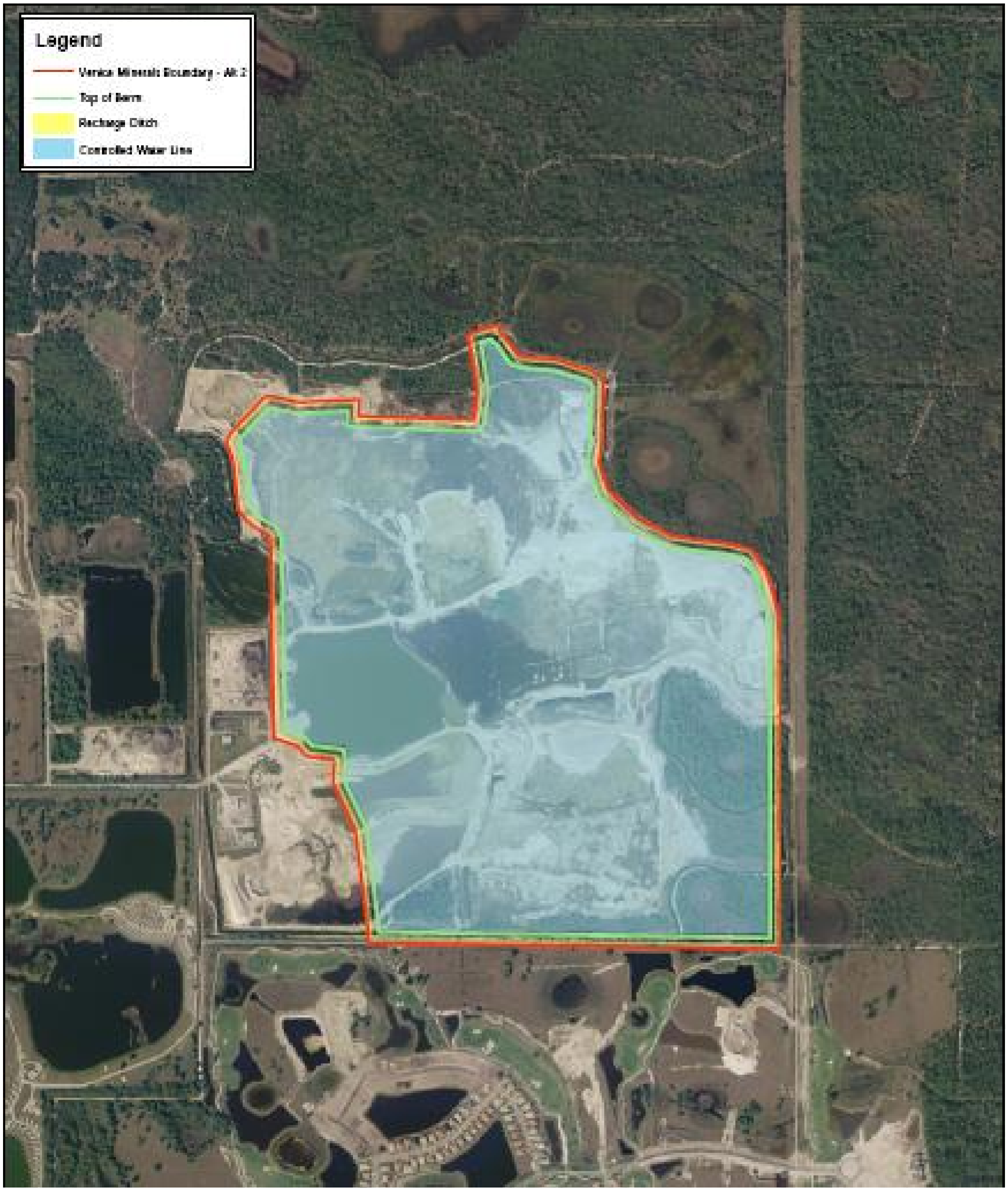


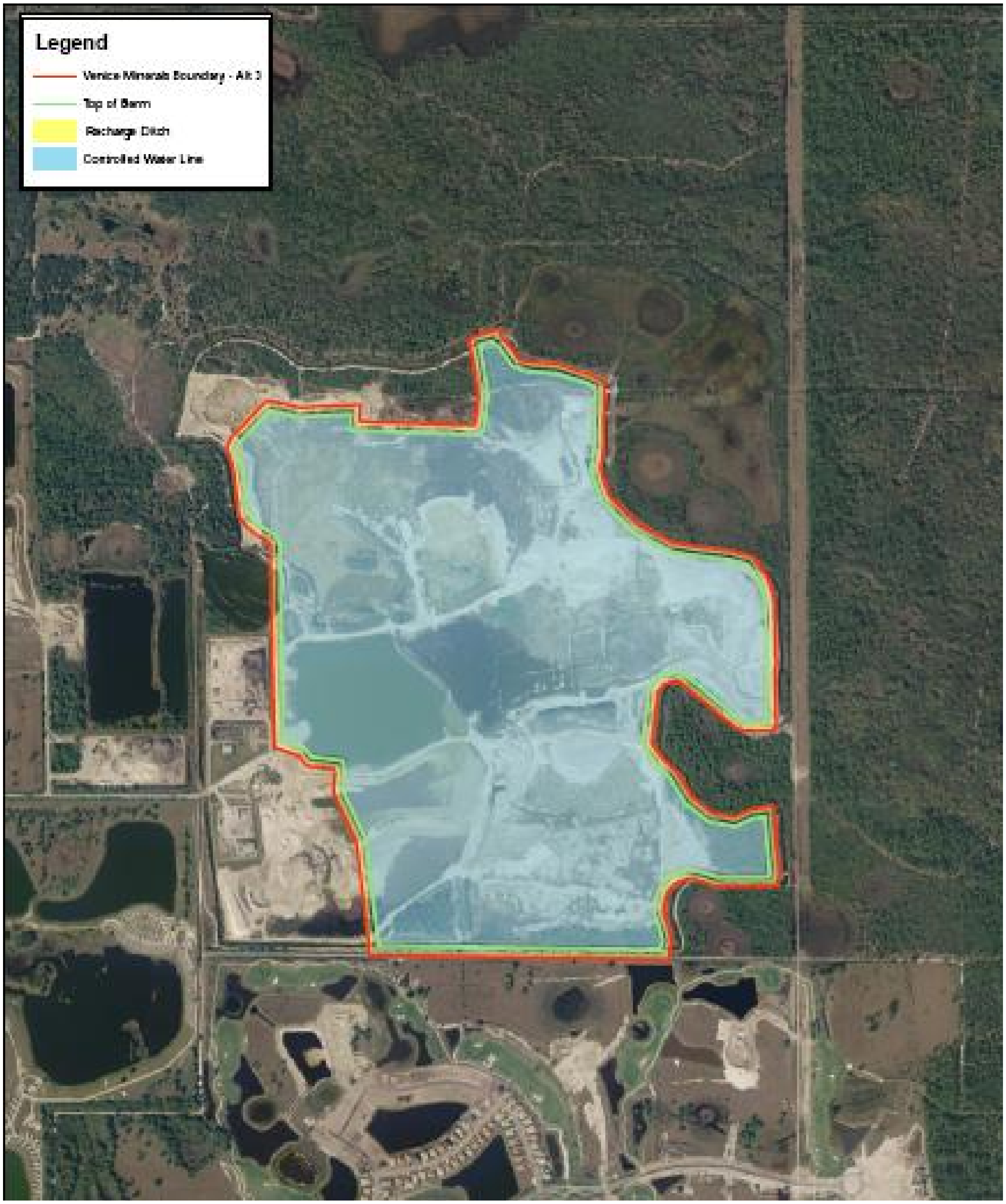
Figure 7 – Venice Minerals, Alternative 1

- Alternative 2 (refer to Figure 8) proposes to impact the four (4) southern, disturbed wetlands.



Alternative 8 – Venice Minerals, Alternative 2

- Alternative 3 (refer to Figure 9) proposes no wetland impacts.



Alternative 9 – Venice Minerals, Alternative 3

Table 8 summarizes the environmental rankings associated with each alternative for the Venice Minerals site.

Alternative	Alternative Detail	Environmental Cost Ranking	Overall Ranking
1	Impact all wetlands	medium ($148,280	low
2	Impact wetlands 1C to 4C	low ($152,069)	high
3	Impact no wetlands	high ($0)	medium

Table 8 - Venice Minerals Alternatives Ranking

Based solely on the estimated cost of mitigation per unit functional gain or loss (Environmental Cost), the alternatives would be ranked as follows:

1. Alternative 1
2. Alternative 2
3. Alternative 3

Based on Technical Memorandum 4.2.2.1 – Evaluation of Surface Storage (Venice Minerals Site), which includes a quantification of storage capacity and environmental costs, the alternatives would be ranked according to the cost/benefit analysis as follows:

1. Alternative 1
2. Alternative 2
3. Alternative 3

Wetland	Wetland Acreage	Functional Loss Units[1]	Alternative 1	Alternative 2
1A	0.68	(0.54	(0.54)	
2A	1.00	(0.80)	(0.80)	
3A	1.20	(0.96)	(0.96)	
1B	12.90	(9.89)	(9.89)	
2B	1.10	(0.88)	(0.88)	
3B	2.20	(1.76)	(1.76)	
4B	0.40	(0.29)	(0.29)	
1C	1.70	(1.13)	(1.13)	(1.13)
2C	0.20	(0.12)	(0.12)	(0.12)
3C	0.20	(0.10)	(0.10)	(0.10)
4C	0.20	(0.10)	(0.10)	(0.10)
Total (FL) [2]		**(16.57)**	**(16.57)**	**(1.45)**
Total BRA-estimated mitigation acreage*			39	3.5
Total BRA-estimated cost**			$2,457,000	$220,500
Cost per Functional Unit***			$148,280	$152,069

Table 9 - Venice Minerals UMAM Functional Loss Units

* Based on projected UMAM scores of "8" for location/landscape, hydrology, and species composition for the value of the created mitigation area

**Total Estimated Cost = (restoration/enhancement acreage X $60,000) + (creation acreage X $63,000)

***Cost per Functional Unit = Total Estimated Cost/Total FL or FG

[1] Total Functional Loss units if wetland is impacted in its entirety.

