MASTERS TRACT REGIONAL STORMWATER TREATMENT FACILITY PRELIMINARY ENGINEERING REPORT

Prepared for:

ST. JOHNS COUNTY

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ACRONYMS AND ABBREVIATIONS

The acronyms and abbreviations described below are used in this Preliminary Engineering Report.

BMP	Best Management Practice
BMAP	Basin Management Action Plan
cfs	cubic feet per second
CIP	Capital Improvement Projects
CR	County Road
cy	cubic yard
ERP	Environmental Resource Permit
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FL	Florida
fps	feet per second
ft	feet
gal	gallon
HDD	Hastings Drainage District
lb	pound
lb/yr	pound per year
LSJR	Lower St. Johns River
mg/L	milligrams per liter
N	Nitrogen
NA	Not Available or Not Applicable
NAVD	North American Vertical Datum (1988)
NH_3	Ammonia
NO_3	Nitrate
NO_x	Nitrite and nitrate
REV	Reuse-Efficiency-Volume
RFG	Relative Functional Gain
RST	Regional Stormwater Treatment
sf	Square Feet
SHGT	Seasonal High Groundwater Table
SJRWMD	St. Johns River Water Management District
SR	State Road
TKN	Total Kjeldahl Nitrogen (as Nitrogen)
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UMAM	Uniform Mitigation Assessment Method
USACE	United States Army Corps of Engineers
yr	year

EXECUTIVE SUMMARY

The Lower St. Johns River (LSJR) is impaired by excess nutrients. The LSJR has a Basin Management Action Plan (BMAP), adopted and enforced by Florida Department of Environmental Protection (FDEP), to achieve what are known as the *Total Maximum Daily Load* (TMDL) *targets*. The LSJR BMAP requires St. Johns County to identify and implement projects to reduce nutrients discharged to the LSJR. The County's nutrient reduction obligations called for in the BMAP for Total Nitrogen and Total Phosphorus are 20,100 lb/yr and 950 lb/yr, respectively (LSJR 2008). One of the projects identified by the County to meet the TMDL is participation in the St. Johns River Water Management District's (SJRWMD) Algal Initiative. As part of the Algal Initiative the County is required to remove 12,220 lb/yr of total nitrogen (based on an 8,435 lb TN/yr reduction from the non-MS4 and a 3,784 lb TN/yr reduction from the MS4). Participation in the Algal Initiative requires projects to be identified, evaluated, and selected for design by November 2010. The County has identified the Masters Tract Regional Stormwater Treatment Facility as a project that will meet a portion of the Algal Initiative and TMDL commitments and also provide an opportunity for constructing wetlands for mitigation credits.

Since the Masters Tract site can provide water quality enhancement and wetland mitigation, Jones Edmunds conducted parallel analyses to develop conceptual plans for the site. The first analysis maximized nutrient removal while the second analysis maximized wetland mitigation potential. Jones Edmunds documented the first analysis in a nutrient optimization memorandum for the County. The memo provides a detailed discussion of the methods used to predict the flows and nutrient loads in each of the canals crossing the Masters Tract, summarizes the potential BMPs, and presents a recommended BMP treatment train as a conceptual design. Upon completion of the conceptual site plan analyses and discussions with the County, a preliminary design was developed. The preliminary design marries the two conceptual plans to provide the maximum nutrient removal while providing the flexibility to gain wetland mitigation credits.

The preliminary design consists of the following major components for maximizing nutrient removal:

- Canal 5 intake and pump station
- Wet detention pond with stormwater harvesting for irrigation
- Flow-way improvements to Canals 4 and 4 North
- Wetland Creation Areas

The total nitrogen loading to the site is estimated at 8,210 lb/yr, and the total estimated nitrogen removal for the preliminary design is estimated at 4,750 lb/yr or a 57% reduction. The total capital cost of the project is estimated at $13.8 million and the total estimated annual maintenance cost is $151,000. The present value of the capital cost plus the maintenance costs over a 20-year term is $16 million, while the annualized cost over the term is $1 million assuming a 6.5% discount rate. This equates to a $296/lb-N removed annually.

The wetland mitigation proposed in the preliminary design of the Masters Tract is comprised of the following:

1. Forested wetland creation (40.3 acres)
2. Forested wetland enhancement (10 acres)
3. Wetland buffer enhancement (18.3 acres)
4. Littoral shelf creation (6 acres)
5. Flow-way enhancement of existing drainage ditches (18.9 acres)
6. RST open water (35.5 acres)

Based on the Uniform Mitigation Assessment Methodology (UMAM), the proposed activities at the Masters Tract are expected to generate approximately 21.4 SJRWMD and 41.8 USACE functional loss mitigation credits. Based on continued discussions with SJRWMD, it may be possible to obtain both wetland credits and treatment credits from the wetland creation areas. This possibility will be further explored during permitting and discussions with FDEP. Initial discussions with the U.S. Army Corps of Engineers (USACE) indicate that the County could receive wetland mitigation credit for the open water and littoral shelf of the RST.

In conjunction with the Masters Tract, the County has purchased two other parcels of land—Floyd and Tatum. Jones Edmunds evaluated the potential wetland mitigation credits on these sites. The Tatum property is an approximately 78-acre site comprised of two adjacent parcels (southwest and northeast parcels) north of Hastings, Florida and northwest of the intersection of SR 207 and East St. Johns Avenue. This property is also adjacent to large areas owned by the SJRWMD. Proposed wetland mitigation activities at Tatum include wetland preservation, wetland enhancement, and wetland buffer enhancement. The 34-acre Floyd property is in the southwest region of the County off CR 13B between the lower St. Johns River and SR 207. Adjacent property to the west is owned by the FDEP and SJRWMD. This property protects a valuable wildlife corridor from undeveloped lands to the east to the large State-owned land holdings west of the Floyd property that fringe the St. Johns River. Proposed wetland mitigation activities at the Floyd property are wetland and wetland buffer preservation. Approximately 13.4 and 3.3 functional loss mitigation credits could be generated at the Tatum and Floyd properties, respectively.

1.0 PROJECT PURPOSE AND OBJECTIVES

The Lower St. Johns River (LSJR) is impaired by excess nutrients. The LSJR has a Basin Management Action Plan (BMAP) adopted and enforced by Florida Department of Environmental Protection (FDEP) to achieve what are known as the *Total Maximum Daily Load* (TMDL) *targets*. The LSJR BMAP requires St. Johns County to identify and implement projects to reduce nutrients discharged to the Lower St. Johns River. The nutrient reductions called for in the BMAP for Total Nitrogen (TN) and Total Phosphorus (TP) are 20,100 lb/yr and 950 lb/yr, respectively (LSJR 2008). One of the projects identified by the County to meet the TMDL is participation in the St. Johns River Water Management District's Algal Initiative. As part of the Algal Initiative, the County is required to remove 12,220 lb/yr of total nitrogen. Participation in the Algal Initiative requires projects to be identified, evaluated, and selected for design by November 2010. The County has identified the Masters Tract RST Facility as a project that will meet a portion of the Algal Initiative and TMDL commitments.

Meeting the TMDL nitrogen reduction commitment is the primary objective for the Masters Tract RST; however, the site was also evaluated for its suitability to provide wetland mitigation. St. Johns County's capital improvement projects (CIP) often result in wetland impacts that require mitigation. On-site mitigation is often not feasible as many of the CIP projects are transportation or linear utility projects. Therefore, the County is actively identifying and establishing off-site mitigation areas in each of the SJRWMD mitigation basins to facilitate the CIP project permitting process and in many cases to save revenue that would otherwise go to purchasing private wetland mitigation bank credits. In conjunction with the Masters Tract, the County has purchased two other parcels of land—Floyd and Tatum—that could provide additional wetland mitigation credits.

Since the Masters site can provide water quality enhancement and wetland mitigation, Jones Edmunds conducted parallel site plan analyses. The first analysis was used to develop a site plan that would maximize nutrient removal and the second analysis maximized wetland mitigation potential. Upon completion of the site plan analyses and discussions with the County, a preliminary design was developed to maximize nutrient removal while providing the flexibility to gain wetland mitigation credits.

2.0 SUMMARY OF SITE CONDITIONS

The Masters Tract is located in St. Johns County east of Hastings. Three agricultural drainage canals cross the property from west to east. The canals convey stormwater runoff from 1,426 acres of land, 74% of which is planted in row crops. The property is bounded on the east by Deep Creek, which flows north to the St. Johns River. These hydrologic features make the site an ideal location to provide stormwater treatment and wetland mitigation. A map of the drainage areas for each canal is presented in Figure 2-1.

Before Masters Tract RST was designed, the Deep Creek watershed was modeled using ICPR, a hydrologic and hydraulic model. It was important to establish a conservative boundary condition to account for the tidal influence of the St. Johns River. The mean high water elevation of 0.5 ft NAVD 88 and the mean low water elevation of -0.6 ft NAVD 88 were determined using water level data from the "Spuds" gauge, a United States Geological Survey gauge located at the railroad trestle north of SR 207. Jones Edmunds used the mean higher high water level (MHHW), 0.80 ft NAVD 88 during the wet season, as the model boundary condition. The MHHW reflects the average of the higher high water height of each tidal day. Using 0.8 ft MHHW as the boundary condition eliminates the need for detailed modeling of the tidal flux.

The Masters Tract is currently a sod farm and has been used for agricultural production for over 60 years. Within the farm there are parallel irrigation ditches, 1 foot wide by 1 foot deep, spaced every 60 feet, which run towards Deep Creek. The irrigation ditches are filled with water using 10 4-inch groundwater wells or, in some fields, a spigot installed at the upstream head of each ditch. Larger ditches intercept flow from the small irrigation ditches and convey it to Deep Creek. In addition, a large berm runs north-south along the tree line of the Deep Creek floodplain. The berm appears to restrict water from Deep Creek during high flows. The Masters Tract property is completely inundated to an elevation of 10.6 ft NAVD during the 100-year flood. The extensive irrigation, ditching, and berming have disturbed the hydrology and artificially elevated the surficial groundwater table at the site.

The following surveys and investigations were used in preparing this report:

- Topographic Survey
- Geotechnical Investigation
- Ecology and Habitat Assessment

The detailed reports for the survey and geotechnical investigation are provided in Appendices A and B. The Ecology and Habitat Assessment is provided in Section 5.0.

In addition to the field investigations performed to support the preliminary engineering, Jones Edmunds performed a Phase 1 Environmental Site Assessment (JE 2009) to support the County's purchasing the property from the District. A primary concern associated with the site is the legacy use of herbicides and pesticides. Based on previous studies and remediation efforts conducted by SJRWMD and additional sampling conducted as a follow up to the Phase 1 ESA, a regional stormwater facility with accompanying wetlands is an appropriate use for the site.

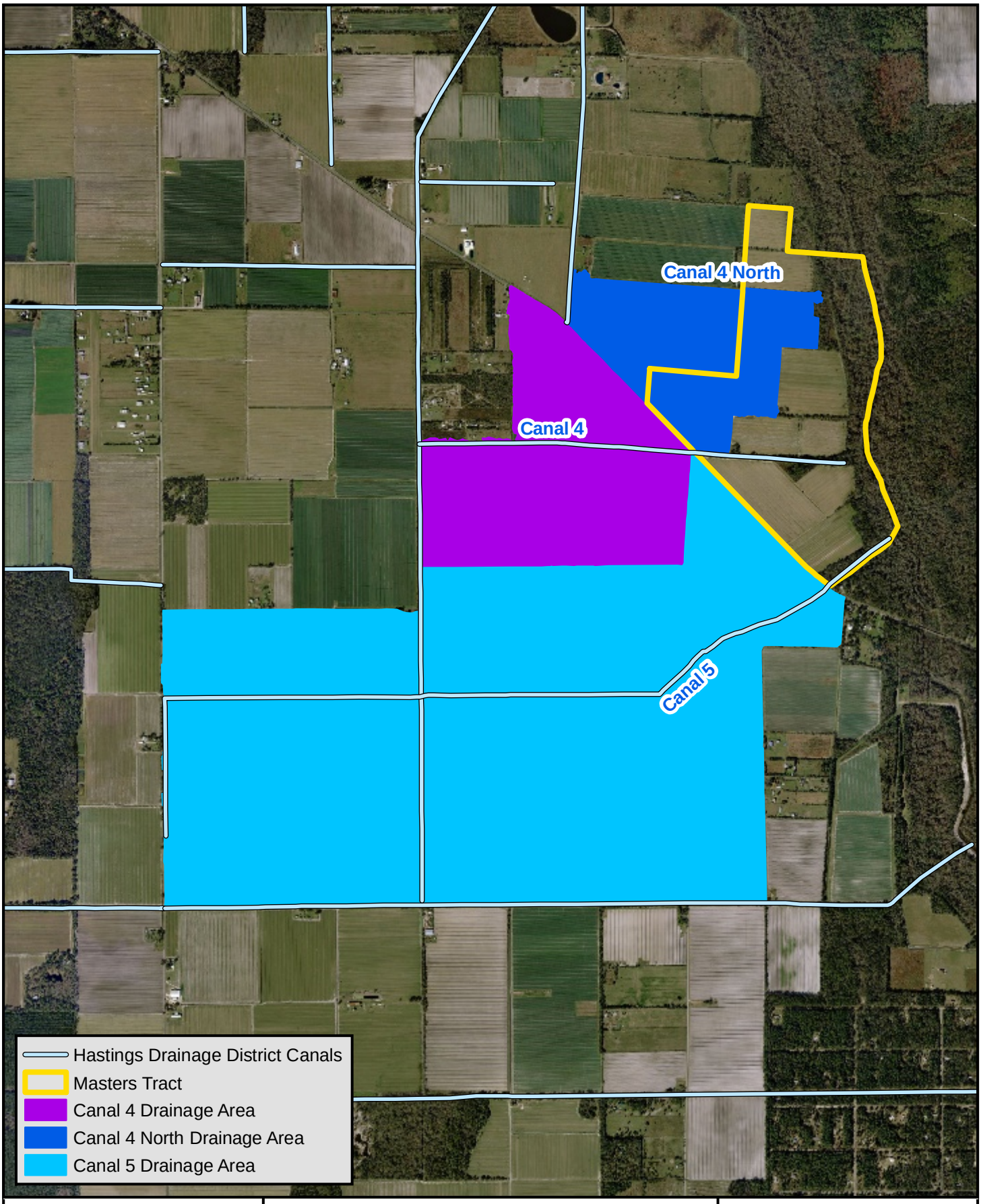

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Figure 2-1

Drainage Areas

Masters Tract

0 1,000 2,000

Feet

1:24,000

N

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3.0 SUMMARY OF CONCEPTUAL DESIGN

Jones Edmunds produced a nutrient optimization memorandum for the County. The memo, in Appendix C, provides a detailed discussion of the methods used to predict the flows and nutrient loads in each of the canals crossing the Masters Tract, summarizes the potential Best Management Practices (BMPs), and presents a recommended BMP treatment train as a conceptual design. The loads used to calculate the removal rates in the conceptual design are based on monitoring data from SJRWMD. Tables 3.1 and 3.2 summarize the predicted flows and loads from the upstream watersheds. The calculated nitrogen loads were adjusted to account for the irreducible concentrations of nitrogen. It is commonly recognized that all natural systems have a nitrogen concentration that will either persist in the system or that cannot be removed by treatment. For the Masters Tract RST these concentrations are assumed to be 1.0 mg/L of TKN and 0.1 mg/L of NOx. The treatable load represents the total nitrogen less the irreducible concentration. The treatable nitrogen load is 5,370 lb/year, which represents approximately 65% of the nitrogen loading coming from the upstream watershed.

Table 3.1 Initial Flow Estimate

	Canal 4	Canal 5	North of Canal 4	Grand Total	Notes
Base flow (cfs)	0.35	1.5	0.22	2	Assumes 12.6 in/yr base flow (CDM, 2003)
Storm flow (cfs)	5	16	1	19	Average Daily Rainfall of 0.2 inches

Table 3.2 Initial Nitrogen Load Estimate

Canal	Drainage Area acres	Flow	TKN lb	NOx lb	Total N lb	Treatable TKN lb	Treatable NOx lb	Total Treatable N lb
Canal 4	242.0	Base	50	30	80	0	20	20
Canal 4N	151.8	Base	30	20	50	0	10	10
Canal 5	1032.2	Base	200	80	280	0	40	40
Canal 4	242.0	Storm	900	270	1170	400	200	600
Canal 4N	151.8	Storm	100	40	140	100	0	100
Canal 5	1032.2	Storm	3000	3570	6570	1200	3400	4600
Total	1426	Both	4200	4010	8210	1700	3670	5370

4.0 PRELIMINARY DESIGN TO OPTIMIZE NITROGEN REDUCTION

Upon completion of the conceptual design and the ecological investigations, the conceptual design was modified to provide the maximum nutrient removal while providing the flexibility to gain wetland mitigation credits. The primary changes to the conceptual design presented above are (1) the sand filter was eliminated due to maintenance concerns and (2) the design now incorporates wetland creation areas detailed in Section 5. Based on continued discussions with SJRWMD regarding the UMAM analysis of the site, it may be possible to obtain wetland credits and treatment credits from the wetland creation areas. This possibility will be further explored during permitting.

The new design, which is designed to maximize nutrient credits and wetland mitigation credits, is called *the preliminary design* and is shown in Figure 4.1. The subsections below provide a summary of each element of the treatment train shown in the preliminary design.

4.1 CANAL 5 BMP: WET DETENTION POND WITH STORMWATER HARVESTING

Canal 5 drains 1032.2 acres of land, 75% of which is planted in row crops (Figure 2.1). The combination of the large land area and the intensive agricultural operations in the Canal 5 basin creates storm events with intense peak flows and high nutrient loads. The base flow in Canal 5 is 1.5 cfs, while the modeled peak flow is 175 cfs during a 1-year/1-hour event and 506 cfs during a 25-year/24-hour event. The total nitrogen concentration varies between 0.7 mg/L during the base flow and 3.7 mg/L following a storm event. The recommended management practice needs to withstand intense hydraulic loading and provide storage to attenuate the peak events. Therefore, the recommended BMP to remove nitrogen from Canal 5 is a wet detention pond designed to allow for stormwater harvesting.

The stormwater harvesting pond was sized using the design guidance for wet detention ponds provided by the SJRWMD in Chapter 40C-42, FAC and recommendations made by Harvey Harper in his report to FDEP (Harper & Baker, 2007). The permanent pool volume is 281 acre-feet, which provides 40 days of residence time for the average flow (base flow + runoff flow) in the wet season. The mean depth of the permanent pool is 8.5 feet. The depth of the permanent pool was checked using the anticipated algal production to ensure adequate aeration. The treatment volume is 86 acre-ft, which provides treatment to 1 inch of runoff over the entire 1032-acre drainage area or 6.3 inches or runoff over the effective impervious area. The mean depth of the treatment volume is 2.5 feet. The calculations used to size the wet detention pond are provided in Appendix D.

The demarcation between the wet detention pond's permanent pool volume and the treatment volume is typically the seasonal high groundwater table (SHGT). The property is currently a sod farm and has been in some form of agricultural production for over 60 years. The sod fields are kept extremely wet and soils throughout the site were saturated during our site visits. The irrigation appears to artificially elevate the surficial groundwater table across the site. Thus, it is extremely difficult to determine the existing or historic SHGT for the Masters Tract site. Jones

Edmunds has designed the elevation of the top of the permanent pool volume at 7.5 ft NAVD, which corresponds to the bottom elevation of the irrigation ditches on site. At this elevation the pond should continue to hydrate the wetland areas along Deep Creek and Canal 5.

4.1.1 Canal 5 Intake

Canal 5 is reportedly owned and operated by the Hastings Drainage District (HDD). However, the boundary survey and title search performed by the SJRWMD did not find a recorded easement for Canal 5.

The wet detention pond proposed for Canal 5 is similar to the one at the Deep Creek RST, with modifications based on Jones Edmunds' review of the Deep Creek RST. We had noted several issues related to the hydraulics of the pumps station, the forebay, and the intake from the canal at Deep Creek (see memo in Appendix E).

Based on the observations at Edgefield, the Masters Tract RST intake is designed to create a preferential flow path to the pump station rather than trying to "pull" water out of the canal using pumps. The diversion is created by placing a weir in the existing canal and constructing a bypass canal that directs the water to the pump station wet well. The bypass canal connects to Canal 5 downstream to allow large storm events to pass without affecting the water levels upstream of the Masters Tract RST. The bypass canal is at the same elevation as Canal 5, but it is three times wider, thereby increasing the capacity of the canal while reducing the velocity during the peak flow events. The increased width allows the bypass channel to serve as a forebay for the pump station. A preliminary plan of the bypass channel/forebay is provided in Figure 4.2.

The design elevation for the diversion weir will be finalized during the design phase using detailed hydraulic modeling of the drainage basin and the Canals. The weir elevation will be designed to minimize changes to the water elevations upstream of the Masters Tract RST.

4.1.2 Pump Station

The preliminary design of the pump station is designed to eliminate the problems observed at the Deep Creek and Edgefield RSTs. To simplify operation and maintenance of the pump station, we selected wet-pit submersible pumps with 2-inch, non-clog, and mixed-flow impellers. These pumps are designed to pump high flows at low heads and handle the types of stringy solids frequently encountered in stormwater. The pumps and motors do not need to be protected from rising flood water, which is a significant advantage considering that the Masters Tract is entirely within the 100-year floodplain. Maintenance and inspection of the pumps and motor do not require anyone to enter the forebay or wet well. Rather, the pump/motor unit is lifted up and out through the pump discharge column pipe.

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A

WCS #8

WCS #9

WCS #7

WETLAND CELL 3
(16.5 AC)
(ZONE 1 = 2.8 AC)
(ZONE 2 = 13.7 AC)

WCS #5

WCS #6

CANAL 5

BYPASS CANAL/ FOREBAY

LITTORAL ZONE
(6.0 AC)

PUMP STATION

WETLAND CELL 2
(15.9 AC)
(ZONE 1 = 1.3 AC)
(ZONE 2 = 14.6 AC)

CANAL 4N
(6.0 AC)
(ZONE 1 = 1.4 AC)
(ZONE 2 = 4.6 AC)

CANAL 4
(12.9 AC)
(ZONE 1 = 3.6 AC)
(ZONE 2 = 9.3 AC)

WET POND (OPEN WATER)
(35.5 AC)

CR 13 S

WCS #4

WETLAND CELL 1
(17.9 AC)
(ZONE 1 = 1.3 AC)
(ZONE 2 = 16.6 AC)

WCS #3

WCS #2

WCS #1

A

HUB BAILEY ROAD

STORMWATER
IRRIGATION FIELD
(30.4 AC)

GRAPHIC SCALE
0 75 150 300
SCALE IN FEET
1"=150'

LEGEND

- MASTERS TRACT (166.4 AC)
- RIGHT OF WAY
- FLAGGED WETLAND LINE (PER JONES EDMUNDS)
- 30' WIDE ACCESS EASEMENT
- 30' WIDE HASTINGS DRAINAGE DISTRICT EASEMENT
- WCS #2 WATER CONTROL STRUCTURE
- SJC PROPOSED SJRWMD RETAINED AREAS (113 AC)
- PROPOSED FLOW-WAY ENHANCEMENT AREAS (18.9 AC)
- FORESTED WETLAND CREATION AREAS (40.3 AC)
- FORESTED WETLAND ENHANCEMENT AREAS (10.0 AC)
- WETLAND BUFFER ENHANCEMENT AREAS (18.3 AC)

FIGURE 4.1
PRELIMINARY DESIGN RST AND WETLAND MITIGATION DESIGN
MASTERS TRACT
ST JOHNS COUNTY, FLORIDA

JONES EDMUNDS

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WET POND
NORMAL
WSE 7.5

4:1
(TYP)

4:1
(TYP)

WSE 5.2
DURING 1
YR 1HR EVENT

4:1

4:1

2:1

2:1

POND INTAKE
PUMP STATION
(SEE DETAIL)

4:1

CANAL 5

CR 13 S

ASPHALT PAVEMENT

OHE

N

GRAPHIC SCALE
0 15 30 60
SCALE IN FEET
1"=30'

LEGEND

- MASTERS TRACT BOUNDARY
- RIGHT OF WAY
- OHE EXISTING OVERHEAD ELECTRIC
- WETLAND LINE

FIGURE 4.2
BYPASS CANAL/FOREBAY
MASTERS TRACT
ST JOHNS COUNTY, FLORIDA

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The preliminary design of the pump station is shown in Figure 4.3 and includes:

- One base flow pump with a capacity of 1.5 cfs.
- Two storm flow pumps, each with a capacity of 8 cfs, to pump the mean annual storm event of 16 cfs.

4.1.3 Littoral Zone

The wet detention pond includes a littoral zone along the eastern boundary of the pond. The area of the littoral zone is 6.03 acres, which is approximately 17% of the pond surface area, slightly less than the 20% recommended by SJRWMD. The elevation of the littoral zone varies between 7.5 feet and 10 feet, which corresponds to the elevations for the treatment volume of the pond. Figure 4.1 shows the location of the littoral zone. Fluctuating water levels associated with stormwater harvesting from the wet detention pond will be further evaluated during final design.

4.1.4 Stormwater Harvesting

The Master Tract RST is currently a sod farm. Growing sod is a water-intensive activity, as demonstrated by the fact that the Master Tract has 10 wells with a permitted consumptive use capacity of 137.67 million gallons per year. Consumptive use permits require agricultural operations to use the lowest quality of water suitable for their crop. In anticipation of future negotiations with agricultural interests, Jones Edmunds recommends that the County continue to grow sod on one field to demonstrate the effectiveness of using harvested stormwater to irrigate the sod. We also recommend transferring the consumptive use permit to the County.

Harvesting stormwater is also a highly effective stormwater treatment BMP. The sod field north of the wet detention pond (see Figure 4.1), is approximately 30 acres. The treatment volume stored in the wet detention pond may be used to irrigate the field 2 inches per week, which is approximately the volume at which the fields are currently irrigated during the dry season. Based on the storage volume, usage rate, and the Reuse-Efficiency-Volume (REV) curve development by the SJRWMD for the Gainesville area, the nitrogen-removal efficiency for stormwater harvesting is approximately 50%. If the County can convince other area farmers to use the pond for irrigation, the efficiency will increase. For example, the removal efficiency for irrigating 75 acres is 90%. To convince area farmers to use the harvested stormwater, the County will likely have to provide a reliable flow and pressure to the farmers' irrigation systems even when the pond is too low to provide water. An existing on-site well could be used to augment the stormwater harvesting system to increase reliability and gain more interest from local farmers.

The stormwater will be harvested from the pond using a horizontal well. The well will be installed between Canal 4 and the wet detention pond to collect water that percolated from the pond into the surficial aquifer. Using a horizontal well to harvest the stormwater provides filtration and removes microorganisms. These types of irrigation wells are frequently used in central and south Florida. They have a long and successful track record of low maintenance.

4.1.5 Wetland Creation Areas

The main function of the wetland creation areas is to provide the County with wetland mitigation credits for future projects. However, wetlands also provide an additional step in the treatment train. The base flow from the wet detention pond, 1.5 cfs, will flow to the wetland to provide a constant source of water. In the wet season when it is not practical to use the harvested stormwater to irrigate sod, the stormwater will also be directed to the wetland. The wetland will provide a vital polishing step to the wet detention effluent. Design calculations show the wetland removing very little TN, because the design calculations are based on a predicted concentration, a constant flow rate, and a constant removal rate. In reality the canal will experience changes in nutrient loading based on upstream fertilizer application, on-farm water control, and storm events, and the wet detention pond will also have changes in residence time, algal density, and temperature. The wetland cells provide an additional filtering capability to address the fluctuations in the performance of the wet detention pond.

4.1.6 Wet Detention Discharge

The wet detention pond is designed to discharge in four directions:

- Subsurface Wetland Hydration – The top of the permanent pool volume in the wet detention pond is at 7.5 feet NAVD. The elevation corresponds to the irrigation ditch elevations in the existing field. The pond should, therefore, continue to hydrate the wetlands south and east of the pond in a manner similar to the way the existing sod farm hydrates the wetlands.

- Surface Wetland Hydration – The normal discharge of the pond through the bleed-down orifice is directed to the wetland creation areas.

- Stormwater Harvesting – Stormwater is harvested to irrigate the 30-acre sod field north of Canal 4. Water for irrigation is supplied using horizontal shallow groundwater wells installed between Canal 4 and the wet detention pond. The water is assumed to come primarily from the groundwater mound created by the wet detention pond.

- Emergency Overflow – The wet pond is provided with an emergency overflow to direct flow to Canal 4 and to allow flood water from Deep Creek to enter the pond in a controlled manner to minimize flood damage to the berm during the 100-year storm event. The pumps will shut off when the pond reaches the overflow elevation.