[2] Functional Loss

2.2 Conclusion

The results of the mitigation alternatives ranking for the Albritton, West Pinelnads, Myakka Connector, and Venice Mienrals sits are summarized in Table 1. However, the environmental benefit ranking is only one consideration necessary to determine the final design for each site.

This page intentionally left blank

DONA BAY WATERSHED MANAGEMENT PLAN: Salinity Targets for Watershed Management in Dona and Roberts Bays and their Tributaries

SARASOTA COUNTY – KIMLEY HORN AND ASSOCIATES
MASTER AGREEMENT FOR CONTINUING PROFESSIONAL SERVICES
TASK 3: WATERSHED GOALS
TASK 4.1.1.1: LIFE HISTORY REQUIREMENTS
TASK 4.1.1.2: OYSTER SURVEY
(INDIVIDUAL PROJECT ORDER NUMBER 1)

JULY 5, 2006

Submitted to:

MIKE JONES
SARASOTA COUNTY ENVIRONMENTAL SERVICES
2817 CATTLEMEN ROAD
SARASOTA, FLORIDA 34232

Submitted by:

E. D. ESTEVEZ
CENTER FOR COASTAL ECOLOGY
MOTE MARINE LABORATORY
1600 KEN THOMPSON PARKWAY
SARASOTA, FLORIDA 34236

MOTE MARINE LABORATORY TECHNICAL REPORT NO. 1114

INTRODUCTION

The Dona Bay Watershed Management Plan (DBWMP) is a regional initiative that promotes and furthers the implementation of the Sarasota County Comprehensive Plan, Comprehensive Conservation and Management Plans of the Sarasota Bay and Charlotte Harbor National Estuary Programs, and the Southwest Florida Water Management District's Southern Coastal Comprehensive Watershed Management Plan.

Specifically, this initiative is to plan, design, and implement a comprehensive watershed management plan and projects for the Dona Bay watershed to achieve the following general objectives: provide a more natural freshwater/saltwater regime in the tidal portions of Dona Bay; provide a more natural hydrologic regime for the Dona Bay watershed; protect existing and future property owners from flood damage; protect and/or improve existing water quality, and develop potential alternative surface water supply options that are consistent with, and support other plan objectives.

The DBWMP is being developed by a team of six organizations, including Mote Marine Laboratory, led by Kimley-Horn and Associates in coordination with Sarasota County Environmental Services. Nine tasks or phases comprise the technical elements of the DBWMP. The second technical task for Mote Marine Laboratory is contributing to the development of watershed goals for the Dona Bay watershed. This report specifically outlines a rationale and method for the use of estuarine information in the establishment of watershed goals, and provides relevant estuarine resource targets. An Appendix reports on findings of a new oyster study in Dona Bay and Shakett Creek.

In May 2006, Sarasota County authorized that the geographic scope of the Dona Bay watershed study be expanded to include Roberts Bay and Curry Creek. This report contains new information on Roberts Bay and Curry Creek and supplants Mote Marine Laboratory Technical Report No. 1090.

ENVIRONMENTAL SETTING

Not counting basin alterations and augmented stream flows, the salinity trend of the Dona and Roberts Bays (DARB) study area during the past few centuries and especially the 20th Century has been one of increase. Sea level rise, the natural opening of Midnight Pass, construction of the Intracoastal Waterway, and Venice Inlet stabilization have been working to increase the reach of tides into and influence of salt waters upon the Bay. The increased connection has influenced water levels and circulation, sedimentation, salinity, and the numbers and kinds of plants and animals inhabiting the study area. In this context the stabilization and maintenance of the inlet may be viewed as consistent with natural trends. During this period, the major source of natural variation was probably related to the incidence and severity of tropical storms and hurricanes.

Without the influence of humans, freshwater inflows would have remained the same. Although an increase in rainfall and runoff might be expected during warmer climate periods, there is no local evidence for trends in increasing rainfall in the area beyond those attributable to known cyclicity. Four principal human actions have caused freshwater inflows to increase: diversion of Cow Pen Slough from the Myakka River; inland expansion of the effective watershed of Cow Pen Slough through man-made drainage diversion; connection of Curry Creek to the Myakka River via Blackburn Canal, and transformation of natural land cover to land uses with heightened runoff in both watersheds. The timing of inflows has been changed by these practices and also by instream structures that generally suppress the local surficial water table and shorten recovery times after storm events.

Increased flows and flow rectification are significant departures from "natural" conditions insofar as the creek and bay are concerned, and have de-stabilized the marine environment. When coupled with natural and cultural forces raising salinity in DARB, the combination of increased inflows and marine effects has created a strong salinity gradient over a relatively short distance, and a local area capable of rapid, high-amplitude oscillations in salinity.

RATIONALE AND METHOD

A Valued Ecosystem Component (VEC) approach is employed to develop management targets for Dona Bay. A VEC is a population, species, community, habitat, or an ecosystem function, recognized as a natural and desirable element of a given management domain (forest, lake, estuary, etc.). Valued ecosystem components are chosen when sufficient data exist within the domain, or in other settings where data are transferable to the domain, to support the establishment of environmental targets for restoration.

By this method,

1. Valued ecosystem components are identified for DARB and their tributaries;
2. Desired spatial distributions for each VEC are determined;
3. Environmental variables that regulate VEC distributions are identified;
4. Target values for environmental variables are recommended, and
5. Historical and modern hydrological studies are made to assess the ability to achieve and/or adjust the range of target values.

This report addresses steps one through four with the expectation that each step will be refined as the DBWMP progresses. Ongoing studies by other members of the project team will contribute to these recommendations. Once target values for environmental variables are refined, their practical feasibility under various watershed and stream management scenarios can be evaluated by engineering and hydrological studies.

GEOGRAPHICAL DEFINITIONS

The Dona Bay study area is defined as extending from Venice Inlet to US 41. The Shakett Creek study area is defined as extending from US 41 to the downstream-most control structure on Cow Pen Slough. The Roberts Bay study area is defined as extending from Venice Inlet to US 41. The Curry Creek study area is defined as extending upstream from US 41 (Mike Jones, personal communication).

VALUED ECOSYSTEM COMPONENTS IDENTIFIED FOR DONA BAY

Four VECs are employed for DARB– location and size of tidal fresh waters; submerged vascular aquatic vegetation (seagrasses), the hard clam *Mercenaria campechiensis*, and the American oyster, *Crassostrea virginica*. Additional information is provided for three valued fish species common in Sarasota County waters.

DESIRED SPATIAL DISTRIBUTIONS

A. Tidal Fresh Water: Based on historical information and data from other tidal streams in southwest Florida,

> Tidal fresh waters will persist during all times, except during extended natural droughts, in Shakett Creek upstream of Fox Creek, and in Curry Creek upstream of the confluence of the historic headwaters of Curry Creek with Blackburn Canal.

B. Seagrasses: Based on their known past and modern distributions,

> *Ruppia maritima* (widgeongrass) and *Halodule wrightii* (shoalgrass) will be the principal SAV species east of US 41, in both systems. Their cover and relative abundances will alternate depending on seasonal and annual variations in stream flow and salinity, and *Halodule* may also occur west of US 41 in wet periods.

> *Syringodium filiforme* (manatee grass) and *Thalassia testudinum* (turtle grass) will be the principal submerged aquatic vegetation (SAV) species in the lower (western) reaches of Dona and Roberts Bays. Their cover and relative abundances will alternate depending on seasonal and annual variations in salinity and water clarity, and both may also occur in middle and upper DARB in dry periods.

C. Hard Clams: Based on their known past and modern distributions,

> *Mercenaria campechiensis* will persist in subtidal and low intertidal beds of *Syringodium* and *Thalassia*. Hard clams will recruit into middle DARB in dry periods.

D. Oysters: Based on their known past and modern distributions,

> *Crassostrea virginica* will persist as living oyster reefs in lower Shakett and Curry Creeks and extend as living reefs west into middle Dona and Roberts Bays.

ENVIRONMENTAL VARIABLES REGULATING DARB VECS

This report focuses on the role of salinity in regulating seagrasses, hard clams, and oysters. As findings by other team members become available the roles of hydrologic regimes, water clarity, dissolved oxygen, or other variables may be considered in addition to salinity. The following sections are adapted from Estevez (2000) and Estevez and Marshall (1993).

A. Tidal Freshwaters

Tidal fresh water reaches of coastal streams provide habitat for the larval and juvenile stages of numerous valued species, and also support a unique flora and fauna. Although the historic location of altered urban streams is often unknown, studies of relatively unaltered coastal streams have identified proxy records for the upstream extent of saltwater encroachment. Estevez, Edwards and Hayward (1991) reported that the transition of bankside soils from alluvial to tidal, as depicted in first generation USDA soil surveys, correspond to long-term surface salinity means of less than 2.0 ppt. The 1959 Soil Survey for Sarasota County depicts the upstream extent of tidal soil in Shakett Creek at a point approximately 2,000 ft upstream of its confluence with Fox Creek, leaving a relatively short and shallow reach of "Salt Creek" as usually fresh in nature. The Soil Survey depicts the upstream extent of tidal soil in Curry Creek at a point upstream of Albee Farm Road, leaving a relatively short and shallow reach of "Historic Curry Creek" as usually fresh in nature.

Surface and bottom salinity where Fox Creek enters Shakett Creek should average less than 2.0 ppt.

Surface and bottom salinity where Historic Curry Creek enters Blackburn Canal should average less than 2.0 ppt.

B. Seagrasses

Seagrasses found near Dona Bay include *Halodule wrightii*, *Thalassia testudinum*, *Syringodium filiforme*, and possibly *Ruppia maritima*. *Ruppia* is not a true marine plant but it often occurs in low salinity waters.