4.2 CANAL 4 BMP: WATER QUALITY FLOW-WAY

Canal 4 conveys the drainage from 242 acres of land, of which 161 acres is potato fields or row crops. The canal is an agricultural drainage canal under the control of the HDD. The recommended

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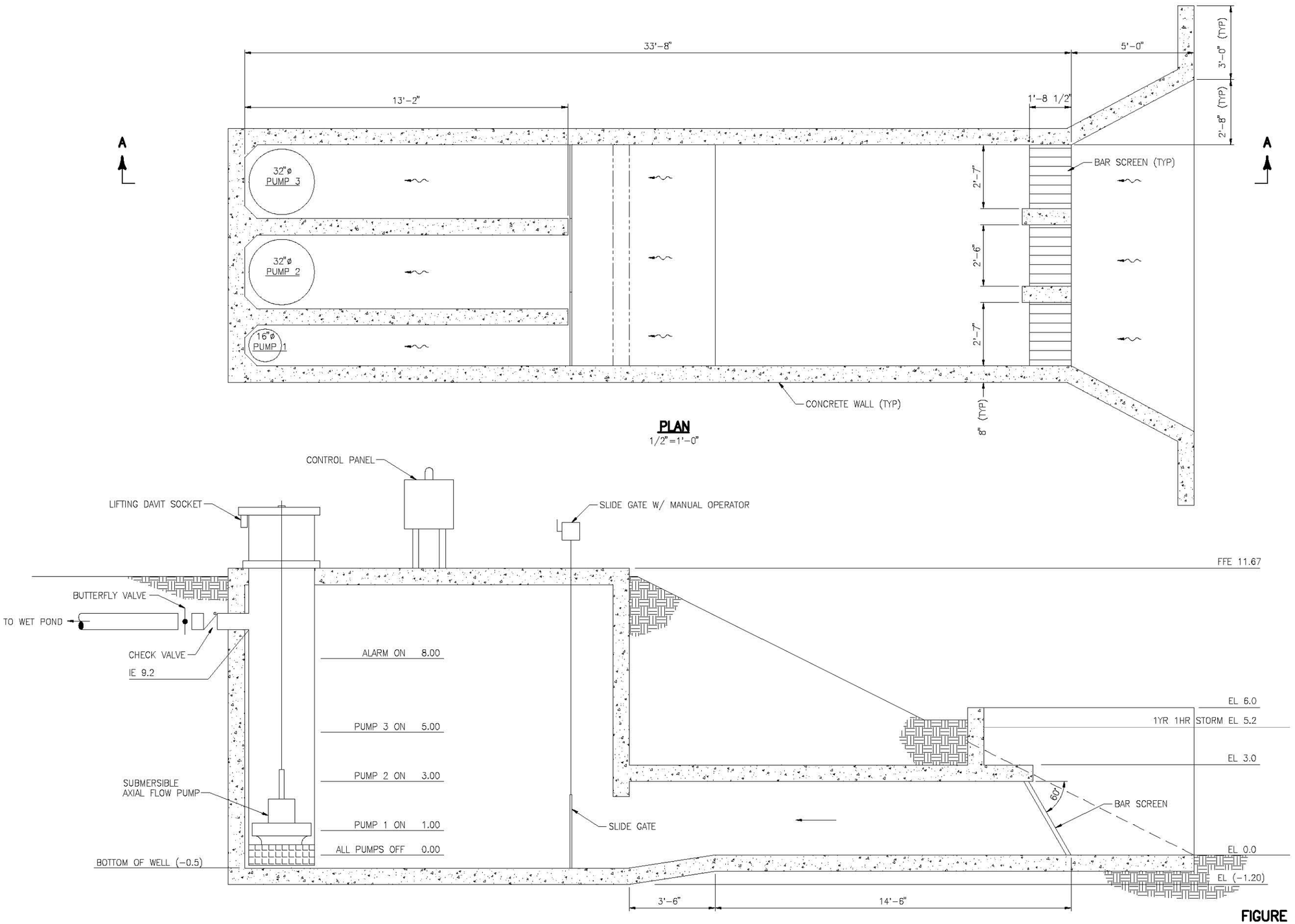


PLAN
1/2"=1'-0"

SECTION A-A
1/2"=1'-0"

FIGURE 4.3
POND INTAKE PUMP STATION DETAIL
MASTERS TRACT
ST JOHNS COUNTY, FLORIDA

JONES EDMUNDS

BMP for Canal 4 is to create a water quality flow-way by widening the existing canal to provide more surface area to allow infiltration and uptake by vegetation (Figure 4.1). The BMP was primarily selected because it will improve the water quality without impeding the flow in the canal.

The water quality flow-way was sized based on SJRWMD criteria for swales found in 40C-41. A water quality flow-way discharging to a Class I or II receiving water should infiltrate 80% of the peak flow from a 3-year/1-hour storm event during the wet season and convey the remaining water without causing erosion. Designing a flow-way for Canal 4 to meet these criteria is difficult because, as previously mentioned, the hydrology of the site is altered, making it difficult to locate the SHGT. The SHGT was therefore estimated at elevation 2.5 ft NAVD based on a lichen line located along Deep Creek. The normal groundwater elevation was estimated at 0.0 ft NAVD. The calculations used to size the water quality flow-way are provided in Appendix F.

The following data were used to size the dimensions of the water quality flow-way:

- Base flow in Canal 4 is 0.35 cfs.
- The mean annual storm flow is 4.7 cfs.
- The peak flow from 3-year/1-hour event is 87 cfs.
- The SHGT assumed to be at elevation 2.5 ft NAVD.

The resulting flow-way has a bottom width of 300 ft, 6:1 side slopes, and a top width of 372 ft. The flow-way is estimated to infiltrate about 48% of the flow from a 3-year/1-hour event during the wet season, and 89% during the dry season. The average velocity in the flow-way is less than 1 fps during the 3-year/1-hour event

4.3 CANAL 4 NORTH BMP: WATER QUALITY FLOW-WAY

Canal 4 North conveys the drainage from 152 acres of land, 94% of which is potato fields or row crops. The canal is also an agricultural drainage canal under the control of the HDD. The recommended BMP for Canal 4 North is to create a water quality flow-way by widening the existing canal width (Figure 4.1). The BMP was primarily selected because it will improve the water quality without impeding the flow in the canal.

The water quality flow-way was sized based on SJRWMD criteria found in 40C-41. A water quality flow-way discharging to a Class I or II receiving water should infiltrate 80% of the peak flow from a 3-year/1-hour storm event during the wet season and convey the remaining water without causing erosion. Designing a flow-way for Canal 4 North to meet these criteria is difficult because it is difficult to locate the SHGT. The SHGT is estimated at elevation 2.5 ft NAVD based on a lichen line located along Deep Creek. The normal groundwater elevation is estimated as 0.0 ft NAVD.

The following data were used to size the dimensions of the water quality flow-way:

- Base flow in Canal 4 North is 0.22 cfs.
- The mean annual storm flow is 1.0 cfs.
- The peak flow from 3-year/1-hour event is 49 cfs.
- The SHGT is at 2.5 ft NAVD.

The resulting flow-way has a bottom width of 200 ft, 6:1 side slopes, and a top width of 248 ft. The flow-way is estimated to infiltrate about 22% of the flow from a 3-year/1-hour event during the wet season, and 30% during the dry season. The average velocity in the flow-way is less than 1 fps during the 3-year/1-hour event. The flow-way is estimated to infiltrate 100% of the base flow and the mean annual flow throughout the year.

4.4 NITROGEN REMOVAL CREDITS FOR PRELIMINARY DESIGN

The nitrogen removal for each BMP is estimated based on the influent nutrient loads, calculated using the base flow, the mean annual storm event, and monitoring data from SJRWMD. The predicted influent load is presented in Table 3.1.

4.4.1 Canal 5 – Nitrogen Removal

The water from Canal 5 is pumped to a wet detention pond where it is held for 40 days. The overflow from the pond is directed to the wetland cells. Additional water is harvested from the surficial groundwater mound adjacent to the pond to the sod field for irrigation. Based on the REV curves, half of the pond storage is directed to irrigation on an annual average basis. The nitrogen removal for each step of the treatment train is provided in Table 4.1.

Table 4.1 Canal 5 Nitrogen Removal

Treatment Step	Removal	Treatable TKN lb/yr	Treatable NOx lb/yr	Treatable Total N lb/yr
Influent	0%	1,200	3,440	4,640
Wet Detention Effluent	40% TKN 100% NO3+NH3	720	0	720
Wetland Influent-	½ of pond effluent	360		
Wetland Effluent	36%	230	0	230
Stormwater Harvesting Influent	½ of pond effluent	360		
Stormwater Harvesting	50% of pond effluent is used REV	0	0	0
Canal 5 Effluent		230	0	230
Total Removal	95% of TN	81%	100%	4410

4.4.2 Canal 4 – Nitrogen Removal

The water from Canal 4 is spread across a 300-foot-wide flow-way and allowed to infiltrate. The nitrogen removal for the base flow and storm flow is provided in Table 4.2.

Table 4.2 Canal 4 Nitrogen Removal

Treatment Step	Removal	Treatable TKN lb/yr	Treatable NOx lb/yr	Treatable Total N lb/yr
Influent – Base Flow		0	20	20
Water Quality Flow-way Infiltration – Base Flow	100%	0	0	0
Influent – Storm Flow		400	200	600
Water Quality Flow-way Effluent –Storm Flow	40%	240	120	360
Total Removal	52% of TN	40%	54%	260

4.4.3 Canal 4 North – Nitrogen Removal

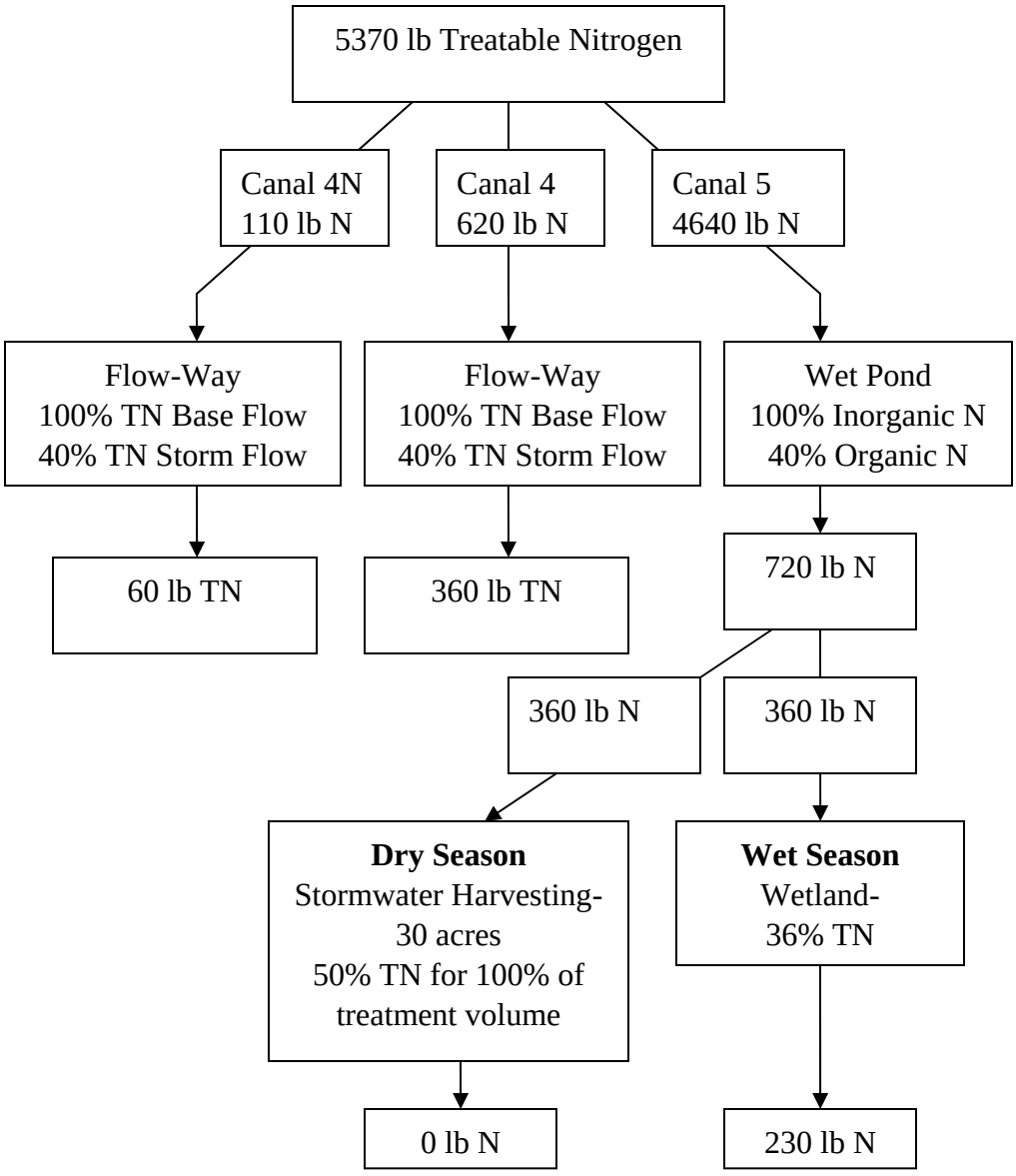
The water from Canal 4 North is spread across a 200-foot-wide flow-way and allowed to infiltrate. The nitrogen removal for the base flow and storm flow is provided in Table 4.3.

Table 4.3 Canal 4 North Nitrogen Removal

Treatment Step	Removal	Treatable TKN lb/yr	Treatable NOx lb/yr	Treatable Total N lb/yr
Influent – Base Flow		0	10	10
Water Quality Flow-way Infiltration – Base Flow	100%	0	0	0
Influent – Storm Flow		100	0	100
Water Quality Flow-way Effluent – Storm Flow	42%	60	0	60
Total Removal	45% of TN	42%	100%	50

4.4.4 Total Modeled Nitrogen Removal

The predicted nitrogen removal, based on modeled influent data and literature values of percent removal, is 4720 pounds of nitrogen, or 88% of the treatable nitrogen. Overall, the recommended BMPs reduce the total nitrogen load from 8,210 to 3490 lb nitrogen per year, a reduction of 57%. A flowchart of the treatment train is presented in Figure 4.4.



Treatable Nitrogen: 5370 lb N to 650 lb N = 88% removal of treatable nitrogen.
Total Nitrogen (TN): 8210 lb N to 3490 lb N = 57% removal of TN.

Total Nitrogen Removed = 4,720 lb

Figure 4.4 Preliminary Treatment Train for Masters Tract RST

5.0 PROPOSED MITIGATION PLAN

The County is actively identifying and establishing off-site mitigation areas in each of the SJRWMD mitigation basins to facilitate the CIP project permitting process and in many cases to save revenue that would otherwise go to purchasing private wetland mitigation bank credits. The County recently acquired the Floyd and Tatum tracts and is in the process of purchasing the Masters Tract, all of which are in the southwest region of the County in SJRWMD Mitigation Basin 8 (St. Johns River Welaka to Bayard) (Figure 5.1).

Jones Edmunds conducted a detailed environmental assessment in July and August 2009 to identify the approximate limits of jurisdictional wetlands, unique habitats, exotic plant species, and anthropogenic impacts at the three properties. This assessment was used to identify and develop mitigation activities that could be implemented to generate wetland mitigation credits for County CIP projects. Jones Edmunds investigated past land-use practices and historical changes to vegetation communities by reviewing historical aerial photography and also completed UMAM analyses to estimate wetland mitigation credits. The following provides a brief description of each project site, results of the UMAM analysis, and a mitigation plan for each of the three properties.

5.1 MASTERS TRACT

The Masters Tract is being used for TMDL-related nutrient reduction credits as well as wetland mitigation. As a result, the site could be used to maximize nutrient removal or wetland mitigation. Jones Edmunds conducted a site plan alternatives analysis to determine a site plan that would maximize wetland mitigation potential of the Masters Tract but that assumed that the southern portion of the site would contain an RST pond. Figure 5.2 depicts the site plan that would optimize the Masters Tract for wetland mitigation by using the entire northern third of the site for such activities. However, based on discussions with the County and the desire to optimize nutrient removal, the proposed mitigation plan was revised to provide additional nutrient removal north of the RST pond. The following provides the proposed wetland mitigation plan for the Masters Tract.

5.1.1 Historical Conditions

The Masters Tract property has been in some form of agricultural production since the early 19th century. Historical aerials from 1942 show that the property was used for row crops in almost the exact same areas as today. The only change in wetland area occurred in the northeast region of the property where approximately 1 acre of the site that was former row crops in 1942 is now forested wetlands (Figure 5.3). However, this conversion to wetland is likely a result of the area's being artificially impounded because it is encircled with a berm and other hydrologic alterations that are common within this site. A review of additional imagery such as that of 1995, 2004, and 2008 did not document the presence of standing water or saturated soils to support the fact that the eastern agricultural portions of Masters Tract were historically wetland.

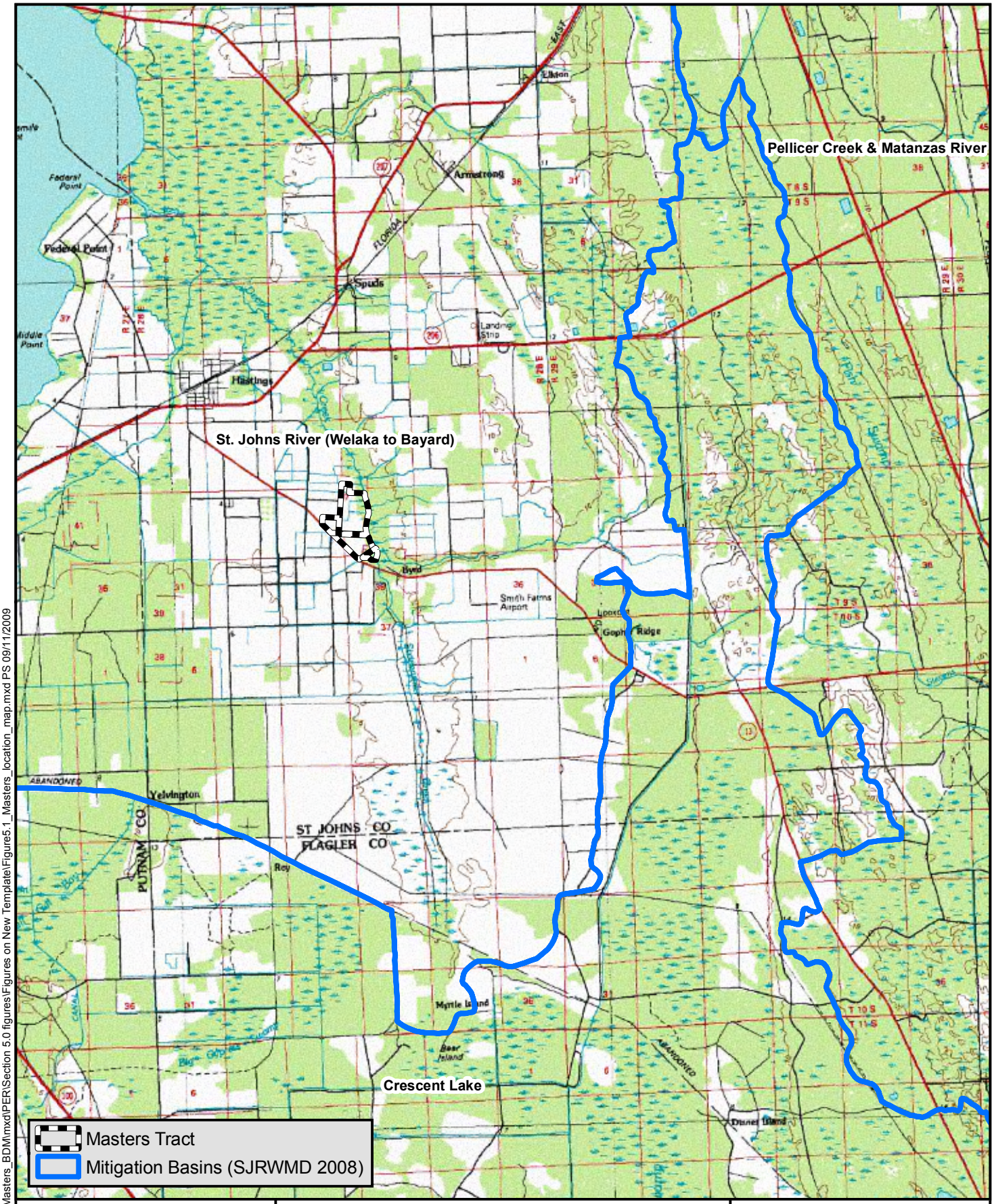


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Figure 5.1
Masters Tract and
SJRWMD Mitigation Basins Map
Masters Tract PER

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Feet
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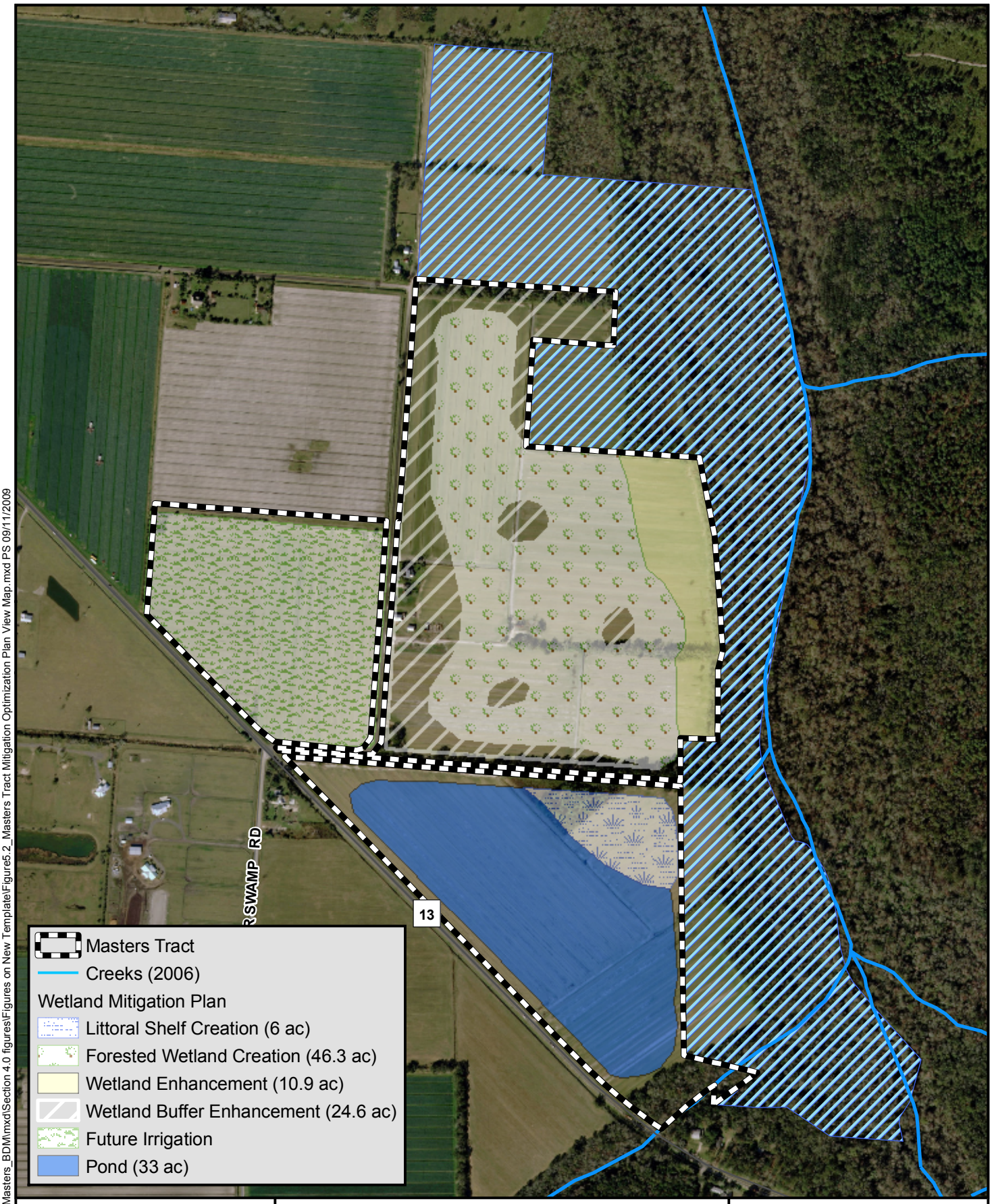

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Figure 5.2

Conceptual Mitigation Optimization Design Plan View Map

Masters Tract PER

0 350 700

Feet

1:8,400

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Figure 5.3

Masters Tract 1942 Aerial Map

Masters Tract PER

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Feet

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5.1.2 Existing Conditions

5.1.2.1 Hydrology

As previously mentioned, the Masters Tract is currently a sod farm and has been in some form of agricultural production such as row crops for well over 60 years. The site contains a myriad of irrigation and drainage ditches to grow the row crops or sod. Within the current sod farm, 1-foot-wide-by-1-foot-deep irrigation ditches, spaced parallel every 60 feet, run towards Deep Creek. These irrigation ditches are filled using 6-inch groundwater wells or, in some fields, a hose bib installed at the upstream head of each ditch.

The sod fields are kept extremely wet and soils throughout the site were saturated during several site visits. There are also several ditches that intercept flow from these small irrigation ditches and convey it to Deep Creek. In addition, there is an approximately 3-foot-high berm that runs north-south along the tree line of the Deep Creek floodplain. The intent of this berm is likely to restrict water from Deep Creek during high flows. As a result of this extensive irrigation, ditching, and berming, the hydrology of the site is very disturbed. In addition, the irrigation is considered to be artificially elevating the surficial groundwater table at the site.

5.1.2.2 Vegetation Communities

Jones Edmunds completed a jurisdictional wetland and surface water delineation of the Masters Tract in June 2009. Delineating jurisdictional wetlands along the Deep Creek floodplain and sod farm was very challenging due to the extensive irrigation network, the lack of native vegetation in the sod farm, and the berms on the west side of the Deep Creek floodplain. Christine Wentzel of SJRWMD met Jones Edmunds at the site on June 29, 2009 to review several flags placed by Jones Edmunds in this area in an effort to reduce any changes to the line by SJRWMD during a jurisdictional review that typically occurs during the ERP review process. Jones Edmunds and SJRWMD discussed the wetland line and agreed on the wetland line using liverworts as an indicator for the southern half of the sod farm and a naturally regenerated wetland area as the approximately north/south line for the northern half of the sod farm. Ms. Wentzel also stated that SJRWMD will only claim the main deep irrigation/drainage ditches (3 feet deep x 6 feet wide) and will not claim the extensive network of small (1 foot deep x 1 foot wide) interior irrigation canals that occur throughout the sod farm.

The Masters Tract is comprised of one main upland, one surface water, and two wetland communities, which were classified using the 1999 FDOT *Florida Land Use, Forms, Cover, and Classification System* (FLUCFCS): Sod Farms (FLUCFCS Code 2420), Streams and Waterways (FLUCFCS Code 5100), Stream and Lake Swamps (Bottomland)(FLUCFCS Code 6150), and Wet Prairies (FLUCFCS Code 6430) (Figure 5.4). Sod Farm comprises a majority of the site

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Figure 5.4

Masters Tract Existing Land Use Map

Masters Tract PER

0 300 600

Feet

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(157.6 ac) and is dominated by turf grass species, such as St. Augustine (*Stenotaphrum secundatum*), which are regularly harvested. The Streams and Waterways community comprises approximately 5.7 acres and refers to the upland cut ditches that traverse the sod farm, which serve as either irrigation or drainage canals for the sod farm (Figure 5.4). These ditches create a network of systems that eventually discharge into the Deep Creek floodplain. Plant species such as cattail (*Typha latifolia*), sedges (*Cyperus* spp.), panicums (*Panicum* spp.), alligator weed (*Alternanthera philoxeroides*), water hyssop (*Bacopa monnieri*), ludwigia (*Ludwigia repens, L. leptocarpa*), and Asian coinwort (*Centella asiatica*) dominate the actual ditch while red maple (*Acer rubrum*), laurel oak (*Quercus laurifolia*), sugarberry (*Celtis laevigata*), sweetgum (*Liquidambar styraciflua*), wax myrtle (*Myrica cerifera*), and swamp dogwood (*Cornuus foemina*) are common along the banks or adjacent spoil mounds. The Stream and Lake Swamps (Bottomland) community is a mature high-quality wetland system comprising 1.1 acres in the southeast corner of the site (Figure 5.4). This community is dominated by large mature sweetgum, bald cypress (*Taxodium ascendens*), laurel oak, pop ash (*Fraxinus caroliniana*), red maple, musclewood, cinnamon fern (*Osmunda cinnamomea*), lizards tail (*Saururus cernuus*), and dwarf palmetto (*Sabal minor*). Stream and Lake Swamps (Bottomland) are the primary land use east of the eastern site boundary and are the floodplain wetlands associated with Deep Creek. These wetlands were originally in the SJRWMD-owned Masters Tract but SJRWMD is retaining ownership of these wetlands as well as areas to the north since the site was purchased with FDOT mitigation funds (Figure 5.4).

Wet Prairies refers to herbaceous wetland communities found in several small areas within the sod farm that have formed in depressions within the sod farm and are often near the terminus of irrigation ditches within the sod farms (Figure 5.4). These communities are dominated by sedges, alligator weed, pennywort (*Hydrocotyle umbellata*), ludwigia, frogfruit (*Lippia nodiflora*), and rushes (*Juncus* sp.).

5.1.2.3 Exotic Species

The Masters Tract has exotic plant species throughout the property in addition to the exotic turf grasses that dominate the site. Additional exotic plant species that were very common, primarily in ditches and on adjacent spoil berms, include Japanese climbing fern (*Lygodium mycrophyllum*), wild balsam apple (*Momordica charantia*), creeping oxeye (*Wedelia trilobata*), alligator weed, primrose willow (*Ludwigia peruviana*), crape myrtle (*Lagerstroemia indica*), air potato (*Dioscorea bulbifera*), and camphor tree (*Camphor cinnamomea*).

5.1.3 Proposed Mitigation Activities

5.1.3.1 Wetland Enhancement

Wetland enhancement of approximately 10.0 acres is proposed along the west side of the Deep Creek floodplain in areas that are currently sod farm but are flagged as jurisdictional wetlands in accordance with delineation guidance received by Christine Wentzel of the SJRWMD during a July 2009 site visit. This area is primarily the eastern portion of wetland Cell 3 (Figure 4.1).

The Deep Creek wetlands serve as natural reference wetlands that were initially going to be used to identify desirable wetland ground elevations for the proposed creation areas. Jones Edmunds staked and surveyed the 33 spot locations in these wetlands to signify low, high, and target elevations for the proposed wetland creation and enhancement areas (Figure 5.5 and Table 5.1). Elevations in the western portions of the sod farm range from 7 to 8 ft NAVD, while elevations in the highest portions of the floodplain wetland near the tree line are 3.0 to 3.3 ft NAVD. As a result, the initial proposed design elevation of the wetland creation areas was approximately 2.75 to 3.5 ft NAVD. However, construction of the wetland enhancement/creation areas at this preliminary elevation range would generate approximately 350,000 cubic yards of material, which would result in a significant project cost. To alleviate this significant cost, Jones Edmunds designed the wetland creation areas to receive water via gravity from the RST pond to support the wetland vegetation rather than constructing the wetland at an elevation that would intercept the groundwater table. Furthermore, the wetland creation areas were designed in three separate cells that are terraced to further reduce the amount of cut required. A water depth of approximately 6 inches to 1 foot is proposed during the wet season in the wetland enhancement and creation cells. Existing and proposed cross sections are provided in Figure 5.6.

The enhancement area (Cell 3) as well as the creation areas (Cells 1 and 2) will be comprised of Zone 1 and Zone 2 (Figures 4.1 and 5.6). Zone 1 represents the transitional zone between the created/enhanced wetland and adjacent upland and will consist of 6:1 side slopes that will tie to upland grade. This area will be planted with the facultative wet and facultative species red maple, laurel oak, musclewood, cabbage palm, sugarberry, sand cordgrass, iris, fetterbush, and muhly grass as these areas will experience minimal inundation. Zone 2 represents the majority of the enhancement or creation area which will become a diverse forested wetland. One-gallon tree species to be planted on 10-foot centers in the Zone 2 include red maple, bald cypress, black gum (*Nyssa sylvatica* var. *biflora*), and pop ash. One-gallon shrub species such as dwarf palmetto, buttonbush, and St. Johns wort will be planted on 10-foot centers and herbaceous species such as royal fern, soft rush, maidencane, duck potato, and lizards tail will also be planted on 10-foot centers. A native wetland wildflower seed mix available from the Florida Wildflowers Grower Cooperative will be broadcast across the cells to facilitate colonization of the site by desirable native wetland species. Please refer to Table 5.2 for a detailed planting plan.

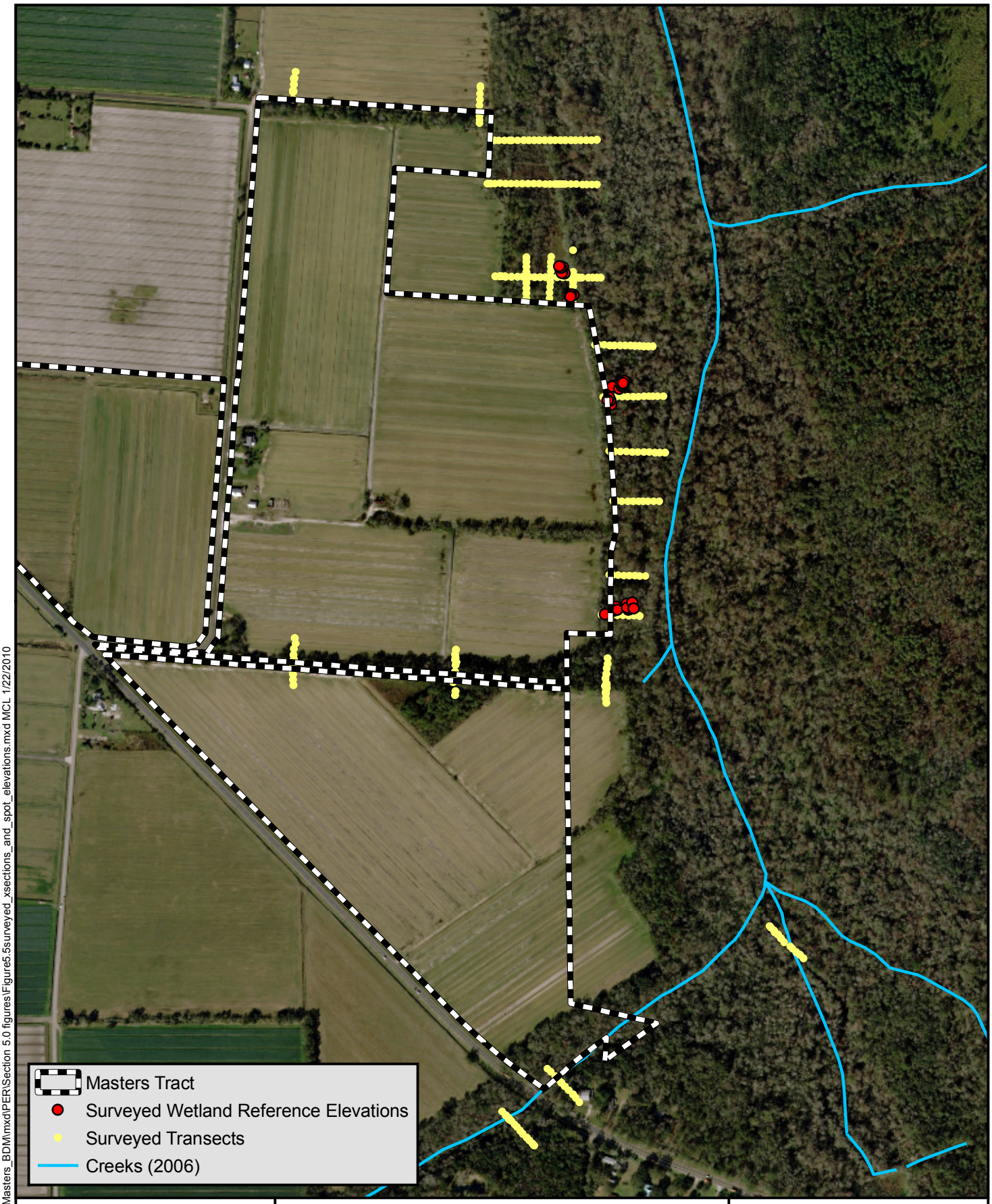

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Figure 5.5

Surveyed Wetland Reference Elevations Location Map

Masters Tract PER

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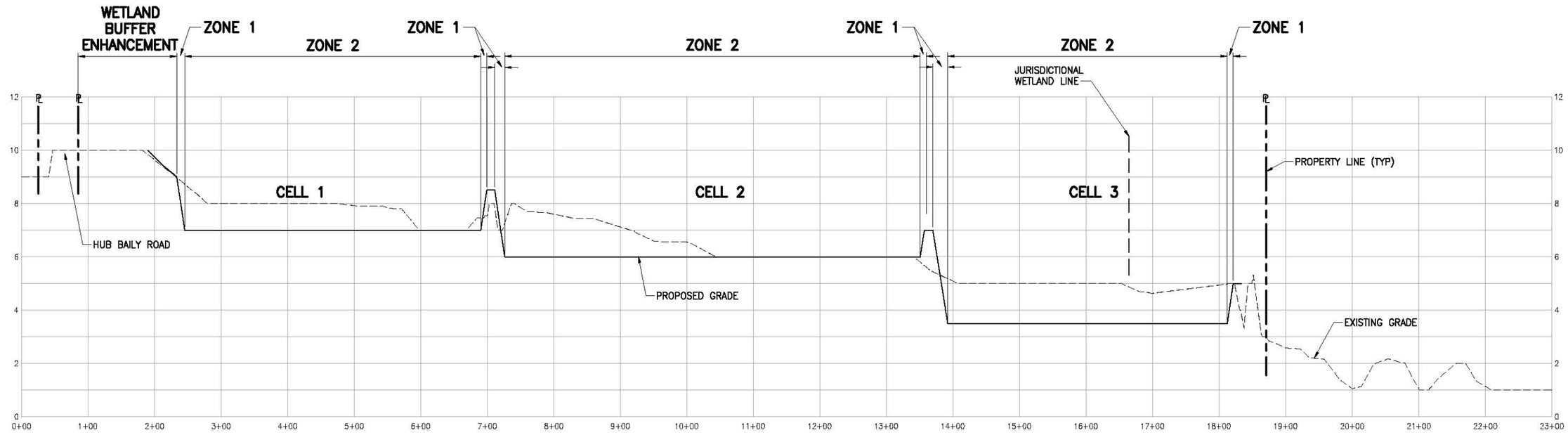

GRAPHIC SCALE
0 40 80 160
SCALE IN FEET
1"=80' HORIZONTAL

GRAPHIC SCALE
0 1 2 4
SCALE IN FEET
1"=2' VERTICAL

FIGURE 5.6 SECTION A–A
EXISTING AND PROPOSED WETLAND CREATION AREAS
MASTERS TRACT
ST JOHNS COUNTY, FLORIDA

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Table 5.1 Reference Elevations Surveyed in Deep Creek Floodplain

ID	Mark	General Location	Elevation (NAVD 88)	Elevation Description	Comments
RE1	Pin flag	Center	3.16	Too high to target high	Set at toe of berm at edge of forested wetland. Fairly dry and rarely inundated in this area. Caesar weed encroaching.
RE2	Pin flag	Center	3.01		
RE3	Pin flag	Center	3.23		
RE4	Pin flag	Center	3.28		
		Average	**3.17**		
RE5	Pin flag	Center	2.44	Target elevation	Area has 1 to 4 inches of standing water. Fairly dense understory of dwarf palmetto.
RE6	Pin flag	Center	2.52		
RE7	Pin flag	Center	2.55		
RE8	Pin flag	Center	2.60		
		Average	**2.53**		
RE9	Pin flag	Center	1.83	Target low elevation	
RE10	Pin flag	Center	2.01		
RE11	Pin flag	Center	1.74		
RE12	Pin flag	Center	1.95		
		Average	**1.88**		
RE20	Pin flag	North	3.63	Too high	Data not consistent with natural floodplain. This area appears to be impounded based elevations and water elevations 50 feet south in sod farm on other side of berm. Has 2 to 3 inches of standing water versus floodplain to the south which was completely dry at this elevation.
RE21	Pin flag	North	3.63		
RE22	Pin flag	North	3.82		
RE23	Pin flag	North	3.63		
RE24	Pin flag	North	3.50		
RE25					
RE26	Pin flag	North	3.57		
RE27	Pin flag	North	3.33		
RE28	Pin flag	North	3.50		
		Average	**3.51**		
EE1 High	Pin flag	Center	5.92	Infrequent high	Based on lichen lines
EE1 Low	Pin flag	Center	5.09	Infrequent high	Based on lichen lines
EE2	Pin flag	Center	5.69	Infrequent high	Based on lichen lines
EE3	Pin flag	Center	5.32	Infrequent high	Based on lichen lines
EE4	Pin flag	Center	5.09	Infrequent high	Based on lichen lines
		Average	**5.42**		
FW1	Pin flag	South	3.19	Target elevation	Areas appear to be not too wet and not too dry based on saturated soils and presence of understory species such as dwarf palmetto and lizards tail. Stain lines at approximately 18 inches on cypress.
FW2	Pin flag	South	3.03		
FW3	Pin flag	South	2.98		
FW4	Pin flag	South	3.02		
FW5			Missing		
		Average	**3.06**		
FW6	Pin flag	South	3.26	Target high	Pin flags placed near edge of forested floodplain and has dry soils. Area dominated by sugarberry and sweetgum but cypress knees present.
FW7	Pin flag	South	3.58		
FW8	Pin flag	South	3.91		
		Average	**3.58**		
FW9	Pin flag	South	1.78	Target low	Saturated soils or 2 inches of standing water with limited vegetation.
FW10	Pin flag	South	1.90		
FW11	Pin flag	South	1.90		
FW12	Pin flag	South	1.92		
		Average	**1.88**		
FW13	Pin flag	South	1.66	Too low	Elevations in un-vegetated flow ways.
FW14	Pin flag	South	1.73		
		Average	**1.70**		

*Target Elevation Range 1.75 - 3.0 ft NAVD 88; Dominate elevation = 2.5 ft NAVD 88

Table 5.2 Proposed Planting Plan for Masters Tract

Masters Tract Forested Wetland Enhancement/Creation Areas (50.3 Acres)							
Type	Zone	Scientific Name	Common Name	% Plants	Feet on Center	Size	Number of Plants*
Tree	1	*Quercus laurifolia*	Laurel Oak	25	10	1 gal	6,025
		Acer rubrum	Red maple	20			4,820
		Celtis laevigata	Sugarberry	15			3,615
		Sabal palmetto	Cabbage palm	25			6,025
		Carpinus caroliniana	Musclewood	15			3,615
						Subtotal	24,102
Shrub	1	*Lyonia lucida*	Fetterbush	100	10	1 gal	24,102
						Subtotal	24,102
Herb	1	*Spartina bakerii*	Sand cordgrass	35	6	Bare Root	8,436
		Iris sp.	Blue iris	35			8,436
		Muhlenbergia capillaris	Muhly grass	30			7,231
						Subtotal	24,102
Tree	2	*Nyssa sylvatica*	Blackgum	20	10	1 gal	4,820
		Acer rubrum	Red maple	20			4,820
		Fraxinus caroliniana	Popash	20			4,820
		Taxodium distichum	Bald Cypress	40			9,641
						Subtotal	24,102
Shrub	2	*Sabal minor*	Dwarf Palmetto	35	10	1 gal	8,436
		Cephalanthus occidentalis	Buttonbush	30			7,231
		Hypericum fasciculatum	St. Johns wort	35			8,436
						Subtotal	24,102
Herb	2	*Juncus effusus*	Soft rush	30	6	Bare Root	7,231
		Panicum hemitomon	Maidencane	25			6,025
		Sagittaria latifolia	Duck potato	25			6,025
		Saururus cernuus	Lizards tail	20			4,820
						Subtotal	24,102

Masters Tract Forested Wetland Buffer Enhancement Areas (18.3 Acres)							
Type	Zone	Scientific Name	Common Name	% Plants	Feet on Center	Size	Number of Plants*
Tree	NA	*Quercus virginiana*	Live oak	15	10	1 gal	1,315
		Acer rubrum	Red maple	20			1,754
		Liquidambar styraciflua	Sweetgum	20			1,754
		Sabal palmetto	Cabbage palm	15			1,315
		Diospyros virginiana	Persimmon	10			877
		Carya glabra	Pignut hickory	10			877
		Carpinus caroliniana	Musclewood	10			877
						Subtotal	8,769

Table 5.2 Proposed Planting Plan for Masters Tract							
Shrub	NA	*Sabal minor*	Dwarf Palmetto	35	6	1 gal	1,526
		Lyonia lucida	Fetterbush	30			1,308
		Hypericum fasciculatum	St. Johns wort	35			1,526
						Subtotal	4,360
Herb	NA	*Juncus effusus*	Soft rush	30	6	Bare Root	3,634
		Spartina bakerii	Sand cordgrass	25			3,028
		Iris sp.	Blue iris	25			3,028
		Osmunda cinnamomea	Cinnamon fern	20			2,422
						Subtotal	12,112
Masters Tract Littoral Shelf Creation Area (6.0 Acres)							
Type	Zone	Scientific Name	Common Name	% Plants	Feet on Center	Size	Number of Plants*
Herb	NA	*Eleocharis sp.*	Spikerush	15	3	Bare Root	4,392
		Panicum hemitomon	Maidencane	10			2,928
		Cladium jamaicense	Sawgrass	15			4,392
		Thalia geniculata	Fire flag	15			4,392
		Pontederia cordata	Pickerelweed	25			7,321
		Sagittaria latifolia	Duck potato	20			5,856
						Total	29,282
Masters Tract Flow-way Enhancement Areas (18.9 Acres)							
Type	Zone	Scientific Name	Common Name	% Plants	Feet on Center	Size	Number of Plants*
Herb	NA	*Eleocharis sp.*	Spikerush	10	3	Bare Root	10,062
		Panicum hemitomon	Maidencane	15			15,094
		Cladium jamaicense	Sawgrass	10			10,062
		Thalia geniculata	Fire flag	15			15,094
		Pontederia cordata	Pickerelweed	15			15,094
		Iris virginica	Iris	10			10,062
		Spartina alterniflora	Sand cordgrass	15			15,094
		Sagittaria latifolia	Duck potato	10			10,062
						Total	100,624

5.1.3.2 Wetland Creation

Creating approximately 40.3 acres of wetlands (Cells 1 and 2) is proposed in the central portion of the site immediately west of the wetland enhancement area (Figure 4.1). The wetland creation and enhancement areas will be hydrologically connected via adjustable drop structures. Small deep pools will be constructed around each of these drop structures to minimize clogging with vegetation. Several snags and large woody material from land clearing that occurs on any of the existing ditches/canals will be placed in creation areas to provide wildlife habitat and roost sites as well as a source of future organic matter. Please refer to Table 5.2 for a detailed planting plan and Figure 5.6 for an existing and proposed cross section through Cells 1, 2, and 3.

5.1.3.3 Littoral Shelf Creation

An approximately 6-acre emergent marsh will be created in the northeast corner of the RST pond to provide additional and more diverse wildlife habitat than the forested wetland creation and enhancement areas. Herbaceous bare-root wetland plants such as spikerush (*Eleocharis* spp.), maidencane, sawgrass (*Cladium jamai*cense), fire flag (*Thalia geniculata*), pickerelweed (*Pontedaria cordata*), and duck potato (*Sagittaria* spp.) will be planted in the wetland creation area on 3-foot centers. The elevation of this creation area will be determined during final design of the RST pond. All herbaceous species will be bare-root or liner stock planted on 3-foot centers. Table 5.2 provides a detailed planting plan.

5.1.3.4 Flow-Way Enhancement Areas

Canal 4 is a large agricultural drainage canal under the control of the HDD which conveys the drainage from 242 acres of land, of which 161 acres is potato fields or row crops. Canal 4 North conveys the drainage from 152 acres of land, 94% of which is potato fields or row crops (Figure 2.1). Jones Edmunds proposes that Canal 4 and Canal 4 North be widened extensively to create 18.9 acres of emergent marsh flow-ways that would allow infiltration, attenuate flows being discharged to Deep Creek, increase nutrient uptake by vegetation, and provide wildlife habitat (Figure 4.1). Attenuation of unnatural excess flows entering Deep Creek from the agricultural dominated drainage basin will help restore a more natural hydroperiod to downstream areas of Deep Creek. The proposed flow-way has a bottom width of 300 ft, 6:1 side slopes, and a top width of 372 ft. More specific design details were previously provided in Section 4.2.

Herbaceous 2-inch liner wetland plants such as iris, spikerush, maidencane, sawgrass, fire flag, pickerelweed, and duck potato will be planted in the wetland creation area on 3-foot centers. The elevation of this creation area will be determined during final design of this feature. All herbaceous species will be bare-root or liner stock. Please refer to Table 5.2 for a detailed planting plan.

5.1.3.5 Wetland Buffer Enhancement

Non wetland forested areas adjacent to the riparian wetlands associated with Deep Creek are characterized as hardwood hammock. Approximately 18.3 acres of sod farm surrounds the forested wetland creation/enhancement cells. Jones Edmunds proposes to enhance this wetland buffer by removing the sod with a mechanical sod cutter and planting desirable native species to create a hardwood hammock community. Plant species proposed include red maple, live oak, sweet gum, cabbage palm, persimmon (*Diospyros virginiana*), pignut hickory (*Carya glabra*), musclewood, wax myrtle, gallberry (*Ilex glabra*), beauty berry (*Callicarpa americana*), switchgrass (*Panicum virgatum*), and muhly grass (*Muhlenbergia capillaris*). Trees and shrubs will be 1 gallon and planted on 10-foot centers. Herbaceous species will be 2-inch liners also planted on 10-foot centers. As with the other mitigation areas, a native upland wildflower seed mix available from the Florida Wildflowers Grower Cooperative will be broadcast across the site to facilitate colonization of the site by desirable native herbaceous species. Please refer to Table 5.2 for a detailed planting plan.

RST Pond

The RST pond will capture a portion of the flow from Canal 5 that enters the property on the southern boundary (Figure 4.1). The canal drains approximately 1,032 acres, 749 acres or 73% of which is in row crops or sod. The RST pond is designed to capture the first flush event and has a 40-day detention time. The pond is anticipated to reduce TKN by 40%, NOx by 100% and TP by 66% from the canal which discharges to Deep Creek, a major tributary of the Lower St. Johns River, an impaired water body. The RST pond will also attenuate unnatural excess flows entering Deep Creek from the agricultural dominated drainage basin, which will help restore a more natural hydroperiod to downstream areas of Deep Creek.

5.1.4 UMAM Analysis

Jones Edmunds and the County held a pre-application meeting regarding mitigation activities at the Masters Tract on February 9, 2009 with Mark Evans and Jessica Spencer of USACE. At this meeting Mr. Evans stated that USACE would likely provide mitigation credit for the open water of the RST pond as well as for any emergent marsh littoral shelf created in this pond. Christine Wentzel of SJRWMD has indicated that SJRWMD would not give wetland mitigation credit for either feature. Thus, the Uniform Mitigation Assessment Method (UMAM) analysis completed for the open water and littoral shelf of the RST pond will be submitted to USACE but not to SJRWMD.

Jones Edmunds completed a UMAM analysis for the following mitigation activities proposed at the Masters Tract to determine the proposed Functional Loss (FL) credits that would be generated:

1. Forested Wetland Enhancement (for SJRWMD and USACE)
2. Forested Wetland Creation (for SJRWMD and USACE)
3. Wetland Buffer Enhancement (for SJRWMD and USACE)

4. Flow-Way Enhancement Area Creation (for SJRWMD and USACE)
5. RST Pond Littoral Shelf Creation (for USACE)
6. RST Pond Open Water Creation (for USACE)

The "Without Mitigation" condition for Wetland Buffer Enhancement was scored as if the assessment area were developed for County infrastructure or facilities. This is a realistic assumption as the County will likely develop the upland areas if they are not used as a regional mitigation site due to CR 13 frontage. The FL credits generated by this project are based on the Relative Functional Gain (RFG) from each proposed mitigation activity multiplied by the proposed mitigation acreage. A total of 21.4 functional loss mitigation credits may be generated for the SJRWMD based on the wetland enhancement, wetland creation, and wetland buffer enhancement activities occurring within the project boundary. A total of 41.8 functional loss mitigation credits may be generated for the USACE based on completing all six wetland mitigation activities referenced above. This UMAM analysis assumes that the USACE would accept 360 acres for the UMAM assessment area acreage used for RST Pond Open Water. This is based on the fact that approximately 900 acres of the 1,200-acre drainage basin is in row crops and the RST pond is anticipated to provide 40% removal efficiency. Table 5.3 summarizes the potential mitigation credits generated from the Masters Tract, the Tatum property, and the Floyd property while Table 5.4 summarizes the proposed activities and the resulting FL credits at the Masters Tract.

Table 5.3 Summary of Potential SJRWMD and USACE UMAM Credits Generated from Each Site

Mitigation Site	SJRWMD Potential Credits	USACE Potential Credits
Master's Tract	21.4	41.8
Tatum Property	13.4	13.4
Floyd Property	3.3	3.3
	38.1	**58.5**

5.2 TATUM PROPERTY

5.2.1 Historical Conditions

The Tatum property is an approximately 78-acre site comprised of two adjacent parcels (southwest and northeast parcels) north of Hastings, Florida and northwest of the intersection of SR 207 and East St. Johns Avenue (Figure 5.7). The property was recently acquired by the County from the Tatum family. The southwest parcel has been in agricultural production for over 60 years. Based on 1942 aerial photography this portion of the property was used for row crops (Figure 5.8). The northeast parcel is primarily Deep Creek floodplain but in the southwest corner some areas were cleared and there is an elevated road leading to a loading dock that was used to ship vegetables to the St. Johns River.

5.2.2 Existing Conditions

5.2.2.1 Hydrology

The southwest parcel has been drained for agricultural use via large ditches that encircle it (Figure 5.7). These ditches are connected to other off-site ditches that flow directly into Deep Creek. There is also a large spoil berm on the north side of the southwest parcel that likely restricts flow from Deep Creek into the parcel during the wet season. In the southwest parcel, bedding rows and adjacent furrows are present in areas planted in slash pine. Fallow areas currently forested in the northwestern portion of the southwest parcel still contain the relic rows and furrows from row crops. The furrows all drain to the large canal on the north side of the southwest parcel.

5.2.2.2 Vegetation Communities

Three communities were identified on-site and classified using the 1999 FDOT *Florida Land Use, Forms, Cover, and Classification System* (FLUCFCS): Coniferous Plantation (FLUCFCS Code 4410), Stream and Lake Swamps (Bottomland)(FLUCFCS Code 6150), and Wetland Coniferous Forest (FLUCFCS Code 6200) (Figure 5.9). The Coniferous Plantation community comprises approximately 17.5 acres and is found throughout the southwestern parcel. This community is dominated by 12- to 15-year-old slash pines that were planted on rows on elevated beds. Other native species that are common include sapling sweetgum, wax myrtle, beautyberry, beggar ticks (*Bidens alba*), trumpet vine (*Ampelopsis arborea*), sapling sweetgums, and blackberry (*Rubus* sp.). The Stream and Lake Swamps (Bottomland) community comprises 47.5 acres of the property and is found in the northwest corner of the southwestern parcel and the entire northeast parcel. The portion of this community in the southwest parcel was formerly row crops but is now dominated by red maple, swamp tupelo, bald cypress, laurel oak, wax myrtle, buttonbush, sedges, lizards tail, and royal fern. The remainder of this community found in the northeast parcel is mature and very high quality. Large bald cypress, swamp tupelo, and red maple are very common in this parcel. The Coniferous Plantation community refers to historic wetland areas that are now dominated by planted pine. The canopy of this community is dominated by slash pine but red maple and other wetland tree species dominated the mid- and understory.

5.2.2.3 Exotic Species

Numerous exotic and invasive plant species are found in the southwestern parcel and dominate the understory in much of the pine plantation and transitional areas. Exotic species observed include Caesar weed (*Urena lobata*), climbing fern, air potato, camphor, and rain tree (*Cassia* sp.).

Table 5.4 Masters Tract UMAM Summary Table

Mitigation Activity	Habitat Type (FLUCCS)	Location and Landscape Support		Water Environment		Community Structure		Time Lag	Risk Factor	Preservation Adjustment Factor	Relative Functional Gain	Acres Provided	Functional Gain Units
		W/Out Mitigation	With Mitigation	W/Out Mitigation	With Mitigation	W/Out Mitigation	With Mitigation						
Forested Wetland Creation	6300	0	7	0	8	0	8	1.68	2.00	1.0	0.228	40.3	9.2
Forested Wetland Enhancement	6300	5	7	3	8	1	8	1.68	2.00	1.0	0.139	10.0	1.4
Flow-Way Enhancement Areas	6410	0	7	0	7	0	8	1.14	2.00	1.0	0.322	18.9	6.1
Wetland Buffer Enhancement	4140	1	7	NA	NA	1	8	1.68	1.50	1.0	0.258	18.3	4.7
											SJRWMD TOTAL	**87.5**	**21.4**
RST Pond	5000	5	6	6	7	0	0	1.03	1.25	NA	0.052	360.0	18.6
RST Littoral Shelf	6410	0	6	0	7	0	8	1.14	2.00	NA	0.307	6.0	1.8
											USACE TOTAL	**453.5**	**41.8**

JONES EDMUNDS

Figure 5.7

Tatum Tract Location and Aerial Map

Masters Tract PER

0 350 700

Feet

1:8,400

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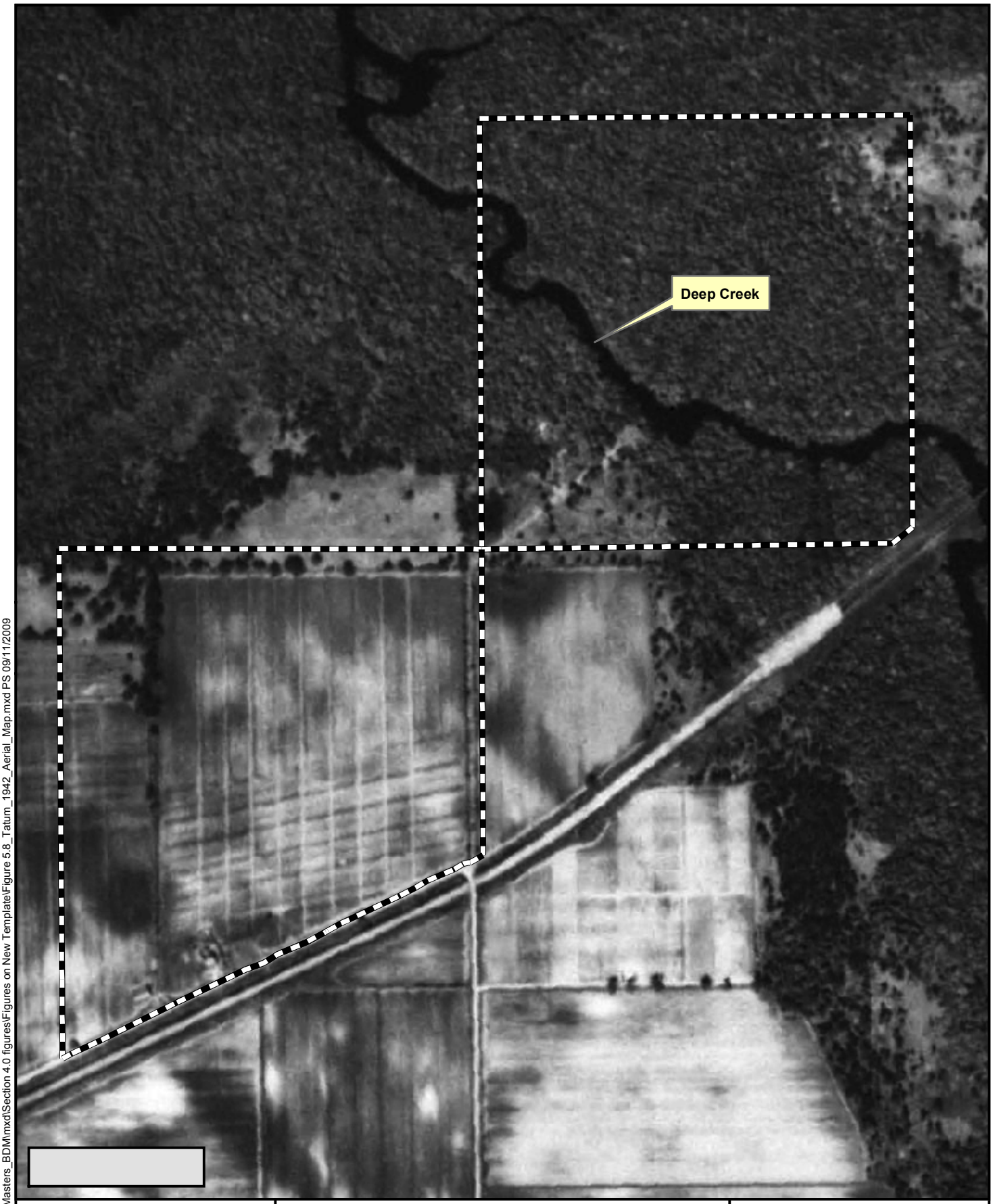

JONES EDMUNDS

Figure 5.8

Tatum Tract 1942 Aerial Map

Masters Tract PER

0 200 400

Feet

1:4,800

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Figure 5.9

Tatum Tract Existing Land Use Map

Masters Tract PER

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Feet

1:4,800

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5.2.3 Proposed Mitigation Activities

Based on results of the field assessment, there do not appear to be wetland mitigation opportunities on the northeast parcel as it is a mature wetland system with no significant anthropogenic impacts. There is a road that serviced the historic loading dock but it likely does not affect the hydrology of this area because it is perpendicular to Deep Creek, which allows flow into the adjacent wetlands on either side of the road. Removing this small road would provide some ecological lift; however, the cost to restore this area would be very high (> $40,000) compared to the credits (0.2) generated.