Using available SWFWMD aerial photography of seagrasses in the region, approximately 36% of Dona Bay's total surface area has seagrass. Compared to Roberts Bay (43% seagrass) and Lyons Bay (75% seagrass), Dona Bay has the lowest seagrass coverage of Venice inland waters.

Seagrass beds have a variety of functions within estuarine habitats (Wood et al., 1969). They are important as a structural habitat for juveniles and adults of many animal species. Seagrasses anchor sediments and slow water currents to the point at which part of the water column sediment load settles to the bottom (Ward et al., 1984). Nutrients carried by these sediments are utilized directly by the seagrass plants and indirectly by the grazers and detritus feeders within the seagrass beds. Reductions in seagrass bed coverage usually result in drastic shifts in community composition. Major seagrass losses typically change the nature of or cause large decreases in the productivity of fisheries within the affected areas (Livingston, 1987). A study in northeastern Florida Bay (Montague et al., 1989) demonstrated that seagrasses and benthic fauna were much less abundant where bottom salinities were highly variable. Montague et al. (1989) stated that:

> "Submerged vegetation found in small quantity at the upstream stations...are known to thrive elsewhere at salinities comparable to the mean salinities found at those stations. Frequent, large, and sudden variations in salinity at a station...might reset succession, preventing good development of any one benthic community."

In a rule-based ecological model of an estuarine lake, Starfield et al. (1989) concluded that the abundance of underwater plant biomass was sensitive to the rate of change of salinity rather than the salinity level *per se*, but these model outputs have not yet been confirmed. Fears (1992) tested the effects of salinity shocks of various intensities and durations on the growth rate and survival of *Thalassia*, *Halodule*, and *Syringodium*. His experimental design did not mimic situations where drastic salinity changes occur on tidal, daily, weekly, or longer temporal cycles. Extreme variation in salinities in and near Dona Bay (Jones, 2004) may be a major cause of SAV limitation.

Ruppia maritima

Wigeongrass is often found with the seagrasses but is not a true marine plant; it is considered a freshwater species with a pronounced salinity tolerance. It behaves as an annual in habitats subject to drought, lethal increases in salinity, or other extremes, or as a perennial in deeper, more stable environments, and has specialized features enabling survival under varying salinities and high temperature beyond those tolerated by other submersed angiosperms. *Ruppia* usually occurs at low intertidal elevations in estuaries, but mixes with true seagrasses up to at least 1.5 km offshore in large oceanic bays.

Widgeongrass has been observed in a wide range of salinities from fresh water to hypersaline waters (Kantrud, 1991), however, a re-analysis of distributional data by Estevez (2000) shows that particular *Ruppia* populations grow in comparatively narrow salinity ranges. It has not been reported from Shakett Creek but grows in tidal freshwater reaches of the Myakka River.

Halodule wrightii

In an early study (McMahan, 1968) pots of *Halodule* maintained vigorous growth in salinities from 23 to 37 ppt, for 5 weeks, and it survived in salinities up to 60 ppt. In a separate experiment an attempt was made to grow *Halodule* at salinities ranging from 0 to 87 ppt. It survived for 6 weeks in salinities ranging from 3.5 to 52.5 ppt. After 2 weeks at salinities under 9 ppt *Halodule* began to show adverse effects. Fears (1993) demonstrated that *Halodule* could tolerate short term, to 24 hrs duration, salinity shocks in fresh water. He warned that longer duration exposures or repeated shocks could kill this seagrass. Field data on *Halodule* distribution near river mouths and on tidally exposed sandbars also suggest that it can tolerate wide salinity fluctuations.

No information is available on the reproduction and germination of this seagrass under artificially manipulated salinity regimes. *Halodule* flowers have been reported to occur in various areas at temperatures between 22 ^{o}C and 26 ^{o}C and in salinities ranging from 26.0 ppt to 36.0 ppt (Moffler and Durako, 1987).

Doering et al. (2002) report that "laboratory experiments indicated that (*Halodule*) mortality could occur at salinities < 6ppt, with little growth occurring between 6ppt and 12ppt. Field data indicated that higher blade densities (> 600 blades per square meter) tend to occur at salinities greater than 12ppt. Relationships between salinity in the estuary and discharge from the Caloosahatchee River indicated that flows > 8.5 m cubic meters per second would produce tolerable salinity (< 10ppt) for *V. americana* and flows < 79 cubic meters per second would avoid lethal salinities (< 6ppt) for *H. wrightii*."

Syringodium filiforme

Phillips (1960) summarized observations related to salinity effects on the distribution of *S. filiforme*. His summary suggested that *Halodule* is more tolerant of low salinities. Phillips reported dense beds of *Syringodium* in the Indian River Lagoon in salinities of 22 - 35 ppt. He suggests that an optimum salinity level to support *Syringodium* should exceed 20 - 25 ppt.

Fears' (1993) results showed that *Syringodium* growth rates were not noticeably affected by salinity shocks (= submergence in water of low or zero salinity) until they were placed in freshwater for 24 hrs. Less harsh treatment did not result in noticeable growth rate decreases for this species.

Syringodium is rarely seen in flower in Florida waters (Phillips, 1960) and therefore no information exists on the effects of salinity on the processes of reproduction and seed germination.

Thalassia testudinum

A dominant species throughout its range, *Thalassia* nonetheless constitutes a relatively minor element of Dona Bay's seagrass cover. The paucity of *Thalassia* may be explained by the Bay's extensive history of dredging and spoiling, coupled with extremes in freshwater inflow. *Thalassia* is intolerant of low salinity (Fears, 1993), and is a slow spreading, poor colonizer among seagrass species. These characteristics give *Thalassia* a low recovery rate during favorable salinity periods. The areal extent of *Thalassia* suggests that modern *Thalassia* beds are not very old.

Many species of seagrasses seem to disappear soon after the introduction of large freshwater inflows (Bellan, 1972), or species diversity among seagrasses is reduced. Thereafter, salinity or other impacts become more difficult to observe because affected living resources left in the area tend to be eurytopic.

To create conditions favorable for *Ruppia* within its desired range, mean bottom salinity should be maintained near 5 ppt, with a standard deviation about the mean less than 10 ppt.

To restore and enhance *Halodule* within its desired range, mean bottom salinity should be maintained near 25 ppt, with a standard deviation about the mean less than 10 ppt.

To enhance the potential for *Syringodium* and *Thalassia* growth in their desired range, the duration of bottom salinities of zero ppt should be kept to less than 24 hours.

C. Hard Clams

Live hard clams occur in Lyons Bay but to date only dead clams have been collected from either Dona Bay or Roberts Bay (Estevez, 2005).

Adult hard clams survive short spells of lowered salinities by closing their valves, and stop pumping at salinities below 15 ppt (Eversole, 1987). Survival times under adverse environmental conditions are age/size dependent. Ambient temperatures and dissolved oxygen levels alter salinity tolerances and survival times. Larval and juvenile clams are more susceptible to low salinities because they lack the protection of the heavy, thick shells of older clams (Wells, 1957). Fishermen in the Indian River lagoon have noted that small clams can tolerate low salinity for 2 to 3 hours while adults may be able to withstand low salinity for several days.

Hard clams already stressed by other environmental factors may be more susceptible to salinity stress (Wells, 1957). High temperatures, for example, increase respiratory demands and decrease the length of valve closure periods (Barnes, 1987). Elevated summertime water temperatures and high biological oxygen demands, created by excess nutrient supplies, reduce dissolved oxygen availability (Windsor, 1985) below the metabolic needs of clams stressed by low salinities.

Sudden increases in salinity, exceeding 8 parts per thousand (ppt) are also lethal to hard clams (M. Castagna, Virginia Institute of Marine Science, personal communication). In fact, hard clams can tolerate a larger decrease -- drops of up to 15 ppt -- if the lowest salinities remain above seasonally changing and geographically variable lethal salinity limits.

Distributional patterns of *Mercenaria mercenaria* in several areas suggest that salinity has a strong influence either on recruitment or on subsequent post-recruitment survival and growth (Wells, 1957; Walker and Tenore, 1984; Craig et al., 1988). Physiological changes occur within clam tissues when exposed to low salinities. Clam tissues leak amino acids at salinities that truly euryhaline species, such as *Mytilus* and many others, can tolerate without amino acid losses (Rice and Stephens, 1988). Amino acid loss continued after a 5-day acclimation period, at 17.0 ppt, for adult *Mercenaria*. Net losses of amino acids can be used as an index of a species' ability to tolerate salinity fluctuations. Adult *Mercenaria* can tolerate long exposures to lowered salinities by tightly closing their thick valves (Wells, 1957), but the duration of the maximal period of closure is a function of temperature.

Patterns of shell growth in adult hard clams have been studied in 10 southeastern estuaries (Jones, et al. 1990). Florida clams have higher growth rates and shorter life spans than northern clams. Shells exhibit a bimodal growth pattern with peak rates of new shell deposition in the spring and late fall of the year. Shell growth is lowest in summer when temperatures are highest and salinities are lowest. Salinity data for three sites are available. At no time were monthly salinities below 10 ppt. In 3 months (8% of 36 station-months), salinities were lower than 15 ppt. Salinities were between 15 and 20 ppt during 33% of visits and salinities were greater than 20 ppt on more than half (56%) of the visits.

Salinity requirements of embryonic, larval, and juvenile clams change throughout development and early growth (Mulholland, 1984). Temperature has a complicating effect on the interpretation of salinity requirements of *Mercenaria mercenaria* and *M. campechiensis*. Female clams in spawning state were found to be almost continuously present in the Indian River near Melbourne (Hesselman et al., 1989). A strong biphasic period of spring (March - June) and fall (August - October) ripening and spawning of female littleneck hard clams in Wassaw Sound, Georgia, was reported by Pline (1964). There was a strong correlation between recruitment failure and depressed winter salinity (< 30 ppt) in winter. Hard clams postponed high experimental mortality in 10.0 ppt salinity by remaining tightly closed for 4 to 5 weeks, but eventually succumbed.