Jones Edmunds proposes wetland enhancement in the southwestern parcel comprised of the following:

1. Wetland Buffer Vegetation Enhancement
2. Wetland Vegetation and Hydrologic Enhancement

5.2.3.1 Wetland Buffer Enhancement

The wetland buffer found at this site was likely dominated by a mesic hammock community based on its proximity to the Deep Creek floodplain and a review of adjacent undeveloped properties. As a result, Jones Edmunds proposes that the densely planted slash pine dominating the wetland buffer community be thinned considerably to allow native hardwoods to recover. Supplemental planting of species such as sweetgum, sugarberry, American elm, and cabbage palm is proposed to facilitate the enhancement process (Table 5.5). We also propose an extensive and aggressive exotic species management program to remove the large populations of species listed in Section 5.2.5.

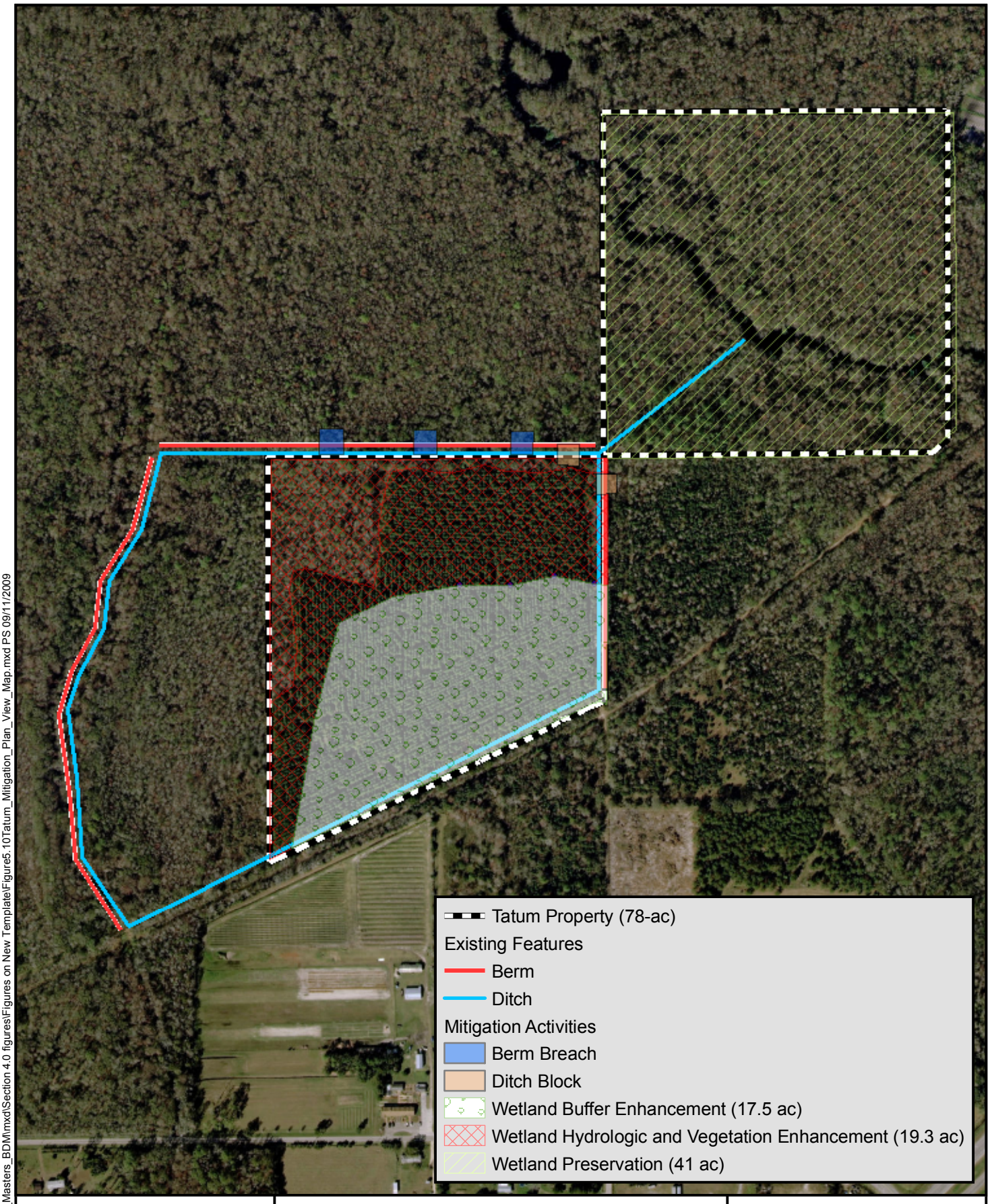
5.2.3.2 Wetland Enhancement

Jones Edmunds proposes enhancing on-site wetlands in the southwest parcel by harvesting and removing pine within the wetland in addition to removing invasive/exotic species combined with supplemental planting of wetland trees. During pine removal, care will be taken to avoid damaging hardwood trees. Supplemental planting of red maple, bald cypress, swamp tupelo, cinnamon fern, royal fern, and lizards tail is proposed in areas that lack hardwood trees or saplings (Table 5.5). Trees and herbaceous species will be planted on 20- and 10-foot centers, respectively. For this planting plan we used a supplemental planting of approximately 40% of the wetland enhancement area to calculate the number of trees that would actually be planted throughout the entire wetland, depending on which areas were lacking native trees.

To restore the hydrology of the property, Jones Edmunds also proposes installing ditch blocks in two locations to slow the flow of water leaving the site and three breaches in the large levee/berm that runs along the northern limits of the western parcel (Figure 5.10). The ditch blocks will be constructed with vinyl sheet piling and a pressure-treated lumber cap with rip rap placed on either side of the sheet piling at 4 (horizontal) to 1 (vertical) maximum slopes. A typical detail for the ditch blocks and berm breaches is provided in Figure 5.11. Berm breaches will be approximately 60 feet wide with 4:1 side slopes and reinforced with geotextile fabric.

Table 5.5 Proposed Planting Plan for Tatum Tract

Tatum Tract Forested Wetland Enhancement (19.3 Acres)						
Type	Scientific Name	Common Name	% Plants	Feet on Center	Size	Number of Plants*
Tree	*Acer rubrum*	Red maple	25	10	1 gal	578
	Nyssa sylvatica var. biflora	Swamp tupelo	25			578
	Taxodium distichum	Bald Cypress	50			1,156
					Subtotal	2,312
Herb	*Osmunda cinnamomea*	Cinnamon fern	30	6	1 gal	2,774
	Osmunda regalis	Royal fern	30		1 gal	2,774
	Saururus cernuus	Lizards tail	40		2" Liner	3,699
					Subtotal	9,248
Tatum Tract Forested Wetland Buffer Enhancement (17.5 Acres)						
Type	Scientific Name	Common Name	% Plants	Feet on Center	Size	Number of Plants*
Tree	*Celtis laevigata*	Sugarberry	20	20	1 gal	419
	Ulmus Americana	American elm	30			629
	Liquidambar styraciflua	Sweetgum	30			629
	Sabal palmetto	Cabbage palm	20			419
					Subtotal	2,096



JONES EDMUNDS

Figure 5.10

Tatum Tract Mitigation Plan View Map

Masters Tract PER

0 250 500

Feet

1:6,000

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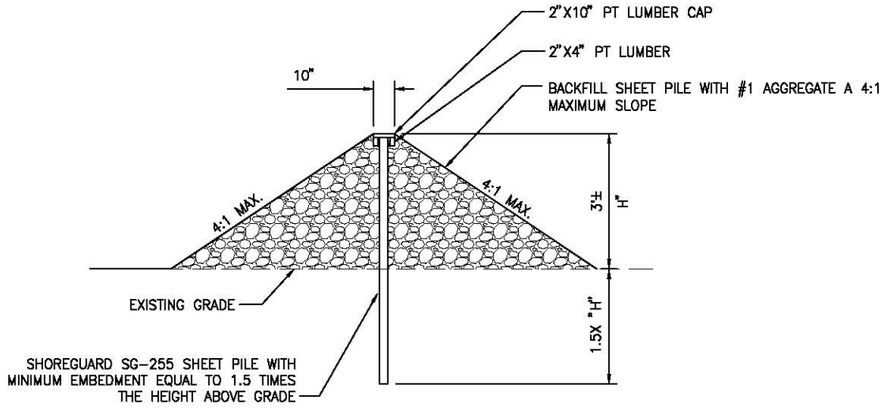
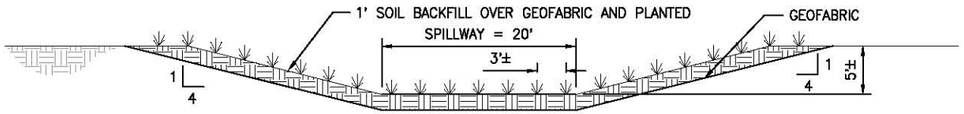


SECTION A-A
NTS



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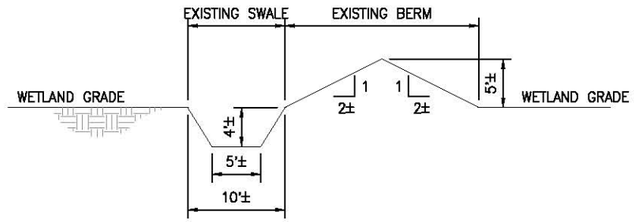

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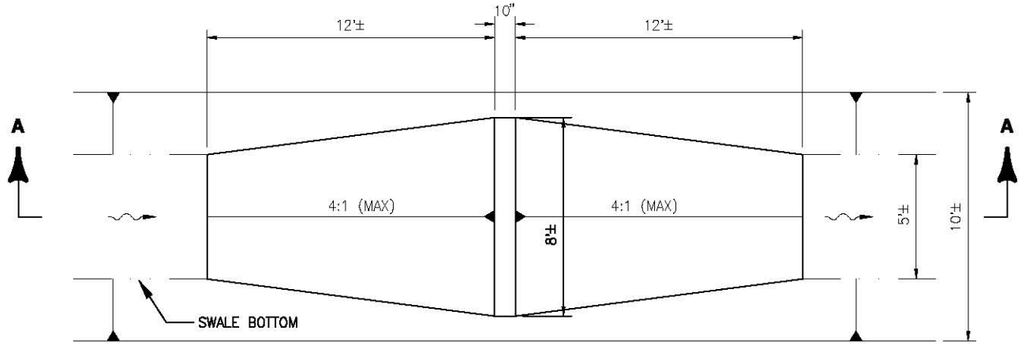
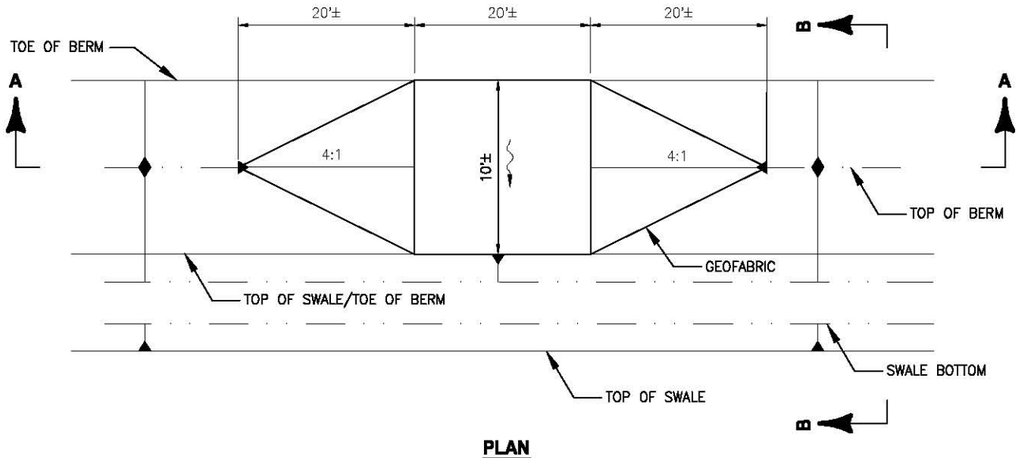


PLAN
NTS
DITCH BLOCK DETAIL



PLAN
NTS
BERM BREACH DETAIL

FIGURE 5.11
DITCH BLOCK AND
BERM BREACH DETAILS
TATUM TRACT MITIGATION AREA
ST JOHNS COUNTY, FLORIDA

JONES EDMUNDS

Plotted: 11/18/09 11:14am hsboudreau
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5.2.4 UMAM Analysis

Jones Edmunds completed a UMAM analysis for the following mitigation activities proposed at the Tatum Property to determine the potential FL credits that would be generated:

1. Wetland Vegetation and Hydrologic Enhancement of Southwest Parcel
2. Wetland Preservation of Northeast Parcel
3. Wetland Buffer Enhancement of Southwest Parcel
4. Wetland Buffer Preservation of Southwest Parcel

The "Without Mitigation" condition for Wetland Buffer Enhancement and Preservation was scored as if the assessment area were developed for County infrastructure or facilities. This is a realistic assumption as the County will likely develop the upland areas if they are not used as a regional mitigation site. The FL credits generated by this project are based on the RFG from each proposed mitigation activity multiplied by the proposed mitigation acreage. A total of 13.4 functional loss mitigation credits may be generated by the Tatum Tract for the SJRWMD and USACE based on the wetland hydrologic and vegetation enhancement, wetland buffer enhancement, and wetland and wetland buffer preservation activities proposed for this site (Table 5.6). More importantly, the purchase of this site and the subsequent enhancement activities that are proposed may be considered regionally significant by SJRWMD because the property is adjacent to large tracts of SJRWMD-owned property to the west and north. If it is deemed regionally significant, the County could use mitigation credits from this site towards wetland impacts in SJRWMD mitigation basins other than Basin 8. This designation will be determined by SJRWMD during the permitting of these mitigation activities.

5.3 FLOYD PROPERTY

The 34-acre Floyd property is in the southwest region of the County off CR 13B between the lower St. Johns River and SR 207. More specifically, it is in Sections 28, Township 8 South, and Range 28 East (Figure 5.12). Adjacent property to the west is owned by the Florida Department of Environmental Protection and SJRWMD. This property protects a valuable wildlife corridor from undeveloped lands to the east to the large State-owned land holdings west of the Floyd property that fringe the St. Johns River.

5.3.1 Historical Conditions

Based on a review of 1942 historical imagery, the Floyd tract has changed little over the last 67 years (Figure 5.13). No evidence of logging was observed during a review of historical aerial imagery or during the site visit. Additionally, the site contained numerous very large loblolly pines (*Pinus taeda*) that had a greater-than-40-inch diameter at breast height, which indicates that the site, if once logged, has not been logged in over 60 years.

5.3.2 Existing Conditions

5.3.2.1 Hydrology

An unnamed creek flows through the center of the Floyd Tract from the east beneath CR 13 S. The property has steep topography, particularly on the south side, that drops over 12 feet from the property boundary down to the riparian wetlands associated with the creek. In the western portions of the property the creek spreads out into several small braids and flows west into a 1,000-acre-plus forested swamp along the east side of the St. Johns River (Figure 5.12). No berms, spoil piles, blockages, or other man-made features are negatively affecting the hydrology of the on-site wetlands. As a result, no hydrologic enhancement activities were identified on this site.

5.3.2.2 Vegetation Communities

The Floyd Tract is comprised of one main upland and one wetland community, which were classified using the 1999 FDOT FLUCFCS: Pine – Mesic Oak (FLUCFCS Code 4140) and Stream and Lake Swamps (Bottomland) (FLUCFCS Code 6150) (Figure 5.14). The Pine – Mesic Oak community comprises approximately 3.8 acres and is found in the northeast corner of the site. This high-quality upland community is dominated by mature loblolly pine, laurel oak, sweetgum, Southern magnolia (*Magnolia grandiflora*), dwarf huckleberry (*Gaylussacia* sp.), bracken fern (*Pteridium aquilinum*), grape vine (*Vitis rotundifolia*), greenbriar (*Smilax* sp.), Carolina jessamine (*Gelsemium sempervirens*), and woodoats (*Chasmanthium* sp.). The Stream and Lake Swamps (Bottomland) community is a mature high-quality wetland system comprising approximately 30.2 acres that has seepage slope wetlands along the relatively steep banks and a braided creek flowing through the central portion. The canopy of this wetland is dominated by bald cypress, red maple, and swamp tupelo in the lower elevations and laurel oak, loblolly pine, silver bay, and blue beech along the side slopes. The understory is dominated by wax myrtle, buttonbush, dwarf palmetto (*Sabal minor*), netted chain fern, cinnamon fern, royal fern, and lizards tail.

5.3.2.3 Exotic Species

No exotic species were observed within the two vegetation communities during this preliminary assessment of the site. However, dense areas of creeping oxeye were observed in the southeast corner of the site along the road right of way. This species should be monitored so that it does not encroach into the wetland. However, its removal will not generate wetland mitigation credits due to its limited coverage and the potential that it is not on County property.

5.3.3 Proposed Mitigation Activities

Based on the results of the field investigation, wetland and wetland buffer (uplands) preservation are the mitigation opportunities available at this site (Figure 5.15). The wetlands and wetland buffer on this property are high-quality mature communities that have not been logged in well over 50 years. Jones Edmunds recommends that the property be placed into a conservation easement that will not allow future development or timber harvesting of the property. As a result, value is generated by eliminating future logging of the wetlands and future logging or development of the uplands.

Table 5.6 Tatum Property UMAM Summary Table

Mitigation Activity	Habitat Type (FLUCCS)	Location and Landscape Support		Water Environment		Community Structure		Time Lag	Risk Factor	Preservation Adjustment Factor	Relative Functional Gain	Acres Provided	Functional Gain Units
		W/Out Mitigation	With Mitigation	W/Out Mitigation	With Mitigation	W/Out Mitigation	With Mitigation						
Wetland Preservation	6150	7	8	9	9	6	9	1.03	1.00	0.5	0.064	41	2.6
Wetland Buffer Enhancement (Thinning, Planting, and Exotic Control)	4410	2	8	NA	NA	3	8	1.25	1.50	1.0	0.292	17.5	5.1
Wetland Buffer Preservation	4140	2	6	NA	NA	2	4	1.03	1.25	0.8	0.186	17.5	3.3
Wetland Enhancement (Pine Removal, Planting, and Ditch Blocks)	6200	7	7	5	8	4	8	1.25	1.50	1.0	0.124	19.3	2.4
											TOTAL	**95**	**13.4**

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JONES EDMUNDS

Figure 5.12

Floyd Tract Location and Aerial Map

Masters Tract PER

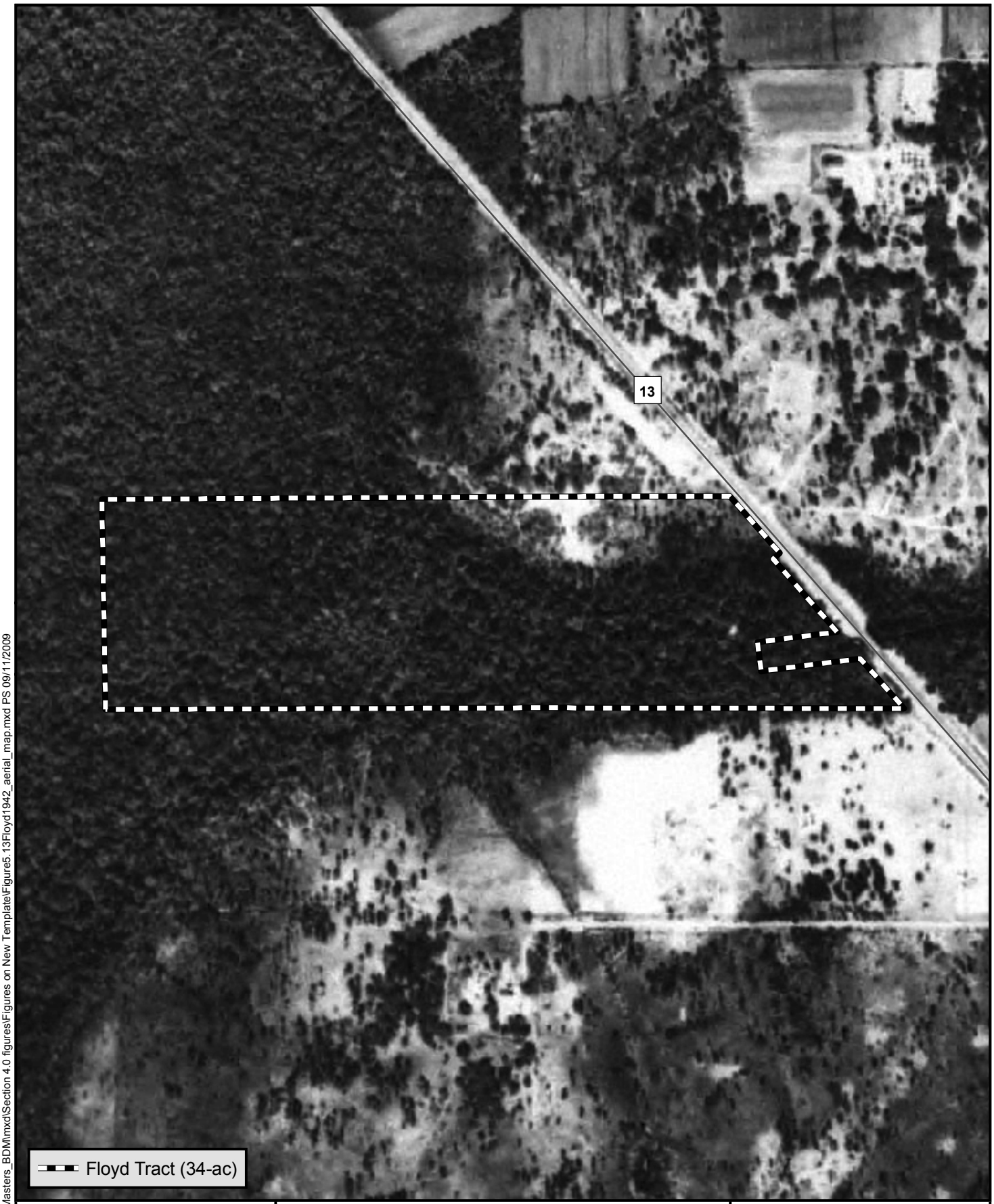
0 1,500 3,000

Feet

1:36,000

N

For Informational Purposes Only



JONES EDMUNDS

Figure 5.13

Floyd Tract 1942 Aerial Map

Masters Tract PER

0 200 400

Feet

1:4,800

N

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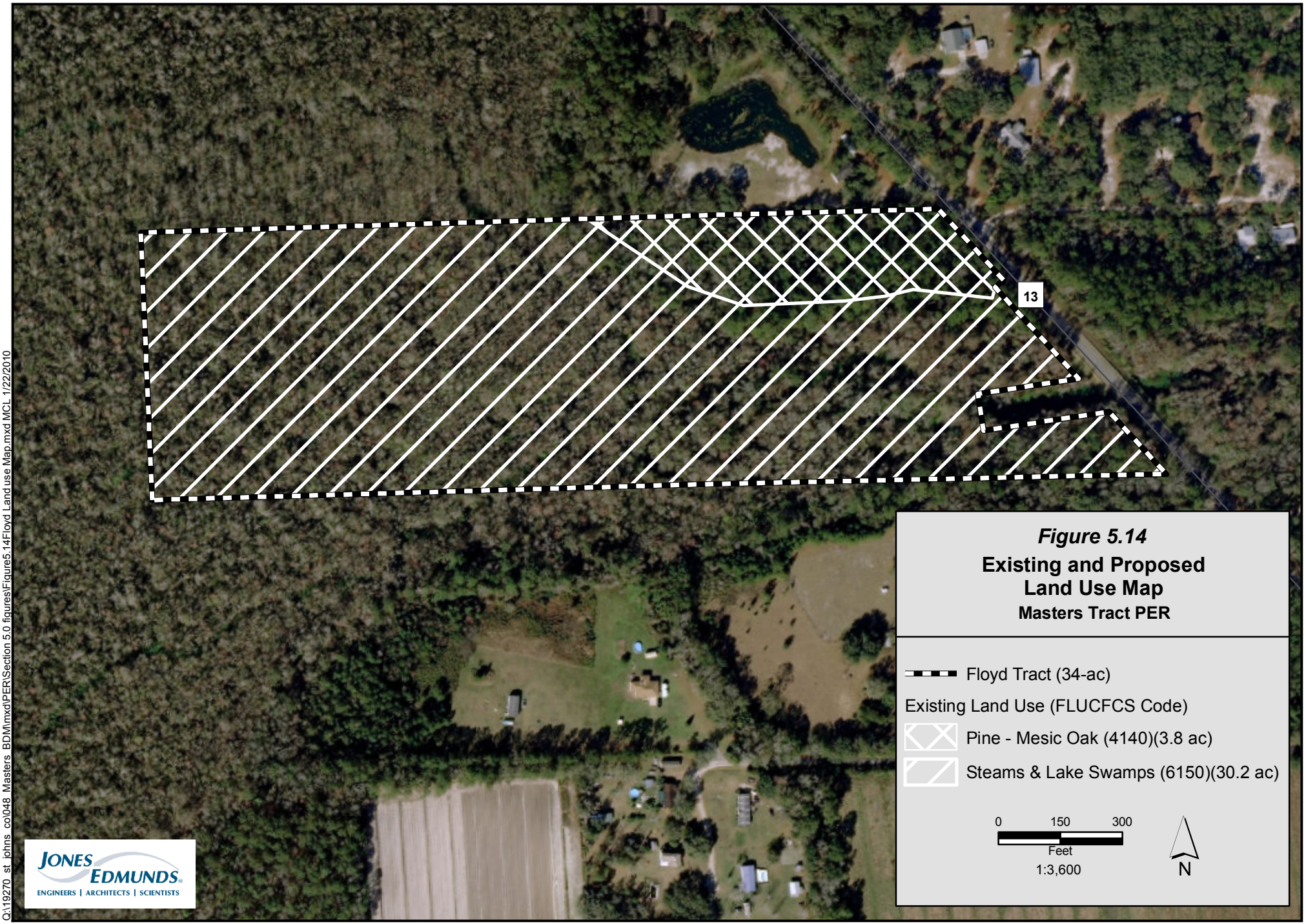

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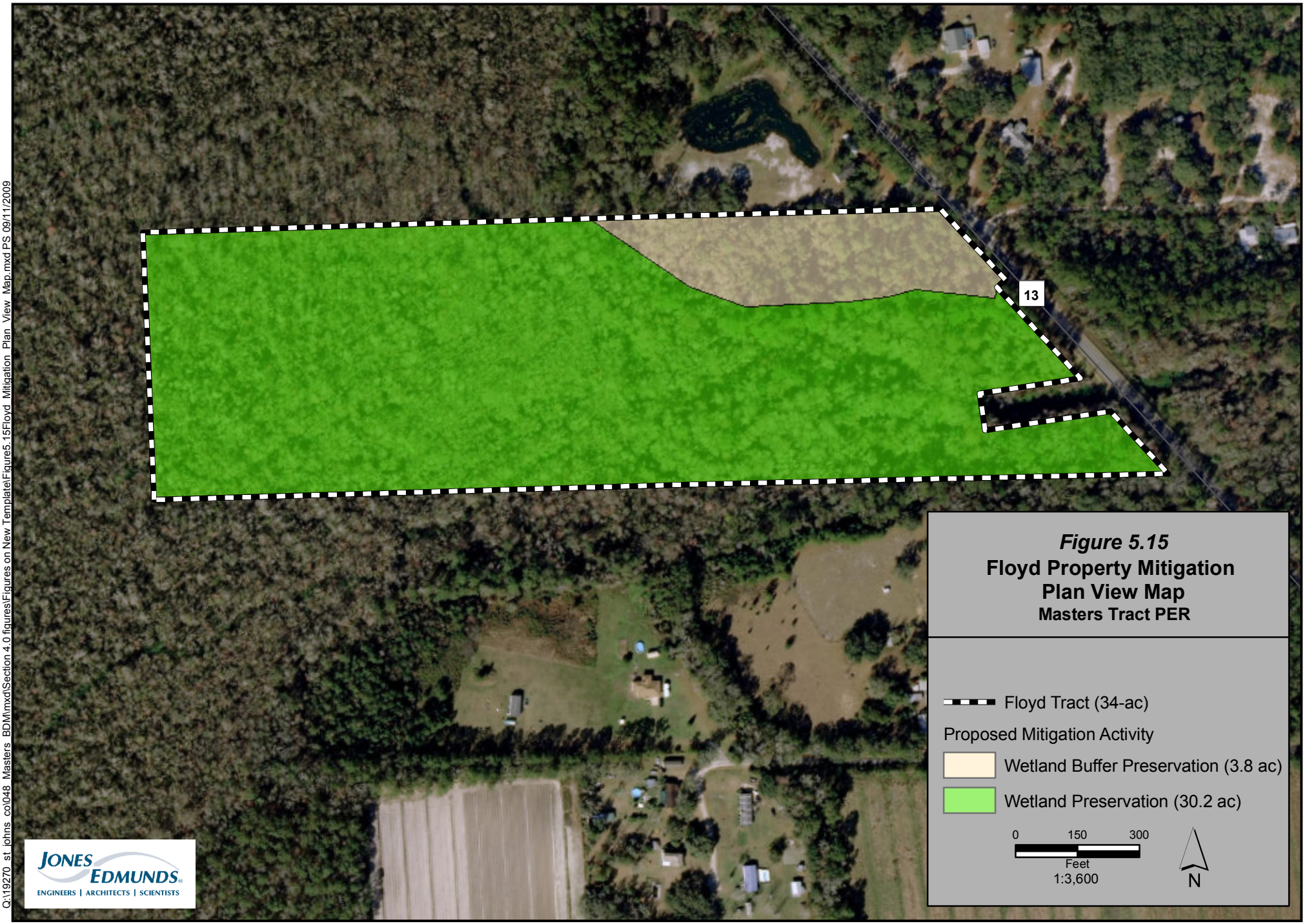

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For Informational Purposes Only

5.3.4 UMAM Analysis

Jones Edmunds conducted a UMAM analysis for this mitigation activity. A low functional gain (lift) value is generated using UMAM for the wetlands because wetlands are protected from development by state and federal laws. The lift generated from wetland preservation is mainly from the increase in the Location and Landscape Support category due to the preservation of the adjacent wetland buffer as well as Community Structure for the on-site wetlands since they will not be logged in the future. Jones Edmunds anticipates that 3.3 functional loss credits would be generated by preserving on-site wetlands and uplands via a conservation easement (Tables 5.3 and 5.7). More importantly, SJRWMD may consider the purchase of this site and the subsequent enhancement activities that are proposed regionally significant because it is adjacent to large tracts of State- and SJRWMD-owned property to the west. If it is deemed regionally significant, the County could use mitigation credits from this site towards wetland impacts in SJRWMD mitigation basins other than Basin 8. SJRWMD will determine this designation during the permitting of these mitigation activities.

Table 5.7 Floyd Tract UMAM Summary Table

Mitigation Activity	Habitat Type (FLUCCS)	Location and Landscape Support*		Water Environment		Community Structure		Time Lag	Risk Factor	Preservation Adjustment Factor*	Relative Functional Gain	Acres Provided	Functional Gain Units
		W/out Preserv	With Preserv	W/out Preserv	With Preserv	W/out Preserv	With Preserv						
Wetland Preservation (Mature)	6150	7	7	9	9	6	10	1.03	1.00	0.5	0.065	30.2	2.0
Wetland Buffer Preservation	4140	3	7	NA	NA	3	8	1.03	1.00	0.8	0.350	3.8	1.3
											TOTAL	**34**	**3.3**

6.0 CUT-AND-FILL ESTIMATE

Table 6.1 summarizes the estimated quantities of earth that must be cut and/or filled to construct each feature on the Masters Tract. The construction of the wet detention pond results in approximately 450,000 cy of excess cut that will need to be removed from the site. This material may be suitable for construction of other CIPs. Further geotechnical information regarding the soils in the area of the pond is available in Appendix B. Constructing the pond in partnership with a CIP to use the excavated soil has a significant cost benefit. The cost of the project is presented in Section 7.0.

Table 6.1 Cut-and-Fill Quantity Estimate

Feature	Total Area acres	Bottom Area acres	Cut cy	Fill cy	Net Cut cy
Canal 5 Intake/ Forebay	1.48	0.6	7,060	526	6,534
Wet Detention Pond	43.73	29.74	484,108	34,324	449,784
Littoral Zone		6.03			
Canal 4	13.35	9.26	95,975	5,484	90,491
Canal 4 North	5.88	4.53	19,477	1,456	18,021
Wetland Cell #1	18.1	16.54	11,681	19,104	(7,423)
Wetland Cell #2	16.77	14.55	11,310	8,622	2,688
Wetland Cell #3	15.36	13.70	29,628	3,251	26,377

7.0 PRELIMINARY OPINION OF PROBABLE COST

7.1 MASTERS TRACT

The preliminary opinion of probable cost to construct the recommended BMPs for the Masters Tract RST is $13.8 million. Table 7.1 summarizes the estimated cost per BMP and detailed costs are presented in Appendix G. The present value of the maintenance costs over a 20-year term is $2.3 million. The present value of the capital cost plus the maintenance costs over a 20-year term is $16 million, while the annualized cost over the term is $1 million assuming a 6.5% discount rate. The overall cost per pound of nitrogen removed is $296/lb.

Table 7.1 Cost Estimate for Masters Tract RST

Description	Estimated Cost	Estimated Annual Operation and Maintenance Costs
Hauling Excess Excavated Soil	$ 2,932,000.00	
Well Abandonment	$ 37,000.00	
Canal 5 Intake and Pump Station	$ 601,000.00	$ 36,000
Canal 5 Wet Detention Pond*	$ 2,216,000.00	$ 22,000
Stormwater Harvesting	$ 79,000.00	$ 5,000
Canal 4 Water Quality Swale*	$ 622,000.00	$ 12,000
Canal 4 North Water Quality Swale*	$ 205,000.00	$ 4,000
Wetland Cell #1*	$ 520,000.00	$ 21,000
Wetland Cell #2*	$ 407,000.00	$ 16,000
Wetland Cell #3*	$ 458,000.00	$ 18,000
Monitoring Equipment	$ 280,000.00	$ 17,000
Subtotal	**$ 8,357,000.00**	**$ 151,000**
Contingency (20%)	$ 1,671,400.00	
Mobilization & Construction Survey (5%)	$ 417,850.00	
OHP (10%)	$ 835,700.00	
Land Acquisition	$ 2,100,000.00	
Engineering Services	$ 375,000.00	
Total	**$ 13,756,950.00**	

*Estimated cost includes vegetation for the enhancement wetland, flow-way, wetland buffers, and littoral zone.

The opinion of probable cost includes an allowance of approximately $2.9 million to haul away over 500,000 cubic yards of excess soil that will be excavated from the site. As mentioned in Section 6, this material may be used as fill material for other CIPs. Coordinating the construction schedule of Masters Tract with other projects may result in a substantial cost savings to the County. It may also be possible to phase the construction of the Masters Tract to allow for the soil to be temporarily stored onsite.

7.2 TATUM TRACT

Jones Edmunds estimates a preliminary opinion of probable cost of $233,000 to construct and complete the proposed improvements (Appendix G). Exotic plant species control was assumed to be $500/acre with three treatments for the first year and subsequent semi-annual treatments for 2 years for a total of seven treatments. Land cost and compliance monitoring were not included in this opinion of probable cost. Wetland mitigation credits generated from this site are estimated at $17,380/credit based on Jones Edmunds' opinion of probable cost and the potential 13.4 mitigation credits.

7.3 FLOYD TRACT

An opinion of probable cost was not generated for this property as the wetland mitigation activity entails recording a conservation easement. Thus, costs associated with this conservation easement mainly consist of staff time to finalize a CE, obtain BOCC approval, and record it at the Clerk of the Courts office.

8.0 SCHEDULES

A summary of the project schedule is presented in Table 8.1. A more detailed schedule is provided in Appendix H.

Table 8.1 Project Schedule Summary

Design Phase	Start	Finish
Preliminary Engineering Report		11/13/2009
ACOE Permitting	1/18/2010	10/12/2010
ERP Permitting	1/18/2010	8/30/2010
50% Design Phase	11/16/2010	1/16/2011
90% Design Phase	8/24/2010	10/16/2010
Final Design Production	10/18/2010	11/5/2010
Bidding Services	11/8/2010	1/21/2011

9.0 REFERENCES

CDM. (2003). Implementation of Regional Stormwater Treatment Systems Edgefield Tract Tri-County Agricultural Area. Final Technical Memorandum prepared for SJRWMD.

Harper, H.H., & Baker, D.M. (2007). Evaluation of Current Stormwater Design Criteria within the State of Florida. Final report prepared for FDEP.

Jones Edmunds & Associates, Inc. (2009)q. Phase I Environmental Site Assessment For Masters Property Hub Bailey Road Hastings, Florida.

Lower St. Johns River (LSJR) TMDL Executive Committee and FDEP (October 2008). Basin Management Action Plan for the Lower St. Johns River Basin Main Stem.

SJRWMD. (2006). *Applicant's Handbook: Regulation of Stormwater Management Systems Chapter 40C-42, F.A.C.*

APPENDIX A

TOPOGRAPHIC SURVEY

APPENDIX B

GEOTECHNICAL INVESTIGATION

UNIVERSAL

ENGINEERING SCIENCES

REPORT OF GEOTECHNICAL CONSULTING SERVICES

Master Regional Stormwater Treatment Facility Project
JEA Project No. 19270-048-01
Hasting, St Johns County, FL
UES Project No. 0230.0900077
UES Report No. 805258

Prepared for:
Jones, Edmunds & Associates, Inc.
730 NE Waldo Road
Gainesville, FL 32641
(352) 377-5821

Prepared by:
Universal Engineering Sciences, Inc.
4475 SW 35th Terrace
Gainesville, Florida 32608
(352) 372-3392

November 9, 2009

UNIVERSAL ENGINEERING SCIENCES
Consultants in: Geotechnical Engineering • Environmental Engineering
Construction Materials Testing • Threshold Inspection • Private Provider Inspection

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• Panama City, FL
• Pensacola, FL
• Rockledge, FL
• Sarasota, FL
• St. Augustine, FL
• Tampa, FL
• West Palm Beach, FL

November 9, 2009

Jones, Edmunds & Associates, Inc.
730 NE Waldo Road
Gainesville, FL 32641

Attention: Mr. Walter A. Nickel, P.E.
Civil Design Department Manager

Reference: **Report of Geotechnical Consulting Services**
Master Regional Stormwater Treatment Facility
JEA Project No. 19270-048-01
Hasting, St Johns County, Florida
UES Project No. 0230.0900077 UES Report No. 805258

Dear Mr. Nickel:

Universal Engineering Sciences, Inc. (UES) has completed the geotechnical engineering services for the subject project in Gainesville, Alachua County, Florida. This Report is submitted in satisfaction of the contracted scope of services as summarized in UES Proposal No. 753856v2, dated February 10, 2009, Revised August 10, 2009.

This Report presents the results of our field subsurface exploration and laboratory soil testing programs, and discusses geotechnical engineering issues associated with roadway embankment, and pump station design and construction.

We appreciate the opportunity to have assisted you on this project and look forward to a continued association. Please do not hesitate to contact our office if you should have any questions, or to assist your office with the remaining phases of project design and construction.

Respectfully submitted,

UNIVERSAL ENGINEERING SCIENCES, INC.
Certificate of Authorization 549

[Reviewed by:]

Eduardo Suarez, P.E.
Project Engineer
Florida P.E. No. 60272
Date: 11.9.09

Jeffrey S. Pruett, P.E.
Vice President
Florida P.E. No. 50775

ES/JSP: es

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EXECUTIVE SUMMARY

We have prepared this executive summary solely to provide a general overview. Do not rely on this executive summary for any purpose except that for which it was prepared. Rely on the full report for information about findings, recommendations, and other concerns.

Project Location and Description

The project parcel is located northeast of the intersection of Country Road 13 and Hub Bailey Road, approximately 3 miles southeast of Hasting, Florida. Our office was provided an aerial map of the project site and a topography survey with boring locations prepared by Jones Edmunds & Associates, Inc. The project element of interest in this geotechnical exploration is the evaluation of the subgrade soils, groundwater levels and technical suitability of soils for roadway embankment and the construction of a Pump Station and associated structures at the south end of the project parcel.

Soil and Groundwater Considerations

The soil borings generally encountered sands with silt and silty sands [SP-SM/SM] to depths of 2 to 3 feet below existing grade. Below the sand mixture, the soil boring encountered very clayey sands to sandy clays [SC/CL/CH] to depths of 5.5 to 8 feet. Below the sand-clay mixtures the soil borings encountered sand with silt [SP-SM] with lenses of silty sand to silty clay [SM/CL] with traces of shells to the boring termination depth of 20 feet.

The groundwater level was measured at depths of 3 to 8 feet below existing site grades at the boring locations at the time of our subsurface exploration. Based on site-specific information and factors listed above, we estimate that the typical wet season groundwater levels in the proposed areas will occur within 12 inches of the surface for more than six months during most years.

Geotechnical Considerations-Embankment –Pump Station Construction

The soils encountered classified as A-3 and A-2-4 are select soils and are satisfactory to use in the subgrade and embankment when utilized in accordance with FDOT-Index 505. However, A-2-4 material is likely to retain excess moisture and be difficult to dry and compact. The A-2-4 soils that are below the groundwater table will require spreading in thin lifts in order to dry back to within workable moisture limits. Soils classified as A-6 and A-7 are plastic and highly plastic soils and are not considered suitable for roadway support. When utilized in the embankment and subgrade shall be in accordance with FDOT-index 505.

Based upon our findings at the boring location, the bottom of the pump station should be located within the clayey soils and close to the water table. These soils should provide suitable support as long as adequate dewatering and subgrade preparation is performed. We recommend that this clayey soil be over excavated to a minimum depth of 2 feet below the bottom of the wet well and replaced with stone and gravel. We also recommend that the lateral limits of over excavation extend at least 2 feet beyond the edges of the pump station.

1.0 INTRODUCTION

1.1 GENERAL

In this report, we present the results of the subsurface exploration of the site for proposed Master Regional Stormwater Treatment Facility in Hasting, St Johns County, Florida. We have divided this report into the following sections:

- SCOPE OF SERVICES - Defines what we did
- FINDINGS - Describes what we encountered
- RECOMMENDATIONS - Describes what we encourage you to do
- LIMITATIONS - Describes the restrictions inherent in this report
- APPENDICES - Presents support materials referenced in this report

2.0 SCOPE OF SERVICES

2.1 PROJECT DESCRIPTION

The project parcel is located northeast of the intersection of Country Road 13 and Hub Bailey Road, approximately 3 miles southeast of Hasting, Florida. Our office was provided an aerial map of the project site and a topography survey with boring locations prepared by Jones Edmunds & Associates, Inc. The project element of interest in this geotechnical exploration is the evaluation of the subgrade soils, groundwater levels and technical suitability of soils for roadway embankment and the construction of a Pump Station and associated structures at the south end of the project parcel.

We note that, our authorized scope of services and this Report do not address any other project elements, such as earth retaining walls, or slope stability issues that may be part of the overall project site plan. Since other site improvements could have detrimental effects on the performance of a foundation system at this site, UES, or other qualified geotechnical consultant, should be consulted to review the entire site development plan and conduct additional services as required to minimize any impact of associated improvements on foundation performance.

2.2 PURPOSE

The purposes of this geotechnical exploration were:

- To perform a limited subsurface exploration within the limits of the proposed improvements to gather general information concerning the near-surface soil conditions,
- To perform a series of laboratory tests on selected subsurface soil specimens, recovered from the field exploration program to assist with engineering soil classifications,
- To evaluate the groundwater level in the area of exploration and make appropriate recommendations,
- To evaluate and discuss technical suitability of subgrade soils for fill suitability in the construction of roadway embankments.

- To provide geotechnical engineering recommendations for foundation design and construction for the proposed pump station.

This report presents an evaluation of site conditions on the basis of traditional geotechnical procedures for site characterization. The recovered samples were not examined, either visually or analytically, for chemical composition or environmental hazards. Universal Engineering Sciences would be pleased to perform these services, if you desire.

Our exploration was confined to the zone of soil likely to be stressed by the proposed construction. Our work did not address the potential for surface expression of deep geological conditions. This evaluation requires a more extensive range of field services than performed in this study. We will be pleased to conduct an investigation to evaluate the probable effect of the regional geology upon the proposed construction, if you desire.

2.3 FIELD EXPLORATION

The field geotechnical testing activities were started on October 13, 2009 and completed on October 15, 2009. Field tests for the geotechnical study included thirteen (13) soil test borings to a depth of 20 feet below the ground surface in accessible areas within the limits of the proposed project site. The test quantities and locations for the proposed project were selected by Jones, Edmunds & Associates, Inc. The actual test locations shown are approximate and were staked in the field by UES engineering personnel using existing landmarks and site features. All boreholes were backfilled upon field work completion.

2.3.1 Standard Penetration Test (SPT) Borings

Penetration tests were performed in accordance with ASTM Procedure D-1586, Penetration Test and Split-Barrel Sampling of Soils. This test procedure generally involves driving a 1.4-inch I.D. split-tube sampler into the soil profile in six inch increments for a minimum distance of 18 inches using a 140-pound hammer free-falling 30 inches. The total number of blows required to drive the sampler the second and third 6-inch increments is designated as the N-value, and provides an indication of in-place soil strength, density and consistency.

Representative portions of the subsurface soil samples recovered were transported to our Gainesville soils laboratory. The soil samples were visually classified by an experienced Geotechnical Engineer. It should be noted that soil conditions may vary between soil test boring locations, and between the subsurface soil strata interfaces which have been shown on the Boring Logs. The soil test boring data reflect information from the specific test locations.

2.4 LABORATORY TESTING

2.4.1 Visual Classification

The soil samples recovered from the soil test borings were returned to our laboratory where an engineer visually reviewed the field descriptions in accordance with ASTM D-2488. Following our review of the field boring logs and samples we classified the soil borings in accordance with the current Unified Soil Classification System (USCS). We then selected representative soil samples for laboratory testing and later refined some of the classifications based on the laboratory tests.

2.4.2 Index Testing

Laboratory testing was performed on selected samples of the soils encountered in the field exploration to better define soil composition and properties. Testing was performed in accordance to ASTM procedures and included Percent passing No. 200 Sieve (ASTM D-1140), Atterberg Limits (ASTM D-4318), and natural moisture content (ASTM D-2216). The test results have been presented on the attached Boring Logs.

3.0 FINDINGS

We reviewed commonly available references for general information about the property. A USGS Site Topographic Map, and a USDA soil survey map are included as pages numbers A-1 and A-2 in **Appendix A.**

3.1 TOPOGRAPHY

The project site is located within Section 37, Township 9 South and Range 28 East. The general vicinity of the property can be characterized as gently sloping to the east. The existing site grades range from approximately +9 to +5 feet NVGD.

3.2 REGIONAL GEOLOGY

The general geology of St. Johns County is characterized by a sandy and loamy surface sediments of Pleistocene and recent age followed by unconsolidated lenses of sand, sandy clay, clay of Miocene and Pliocene deposits overlying the Miocene-age Hawthorn Group. The Hawthorn Group includes a highly variable mixture of interbedded quartz sands, clays, carbonates, pebbles and grains occurring with thicknesses of up to 100 feet. Upper zones of the Hawthorn consist of quartz sandy, clayey, phosphate dolomites, phosphatic quartz sands with some clay beds. Shelly sands and clays overlie the Hawthorne Group.The Floridan Aquifer is composed of limestone formation underlying the Hawthorn formation. Information obtained from the Saint Johns River Water Management District (SJRWMD) Potentiometric Surface Map suggests the potentiometric level of the Floridan Aquifer in the general area of the project site to be on the order of +10 feet, NGVD in the general site area.

3.3 GENERAL AREA SOIL INFORMATION

The United States Department of Agriculture (USDA) *Soil Survey of St. Johns County, Florida* describes the near-surface soil profile in the project parcel as Floridana fine sand and Winder fine sands. Floridana and Winder sands are described as nearly level, poorly drained, with a seasonal high groundwater table of 0 to 10 inches below the surface. Relevant engineering index properties for Floridana sands and Winder sands are summarized in Tables 1 and 2.

Table 1 – Relevant Engineering Index Properties of Floridana Sand Soils							
Depth, Inches	Texture	Classification	% Passing #200 Sieve	Plasticity Index	Risk of Corrosion		Permeability
					Steel	Concrete	
0 – 11	Fine sand	SP-SM, SM	5 to 25	Non-plastic	Moderate	Low	6.0 to 20 in/hr
11 – 30	Fine sand, sand	SP, SP-SM	2 to 10	Non-plastic	Moderate	Low	6.0 to 20 in/hr
30 – 80	Sandy loam, sandy loam, sandy clay loam	SM-SC, SC	20 to 35	7 -16	Moderate	Low	<0.2 in/hr

Table 2 - Relevant Engineering Index Properties of Winder Sand Soils							
Depth, Inches	Texture	Classification	% Passing #200 Sieve	Plasticity Index	Risk of Corrosion		Permeability
					Steel	Concrete	
0 – 10	Fine sand	SP, SP-SM	2 to 14	NP	High	Low	6.0 to 20 in/hr
10 – 14	Loamy sand, sandy loam, fine sandy loam	SM	15 to 25	NP – 10	High	Low	0.2 to 0.6 n/hr
14 – 56	Sandy clay loam	SC	18 to 35	9 to 26	High	Low	<0.2 in/hr
56 – 81	Sandy loam, fine sandy loam, sandy clay loam	SM, SM-SC, SC	15 to 35	NP - 20	High	Low	<0.2 in/hr

3.4 SURFACE CONDITIONS

UES engineering personnel visited the project site prior to and during the performance of the field portion of this geotechnical study. At the time of our exploration, the project parcel was within pasture lands. Surface soils were observed to be moist and sandy. Surface organic soils, surface debris, unusual ground depressions, or rock outcroppings were not observed on the project site.

3.5 SUBSURFACE CONDITIONS

The field exploration performed for this project disclosed subsurface conditions that were consistent with the local geology and general area soils information described above. The soil test borings performed were reviewed to evaluate the subsurface soil strata lateral continuity and uniformity, both parameters that would have an impact in suitability, selection and performance. Soil classifications and descriptions for this geotechnical study are based both on the results of the laboratory soil testing programs and on visual examinations of soil specimens by the Geotechnical Engineer. The subsurface soil conditions encountered in the soil test borings are presented in **Appendix B** and described below.

The soil borings generally encountered sands with silt and silty sands [SP-SM/SM] to depths of 2 to 3 feet below existing grade. Below the sand mixture, the soil boring encountered very clayey sands to sandy clays [SC/CL/CH] to depths of 5.5 to 8 feet. Below the sand-clay mixtures the soil borings encountered sand with silt [SP-SM] with lenses of silty sand to silty clay [SM/CL] with traces of shells to the boring termination depth of 20 feet.

3.6 GROUNDWATER DEPTH

The groundwater level was measured at depths of 3 to 8 feet below existing site grades at the boring locations at the time of our subsurface exploration. Typically, fluctuations in groundwater levels should be anticipated throughout the year, primarily due to seasonal variations in rainfall, surface runoff, construction activity, and other specific site factors that may vary from the time the soil test borings were conducted.

3.7 LABORATORY TESTING

The soil samples recovered from the field exploration program were placed in plastic containers and returned to our soils laboratory, where the Geotechnical Engineer visually examined and classified the samples. Laboratory soil tests are performed to aid in the classification of the soils, and to help in the evaluation of engineering characteristics of the soils. Representative soil samples were selected for grain size determination, percent fines determination, moisture content, and Atterberg Limits testing. The test results are presented on the attached Boring Logs and summarized in **Appendix C**.

3.7.1 Percent Passing No. 200 Sieve

Certain recovered soil samples were selected to determine the percentage of fines. In these tests the soil sample was dried and washed over a U.S. No. 200 mesh sieve. The percent of soil by weight passing the sieve was the percentage of fines or portion of the sample in the silt and clay size range. This test was conducted in accordance with ASTM Procedure D-1140, *Standard Test Methods for Amount of Material in Soils Finer than the No. 200 Sieve.*

3.7.2 Atterberg Limits

Certain recovered soil samples were selected for Atterberg Limits testing to evaluate the soil plasticity characteristics. The soil's Plasticity Index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The LL is the moisture content at which the soil will flow as a heavy viscous fluid. The PL is the lowest moisture content at which the soil is sufficiently plastic so as to be manually rolled into a 1/8-inch diameter thread. These tests were conducted in accordance with ASTM Procedure D-4318, Standard Test Methods for LL, PL and PI of Soils.

3.7.3 Moisture Content

Certain recovered soil samples were selected to determine their moisture content. The moisture content was the ratio expressed as a percentage of the weight of water in a given mass of soil to the weight of the solid particles. These tests were conducted in accordance with ASTM Procedure D-2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 GENERAL

The conclusions and recommendations presented below are based on limited data collection activities and experience with local geotechnical engineering issues. Our office should be advised of any final design concept changes so that we may evaluate any impact to our conclusions and recommendations. In this section of the report, we present our discussion for groundwater control, roadway embankment and pump station design, construction, and site preparation.

4.2 ROADWAY EMBANKMENT CONSTRUCTION CONSIDERATIONS

Roadway construction should be performed in general accordance with the appropriate section of the current edition of the Florida Department of Transportation (FDOT) *Standard Specifications for Road and Bridge Construction.* The removal of unsuitable soils and embankment construction should be performed in accordance with FDOT Standard Indices 500 and 505, respectively. We recommend positive drainage be established and maintained on the site during construction. Due to possible high groundwater levels, temporary dewatering should be anticipated for earthwork operations.

The soils encountered classified as A-3 and A-2-4 are select soils and are satisfactory to use in the subgrade and embankment when utilized in accordance with FDOT-Index 505. However, A-2-4 material is likely to retain excess moisture and be difficult to dry and compact. The A-2-4 soils that are below the groundwater table will require spreading in thin lifts in order to dry back to within workable moisture limits. Soils classified as A-6 and A-7 are plastic and highly plastic soils and are not considered suitable for roadway support. When utilized in the embankment and subgrade shall be in accordance with FDOT-index 505.

One of the most critical factors influencing pavement performance is the relationship between the pavement subgrade and the normal seasonal high groundwater level. Many roadways and parking areas have been damaged as a result of deterioration of the base conditions and/or the base/surface course bond. We recommend that the normal seasonal high groundwater level and the bottom of the flexible pavement limerock base course be separated by at least 24 inches. The minimum separation may be reduced to 18 inches, provided the compacted base (i.e crushed concrete base) and subgrade in "free-draining" material. If this separation cannot be establish and maintained by grading and surface drainage improvements, permanent groundwater control measures (underdrains) will be required.

4.3 SUITABILITY OF EXCAVATED SOILS FOU USE AS STRUCTURAL FILL

The recovered soil samples were classified using visual and textural means, and limited laboratory testing. We offer below ***preliminary guidelines*** for the use of on-site soils as structural fill material for the project.

Soil materials excavated and classified as fine sands to sand with silts and sand with clay (SP, SP-SM, SP-SC), with typically 12% fines or less (silt/clay fraction), may be considered suitable for use as utility trench backfill, as well as pavement subgrade structural fill, provided said materials are properly dried, placed, and compacted.

Soil materials excavated and classified as silty fine sands [SM], with typically 12% to 25% fines, are considered marginal for use as utility trench backfill, as well as pavement subgrade structural fill, after significant drying and some mixing with the fine sand material described above. Proper placement, proof rolling and compaction must also be performed.

Soil materials excavated and classified as clayey sand, silt or clay (SC, ML, MH, CL, and CH) and any organic-laden soils (5% or greater organics by weight) should not be reused as fill beneath buildings or pavement sections. These materials could be used in green areas, if applicable and in non-structural applications where excessive ground subsidence will not create functional or aesthetic problems. It should be noted that silt and clay materials will retain water and if used may become saturated and soft for a significant period of time following a rain event.

Soil borings for a typical geotechnical report are widely spaced and generally not sufficient for reliably detecting the presence of isolated, anomalous surface or subsurface conditions, or reliably estimating unsuitable or suitable material quantities. Accordingly, UES does not recommend relying on our boring information to negate presence of anomalous materials or for estimation of material quantities unless our contracted services ***specifically*** include sufficient exploration for such purpose(s) and within the report we so state that the level of exploration provided should be sufficient to detect such anomalous conditions or estimate such quantities. Therefore, UES will not be responsible for any extrapolation or use of our data by others beyond the purpose(s) for which it is applicable or intended.

4.4 PUMP STATION FOUNDATION DESIGN RECOMENDATIONS

Based on the project information provided, we understand that this project includes the construction of a new pump station with wet well and associated piping and electrical equipment. The proposed bottom of these structures will be located approximately 4 below existing grade.

Based upon our findings at the boring location, the bottom of the pump station should be located within the clayey soils and close to the water table. These soils should provide suitable support as long as adequate dewatering and subgrade preparation is performed. We recommend that this clayey soil be over excavated to a minimum depth of 2 feet below the bottom of the wet well and replaced with stone and gravel. We also recommend that the lateral limits of over excavation extend at least 2 feet beyond the edges of the pump station.

We estimate that lift station foundations designed with an average net bearing pressure not exceeding 2,000 psf will provide satisfactory performance on this project. Removal of the overburden soils during the excavation process for precast concrete structure installation will result in the reduction of in-place soil stresses.