Studies of the salinity requirements of larval and juvenile clams find that the minimum tolerable salinity was 20 ppt or greater. Given that low-latitude clam populations encounter higher water temperatures, published salinity requirements of larval clams suggest that it would be advisable to avoid salinity decreases to levels below 20 ppt at least during spawning and preferably throughout the year.

Wells (1957) noted that few hard clams were found in parts of Chincoteague Bay where salinities often reached levels ranging from 13 to 21 ppt. The western and northern margins of the bay are affected by fresh water from creeks and rivers. Wells stated that productive clam beds in Chincoteague Bay are located near inlets in relatively saline waters. Further south in Georgia's Wassaw Sound, dense clam beds (with finds of >15/15 min effort) are mostly located in the shallow waters of the Sound within 6 km of coastal inlets.

Adult clams can, under certain conditions, tolerate low salinities for extended periods. Burrell (1977) found that oysters, although tolerant of lower salinities than clams, suffered much higher mortality during floodwater discharges from the Santee River system in South Carolina. Salinities remained below 10 ppt for 2 to 3-week periods. Oysters suffered mortalities ranging from 32% to 66% in various areas while clam mortality was less than 5%. Clam and oyster internal liquors remained at higher salinities than did their ambient environment. Hard clams can withstand direct exposures to fresh water for up to 114 hours (Pearse, 1936). Despite these extreme exposures, Eversole (1987) describes the hard clam as only moderately euryhaline and concludes, in reviewing the literature on clam responses to salinity, that optimum salinities for egg development, larval growth and survival, and adult growth are in the 24 to 28 ppt range.

In general, salinity below 15 ppt may be considered "low;" such salinities affect clam physiology, behavior, reproduction, and survival. Small clams may survive low salinities for hours while large clams may survive for days, or even weeks, but they do so under stressful conditions.

A bottom salinity of 20 ppt is recommended as the lowest average salinity genuinely suitable for hard clams in DARB. This value emerges from divergent studies of shell growth, spawning, larval growth, and field studies. In the spring and fall, when shell growth and spawning are normally at peak levels, salinities of 25 ppt or greater would be protective. With these as reference-points, salinity characteristics that may be recommended to maintain and enhance hard clam populations are that, within their desired range:

1. For a year as a whole, mean bottom salinity should be maintained at levels above 20 ppt.
2. The lower limit of bottom salinity should be 10 ppt and the upper limit can equal oceanic values.
3. In summer, mean bottom salinities should exceed 20 ppt and be associated with standard deviations not greater than 5 ppt. Excursions of summer-time salinity below 15 ppt should not persist for more than 1 week (7 days).
4. During other times of the year, mean bottom salinities should be equal to or exceed 25 ppt and be associated with standard deviations not greater than 5 ppt.
5. Successive high tide, bottom salinities should not increase by more than 5 ppt, and successive low tide, bottom salinities should not decrease by more than 10 ppt, beyond background rates as a result of surface water management operations.

D. Oysters

Oysters were once present in sufficient quantities to form significant archaeological formations at Venice. Jones (2005) reported a one year increase in percentages of live oysters and number of live oysters at fixed stations in DARB, significant improvements since 2003. All measures of oyster abundance and condition indicate that DARB and their tributaries experience intermittent conditions inimical to oyster success.

Oysters are immobile, after a larval stage, and are therefore subject to the permanent effects of salinity changes due to alterations of riverine inflow, ocean influence, or circulation. Low riverine flows of short duration result in high salinities in Apalachicola Bay and result in increased predation on newly settled spat; population sizes of adult, harvestable oysters are reduced 2 and 3 years later (Wilber, 1992). Wilber found little evidence that high flows of short duration (≤ 30 days) adversely affected oyster harvests for the same or subsequent years. Her analyses were based on river flow data (kept by the Northwest Florida Water Management District) and oyster harvest data from 1960 to 1981.

Oysters can avoid predation by tolerating salinity fluctuations that their natural predators cannot tolerate (Gunter, 1955). Low salinities kill oyster drills and starfish (Sellers and Stanley, 1984). Maintenance of salinities within ranges above the lower tolerance limits of oyster predators usually results in major declines in oyster abundance (Allen and Turner, 1989). Ortega and Sutherland (1992) found adequate spat settlement in both low salinity (< 15 ppt) and high salinity (> 20 ppt) reaches of Pamlico and Core Sounds, North Carolina. Algal turfs and poor sediment inhibited growth in low salinity areas and competition by fouling organisms retarded success in high salinity areas.

Salinity requirements of *Crassostrea virginica* are reviewed in Sellers and Stanley (1984). Adult oysters tolerate a salinity range of 5 to 30 ppt. They do best within a salinity range of 10 to 28 ppt (Loosanoff 1965a). Salinities below 7.5 ppt inhibit spawning. Maximum larval growth and survival occur above salinities of 12.5 ppt and maximum spat growth occurs between 15 and 20 ppt.

Oysters can tolerate salinities as low as 3.0 ppt for 14 days, and 6.0 ppt for up to 30 days (Loosanoff 1965b). When flood conditions persist for 30 days or more, oyster mortalities typically reach 100% (Allen and Turner, 1989). Sellers and Stanley (1984) reported major oyster mortalities in several areas that were affected by major floods when salinities remained below 2 ppt for extended periods.

On Louisiana's state seed grounds Chatry et al. (1983) found that salinity in the setting year is the prime determining factor for the production of seed oysters. Both high and low salinities resulted in poor seed production. Low salinities resulted in insufficient setting while the negative effects of high salinities were believed due to the effects of predation on oyster spat. The maintenance of optimum setting salinities was most critical from May through September. To optimize Louisiana spat production, Chatry et al. recommended May salinities between 6 to 8 ppt; salinities should average 13 ppt in June and July and not increase to greater than 15 ppt until late August, and September salinities should not average more than 20 ppt.

Volety et al. (2005) report that "oysters in the Caloosahatchee estuary spawn continuously from April to October, a period that coincides with freshwater releases into the estuary. Upstream, sub-tidal locations exhibited good spat recruitment, low disease intensity, and higher juvenile growth rates compared to downstream, intertidal sites. High freshwater flows during summer either flushes out oyster larvae and spat from areas with suitable cultch and/or reduce, salinities to levels that are unfavorable for spat settlement and survival. Freshwater releases in the range of 500 to 2000 CFS (cubic feet per second) will result in optimum salinities for oysters. Limited freshwater releases during winter coupled with decreased releases in summer should result in decreased *P. marinus* infections, suitable conditions for survival and enhancement of oyster reefs in the Caloosahatchee River."

Based on a review of oyster salinity requirements, to promote reefs in desired areas:

1. Salinities in areas where oyster bars are desired can be allowed to fluctuate broadly between 10 to 28 ppt, and these areas should possess strong longitudinal salinity gradients and mixing.
2. Lower salinities can be briefly tolerated by adult oysters. Salinities less than 6 ppt should not be allowed to persist longer than 2 weeks, nor should salinities lower than 2 ppt be allowed for longer than a week.
3. To protect recruitment, salinity during local spawning seasons should be above 10 ppt. Optimal larval and spat growth and survival can be obtained in salinities between 12.5 and 20 ppt.

Once salinity data have been analyzed by other members of the project team, these guidelines will need to be tested against new data for DARB oysters (Appendix 1).

E. Fish

Fish populations may be affected greatly by rapid salinity shifts. Spotted seatrout (*Cynoscion nebulosus*), snook (*Centropomus undecimalis*), and red drum (*Sciaenops ocellatus*) are common residents of Venice waters. They are variably affected by low salinities, and a single salinity regime may not be suitable for all three species. Additionally, these three fish are dependent on a rich and diverse invertebrate and fish-based food chain. Altered salinities can be predicted to have different effects on each of the prey species of the three carnivorous species. A study of salinity change effects on fish and invertebrate populations in the St. Lucie estuary (Haunert and Startzman, 1980), while informative, was concerned with short-term changes in fish and invertebrate populations. They did not consider the long-term biotic changes in this estuary that resulted from the permanent alteration of stream flow caused by the various water control structures upstream from the St. Lucie Estuary. Their study basically reported that animal communities which had already been affected by a long history of stream flow alterations were not significantly affected by a single test discharge.

Adults of the three species are mobile, and they have wide salinity tolerance ranges (Haunert and Startzman, 1980; Banks et al., 1991). Their larvae and juveniles are poor to weak swimmers and have more narrow salinity tolerance ranges. Adult snook, for example, spawn in inlets and spend much time in the vicinity of dams feeding on freshwater prey species that are stunned or killed by their passage over dams (Marshall, 1958; Seaman and Collins, 1983). Much of the following discussion centers on the salinity requirements of the larval and juvenile stages of these three fishes.

Spotted Seatrout

Banks et al. (1991) demonstrated that salinity tolerances of spotted seatrout are age-linked. Upper and lower tolerances changed during early growth. The results of this study were complicated by the fact that seatrout embryos -- acclimated to altered salinities -- produced larvae that were more tolerant of extreme salinities. The narrowest range of salinity tolerance, 6.4 to 42.5 ppt, occurred on day 3 after hatching. Feeding begins on day 3 after hatching; the change from dependency on yolk to exogenous foods and the immature state of the osmoregulatory system undoubtedly account for the higher sensitivity to salinity change. Salinity ranges for successful reproduction and larval survival of spotted seatrout were approximately 20 - 45 ppt and 10 - 40 ppt, respectively (Holt and Banks, 1989).

Seatrout spawn in deep channels adjacent to seagrass beds or in tidal portions of estuaries (Lorio and Perret, 1978). The Intracoastal Waterway in the vicinity of Dona Bay would fully fit this description of optimum spawning grounds. Florida's spotted seatrout spawn from April through September with peaks in late May or early June (Lorio and Perret, 1978). Salinity reductions, to levels below the tolerance limits of seatrout larvae (below 10 ppt), during this time could cause tremendous mortalities to occur among populations of recently hatched seatrout larvae.

Sudden, massive salinity reductions have been observed to cause either mass migrations from or mortalities of adult seatrout in Florida estuaries (Tabb, 1966). Adult seatrout are a truly euryhaline species, but they apparently cannot tolerate sudden salinity changes of the type that may occur during hurricanes or tropical storms.

Snook

Snook utilize a series of habitat types that are dependent upon the growth stage of this species (Gilmore et al., 1983). Juvenile snook, ranging from 11-156 mm SL (mean = 27.5 mm) reside for 10 to 70 days within the freshwater tributaries of the Indian River Lagoon. Larger juveniles, from 10-174 mm SL (mean = 67 mm) are found in marsh habitats where they remain from 60 to 90 days. Freshwater and marsh recruitment peak in summer and fall (Gilmore et al, 1983). Juvenile snook move from marshes to seagrass meadows after reaching lengths from 100 to 150 mm SL at ages of 4 months or more.

Snook diets change during juvenile growth and adult maturation. In freshwater, juveniles prey upon microcrustacea, palaemonid shrimp, and neonatal mosquitofish, *Gambusia affinis* (Gilbert et al, 1983). Saltmarsh juveniles prey upon sheepshead minnows (*Cyprinodon variegatus*), mosquito fish, palaemonid shrimp, and microcrustacea (mysids, copepoda, etc.). In seagrass beds, larger juveniles prey upon a variety of fish and penaeid shrimp (Gilbert et al., 1983). Adult snook switch diets as they move from areas of higher to lower salinity (Marshall, 1958).

Snook survive in freshwater but they cannot reproduce because their spermatozoa require activation by saltwater (Seaman and Collins, 1983). Large releases of freshwater into Shakett Creek probably do not compromise the osmoregulatory abilities of the common snook, but increased flows could wash weakly swimming juveniles and their prey from the preferred low-salinity habitats.

Red Drum

Red drum are tolerant of a wide range of salinities (reviewed by Reagan, 1985). Adults have been collected from areas of virtual freshwater (0.3 ppt in Louisiana) and from areas with salinities exceeding that of full strength seawater (40 - 50 ppt in Texas). Small fish are more common at low salinities, and large fish seem to prefer higher salinities (Yokel, 1966). Perret et al. (1980) summarized numerous studies from widely scattered areas to report that juvenile red drum have been captured at salinities ranging from 0 ppt to 30 ppt. Highest catches of small red drum in Mississippi occurred when salinities ranged from 20 to 25 ppt.

Red drum larvae have salinity tolerances of 15 - 35 parts per thousand, somewhat narrower than the salinity range tolerated by larval spotted seatrout (Holt and Banks, 1989). These authors found that salinities above and below these ranges significantly impaired all phases of reproduction and larval development in red drum.

Adult red drum are likely to swim away from areas with salinities above or below their preference range. Juveniles may be able to tolerate extremely low salinities, but their rates of acclimation to freshwater are not known. A sudden salinity shock could have a large negative impact on red drum juveniles.

Based on a review of seatrout, snook, and red drum salinity requirements:

1. Salinities must be held at seasonally appropriate levels within nursery grounds and spawning areas for each of these three species. When red drum and seatrout larvae are present the red drum larval tolerance range of 15 -35 ppt should not be exceeded.

2. Juvenile snook must have access to freshwater nursery areas such as those that exist in the upper reaches of Shakett and Curry Creeks. Salt-water should not be allowed to encroach on these areas due to its lethal effects on many of the prey species consumed by juvenile snook.

Existing flood control structures may block juvenile snook from a large part of their favored nursery habitat.

TARGET VALUES FOR SALINITY IN DONA AND ROBERTS BAYS

Ecological features of the DARB system and tidal coastlines generally are created through the action of geological, hydrological, chemical, and biological forces. The distribution, composition, abundance and condition of living resources along these coasts acquire common features and regionally unique features (Odum et al., 1975). Soils, wetlands, seagrass beds, oyster reefs, and other structural ecosystem features develop in analogous ways across estuaries within specific climatic zones. The relationship of these features to freshwater inflow, tidal amplitude, salinity and other dynamical features also follow regular patterns. Productivity of individual species is regulated by the overlap of structural and dynamic habitat (Browder and Moore, 1981). It follows from the regularity of these patterns and processes that salinity recommendations registered to major landscape features of the study area form an environmentally acceptable point of beginning.

In Dona Bay, major features include the downstream-most control structure of Cow Pen Slough; the canalized reach of Shakett Creek; the emergence of the canalized creek into the broader natural lower creek east of US 41; the highway and bridge at US 41; upper, middle and lower Dona Bay, and the ICW-Venice Inlet area. The entire area is tidally affected. The area and volume of tidal reaches increases logarithmically toward Venice Inlet.

In Roberts Bay, major features include the canalized reach of Blackburn Canal; remnants of Historic Curry Creek entering the canal upstream of Albee Farm Road; the emergence of the canalized creek into the broader natural lower creek east of US 41; the highway and bridge at US 41; upper, middle and lower Roberts Bay, and the ICW-Venice Inlet area. The entire area is tidally affected. The area and volume of tidal reaches increases logarithmically toward Venice Inlet.

A. Initial salinity targets (in parts per thousands) are established for these landscapes of Shakett Creek and Dona Bay:

Area	RK	Mean	Standard Deviation	Minimum	Maximum	Range
Control Structure	6.5?	0.5	<1.0	0.0	1.0	2.0
Fox Creek	5.5	1.0	<2.0	0.0	5.0	5.0
Middle Shakett Creek	3.0 to 4.5	5.0	10.0	0.0	15.0?	15.0?
Lower Shakett Creek	2.0 to 3.0	20.0	10.0	6.0	28.0	22.0
Upper Dona Bay	1.3 to 2.0	25.0	10.0	12.0	35.0	23.0
Lower Dona Bay	0.8 to 1.3	28.0	5.0	20.0	35.0	15.0

B. Initial salinity targets (in parts per thousands) are established for these landscapes of Curry Creek/Blackburn Canal, and Roberts Bay:

Area	RK	Mean	Standard Deviation	Minimum	Maximum	Range
Blackburn Canal	5.5	0.5	<1.0	0.0	1.0	2.0
Historic Curry Creek	5.0	1.0	<2.0	0.0	5.0	5.0
Middle Curry Creek	3.7 to 4.5	5.0	10.0	0.0	15.0?	15.0?
Lower Curry Creek	3.0 to 3.5	20.0	10.0	6.0	28.0	22.0
Upper Roberts Bay	2.3 to 3.0	25.0	10.0	12.0	35.0	23.0
Lower Roberts Bay	1.2 to 2.0	28.0	5.0	20.0	35.0	15.0

Additional Salinity Standards

Additional constraints on salinity can be placed on the landscape-level targets described above. Most involve bottom salinity, SAV, oysters, and hard clams. Most are also supportive of or consistent with targets listed above. One of the additions, the second oyster target, calls for the duration of salinities below 2 ppt to last no longer than 7 days.

Targets addressing the duration of limiting conditions cannot be assessed by spatially intensive but temporally practical sampling and measurement. In these cases, continuous recording instruments should be deployed at stations in the designated segments found to be representative of potentially critical conditions. Because the duration targets pertain to neighboring segments, it may be possible to employ just one such instrument in each creek, in the vicinity of the U.S. 41 bridge. Because the critical targets reflect summer and/or high discharge periods, instrument use could be restricted to times and conditions when duration limits were most likely to be exceeded.

Additional salinity (S) targets, in parts per thousand (ppt).

Target	Affected VEC
Mean bottom S = 25 ppt $\pm$ 10 ppt or less	*Halodule*
0 ppt duration at bottom < 24 hr.	*Syringodium and Thalassia*
Annual mean bottom S > 20 ppt.	*Mercenaria*
Minimum bottom S $\geq$ 10 ppt.	*Mercenaria*
Summer mean bottom S > 20 ppt $\pm$ 5 ppt or less	*Mercenaria*
Duration of summer mean bottom S < 15 ppt $\leq$ 7 days	*Mercenaria*

Non-summer mean bottom S $\geq$ 25 ppt $\pm$ 5 ppt or less	*Mercenaria*
Duration of S < 6 ppt < 14 days	*Crassostrea*
Duration of S < 2 ppt < 7 days	*Crassostrea*

Rate Limits

We found very little useful information concerning the maximum rates of salinity change tolerable by estuarine or marine organisms. The only finding, for hard clams,

> Successive high tide, bottom salinities should not increase by more than 5 ppt, and successive low tide, bottom salinities should not decrease by more than 10 ppt, beyond background rates[1] as a result of surface water management operations,

requires explanation. Based on personal communications with scientists and fishermen in the clam industry, the amplitude of tolerable "sudden" salinity increases and decreases were trimmed and are expressed in terms of successive tides. This modification results in the fastest possible rate of salinity change that is measurable. Without better data on real-time rates of salinity change in lower DARB, we felt obligated to take the additional precaution of suggesting that the limits be contingent upon a comparison to "background" rates of change. A definition of background is offered but it does little to change our view that this target should be advisory rather than certain.

In the event that all salinity targets cannot simultaneously be met, the following priorities are suggested. Minimum targets are more important than maximum targets. In upstream waters, low mean salinities are more important than their variation. In marine waters, low variation is probably more important than the mean salinities they accompany.

---

[1]/ Defined as the rates of salinity change that would occur between reference tides in the absence of surface water management structures and operations.

REFERENCES

Arnold, W.S., Bert, T.M., Marelli, D.C., Cruz-Lopez, H., and Gill, P.A. 1996. Genotype-specific growth of hard clams (genus *Mercenaria*) in a hybrid zone: Variation among habitats. Marine Biology. Vol. 125, no. 1, pp. 129-139.

Bahr, L.M. and W.P. Lanier, 1981. The ecology of intertidal oyster reefs of the South Atlantic coast: a community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-81/15. 105 pp.

Banks, M.A., G.J. Holt, and J.M. Wakeman, 1991. Age-linked changes in salinity tolerance of larval spotted seatrout (Cynoscion nebulosus, Cuvier). J. Fish Biology 39: 505-514.

Barnes, R.D., 1987. Invertebrate Zoology, Fifth Edition. Saunders College Publishing, Philadelphia. 898 pp.