It is understood the pump stations will bear at a depth of approximately 4 feet in clayey sands to clay. We recommend all foundations incorporate the seasonal high groundwater conditions. All wet well structures should be designed to overcome buoyancy forces exerted on the installed structure. The project requires the subgrade be dewatered to a minimum of 2 feet below the excavation bottom. Use of temporary dewatering measures will be needed to facilitate construction in the dry. The amount and method of the dewatering system should be determined by the contractor, and based upon their experience. The method of dewatering must be submitted by the contractor and approved by the design engineer.

If compaction of the stones or gravel is to be performed by impact using the loader bucket, lifts should not exceed about 6 inches. For compaction using hand operated vibratory equipment, lifts should not exceed 12 inches. All excavation must meet OSHA safety requirements. The contractor should supply a trench excavation plan. We recommend the wet well excavations be properly shored during construction, and that dewatering systems be maintained on until all construction has been completed.

We anticipate the buried structure (pump station) will exert little or no net downward pressure on the soils rather, the structure may be subject to hydrostatic uplift pressure when the lift station is empty. Below grade structures should be designed to resist lateral earth pressures and hydrostatic uplift pressures appropriate for their depth below existing grade and wet season groundwater table.

The walls of the structure should be designed to resist at-rest lateral earth pressures, with equivalent fluid densities above and below the water table being as follows:

Above Water Table - Equivalent Fluid Density	55 pcf
Below Water Table - Equivalent Fluid Density	90 pcf

The water table for wall design purposes should be assumed to be at the existing grade.

4.4.1 Foundation Preparation

Based on our evaluation of the soil conditions encountered in this area, we offer the following recommendations for the propose underground construction

- The proposed construction area should be dewatered as necessary and excavated to the required foundation depth. Excavation work will be required to meet OSHA Excavation Standard Subpart P regulations, Type C Soils. Either a braced sheet pile structure and/or an excavation with temporary side slopes cut back at 1.5 horizontal to 1.0 vertical can be implemented, depending on the specific project requirements. The side slope of 1.5 horizontal to 1.0 vertical is contingent upon the dewatering system adequately controlling slope seepage. Sheet piling should be designed according to OSHA sheeting and bracing requirements. We recommend a Florida registered Professional Engineer design the sheeting/bracing system.

- A dewatering system should be anticipated for the project. The water table should be maintained at least 2 feet below the proposed excavation bottom. The dewatering system should not be decommissioned until sufficient deadweight exists on the structure to prevent uplift or the uplift protection system as described below, if necessary, is in place.

- FDOT No. 57 stone that may be required for the foundation excavation bottom should be placed in 6 inch lifts and densified using hand-operated compaction equipment. Compaction should continue until the stone is well seated. Density testing will not be necessary if the placement and compaction of the stone is appropriately documented.

- Backfill which will be required around buried walls should be compacted with a light hand-operated compactor to a density of 95 percent of the soils Modified Proctor maximum dry density. All backfill should be placed in level lifts not exceeding six inches loose thickness. Care should be taken not to over compact the backfill (i.e., limit compaction to a maximum of 98 percent of the maximum density) in order to limit the lateral loads on the proposed walls.

- Structural fill/backfill should consist of an inorganic non-plastic granular soil with less than 10 percent fines and a Unified soil classification of SP, SP-SM, SW or SW-SM (relatively clean sand).

- Universal Engineering Sciences should be retained to provide a representative for on-site inspection and testing of compaction/filling operations so that proper documentation of the required minimum compaction and compliance with the recommendations contained herein can be provided.

4.4.2 Uplift Protection

When the water level within below-grade structures is maintained at or above the surrounding groundwater level, no net buoyancy will occur to the structure. However, when these structures are drained for maintenance or as water levels fluctuate within the lift stations, a positive means of uplift protection may be necessary. Hydrostatic uplift forces can be resisted in several ways including:

- Addition of dead weight to the structure.

- Mobilizing the dead weight of the soil surrounding the structure through extension of footings outside the perimeter of the structure.

- Use of a permanent gravity or mechanical dewatering system that is operated only when the structure is to be drained.

- Use of pressure relief valves in the slab bottom in combination with one or more of the above methods, or

- Use of uplift piles.

We anticipate that one or more of the noted methods will be needed for this construction. At your request, we would be pleased to assist you in evaluating uplift protection requirements.

4.5 TRENCH BEDDING AND BACKFILLING RECOMMENDATIONS

We recommend that all excavation, backfilling, and verification procedures conform to the most current Florida Department of Transportation Standard Specifications for Roadway and Bridge Construction.

The following recommendations should be followed while installing the proposed utility lines.

- Where required, the soils in the areas of excavations for the installation of the utilities lines should be dewatered prior to the start of excavation. The groundwater level should be maintained at least 24 inches below the base of the trench and compaction surface during construction and backfill activities.

- After proper dewatering, excavate the trench as per the design configuration. Excavated trenches should be set back to a stable configuration or shored, in either case in accordance with OSHA requirements. Adequate bracing should be provided if necessary to prevent side slope failures.

- Compact the trench bottom to a minimum density of 95 percent of the Modified Proctor maximum dry density to a depth of 1-foot below the bottom of the pipe or place the pipe in gravel bedding. The subgrade after excavation in some areas may include silty-clayey sands, which will be difficult to compact. If these soils are soft in nature, they should be over-excavated and removed under the direction of the testing agency representative. Alternatively, approximately 6 to 12 inches of #57 stone (gravel) may be placed at the bottom and compacted to stabilize the subgrade.

- Fill materials above the spring-line of the structures should be compacted to a minimum of 95 percent of the Modified Proctor maximum dry density (AASHTO T-180/ASTM D-1557). Native soils consisting of clean sands with less than 12 percent fines may be used as backfill material provided they are inorganic, have moisture contents below the optimum level and are properly placed.

- If imported materials are used as trench backfill material, the imported fill should contain less than 5 percent soil fines passing a number 200 sieve. You may also use imported fill material containing 5 to 12 percent soil fines; however, strict moisture control measures will be required, particularly for placement of these materials in excavations extending below the groundwater level. Backfill placed around the pipe and extending up to a level of 12 inches above the top of the pipe should be placed in loose, 6-inch lifts and compacted with light-weight equipment such as a small plate compactor. The remaining backfill may be placed in loose, 12-inch lifts across the full trench width and compacted. All backfill lifts should be compacted to a minimum density of 95 percent of the Modified Proctor maximum dry density prior to the placement of additional backfill. Compaction within the backfill trench should be performed using light-weight compaction equipment until the backfill has attained a level of at least 4 feet above the crown of the pipe.

- Compliance test for densities should be performed as recommended by FDOT standards.

4.6 GROUNDWATER CONDITIONS

4.6.1 Existing Groundwater Level

The groundwater level was measured at depths of 3 to 8 feet below existing site grades at the boring locations at the time of our subsurface exploration. Typically, fluctuations in groundwater levels should be anticipated throughout the year, primarily due to seasonal variations in rainfall, surface runoff, construction activity, and other specific site factors that may vary from the time the soil test borings were conducted.

4.6.2 Typical Wet Season Groundwater Level

The typical wet season groundwater level is defined as the highest groundwater level sustained for a period of 2 to 4 weeks during the "wet" season of the year, for existing site conditions, in a year with average normal rainfall amounts. Based on historical data, the rainy season in Alachua County, Florida typically occurs between June and September. To estimate the wet season groundwater level at the soil test boring locations, many factors may be considered, such as the following:

a. Measured groundwater level
b. Drainage characteristics of existing soil types
c. Season of the year (wet/dry season)
d. Current & historical rainfall data (recent and year-to-date)
e. Natural relief points (such as lakes, rivers, swamp areas, etc.)
f. Man-made drainage systems (ditches, canals, etc.)
g. Distances to relief points and man-made drainage systems
h. On-site types of vegetation
i. Area topography (ground surface elevations)
j. Available Published Data

Based on site-specific information and factors listed above, we estimate that the typical wet season groundwater levels in the proposed areas will occur within 12 inches of the surface for more than six months during most years. Some areas will have water ponded on the surface for four months or more. However, it should be noted that peak stage elevations immediately following various intense storm events, may be somewhat higher than the estimated typical wet season levels. Further, it should be understood that changes in the surface hydrology and subsurface drainage from on-site or off-site improvements could have significant effects on the normal and seasonal high groundwater levels.

It should be noted that the normal estimated seasonal high water levels do not provide any assurance that groundwater levels will not exceed these estimated levels during any given year in the future. Should the impediments to surface water drainage be present, or should rainfall intensity and duration, or total rainfall quantities, exceed the normally anticipated rainfall quantities, groundwater levels might once again exceed our seasonal high estimates. We recommend positive drainage be established and maintained on the site during construction.

4.7 DEWATERING

Based on the groundwater level conditions encountered and expected on this project site, control of the groundwater may be required to achieve the necessary excavation, construction, backfilling and compaction requirements presented in the preceding report sections. The actual method(s) of dewatering should be determined by the contractor. We recommend the contract documents provide for determining the depth to the groundwater table just prior to construction, and for any required remedial dewatering. Regardless of the method(s) used, we suggest drawing down the water level at least 2 feet below the bottom of the excavations to preclude "pumping" and/or compaction-related problems with the foundation and/or subgrade soils.

Dewatering should be accomplished with the knowledge that the permeability of soils decreases with an increasing silt and clay content. The sand (SP) and sand with silt (SP-SM) soil types can usually be dewatered by well pointing. Alternative means of dewatering may be necessary for the silty/clayey fine sands.

We recommend the project specifications call for avoiding any unnecessary dewatering activities and monitoring existing utilities and structures for any potential settlement in case dewatering is unavoidable.

Exposed subgrade soils consisting of silty and clayey will most likely result in saturated and pumping conditions due to the perched or standing water conditions. Further, short periods of intense rainfall can saturate surface soils, leading to instability during compaction and placement. In the event that heavy rainfall during construction activities resulted in unstable saturated conditions, the exposed saturated subgrade soils should be windrowed and aerated to reduce the moisture contents prior to further earthwork operations

5.0 REPORT LIMITATIONS

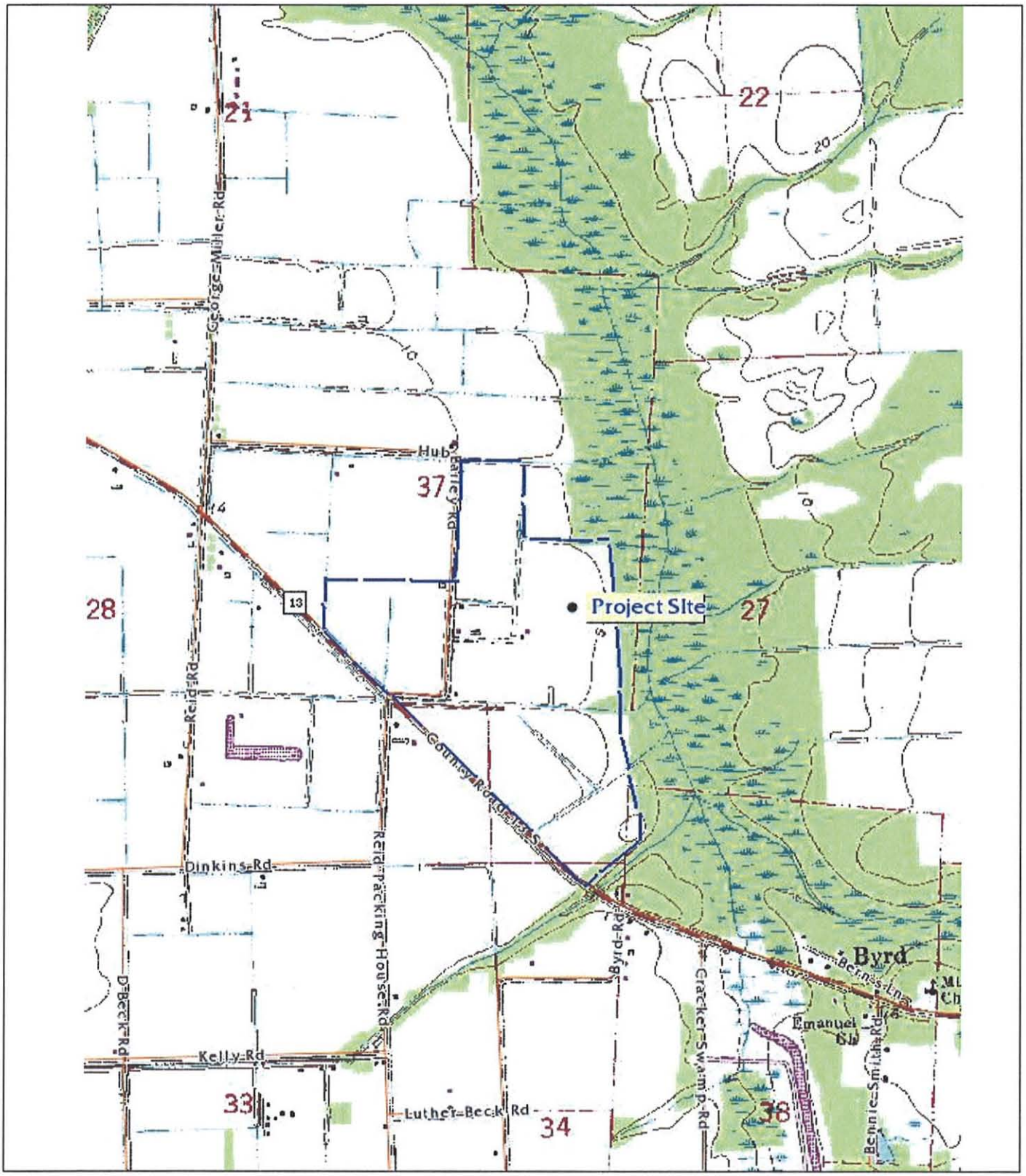
This Report has been prepared for the exclusive use of Jones, Edmunds & Associates, Inc., and other members of the Design/Construction team for the specific project discussed in this Report. This Report has been prepared in accordance with generally accepted local geotechnical engineering practices; no other warranty is expressed or implied.

The evaluation and recommendations submitted in this Report are based in part upon the data collected from the field exploration. The nature or extent of variations throughout the subsurface profile may not be fully reflected in the findings. If any changes in the design or location or elevation of the proposed construction as outlined in this Report are planned, or if any structures are included or added that are not discussed in the Report, the conclusions and recommendations contained in this Report shall not be considered valid unless the changes are reviewed and the conclusions modified or confirmed by Universal Engineering Sciences.

Because of the natural limitations inherent in working with the subsurface, it is not possible for geotechnical/geologic professionals to anticipate and predict all possible subsurface variations and their potential affect on the subject of this study. An ASFE publication, "Important Information about Your Geotechnical Engineering Report" appears in **Appendix D**, and will help explain the nature of geotechnical issues. Further, we present documents in Appendix: Constraints and Restrictions, to bring to your attention the potential concerns and the basic limitations of a typical geotechnical report.

APPENDIX A

UNIVERSAL ENGINEERING SCIENCES	USDA SOIL SURVEY		
	Master Regional Stormwater- Hasting, FL		
	DATE: 11-3-09	UES PROJECT NO.: 0230.0900077	APPENDIX NO.: A-3
	SCALE: N.T.S.	REPORT NO.: 805258	FIGURE NO.: 1



UNIVERSAL ENGINEERING SCIENCES	USGS TOPO MAP		
	Master Regional Stormwater- Hasting, FL		
	DATE: 11-3-09	UES PROJECT NO.: 0230.0900077	APPENDIX NO.: A
	SCALE: N.T.S.	REPORT NO.: 805258	FIGURE NO.: 2

APPENDIX B

LEGEND

STANDARD PENETRATION TEST BORING LOCATION

NOTE: ALL SOIL TEST BORING LOCATIONS SHOWN ARE APPROXIMATE.

500 0 250 500

GRAPHIC SCALE

N

PAGE NO: B - 1

UNIVERSAL ENGINEERING SCIENCES

MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA

BORING LOCATION PLAN

CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.

DRAWN BY: KD	DATE: 10/16/09
CHECKED BY: ES	DATE: 11/02/09
SCALE: AS SHOWN	ACADFILE:0230.0900077-B
PROJECT NO: 0230.0900077.0000	REPORT NO: 805258

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-2

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°40'45N
081°28'33W

BORING NO: **B - 1** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/15/09
WATER TABLE (ft): 5.5 DATE FINISHED: 10/15/09
DATE OF READING: 10/15/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose brown silty SAND [SM] (A-2-4)						
		4-2-1	3			Very loose light brown and orange SAND [SP]						
		1-2-2	4			Loose orange and gray very clayey SAND to sandy CLAY [SC/CH] (A-7)	50	32	52	31		
5		3-4-5	9	▼								
		5-5-5	10			Medium dense to very loose light gray SAND, with silt [SP-SM] (A-2-4)						
		4-3-4	7				12	22				
10		2-1-2	3									
						Very soft green silty CLAY, with trace of sand and organics [CL] (A-7)						
15		2/12"	1									
						Loose gray SAND, with silt and trace of organics [SP-SM] (A-3)						
20		1-3-6	9									
						Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
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PAGE:	B-3

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°40'49N
081°28'31W

BORING NO: **B - 2** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/15/09
WATER TABLE (ft): 6 DATE FINISHED: 10/15/09
DATE OF READING: 10/15/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./DAY)	ORG. CONT. (%)
0												
						Loose to very loose brown silty SAND [SM] (A-2-4)						
		4-3-3	6									
		1-1-1	2			Very loose to loose orange and gray very clayey SAND to sandy CLAY [SC/CL] (A-6)	38	22	34	18		
5		2-2-3	5	▼								
		4-6-5	11			Medium dense to very loose gray SAND, with silt [SP-SM] (A-2-4)						
		4-3-2	5				12	25				
10		1-1-2	3									
						Loose gray SAND, with silt and trace of organics [SP-SM] (A-3)						
15		5-5-4	9									
20		3-3-2	5									
						Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-4

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°40'50N
081°28'39W

BORING NO: **B - 3** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/15/09
WATER TABLE (ft): 5.5 DATE FINISHED: 10/15/09
DATE OF READING: 10/15/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./DAY)	ORG. CONT. (%)
0						Loose brown silty SAND [SM] (A-2-4)						
		4-4-1	5			Loose to very loose brown and orange silty SAND [SM] (A-2-4)						
		1-1-1	2			Loose orange very clayey SAND to sandy CLAY [SC/CL] (A-7)	46	55				
5		3-4-4	8	▼		Medium dense to loose light gray SAND, with silt [SP-SM] (A-3)						
		4-5-5	10									
		4-4-5	9				9	23				
10		3-2-3	5									
						Soft green silty CLAY, with lenses of sand [CL] (A-7)						
15		1-1-1	2			Very loose green and gray silty SAND [SM] (A-2-4)						
20		WOH	WOH			Very loose tan SAND, with silt [SP-SM] (A-3)						
		WOH-2-1	3									
						Boring Terminated at 22'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-5

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°40'57N
081°28'31W

BORING NO: **B - 4** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/15/09
WATER TABLE (ft): 7 DATE FINISHED: 10/15/09
DATE OF READING: 10/15/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./DAY)	ORG. CONT. (%)
0						Loose brown SAND, with silt [SP-SM] (A-2-4)						
		3-3-2	5			Firm orange and gray sandy CLAY [CH] (A-7)						
		2-3-4	7									
5		6-6-7	13			Medium dense orange and gray silty clayey SAND [SM-SC] (A-2-4)	27	19	25	4		
		8-7-6	13	▼		Medium dense to loose orange SAND, with trace of silt [SP-SM] (A-2-4)						
		4-4-3	7			Loose tan SAND, with silt [SP-SM] (A-3)						
10		3-2-3	5									
						Green silty CLAY [CL] (A-7)						
						Medium dense tan SAND, with silt [SP-SM] (A-3)						
15		6-13-17	30				6	24				
						Medium dense gray SAND, with silt [SP-SM] (A-3)						
20		6-9-7	16			Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-6

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°40'54N
081°28'44W

BORING NO: **B - 5** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/14/09
WATER TABLE (ft): 8 DATE FINISHED: 10/14/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose brown silty SAND [SM] (A-2-4)						
		3-3-1	4			Very loose brown and orange silty SAND [SM] (A-2-4)	16	15				
		WOH	WOH			Very loose orange and gray very clayey SAND to sandy CLAY [SC/CL] (A-7)	40	35				
5		WOH-3-5	8			Medium dense to loose light gray SAND, with silt [SP-SM] (A-2-4)						
		4-5-6	11									
		4-4-3	7	▼		Loose gray SAND, with trace of silt [SP-SM] (A-3)						
10		2-2-3	5									
						Green silty SAND [SM] (A-2-4)						
15		WOH-1	1			Very soft green silty CLAY, with trace of sand [CL] (A-7)						
20		1/18"	1			Very loose green very silty clayey SAND [SM-SC] (A-2-4)						
		1-3	4			Very loose green silty SAND, with rock and shell [SM] (A-2-4)						
						Boring Terminated at 22.5'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-7

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°40'59N
081°28'45W

BORING NO: **B - 6** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/14/09
WATER TABLE (ft): 8 DATE FINISHED: 10/14/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose brown silty SAND [SM]						
		4-3-1	4			Very loose to loose orange and gray very clayey SAND to sandy CLAY [SC/CL]						
		WOH-1-1	2									
5		1-2-3	5			Loose orange and gray clayey SAND [SC]	23	21				
		3-4-4	8									
		4-3-3	6	▼		Loose tan SAND, with trace of silt [SP-SM]						
10		2-2-2	4									
						Very loose gray silty SAND, with lenses of clay [SM] (A-2-4)						
15		WOH	WOH				30	28	24	2		
						Greenish-gray silty CLAY [CL] (A-7)						
		1/12"	1			Very loose greenish-gray silty clayey SAND [SM-SC] (A-2-4)						
20		WOH-1	1									
						Boring Terminated at 22'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-8

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'03N
081°28'51W

BORING NO: **B - 7** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/14/09
WATER TABLE (ft): 7.5 DATE FINISHED: 10/14/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose brown silty SAND [SM] (A-2-4)						
		3-1-1	2			Very loose to loose orange and gray very clayey SAND to sandy CLAY [SC/CH] (A-7)						
		1-2-3	5									
5		3-4-6	10				55	26				
						Medium dense orange and gray clayey SAND [SC] (A-2-6)						
		5-6-6	12	▼		Loose to medium dense tan SAND, with silt [SP-SM] (A-2-4)						
		5-4-2	6									
10		2-2-4	6									
15		3-5-6	11									
						Loose gray SAND, with silt and shell [SP-SM] (A-3)						
20		3-3-4	7				9	22				
						Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-9

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'09N
081°28'59W

BORING NO: **B - 8** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/14/09
WATER TABLE (ft): 7 DATE FINISHED: 10/14/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose brown silty SAND [SM] (A-2-4)						
		2-2-2	4			Very loose brown and orange SAND, with trace of clay [SP-SC] (A-2-4)						
		WOH-1-2	3			Very loose orange and gray very clayey SAND to sandy CLAY [SC/CH] (A-2-6)						
5		1-1-2	3				35	25				
		3-3-3	6	▼		Loose orange SAND, with trace of silt [SP-SM] (A-3)						
		2-2-2	4			Very loose gray SAND, with trace of silt [SP-SM] (A-3)						
10		3-1-2	3									
15		1-2-3	5									
						Very loose gray SAND, with silt and shell [SP-SM] (A-3)						
20		3-1-2	3									
						Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-10

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'04N
081°28'32W

BORING NO: **B - 9** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/13/09
WATER TABLE (ft): 7 DATE FINISHED: 10/13/09
DATE OF READING: 10/13/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./DAY)	ORG. CONT. (%)
0						Loose brown silty SAND [SM] (A-2-4)						
		3-3-2	5									
						Soft light green and orange sandy CLAY, with trace of sand [CL] (A-7)						
		1-1-2	3				54	33	44	25		
5		3-4-6	10			Medium dense orange clayey SAND [SC] (A-2-6)						
		6-6-7	13	▼								
						Medium dense to loose tan SAND, with silt [SP-SM] (A-3)						
		7-5-5	10				8	27				
						Loose to very loose gray SAND, with silt [SP-SM] (A-3)						
10		4-3-4	7									
15		1-3-1	4									
20		1-2-1	3									
						Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-11

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'03N
081°28'41W

BORING NO: **B - 10** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/12/09
WATER TABLE (ft): 3 DATE FINISHED: 10/12/09
DATE OF READING: 10/12/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose brown and orange silty SAND [SM] (A-2-4)						
		3-2-1	3	▼			14	15				
		WOH	WOH			Very soft to stiff orange sandy CLAY, with lenses of sand [SC/CH] (A-7)						
5		3-4-4	8			Loose to medium dense orange clayey SAND [SC] (A-6)						
		4-5-6	11			Medium dense to loose gray and orange silty SAND [SM] (A-2-4)						
		2-2-3	5			Loose to very loose tan SAND, with silt [SP-SM] (A-3)						
10		1-2-1	3									
						Very loose gray and green SAND, with trace of silt [SP-SM] (A-3)						
15		WOH	WOH									
		1-1-1	2			Very loose clayey SAND [SC/CL] (A-7)	50	36				
20		WOH	WOH									
		2-3-6	9			Loose gray SAND, with silt and trace of shell [SP-SM] (A-3)						
						Boring Terminated at 21.5'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-12

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'10N
081°28'37W

BORING NO: **B - 11** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/13/09
WATER TABLE (ft): 3 DATE FINISHED: 10/13/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Very loose gray silty SAND [SM] (A-2-4)						
		2-2-1	3	▼		Soft to firm orange and gray sandy CLAY [CL] (A-7)						
		WOH-1	1									
5		2-3-4	7			Medium dense orange and gray clayey SAND [SC] (A-2-6)						
		5-6-6	12			Medium dense to loose orange and gray silty SAND [SM] (A-2-4)						
		5-5-5	10				14	23				
10		4-3-3	6									
						Green and orange silty CLAY [CL] (A-7)						
		WOH-1/12"	1			Very loose green silty SAND [SM] (A-2-4)						
15						Loose gray SAND, with shell and sandstone [SP] (A-3)						
		4-3-4	7									
20						Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-13

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'14N
081°28'43W

BORING NO: **B - 12** SHEET: 1 of 1

SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/13/09
WATER TABLE (ft): 3 DATE FINISHED: 10/13/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./DAY)	ORG. CONT. (%)
0						Very loose brown silty SAND [SM] (A-2-4)						
		3-2-1	3	▼		Soft to stiff orange and gray sandy CLAY [CL] (A-7)						
		1-2-2	4									
5		3-3-4	7				54	26	46	28		
		4-5-5	10									
		4-4-4	8			Loose gray silty SAND [SM] (A-2-4)						
10		4-3-3	6									
						Very loose green silty SAND, with lenses of clay [SM] (A-2-4)						
15		1-1-1	2									
						Loose gray SAND, with silt and shell [SP-SM] (A-3)						
20		2-1-4	5			Boring Terminated at 20'						

UNIVERSAL ENGINEERING SCIENCES
BORING LOG

PROJECT NO.:	0230.0900077.0000
REPORT NO.:	805258
PAGE:	B-14

PROJECT: MASTER REGIONAL STORMWATER
TRACT OFF COUNTY ROAD 13S
HASTINGS, ST. JOHNS COUNTY, FLORIDA
CLIENT: JONES, EDMUNDS & ASSOCIATES, INC.
LOCATION: SEE BORING LOCATION PLAN
REMARKS: GPS COORDINATES:
29°41'24N
081°28'45W

BORING NO: **B - 13** SHEET: 1 of 1

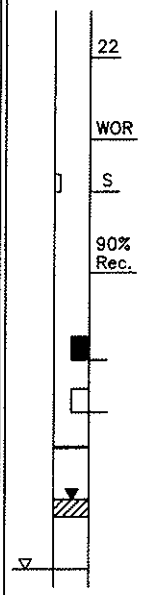
SECTION: 37 TOWNSHIP: 9S RANGE: 28E
GS ELEVATION(ft): DATE STARTED: 10/13/09
WATER TABLE (ft): 3 DATE FINISHED: 10/13/09
DATE OF READING: 10/14/09 DRILLED BY: M. BOATRIGHT
EST. WSWT (ft): TYPE OF SAMPLING: ASTM D-1586

DEPTH (FT.)	SAMPLE	BLOWS PER 6" INCREMENT	N VALUE	W.T.	SYMBOL	DESCRIPTION	-200 (%)	MC (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	K (FT./ DAY)	ORG. CONT. (%)
0						Loose brown silty SAND [SM] (A-2-4)						
		3-4-2	6			Loose brown and orange SAND [SP] (A-3)						
		1-2-2	4	▼		Loose orange and gray very clayey SAND to sandy CLAY [SC/CL] (A-7)	48	26				
5		2-2-3	5									
		4-4-6	10			Medium dense to loose orange and gray silty SAND [SM] (A-2-4)						
		4-4-4	8			Loose to very loose gray silty SAND [SM] (A-2-4)						
10		2-2-3	5									
		WOH	WOH			Very loose gray SAND, with lenses of clay [SP-SC] (A-3)						
15												
		5-4-4	8			Loose gray SAND, with silt [SP-SM] (A-3)						
20						Boring Terminated at 20'						

UNIVERSAL
ENGINEERING SCIENCES

KEY TO BORING LOGS

SYMBOLS



22	Number of Blows of a 140–lb Weight Falling 30 in. Required to Drive Standard Spoon One Foot
WOR	Weight of Drill Rods
S	Thin–Wall Shelby Tube Undisturbed Sampler Used
90% Rec.	Percent Core Recovery from Rock Core–Drilling Operations
	Sample Taken at this Level
	Sample Not Taken at this Level
	Change in Soil Strata
	Free Ground Water Level
	Seasonal High Ground Water Level

RELATIVE DENSITY
(sand-silt)

Very loose – Less Than 4 Blows/Ft.
Loose – 4 to 10 Blows/Ft.
Medium Dense – 10 to 30 Blows/Ft.
Dense – 30 to 50 Blows/Ft.
Very Dense – More Than 50 Blows/Ft.