Bellan, G. 1972. Effects of an artificial stream on marine communities. Marine Pollution Bulletin 3:74-78.

Browder, J.A. and D. Moore, 1981. A new approach to determining the quantitative relationship between fishery production and the flow of fresh water to estuaries, pp. 403-430 in R. Cross and D. Williams (eds.), Proc. Nat. Symp. on Freshwater Flow to Estuaries. Vol. 1 FWS/OBS-81/04. U.S. Fish and Wildlife Service, Washington, D.C.

Burrell, V.G., 1977. Mortalities of oysters and hard clams associated with heavy runoff in the Santee River System, South Carolina in the spring of 1975. Proc. Natl. Shellfish. Assoc. 67: 35-43.

Chatry, M., R.J. Dugas, and K.A. Easley, 1983. Optimum salinity regime for oyster production on Louisiana's state seed grounds. Contrib. Mar. Sci. 26: 81-94.

Craig, M.A., T.J. Bright, and S.R. Gittings., 1988. Growth of Mercenaria mercenaria and Mercenaria mercenaria texana seed clams planted in two Texas bays. Aquaculture 71: 193-207.

Davis, H.C. 1958. Survival and growth of clam and oyster larvae at different salinities. Biol. Bull. (Woods Hole) 114: 296-307.

Dawson, C.E., 1955. A study of the oyster biology and hydrography at Crystal River, Florida. Contrib. Inst. Mar. Sci. Univ. Texas 4(1): 279-302.

Doering, P.H., Chamberlain, R.H., and Haunert, D.E. 2002. Using Submerged Aquatic Vegetation to Establish Minimum and Maximum Freshwater Inflows to the Caloosahatchee Estuary, Florida. Estuaries Vol. 25, no. 6B, pp. 1343-1354.

Estevez, E.D. 2000. Matching salinity metrics to estuarine seagrasses for freshwater inflow management, Ch. 22 in S. Bortone (ed.), Seagrasses: Monitoring, Ecology, Physiology and Management. CRC Press, Boca Raton.

Estevez, E.D. 2005. Molluscan bioindicators of the tidal Myakka River and Inshore Waters of Venice, Florida. Mote Marine Laboratory Technical Report No. 990.

Estevez, E.D., R.E. Edwards and D.M. Hayward. 1991. An ecological overview of Tampa Bay's tidal rivers, pp. 263-277 in S.F. Treat and P.A. Clark (eds.), Proceedings, Tampa Bay Scientific Information Symposium 2. Tampa Bay Regional Planning Council.

Estevez, E.D. and M.J. Marshall. 1992. Sebastian River Salinity Regime, Parts 3 and 4: Recommended Targets. Contract 92W-177 Report to St. Johns River Water Management District. Mote Marine Laboratory Technical Report No. 308. 171 p.

Eversole, A.G., 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic): Hard Clam. U.S. Fish and Wildlife Service Biological Report 82(11.75). 33 pp.

Fears, S. 1993. The role of salinity fluctuation in determining seagrass distribution and species composition. Master of Science thesis, Department of Environmental Engineering, University of Florida, Gainesville. 91 p.

Gilmore, R.G., C.J. Donohue, and D.W. Cooke, 1983. Observations on the distribution and biology of east-central Florida populations of the common snook, Centropomus undecimalis (Bloch). Fla. Sci. 46: 313-336.

Gunter, G., 1955. Mortality of oysters and abundance of certain associates as related to salinity. Ecology 36: 601-605.

Hesselman, D.M., B.J. Barber, and N.J. Blake., 1989. The reproductive cycle of adult hard clams, Mercenaria spp. in the Indian River Lagoon, Florida. J. Shellfish Res. 8: 43-49.

Holt, G.J. and M. Banks, 1989. II. Salinity tolerance in larvae of spotted seatrout, red drum, and atlantic croaker. pp. 46-81 in: Salinity requirements for reproduction and larval development of several important fishes in Texas estuaries. Final report to the Texas Water Development Board.

Jones, M. 2005. Dona and Robert's Bay Second Annual Watershed and Estuary Report. Sarasota County Environmental Services.

Jones, D.S., I.R. Quitmyer, W.S. Arnold and D.C. Marelli, 1990. Annual shell banding, age, and growth rate of hard clams (Mercenaria spp.) from Florida. J. Shellfish Res. 9:215-225.

Kantrud, H.A. 1991. Wigeongrass (*Ruppia maritima*): a literature review. USFWS, Fish and Wildlife Research 10, 58 p.

Livingston, R.J., 1987. Historic trends of human impacts on seagrass meadows in Florida. pp. 139-152 in M.J. Durako, R.C. Phillips, and R.R. Lewis (eds.). Proceedings of the Symposium on Subtropical-Tropical Seagrasses of the Southeastern United States. Fla. Mar. Res. Publ. No. 42., Florida Marine Research Institute, St. Petersburg, Florida.

Loosanoff, V.L., 1965(a). The American or eastern oyster. U.S. Fish. Wildlife Serv. Circ. 205. 36pp.

Loosanoff, V.L., 1965(b). Gonad development and discharge of spawn in oysters of Long Island Sound. Biol. Bull. 129: 546-561.

Lorio, W.J. and W.S. Perret, 1978. Biology and ecology of the spotted seatrout (Cynoscion nebulosus Cuvier). Proc. Red Drum and Seatrout Colloquium, Oct. 19-20, 7-13.

Marshall, A.R., 1958. A survey of the snook fishery of Florida with studies of the biology of the principal species, Centropomus undecimalis (Bloch). Fla. Board Conserv. Mar. Res. Lab. Tech Ser. No. 11. 37pp.

McMahan, C. A. 1968. Biomass and salinity tolerance of shoal grass and manatee grass in Lower Laguna Madre, Texas. J. Wildl. Manag. 32, 501-506.

Moffler, M.D. and M.J. Durako, 1987. Reproductive biology of the tropical-subtropical seagrasses of the southeastern United States. In: M.J. Durako, R.C. Phillips, and R.R. Lewis, III, (eds.) Proceedings of the Symposium on Subtropical-Tropical Seagrasses of the Southeastern United States, pp. 77-88. Florida Marine Research Publications Number 42, Florida Department of Natural Resources, Bureau of Marine Research, St. Petersburg, Florida.

Odum, H.T., B.J. Copeland and E.A. McMahan, 1975. Coastal Ecological Systems of the United States. Conservation Foundation, Washington, D.C.

Pearse, A.S., 1936. Estuarine animals at Beaufort, North Carolina. J. Elisha Mitchell Sci. Soc. 52: 174-222.

Perret, W.S., J.E. Weaver, R.O. Williams, P.L. Johansen, T.D. McIlwain, R.C. Raulerson, and W.M. Tatum, 1980. Fishery profiles of red drum and spotted seatrout. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. 60 pp.

Pline, M.J., 1964. Reproductive cycle and low salinity stress in adult Mercenaria mercenaria of Wassaw Sound, Georgia. M.Sc. Thesis, Georgia Institute of Technology School of Applied Biology. 74 p.

Reagan, R.E., 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico). Biological Report 82(11.36), TR EL-82-4, U.S. Fish and Wildlife Service. 16 pp.

Seaman, W., Jr. and M. Collins, 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Florida)--Snook. U.S. Fish Wildl. Serv. FWS/OBS-82/11.16. U.S. Army Corps of Engineers, TR EL--82-4. 16 pp.

Sellers, M.A. and J.G. Stanley, 1984. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) -- American oyster. U.S. Fish Wildl. Serv. FWS/OBS-82/11.23. U.S. Army Corps of Engineers, TR EL--82-4. 15pp.

Starfield, A.M., B.P. Farm and R.H. Taylor, 1989. A rule-based ecological model for the management of an estuarine lake. Ecol. Modeling 46: 107-119.

Tabb, D.C., 1966. The estuary as a habitat for spotted seatrout, Cynoscion nebulosus. Am. Fish. Soc. Spec. Publ. 3: 58-67.

Volety, A.S., Tolley, G., Savarese, M., and Winstead, J.T. 2004. Role of anthropogenic and environmental variability on the physiological and ecological responses of oysters in southwest Florida. Journal of Shellfish Research. Vol. 23, no. 1, pp. 315-316.

Volety, A.K., Tolley, S.G., Savarese, M., Rsanake, E., Haynes, L., Winstead, J.T., Barnes, T. and Doering, P.H. 2005. The role of oysters and adaptive resource management in setting restoration targets for southwest Florida estuaries. Journal of Shellfish Research Vol. 24, no. 1, p. 338.

Walker, R.L. and K.R. Tenore., 1984. The distribution and production of the hard clam, Mercenaria mercenaria in Wassaw Sound, Georgia. Estuaries 7: 19-27.

Ward, L.G., W.M Kemp, and W.R. Boynton, 1984. The influence of waves and seagrass communities on suspended particulates in an estuarine embayment. Marine Geology 59:85-103.

Wells, H.W., 1957. Abundance of the hard clam Mercenaria mercenaria in relation to environmental factors. Ecology 38, 123-128.

Wilber, D., 1992. Associations between freshwater inflows and oyster productivity in Apalachicola Bay, Florida. Estuarine, Coastal and Shelf Science 35: 179-190.

Windsor, J.G., 1985. Nationwide review of oxygen depletion and eutrophication in estuarine and coastal waters: Florida region. Florida Institute of Technology, Melbourne.

Wood, E.J.F., W.E. Odum, and J.C. Zieman, 1969. Influence of seagrasses on the productivity of coastal lagoons. Lagunas Costeras. pp. 495-502 in Proc. UN Symposio Mem. Simp. Intern. UNAM-UNESCO, Mexico, D.F. Nov. 1967.

Yokel, B.J., 1966. A contribution to the biology and distribution of the red drum, Sciaenops ocellata. M.S. Thesis, Univ. Miami, Coral Gables: 160pp.