CONSISTANCY
(clay)

Very Soft – Less Than 2 Blows/Ft.
Soft – 2 to 4 Blows/Ft.
Firm – 4 to 8 Blows/Ft.
Stiff – 8 to 15 Blows/Ft.
Very Stiff – 15 to 30 Blows/Ft.
Hard – More Than 30 Blows/Ft.

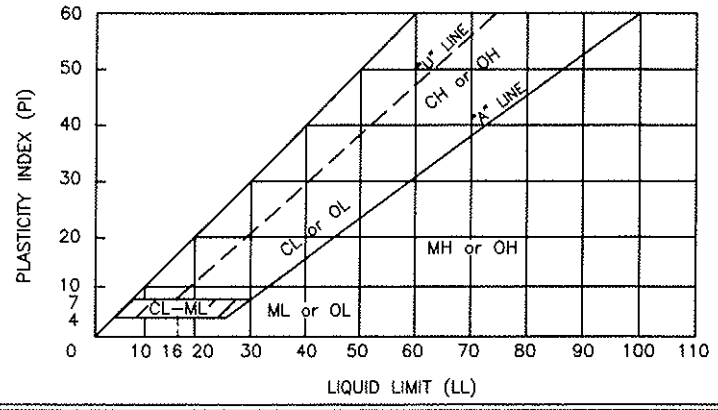
Based on Safety Hammer N–Values

UNIFIED CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 200 sieve	CLEAN GRAVELS	GW	Well–graded gravels and gravel–sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel–sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels, gravel–sand–silt mixtures
			GC	Clayey gravels, gravel–sand–clay mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well–graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand–silt mixtures
			SC	Clayey sands, sand–clay mixtures
FINE-GRAINED SOILS 50% or more passes No. 200 sieve*	SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomacaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly organic Soils			PT	Peat, muck and other highly organic soils

* Based on the material passing the 3–in. (75mm) sieve.

PLASTICITY CHART



APPENDIX C

SUMMARY OF LABORATORY RESULTS

UNIVERSAL
ENGINEERING SCIENCES

PROJECT: MASTER REGIONAL STORMWATER TREATMENT FACILTY-HASTING, FL

REPORT: 805258

CLIENT: JONES EDMUNDS & ASSOC.

November 4, 2009

BORING NO.	SAMPLE DEPTH (FT)	SOIL DESCRIPTION	SAMPLE TYPE*	NATURAL MOISTURE (%)	ATTERBERG LIMITS		ORGANIC CONTENT (%)	SIEVE ANALYSIS (% PASSING)						AASHTO SOIL CLASSIFICATION	UNIFIED SOIL CLASSIFICATION
					LIQUID LIMIT (%)	PLASTICITY INDEX (%)		No. 4	No. 10	No. 40	No. 60	No. 100	No. 200		
B-1	3	Orange, gray very clayey Sand	SS	32	52	31							50		SC/CH
B-1	8	Gray Sand with silt	SS	22									12		SP-SM
B-2	4	Gray very clayey Sand	SS	22	34	18							38		SC
B-2	8	Gray Sand with silt	SS	25									12		SP-SM
B-3	5	Gray very clayey Sand	SS	55									46		SC
B-3	8	Gray Sand with silt	SS	23									9		SP-SM
B-4	5	Gray silty-clayey Sand	SS	19	25	4							27		SM-SC
B-4	15	Tan Sand with silt	SS	24									6		SP-SM
B-5	3	Orange silty Sand	SS	16									16		SM
B-5	4	Orange, gray very clayey Sand	SS	35									40		SC
B-6	7	Gray clayey Sand	SS	21									23		SC
B-6	15	Gray silty Sand	SS	28	24	2							30		SM
B-7	5	Gray, orange clayey Sand	SS	26									55		CH
B-7	20	Gray Sand with silt and shells	SS	22									9		SP-SM

*SS-Split Spoon
ST-Shelby Tube
A-Auger

SUMMARY OF LABORATORY RESULTS

UNIVERSAL
ENGINEERING SCIENCES

PROJECT: MASTER REGIONAL STORMWATER TREATMENT FACILTY-HASTING, FL

REPORT: 805258

CLIENT: JONES EDMUNDS & ASSOC.

November 4, 2009

BORING NO.	SAMPLE DEPTH (FT)	SOIL DESCRIPTION	SAMPLE TYPE*	NATURAL MOISTURE (%)	ATTERBERG LIMITS		ORGANIC CONTENT (%)	SIEVE ANALYSIS (% PASSING)						AASHTO SOIL CLASSIFICATION	UNIFIED SOIL CLASSIFICATION
					LIQUID LIMIT (%)	PLASTICITY INDEX (%)		No. 4	No. 10	No. 40	No. 60	No. 100	No. 200		
B-8	5	Orange, gray very clayey Sand	SS	25									35		SC
B-9	4	Orange, green sandy Clay	SS	33	44	25							54		CL
B-9	8	Tan Sand with silt	SS	27									8		SP-SM
B-10	1	Brown, orange silty Sand	SS	15									14		SM
B-10	16	Gray very clayey Sand	SS	36									50		SC/CL
B-11	8	Orange, gray silty Sand	SS	23									14		SM
B-12	5	Orange, gray sandy Clay	SS	26	46	28							54		CL
B-13	4	Gray very clayey Sand	SS	26									48		SC/CL

*SS-Split Spoon
ST-Shelby Tube
A-Auger

APPENDIX D

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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CONSTRAINTS AND RESTRICTIONS

WARRANTY

Universal Engineering Sciences has prepared this report for our client for his exclusive use, in accordance with generally accepted soil and foundation engineering practices and makes no other warranty either expressed or implied as to the professional advice provided in the report.

UNANTICIPATED SOIL CONDITIONS

The analysis and recommendations submitted in this report are based upon the data obtained from soil borings performed at the locations indicated on the Boring Location Plan. This report does not reflect any variation which may occur between these borings.

The nature and extent of variations between borings may not become known until excavation begins. If variations appear, we may have to re-evaluate our recommendations after performing on-site observations and noting the characteristics of any variations.

CHANGED CONDITIONS

We recommend that the specifications for the project require that the contractor immediately notify Universal Engineering Sciences, as well as the owner, when subsurface conditions are encountered that are different from those present in this report.

No claim by the contractor for any conditions differing from those anticipated in the plans, specifications, and those found in this report, should be allowed unless the contractor notifies the owner and Universal Engineering Sciences of such changed conditions. Further, we recommend that all foundation work and site improvements be observed by a representative of Universal Engineering Sciences to monitor field conditions and changes, to verify design assumptions and to evaluate and recommend any appropriate modifications to this report.

MISINTERPRETATION OF SOIL ENGINEERING REPORT

Universal Engineering Sciences is responsible for the conclusions and opinions contained within this report based upon the data relating only to the specific project and location discussed herein. If the conclusions or recommendations based upon the data presented are made by others, those conclusions or recommendations are not the responsibility of Universal Engineering Sciences.

CHANGED STRUCTURE OR LOCATION

This report was prepared in order to aid in the evaluation of this project and to assist the architect or engineer in the design of this project. If any changes in the design or location of the structure as outlined in this report are planned, or if any structures are included or added that are not discussed in the report, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusion modified or approved by Universal Engineering Sciences.

USE OF REPORT BY BIDDERS

Bidders who are examining the report prior to submission of a bid are cautioned that this report was prepared as an aid to the designers of the project and it may affect actual construction operations.

Bidders are urged to make their own soil borings, test pits, test caissons or other investigations to determine those conditions that may affect construction operations. Universal Engineering Sciences cannot be responsible for any interpretations made from this report or the attached boring logs with regard to their adequacy in reflecting subsurface conditions which will affect construction operations.

STRATA CHANGES

Strata changes are indicated by a definite line on the boring logs which accompany this report. However, the actual change in the ground may be more gradual. Where changes occur between soil samples, the location of the change must necessarily be estimated using all available information and may not be shown at the exact depth.

OBSERVATIONS DURING DRILLING

Attempts are made to detect and/or identify occurrences during drilling and sampling, such as: water level, boulders, zones of lost circulation, relative ease or resistance to drilling progress, unusual sample recovery, variation of driving resistance, obstructions, etc.; however, lack of mention does not preclude their presence.

WATER LEVELS

Water level readings have been made in the drill holes during drilling and they indicate normally occurring conditions. Water levels may not have been stabilized at the last readings. This data has been reviewed and interpretations made in this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, tides, and other factors not evident at the time measurements were made and reported. Since the probability of such variations is anticipated, design drawings and specifications should accommodate such possibilities and construction planning should be based upon such assumptions of variations.

LOCATION OF BURIED OBJECTS

All users of this report are cautioned that there was no requirements for Universal Engineering Sciences to attempt to locate any man-made buried objects during the course of this exploration and that no attempt was made by Universal Engineering Sciences to locate any such buried objects. Universal Engineering Sciences cannot be responsible for any buried man-made objects which are subsequently encountered during construction that are not discussed within the text of this report.

TIME

This report reflects the soil conditions at the time of investigation. If the report is not used in a reasonable amount of time, significant changes to the site may occur and additional reviews may be required.

Universal Engineering Sciences, Inc.

GENERAL CONDITIONS

SECTION 1: RESPONSIBILITIES

1.1 *Universal Engineering Sciences, Inc.*, herefore referred to as the "Consultant," has the responsibility for providing the services described under the "Scope of Services" section. The work is to be performed according to accepted standards of care and is to be completed in a timely manner.

1.2 The "Client" or a duly authorized representative is responsible for providing the Consultant with a clear understanding of the project nature and scope. The client shall supply the Consultant with sufficient and adequate information, including, but not limited to, maps, site plans, reports, surveys and designs, to allow the Consultant to properly complete the specified services. The Client shall also communicate changes in the nature and scope of the project as soon as possible during performance of the work so that the changes can be incorporated into the work product.

SECTION 2: STANDARD OF CARE

2.1 Services performed by the Consultant under this Agreement are expected by the Client to be conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Consultant's profession practicing contemporaneously under similar conditions in the locality of the project. No other warranty, express or implied, is made.

2.2 The Client recognizes that subsurface conditions may vary from those observed at locations where borings, surveys, or other explorations are made, and that site conditions may change with time. Date, interpretations, and recommendations by the Consultant will be based solely on information available to the Consultant at the time of service. The Consultant is responsible for those data, interpretations, and recommendations, but will not be responsible for other parties' interpretations or use of the information developed.

SECTION 3: SITE ACCESS AND SITE CONDITIONS

3.1 Client will grant or obtain free access to the site for all equipment and personnel necessary for the Consultant to perform the work set forth in this Agreement. The Client will notify any and all possessors of the project site that Client has granted Consultant free access to the site. The Consultant will take reasonable precautions to minimize damage to the site, but it is understood by Client that, in the normal course of work, some damage may occur, and the correction of such damage is not part of this Agreement unless so specified in the Proposal.

3.2 The Client is responsible for the accuracy of locations for all subterranean structures and utilities. The Consultant will take reasonable precautions to avoid unknown subterranean structures, and the Client waives any claim against Consultant, and agrees to defend, indemnify, and hold Consultant harmless from any claim or liability for injury or loss, including costs of defense, arising form damage done to subterranean structures and utilities not indentified or accurately located. In addition, Client agrees to compensate Consultant for any time spent or expenses incurred by Consultant in defense of any such claim with compensation to be based upon Consultant's prevailing fee schedule and expense reimbursement policy.

SECTION 4: SAMPLE OWNERSHIP AND DISPOSAL

4.1 Soil or water samples obtained from the project during performance of the work shall remain the property of the Client.

4.2 The Consultant will dispose of or return to Client all remaining soils and rock samples 60 days after submission of report covering those samples. Further storage or transfer of samples can be made at Client's prior written request.

4.3 Samples which are contaminated by petroleum products or other chemical waste will be returned to Client for treatment or disposal, consistent with all appropriate federal, state, or local regulations.

SECTION 5: BILLING AND PAYMENT

5.1 Consultant will submit invoices to Client monthly or upon completion of services. Invoices will show charges for different personnel and expense classifications.

5.2 Payment is due 30 days after presentation of invoice and is past due 31 days from invoice date. Client agrees to pay a finance charge of one and one-half percent (1- ½ %) per month, or the maximum rate allowed by law, on past due accounts.

5.3 If the Consultant incurs any expenses to collect overdue billings on invoices, the sums paid by the Consultant for reasonable attorney's fees, court costs, Consultant's time, Consultant's expenses, and interest will be due and owing by the Client.

SECTION 6: OWNERSHIP OF DOCUMENTS

6.1 All reports, boring logs, field data, field notes, laboratory test data, calculations, estimates, and other documents prepared by the Consultant, as instruments of service, shall remain the property of the Consultant.

6.2 Client agrees that all reports and other work furnished to the Client or his agents, which are not paid for, will be not be used or relied upon by the Client for any purpose.

6.3 The Consultant will retain all pertinent records to the services performed for a period of five years following submission of the report, during which period the records will be made available to the Client at all reasonable times.

SECTION 7: DISCOVERY OF UNANTICIPATED HAZARDOUS MATERIALS

7.1 Client warrants that a reasonable effort has been made to inform Consultant of known or suspected hazardous materials on or near the project site.

7.2 Under this agreement, the term hazardous materials include hazardous materials (40 CFR 172.01), hazardous wastes (40 CFR 261.2), hazardous substances (40 CFR 300.6), petroleum products, polychlorinated biphenyls, and asbestos.

7.3 Hazardous materials may exist at a site where there is no reason to believe they could or should be present. Consultant and Client agree that the discovery of unanticipated hazardous materials constitutes a changed condition mandating a renegotiation of the scope of work. Consultant and Client also agree that the discovery of unanticipated hazardous materials may make it necessary for Consultant to take immediate measures to protect health and safety. Client agrees to compensate Consultant for any equipment decontamination or other costs incident to the discovery of unanticipated hazardous waste.

7.4 Consultant agrees to notify Client when unanticipated hazardous materials or suspected hazardous materials are encountered. Client agrees to make any disclosure required by law to the appropriate governing agencies. Client also agrees to hold Consultant harmless for any and all consequences of disclosures made by Consultant which are required by governing law. In the event the project site is not owned by Client, Client recognizes that it is the Client's responsibility to inform the property owners of the discovery of unanticipated hazardous materials or suspected hazardous materials.

7.5 Notwithstanding any other provision of the Agreement, Client waives any claim against Consultant, and to the maximum extent permitted by law, agrees to defend, indemnify, and save Consultant harmless from any claim, liability, and/or defense costs for injury or loss arising from Consultant's discovery of unanticipated hazardous materials or suspected hazardous materials including any costs created by delay of the project and any cost associated with possible reduction of the property's value. Client will be responsible for ultimate disposal of any samples secured by Consultant which are found to be contaminated.

SECTION 8: RISK ALLOCATION

8.1 Client agrees that Consultant's liability for any damage on account of any error, omission or other professional negligence will be limited to a sum not to exceed $50,000 or Consultant's fee, whichever is greater. Client agrees that the foregoing limits of liability extend to all Consultant's employees and professionals who perform any services for Client. If Client prefers to have higher limits on professional liability, Consultant agrees to increase the limits up to a maximum of $1,000,000.00 upon Client's written request at the time of accepting our proposal provided that Client agrees to pay an additional consideration of four percent of the total fee, or $400.00, whichever is greater. The additional charge for the higher liability limits is because of the greater risk assumed and is not strictly a charge for additional professional liability insurance.

SECTION 9: INSURANCE

9.1 The Consultant represents and warrants that it and its agents, staff and Consultants employed by it, is and are protected by worker's compensation insurance and that Consultant has such coverage under public liability and property damage insurance policies which the Consultant deems to be adequate. Certificates for all such policies of insurance shall be provided to Client upon request in writing. Within the limits and conditions of such insurance, Consultant agrees to indemnify and save Client harmless from and against loss, damage, or liability arising from negligent acts by Consultant, its agents, staff, and consultants employed by it. The Consultant shall not be responsible for any loss, damage or liability beyond the amounts, limits, and conditions of such insurance or the limits described in Section 8, whichever is less. The Client agrees to defend, indemnify, and save Consultant harmless for loss, damage or liability arising from acts by Client, Client's agent, staff, and other consultants employed by Client.

SECTION 10: DISPUTE RESOLUTION

10.1 All claims, disputes, and other matters in controversy between Consultant and Client arising out of or in any way related to this Agreement will be submitted to "alternative dispute resolution" (ADR) such as mediation and/or arbitration, before and as a condition precedent to other remedies provided by law.

10.2 If a dispute at law arises related to the services provided under this Agreement and that dispute requires litigation instead of ADR as provided above, then:

(a) the claim will be brought and tried in judicial jurisdiction of the court of the county where Consultant's principal place of business is located and Client waives the right to remove the action to any other county or judicial jurisdiction, and

(b) The prevailing party will be entitled to recovery of all reasonable costs incurred, including staff time, court costs, attorneys' fees, and other claim related expenses.

SECTION 11: TERMINATION

11.1 This agreement may be terminated by either party upon seven (7) days written notice in the event of substantial failure by the other party to perform in accordance with the terms hereof. Such termination shall not be effective if that substantial failure has been remedied before expiration of the period specified in the written notice. In the event of termination, Consultant shall be paid for services performed to the termination notice date plus reasonable termination expenses.

11.2 In the event of termination, or suspension for more than three (3) months, prior to completion of all reports contemplated by the Agreement, Consultant may complete such analyses and records as are necessary to complete his files and may also complete a report on the services performed to the date of notice of termination or suspension. The expense of termination or suspension shall include all direct costs of Consultant in completing such analyses, records and reports.

SECTION 12: ASSIGNS

12.1 Neither the Client nor the Consultant may delegate, assign, sublet or transfer his duties or interest in the Agreement without the written consent of the other party.

SECTION 13: GOVERNING LAW AND SURVIVAL

13.1 The laws of the State of Florida will govern the validity of these Terms, their interpretation and performance.

13.2 If any of the previous contained in this Agreement are held illegal, invalid, or unenforceable, the enforceability of the remaining provisions will not be impaired. Limitations and liability and indemnities will survive termination of this Agreement for any cause.

APPENDIX C

MEMORANDUM: NUTRIENT OPTIMIZATION

MEMORANDUM

JONES EDMUNDS

TO:	Greg Caldwell, Tony Cubbedge - St. Johns County
FROM:	Amy Goodden, P.E.
DATE:	August 31, 2009
XC:	Brett Goodman, P.E., Walt Nickel, P.E., Mark Nelson, P.E. – Jones Edmunds
RE:	Task 3.2 Optimize Nutrient Removal

Task 3.2: "There is the potential for a portion of the nutrients removed as part of the Master's Tract RST to be applied to water quality needs of other County projects, with the remaining nutrient removal being applied to the County's TMDL load reductions. The County will benefit by maximizing the amount of nutrients that can be removed at the RST. This task will look at optimizing the site for nutrient removal by evaluating the larger treatment volumes, chemical injection, natural systems, and stormwater reuse. The information from this task will be used to evaluate the potential for including additional nutrient removal components with the initial design or future phases."

1.0 INTRODUCTION

The Lower St. Johns River (LSJR) is impaired by excess nutrients. The LSJR has a Basin Management Action Plan (BMAP), adopted and enforced by Florida Department of Environmental Protection (FDEP), to achieve what are known as the *Total Maximum Daily Load* (TMDL) *targets*. The LSJR BMAP requires St. Johns County to identify and implement projects to reduce nutrients discharged to the Lower St. Johns River. The nutrient reductions called for in the BMAP for Total Nitrogen (TN) and Total Phosphorus (TP) are 20,100 lb/yr and 950 lb/yr, respectively, as shown in Table 1-1. One of the projects identified by the County to meet the TMDL is participation in the St. Johns River Water Management District's Algal Initiative. As part of the Algal Initiative, the County is required to remove 12,220 lb/yr of total nitrogen. Participation in the Algal Initiative requires projects to be identified, evaluated, and selected for design by November 2010. The County has identified the Master's Tract RST as a project that will meet a portion of the Algal Initiative and TMDL commitments.

The purpose of this memorandum is to select the best "treatment train" to cost-effectively maximize nutrient removal on the Master's Tract.

Table 1-1. St. Johns County BMAP Load Reductions (lb/yr)

Parameter	Marine			Freshwater	
	Load Reduction	Credit/Deficit with BMAP Projects Implemented	Algal Initiative Commitment	Load Reduction	Credit/Deficit with BMAP Projects Implemented
Total Nitrogen					
MS4	5,084	-3,784	3,784	N/A	N/A
Non-MS4	10,958	-8,435	8,435	4,070	+3,386
Total Phosphorus					
MS4	N/A	N/A	N/A	N/A	N/A
Non-MS4	N/A	0	0	948	+503

2.0 NITROGEN REMOVAL PROCESSES

Nitrogen is the primary nutrient of concern for the Master's Tract RST. Figure 2-1 shows the nitrogen cycle. A simple review of nitrogen removal processes is presented here to emphasize the importance of the various chemical and biological forms of nitrogen in the selection of the best removal strategy.

Nitrogen is removed from the aquatic environment in three ways: as harvested plant protein, as harvested animal protein, or as atmospheric nitrogen. The main function of an advanced wastewater treatment plant is to optimize microbial processes to maximize the conversion of ammonia and nitrate to nitrite, which is then converted to atmospheric nitrogen. Additional nitrogen is removed from the aquatic environment as harvested plant and animal protein in the form of sludge.

In stormwater treatment systems, nitrogen is typically converted into plant protein. Examples of this are plants in a constructed wetland and submerged aquatic vegetation and algae in a wet detention pond. The nitrogen in the plant material is converted to animal protein, stored in a rich organic soil layer, released to the atmosphere as nitrogen gas, or released back into the water.

Wastewater plant operators optimize the nitrogen removal process by adjusting the predominant microbe species through controlling aeration and the contact time between the water and the microbes. Similar to a wastewater treatment plant, nitrogen removal in stormwater treatment systems is a function of aeration and contact time. The control is passive and is determined by water depth and hydraulic loading.

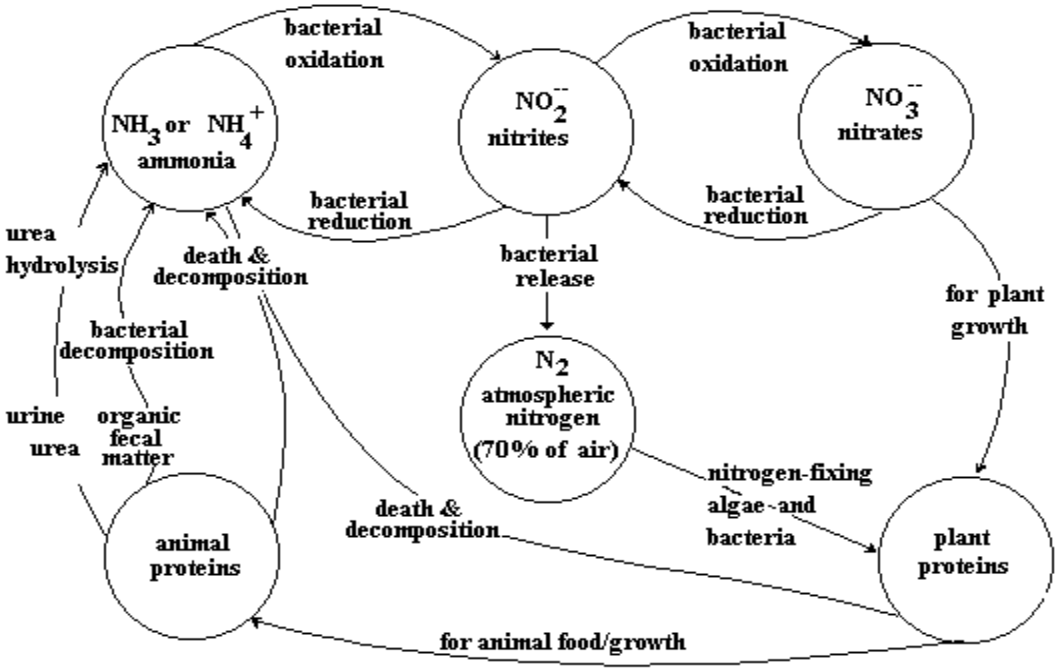


Figure 2-1. The Nitrogen Cycle (http://www.wrights-trainingsite.com/)

Controlling the hydraulic loading in a stormwater system is complicated by the inherent flow variability of stormwater water runoff. Stormwater nutrient removal treatment technologies applicable to the Master's Tract RST were selected for their ability to remove nitrogen and for their ability to tolerate the hydraulic loading required during the wet and dry seasons.

The treatment technologies were identified from the National BMP Database, National Pollutant Removal Database, and a review of the design criteria provided in "Evaluation of Current Stormwater Design Criteria within the State of Florida" (Harper, 2007). These references summarize studies of existing structural BMPs to provide design guidance for similar site-specific BMPs for development projects. The proposed RST differs from the designs presented in these studies because it is a retrofit of an existing system, it has a much larger contributing watershed, and the water is conveyed using a network of canals.

The treatment technologies evaluated for use at the Master's Tract RST include:

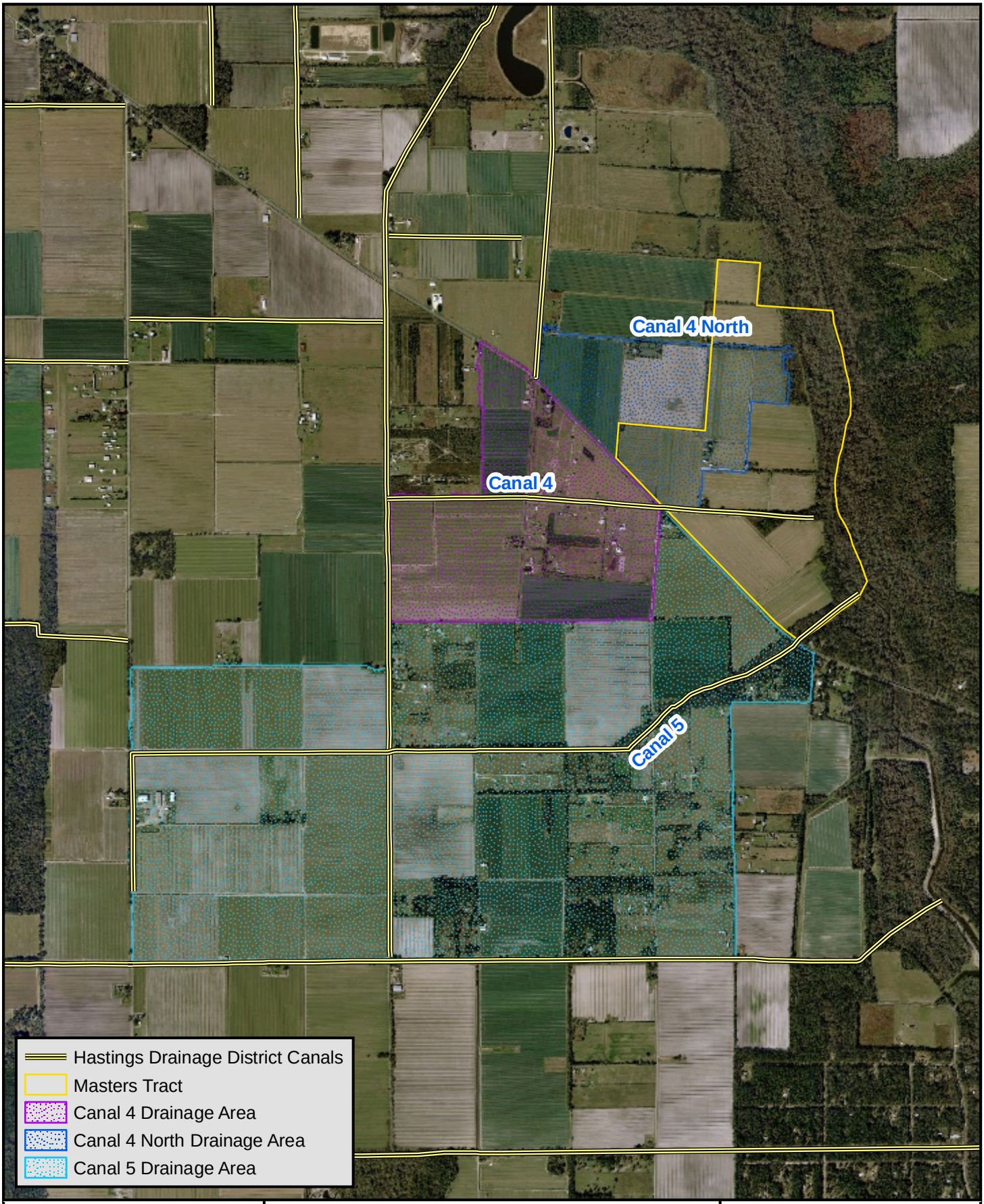
1. Wet Detention
2. Retention Pond
3. Media Filter
4. Constructed Wetlands
5. Vegetated Swale
6. Riparian Restoration
7. Alternative Irrigation Water Supply
8. Chemical Addition

Pollutant-load reductions are frequently discussed in terms of percent removal because it is a convenient way to compare alternatives. It also provides a means of estimating the pounds of nitrogen removed. There are shortcomings associated with using percent removal and consideration should be given to the following points when comparing alternatives:

1. Percent removal is mainly a function of influent quality. If the farms stopped using their BMPs, the percent removal for the RST would increase, although the net removal of the system would probably decrease.
2. Percent removal does not account for irreducible concentrations. Nutrients such as nitrogen are not completely removed by treatment systems (bmpdatabase.org, 2007).
3. In terms of meeting receiving water standards, BMP discharges can comply with receiving water numeric targets while simultaneously not showing favorable percent removals. Designing for a range of expected effluent quality concentrations is a better approach than percent removal estimates. This is particularly important in sensitive watersheds where it is important to have confidence that BMPs will be adequately protective. In this case, neither the BMAP nor the TMDL provide a target water quality concentration. (bmpdatabase.org, 2007)
4. Load reduction estimates based on percent removal calculations do not convey the dependence of the load reduction of the percent of runoff which is treated. In this case it is unlikely that all of the water will be diverted out of the Hastings Drainage District (HDD) canals. (bmpdatabase.org, 2007)
5. Percent removal values do not distinguish between the removal for peak flow and for average flow conditions

3.0 MASTER'S TRACT

The Master's Tract is a 272-acre parcel. Deep Creek runs from the south to the north along the east side of the parcel. The Hastings Drainage District maintains three canals which cross the site from west to east and connect to Deep Creek. The three canals, from south to north, are Canal 5, Canal 4, and Canal 4 North. Table 3-1 summarizes the land use and drainage area routed to each canal. Figure 3-1 shows the drainage areas associated with each canal.