APPENDIX 1: A STUDY OF OYSTERS IN DONA AND ROBERTS BAYS

BACKGROUND

Sarasota County has embraced the use of American oysters as bioindicator organisms in Dona and Roberts Bays, and their tributaries. Jones (2004) used 1948 and ground-truthed 2001 aerial photographs to depict historic and modern reef distributions, and modern live:dead ratios and spat settlement. About ten percent of historic oyster cover has been lost. Lyon's Bay had the most live and percent live oysters. Few live oysters were found upstream of US 41 in Shakett or Curry creeks and oysters in Dona Bay were mostly dead. The most live beds and robust oysters occurred between RK 2.1-3.3 on Shakett Creek.

Jones (2005) found that oysters in Shakett and Curry creeks and their respective bays generally improved during the following year, while Lyons Bay oysters were unchanged. In Shakett Creek, live oysters upstream of US 41 increased from <50% in 2003 to >75% in 2004. Percent live oysters also increased in Dona Bay. The 2003 mortality event was attributed to an abnormally wet, rainy season.

Also in 2004, Estevez (2005) surveyed mollusks at half-kilometer intervals in Dona Bay and Shakett Creek, from Venice Inlet to the Cow Pen Slough control structure near RK 6.0. Oyster was the dominant species and it with another 9 species comprised 90% of the collection. Oyster range was greater for dead material than live and more live oyster was found intertidally than in the subtidal. Jones (2004) and Estevez (2005) also probed sediments in Dona Bay and Shakett Creek for buried, relict reefs. There is evidence that historic oysters occurred farther upstream than modern ones in Curry Creek, but habitat alterations associated with channelization of Cow Pen Slough prevent a similar conclusion for Shakett Creek.

Other oyster-related investigations are underway or recently finished. As part of the DBWMP, the USF Department of Geology has conducted a study of sediments and sedimentation in the larger DARB study area. Field work for that effort is complete and a report is forthcoming. Also, SCG is implementing a county-wide oyster monitoring program that will occupy existing stations in DARB.

As part of the development of resource management targets for the DBWMP, Mote Marine Laboratory performed another oyster survey. Originally intending to use oyster epibiont and predator damage as a proxy record for historical salinities in Dona Bay and Shakett Creek, preliminary sampling found that shell damage was insufficient for use as a salinity proxy. Also, concerns for sampling buried reefs so as to address time-averaging issues discussed by Lindland et al. (2001) could not be addressed within the present scope of study.

In order to further the development of ecological targets for the study area, a related study of oyster condition, defined as largest live and largest dead shells, was undertaken. This metric was developed in the Loxahatchee River and has been applied in SWFWMD minimum flows and levels studies of the Alafia River (Estevez 1990; Culter et al., 2001).

METHODS

Intertidal reefs in Dona Bay and Shakett Creek were visited in March 2006. Intertidal reefs in Roberts Bay and Curry Creek were visited in June 2006. At each site, fifteen oyster clumps were haphazardly collected across the reef and along the perimeter of the reef. Each clump was dissected and the height of the largest living and largest dead oyster was measured to the nearest millimeter.

Oysters do not grow as reefs at RK 0.5 near Venice Inlet. There, oysters were located by snorkeling and wading along boulder rip-rap and mangrove shorelines and measurements were made on oysters encountered at mid to low intertidal elevations.

RESULTS

Figures A1 and A2 depict Shakett Creek and Dona Bay means and standard deviations of live and dead oyster heights, and box-and-whisker plots of data distributions, respectively.

Mean heights are lowest at RK 0.5 near Venice Inlet, and at RK 3.5 to 4.3 in Shakett Creek (Figure A1). Mean values are highest at RK 1.0 to 2.5 but differ between live and dead material. Largest dead oysters occur from RK 1.0 to 3.0 whereas largest live oysters occur over a shorter range, from RK 1.0 to 2.5 with a peak value at RK 2.0. More large dead oysters occur farther upstream in Shakett Creek, than do large live ones.

Figure A2 depicts data distribution as percentiles-- 5^{th}, 10^{th}, 25^{th}, 50^{th} (median), 75^{th}, 90^{th}, and 95^{th}.

Figures A3 and A4 depict Curry Creek and Roberts Bay means and standard deviations of live and dead oyster heights, and box-and-whisker plots of data distributions, respectively.

Mean heights are lowest at RK 0.5 near Venice Inlet, and at RK 1.5 in Roberts Bay (Figure A3). Mean values are highest at RK 2.0 to 3.0 with little difference between live and dead material. More large dead oysters occur farther upstream in Curry Creek, than do large live ones. Largest dead oysters occur at RK 3.5, than live oysters, signifying that favorable conditions for growth have occurred at some earlier time.

Figure A4 depicts data distribution as percentiles-- 5^{th}, 10^{th}, 25^{th}, 50^{th} (median), 75^{th}, 90^{th}, and 95^{th}.

DISCUSSION

Oyster sizes assessed by this method tend to identify upstream and downstream reaches where suboptimal oyster conditions exist. In high salinity water near Venice Inlet, small oyster size may be related to limited food supply, higher salinity, and mortality caused by marine parasites, diseases, and predators. In low salinity reaches, small oyster size may be caused by mortality resulting from prolonged exposure to fresh water, oxygen stress, or poor recruitment.

In Shakett Creek, the RK "footprint" of large dead oysters is larger than for live oysters, signifying that favorable conditions for oysters have existed over a longer reach of the study area than has existed for the few years since the largest living oysters have matured. Jones (2004) observed that the most live beds and robust oysters of 2003 occurred between RK 2.1-3.3, which includes part of but was also upstream of the optimal zone identified in the 2006 survey. This difference is consistent with the finding that larger dead oysters occurred farther upstream than live ones in 2006.

CONCLUSION AND RECOMMENDATION

The present study adds spatial detail to the organization and condition of oyster resources in the DARB study area. The pattern of largest live and dead oyster heights is comparable to that seen in other coastal rivers sampled by the same method, and depicts two common findings: that a central reach of largest oysters occurs between reaches with smaller animals; and that the reach of large dead material is longer than that for large live material. Over an antecedent period of unknown length, and also for the past few years, conditions conducive to oysters have occurred between RK 1.0 to 3.0 in Shakett Creek/Dona Bay, and between RK 2.0 to 3.0 in Curry Creek/Roberts Bay.

Further study of surface water quality data near and upstream of RK 3.0 in both streams should be undertaken by other members of the DBWMP team to identify conditions that may be depressing oyster success.

REFERENCES

Culter, J.K., Estevez, E.D., Sprinkel, J., Leverone, J., Baird, A., Osterhoudt, J. and D. Ingrao. 2001. An investigation of relationships between freshwater inflows and benthic macroinvertebrates in the Alafia River estuary. Mote Marine Laboratory Technical Report no.773.

Estevez, E.D. 1990. Environmental studies of the tidal Loxahatchee River / Palm Beach and Martin Counties, Florida. Mote Marine Laboratory Technical Report no. 181.

Estevez, E.D. 2005. Molluscan Bioindicators of the Tidal Myakka River and Inshore Waters of Venice, Florida. Mote Marine Laboratory Technical Report no. 990.

Jones, M. 2004. Dona and Robert's Bay Estuary Analysis. Sarasota County Environmental Services.

Jones, M. 2005. Dona and Robert's Bay Second Annual Watershed and Estuary Report: 2004. Sarasota County Environmental Services.

Lindland, E., C. Burt, J. Edlin, M. Elkins, J. Leavor, J. Mallon, M. Myers, S. Obley, M. Savarese, and G. A. Goodfriend. 2001. Time averaging on oyster reefs: implications for environmental reconstruction and historical change. Geological Society of America 33(2):A74.

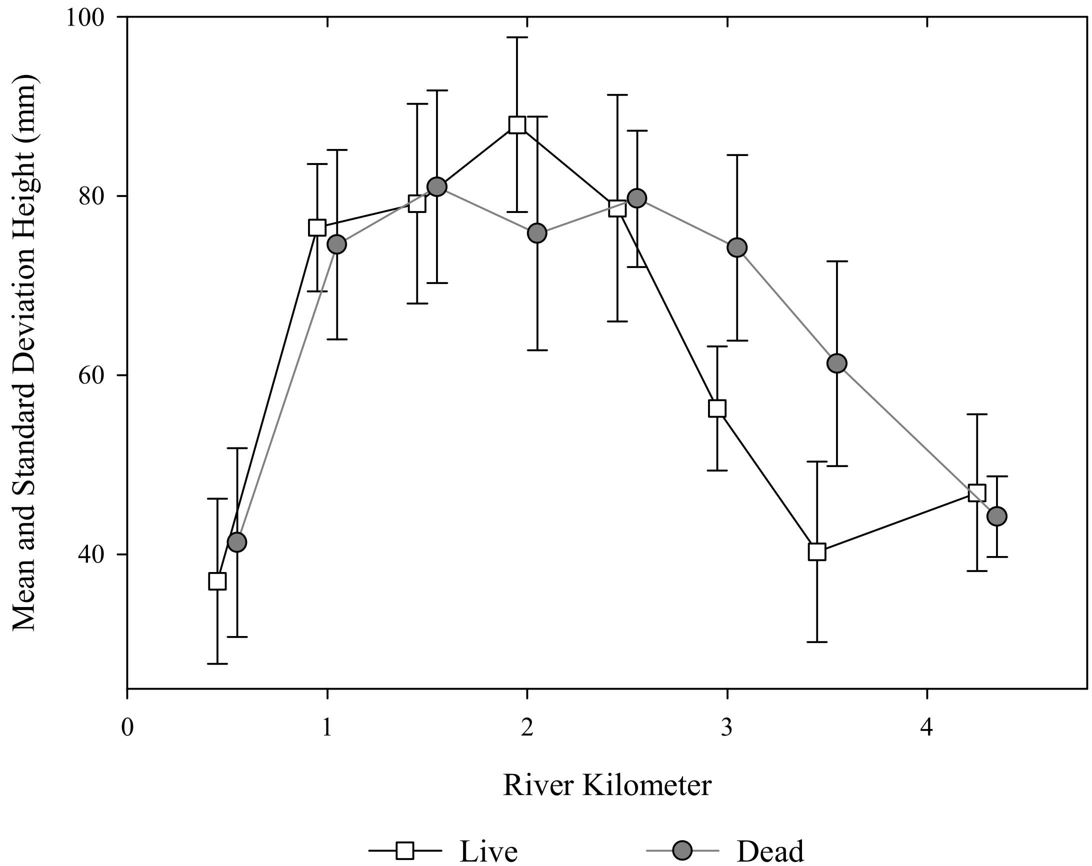


Figure A1. Mean and standard deviation of oyster shell height for live and dead material in Shakett Creek and Dona Bay.

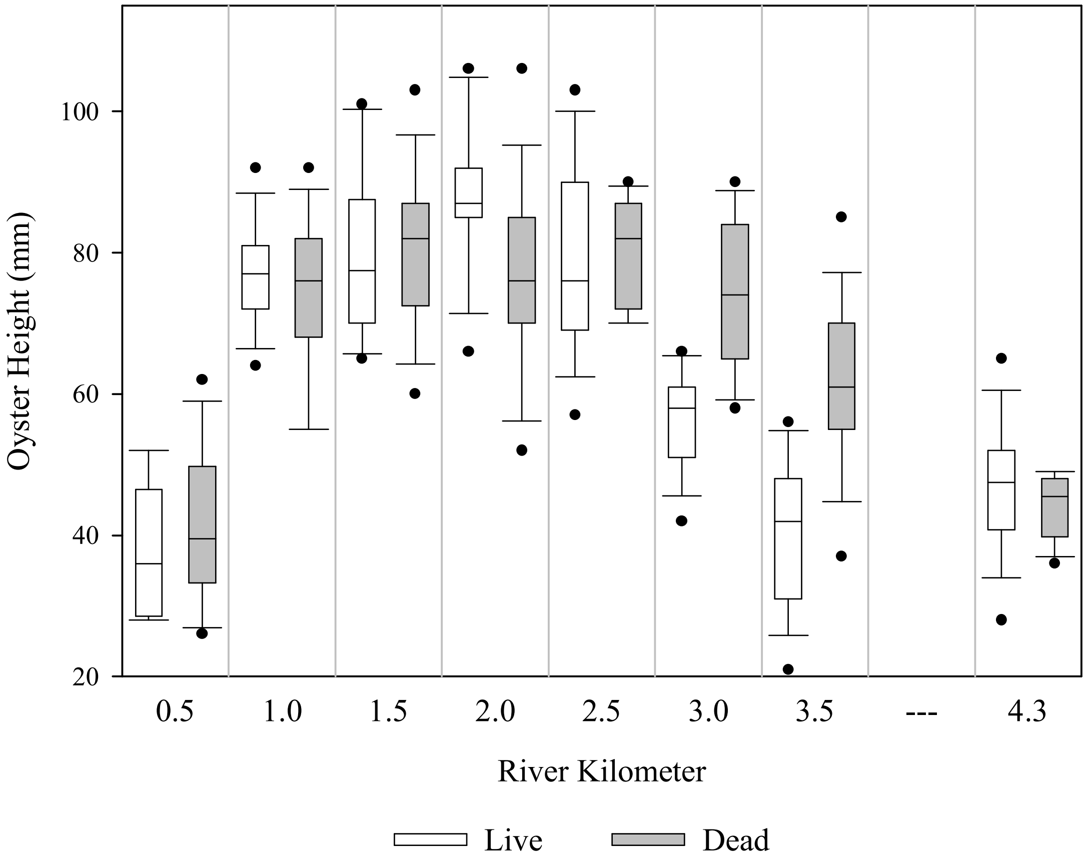


Figure A2. Live and dead oyster heights in Shakett Creek and Dona Bay, with data distributions as percentiles-- 5th, 10th, 25th, 50th (median), 75th, 90th, and 95th.

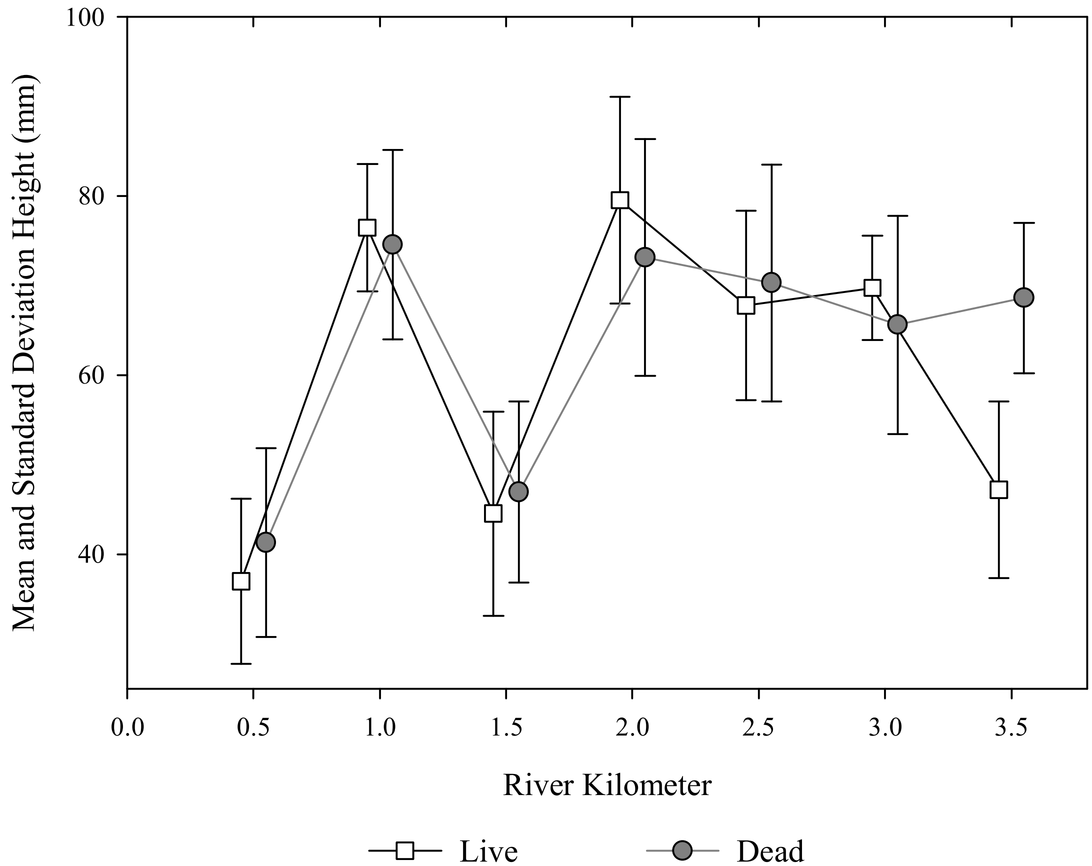


Figure A3. Mean and standard deviation of oyster shell height for live and dead material in Curry Creek and Roberts Bay.

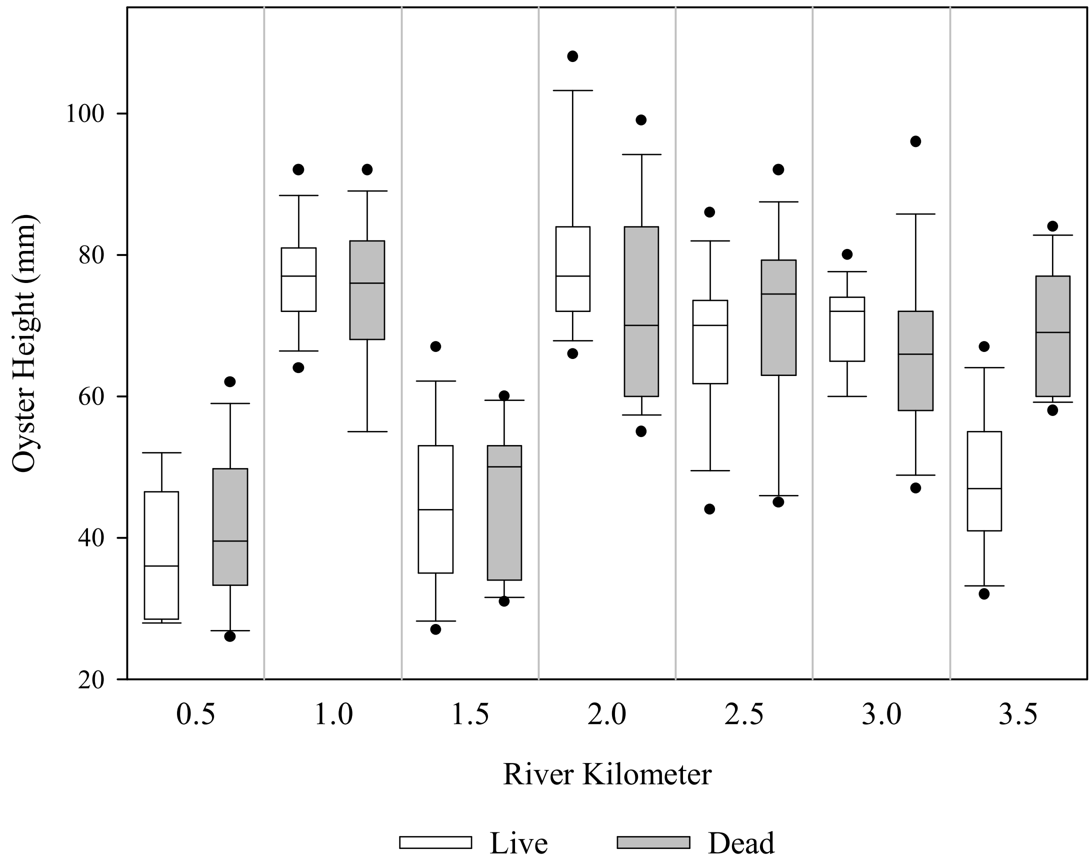


Figure A4. . Live and dead oyster heights in Curry Creek and Roberts Bay, with data distributions as percentiles-- 5th, 10th, 25th, 50th (median), 75th, 90th, and 95th.