JONES EDMUNDS

Figure 3-1

Drainage Areas

Masters Tract

0 1,000 2,000

Feet

1:24,000

N

Q:\19270_st_johns_co\048_Masters_BDM\mxd\Figure3_1_Drainage_Areas.mxd MCL 8/18/2009

For Informational Purposes Only

Table 3-1. Master's Tract Drainage Area Summary

Land Use	Master's Tract Drainage Basin in Acres				Row Crop
	Canal 4	Canal 5	Canal 4 N	Grand Total	
FALLOW CROPLAND	0.0	40.5	13.3	53.8	yes
FIELD CROPS		42.4		42.4	yes
FOOD PROCESSING		9.6		9.6	
HERBACEOUS UPLAND		6.4		6.4	
HORSE FARMS	25.1	9.3	0.1	34.5	
IMPROVED PASTURE	32.4	77.1	0.1	109.6	
MIXED SCRUB/SHRUB WETLAND		9.7		9.7	
MIXED UPLAND NON-FORESTED		14.4		14.4	
MIXED WETLAND HARDWOODS		19.1	1.1	20.2	
PINE FLATWOODS		13.9		13.9	
POTATOES AND CABBAGE	161.1	661.8	129.9	952.8	yes
RESERVOIRS	3.1			3.1	
RESIDENTIAL LOW DENSITY	18.7	82.0	7.2	108.0	
RESIDENTIAL MED DENSITY		0.3		0.3	
ROW CROPS	0.0	4.0		4.0	yes
SHRUB AND BRUSH-LAND		7.6	0.2	7.8	
UNIMPROVED PASTURE	1.5	15.3		16.7	
UPLAND MIXED CONIFER		18.8		18.8	
Grand Total	242.0	1032.2	151.8	1426.0	
Area in Row Crops	161.1	748.7	143.2	1053.1	
Percent in Row Crops	67%	73%	94%	74%	

4.0 INFLUENT WATER QUALITY DATA

SJRWMD collected water quality data from Canal 4 and Canal 5 from October 2007 through April 2009. The water quality data were compared with rainfall data to see if the spikes in nitrogen correlated to storm events. Rainfall data are provided in Table 4-1. The closer the storm event was to the sample date the higher the concentration of inorganic nitrogen. The spikes in nitrogen levels in October 2007, April 2008, July 2008, August 2008, January 2009, and April 2009 appear to coincide with storm events. It is interesting to note that elevated levels of TKN appear up to 1 week following a storm event.

SJRWMD noted three occasions (Sept 2008, March 2009 and April 2009) when Canal 4 was dry. In April 2009, the Hasting rain gauge indicates Canal 4 should not have been dry; therefore, it seems likely that upstream control structures were used to retain water on farm fields in accordance with the recommended on-farm BMPs. Canal 5 was sampled on several other occasions when Canal 4 was not. Based on the rainfall data it seems likely that Canal 4 was dry during these sampling events.

Table 4-1. Rainfall Amounts by Sample Date.

Sample Date	Rainfall in Inches				Canal 5 Sampled	Canal 4 Sampled
	2 week prior	1 week prior	1 day prior	Sample Day		
10/3/2007	2.07	1.83	1.75	0.19	yes	yes
11/13/2007	0.08	0.00	0.00	0.00	yes	yes
12/12/2007	0.08	0.03	0.01	0.00	yes	yes
1/10/2008	0.18	0.03	0.01	0.00	yes	yes
2/11/2008	0.86	0.85	0.00	0.00	yes	yes
3/27/2008	0.44	0.00	0.00	0.00	yes	no*
4/7/2008	1.68	1.68	0.80	0.05	yes	yes
5/7/2008	0.20	0.00	0.00	0.00	yes	no*
6/5/2008	0.72	0.53	0.01	0.00	yes	yes
7/21/2008	3.81	3.34	0.01	0.00	no	yes
8/4/2008	2.02	1.63	0.02	0.00	yes	no*
9/15/2008	0.81	0.25	0.00	0.00	yes	no flow
10/16/2008	2.78	1.29	0.00	0.00	yes	yes
11/17/2008	0.75	0.73	0.00	0.00	yes	no*
12/29/2008	0.05	0.02	0.01	0.01	yes	no*
1/14/2009	2.23	2.20	0.81	0.00	yes	yes
2/26/2009	0.61	0.00	0.00	0.00	yes	no*
3/5/2009	0.12	0.12	0.00	0.00	yes	no flow
4/2/2009	3.64	3.49	1.07	0.01	yes	no flow

* indicates that SJRWMD did not provide an explanation for not sampling.

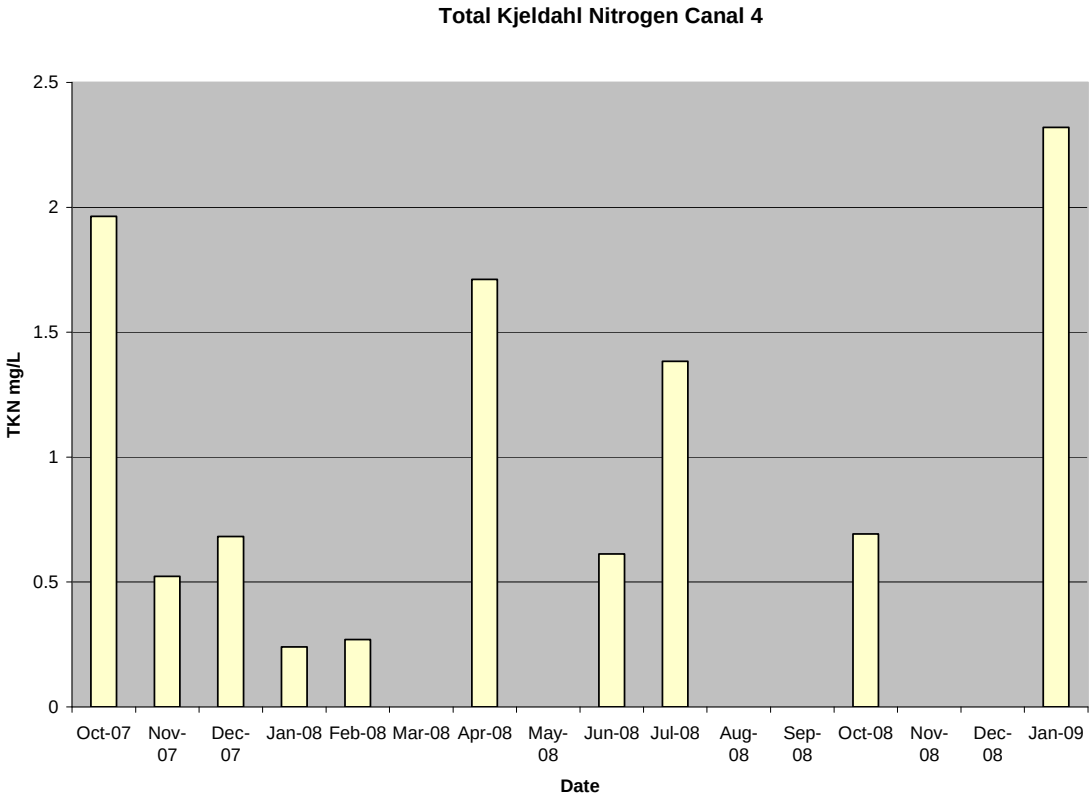


Figure 4-1. Total Kjehldahl Nitrogen in Canal 4

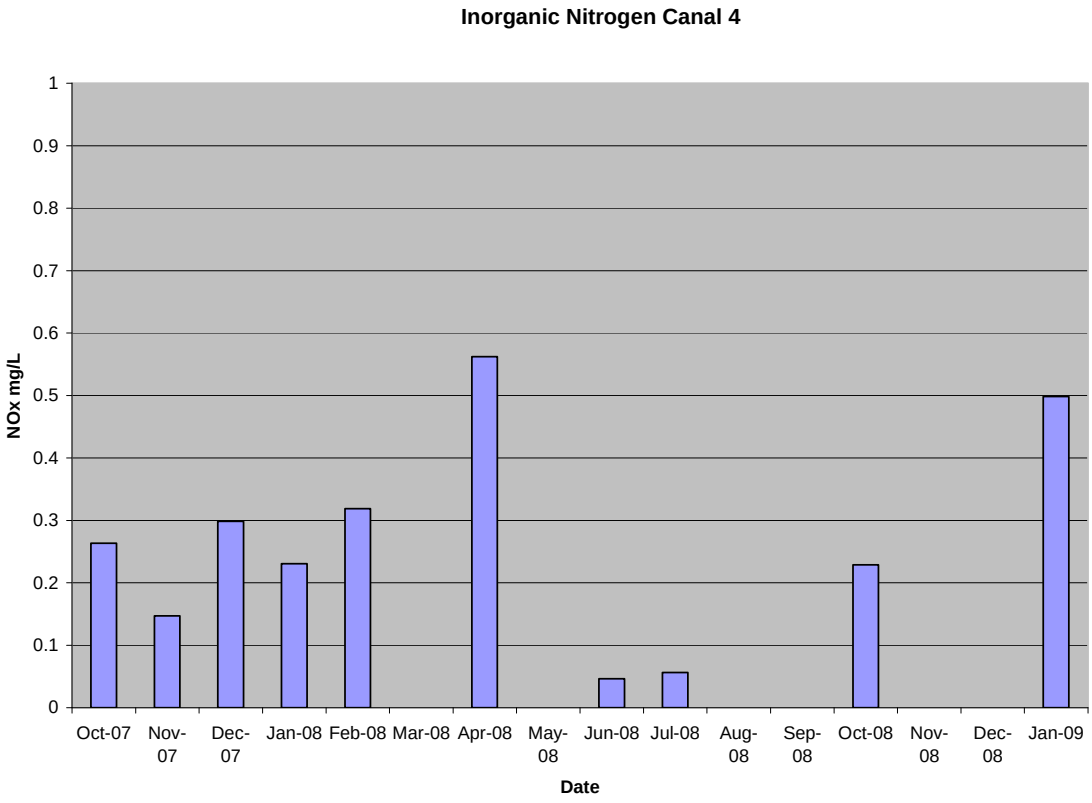


Figure 4-2. Inorganic Nitrogen in Canal 4

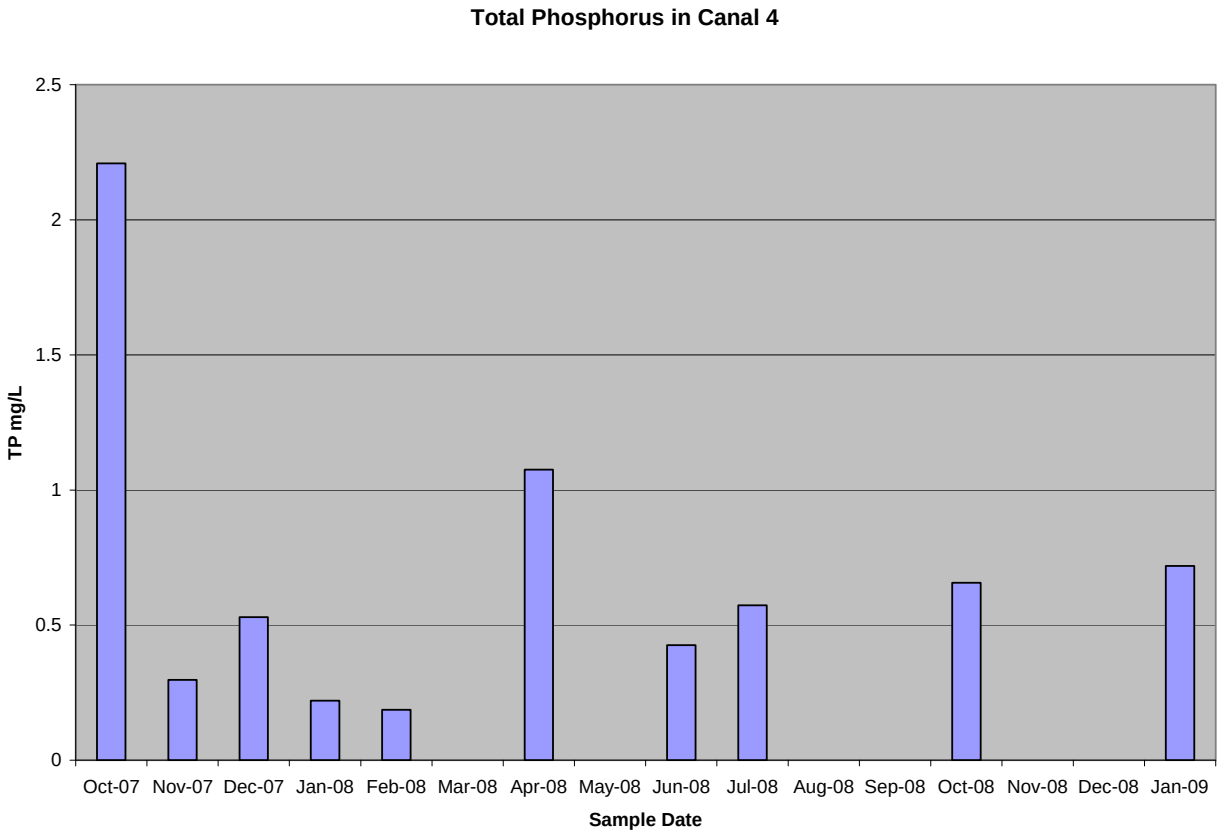


Figure 4-3. Total Phosphorus in Canal 4

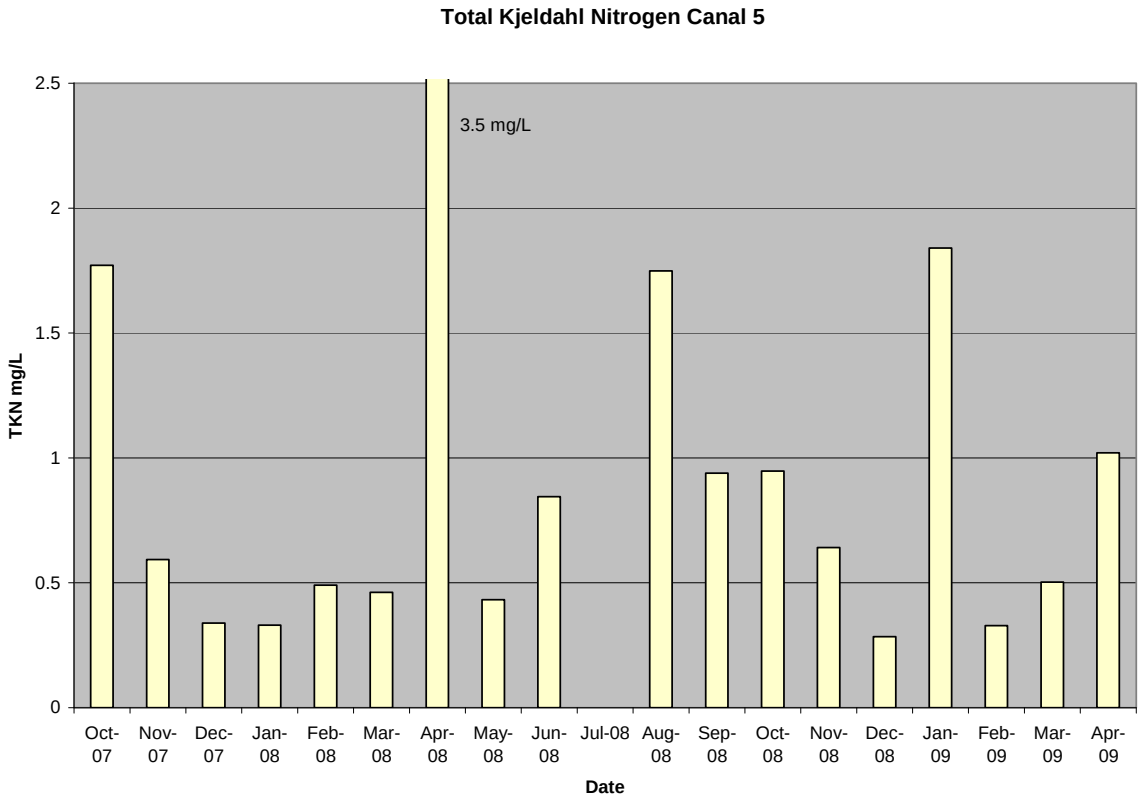


Figure 4-4. Total Kjehldahl Nitrogen in Canal 5

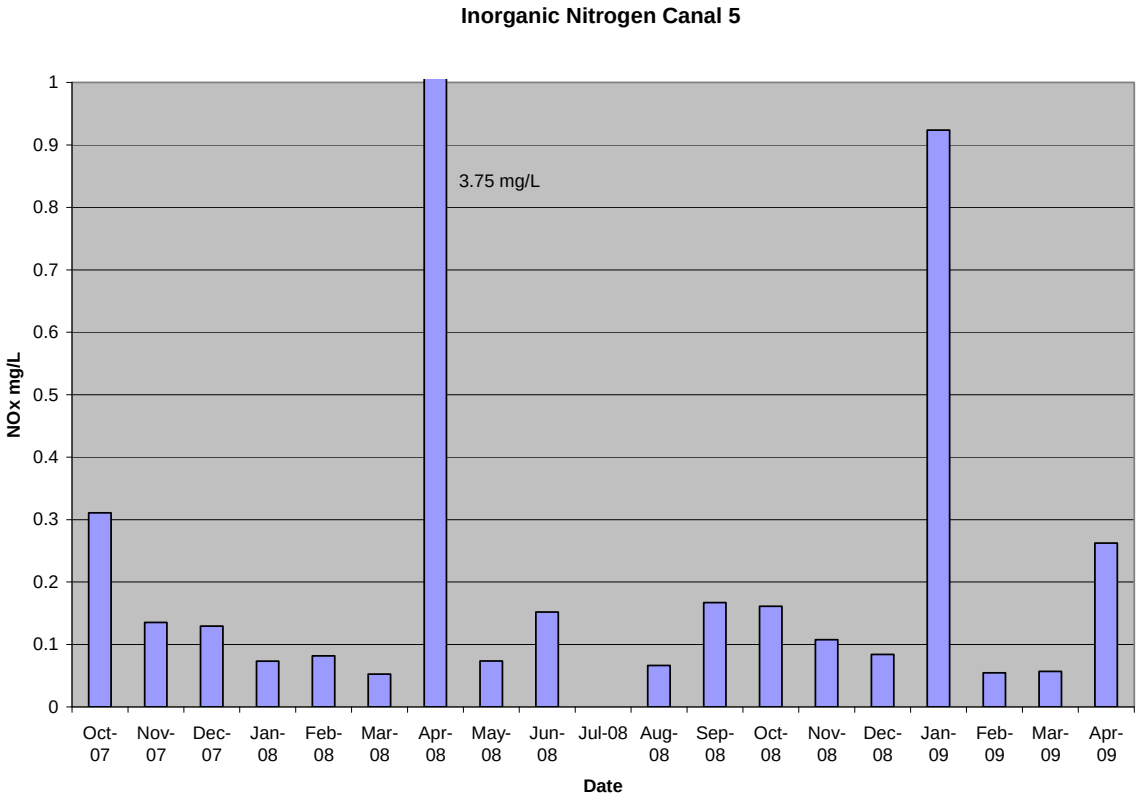


Figure 4-5. Inorganic Nitrogen in Canal 5

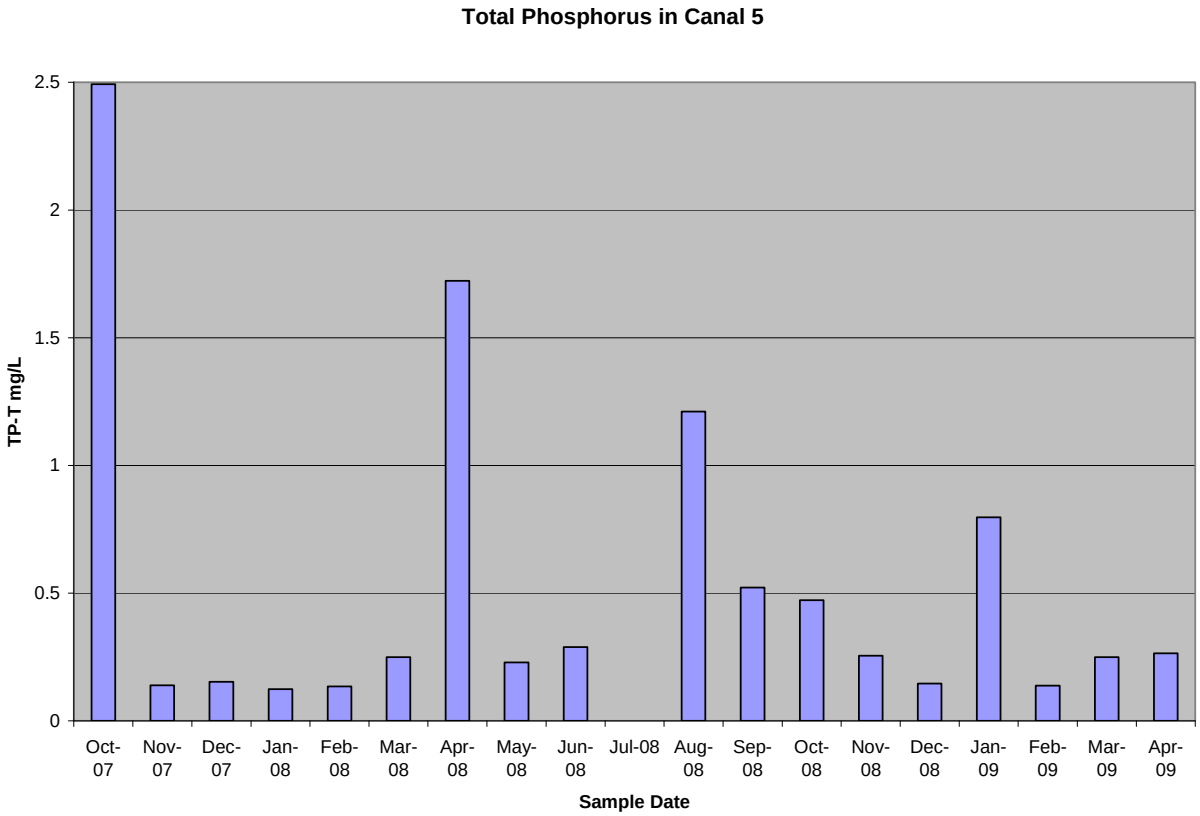


Figure 4-6. Total Phosphorus in Canal 5

5.0 INFLUENT FLOW ESTIMATE

The water quality data from Canals 4 and 5 indicate that the most nutrients are carried in the stormwater. For Canal 4, most of the nutrients are in the form of organic nitrogen and the difference in concentration between the storm events and the base flow is relatively low. The data for Canal 5 show sharp peaks of inorganic nitrogen during storm events. To calculate the nitrogen load in pounds, it is necessary to estimate the flow in each canal

For planning purposes an initial estimate of peak runoff rate and volume was determined using the SCS Curve Number method to predict flow from average daily rainfall. The rainfall event used in the estimate was based on average daily rainfall recorded at the Hastings gauge. The average daily rainfall in the summer is about 0.20 inches. As an initial estimate, the base flow was estimated using an assumed value of 12.6 in/year across each drainage area (CDM, 2003). Table 5-2 provides a summary of the initial flow estimate for each canal.

Table 5-1. Hastings Average Rainfall by Month

Month	Average Daily Rainfall (inches)	Average number of days of rain	Average Days of Rain > 0.2-in	Average Days of Rain > 0.5-in	Season
Jan	0.08	11	3	2	Dry/ Potato Season
Feb	0.10	10	3	2	Dry/ Potato Season
Mar	0.11	10	4	2	Dry/ Potato Season
Apr	0.07	6	2	2	Dry/ Potato Season
May	0.06	8	3	1	Dry/ Potato Season
Jun	0.20	17	7	4	Wet Season
Jul	0.17	17	6	4	Wet Season
Aug	0.20	17	8	4	Wet Season
Sep	0.27	17	8	5	Wet Season
Oct	0.13	12	4	3	Wet Season
Nov	0.06	10	2	1	Dry Season
Dec	0.09	12	3	2	Dry Season

* Fertilizer is typically applied in late December or January, when potatoes are typically planted, and again 30 to 40 days after planting

Table 5-2. Initial Flow Estimate

	Canal 4	Canal 5	North of Canal 4	Grand Total	Notes
Base flow (cfs)	0.35	1.5	0.22	2	Assumes 12.6 in/yr base flow based on CDM report
Storm flow (cfs)	5	16	1	19	Average Daily Rainfall of 0.2 inches

To maximize the pounds of nitrogen removed from the system it is necessary to capture as much of the stormwater as possible, particularly from Canal 5. However, there are practical limits to the amount can be captured:

1. To route all the stormwater to the RST it is necessary to divert the flow from the HDD canals. The HDD will need to grant permission for the canals to be impeded with check dams, weirs, or drop structures.
2. Based on the topography it is likely the system will require pumping. To capture a full range of flows resulting from the storm events it will be necessary to provide several pumps and/ or variable speed drives.
3. Most of the nutrient load appears to be from fertilizer application. Fertilizer is applied to potato crops in the winter growing season, which corresponds to the dry season. Therefore capturing the large, wet season storm events may not be necessary to provide the optimum cost-effective nutrient removal.
4. The farms upstream have water-control structures, making it difficult to accurately model the flow in the canals. One of the on-farm BMPs for the Tri-County Agricultural Area (TCAA) requires the farms to retain as much water as possible on site, which reduces the amount of water routed to the Master's Tract during many storm events. However, when the control gates are opened the water released is the runoff plus the stored water. This is difficult to model and will vary with BMP use and changes in future land use.

6.0 INFLUENT NUTRIENT LOAD

The influent nutrient load for the Master's Tract depends on the quantity and quality of the upstream runoff. The "quantity" is based on the flow rate presented in Section 5.0. The "quality" portion of influent nutrient load was calculated using the monitoring data from the District. As the monitoring data are limited, the predicted influent load was checked with a GIS-based model using typical runoff values and an annual average storm event.

6.1 INFLUENT NUTRIENT LOAD FROM MONITORING DATA

Assumed nitrogen concentrations were estimated from the water quality data previously presented. The assumed nitrogen concentrations, presented in Table 6-1, are used with the flows presented in Section 5.0 to estimate the treatable nitrogen. The treatable nitrogen is calculated using the assumed concentration less the irreducible concentration. The annual load of treatable nitrogen, by species and canal, is presented in Table 6-2.

Table 6-1. Assumed Nitrogen Concentrations for Master's Tract RST

	Flow	TKN	NOx
Canal 4	Base	0.5	0.3
Canal 4N	Base	0.5	0.3
Canal 5	Base	0.5	0.2
Canal 4	Storm	1.7	0.5
Canal 4N	Storm	1.7	0.5
Canal 5	Storm	1.7	2.0
Irreducible	All	1	0.1

Table 6-2. Annual Load of Treatable Nitrogen

Area	Flow	lb TKN	lb NOx	Total lbs N	Treatable lb TKN	Treatable lb NOx	Total lb Treatable N
Canal 4	Base	0	30	30	0	20	20
Canal 4N	Base	0	20	20	0	10	10
Canal 5	Base	200	80	280	0	40	40
Canal 4	Storm	900	270	1170	400	200	600
Canal 4N	Storm	100	40	140	100	0	100
Canal 5	Storm	3000	3570	6570	1200	3400	4600
Total	Both	4200	4010	8210	1700	3670	5370

6.2 INFLUENT NUTRIENT LOADS FROM SIMPLE MODEL

The nutrient loads were also calculated using a GIS-based pollutant-loading model developed by Jones Edmunds called SIMPLE: Spatially Integrated Model for Pollutant Loading Estimation. This peer-reviewed model incorporates the methodologies of two previously applied pollutant-load models: the Lemon Bay Model developed by Environmental Research and Design and the Watershed Management Model (WMM) developed by Camp Dresser and McKee. SIMPLE calculates non-point-source pollutant loads by multiplying annual rainfall times a runoff coefficient times the event mean pollutant concentration (EMC) times the BMP removal efficiency, if applicable, for that constituent. It also has the ability to simulate point sources,

septic tanks, and baseflow loading. The existing land use was modeled, as well as several future land use scenarios, using literature values of EMCs.

The loads predicted by the SIMPLE model for the existing land using the EMCs presented in Table 6-3. The SIMPLE model calculated the nutrient load for the existing land use as 8100 lb of total nitrogen annually, which is similar to the 8200 lb calculated from measured nutrient concentrations. A breakdown of the nutrient load for the existing land use by canal and constituent is presented in Table 6-4.

As a part of the analysis, SIMPLE was used to evaluate possible future changes in the surrounding land use. The SIMPLE model revealed that changes in land use may result in a substantial nutrient reduction. It may be possible for the County to direct land use changes to achieve a portion of the County's nutrient reduction goal. Further analysis of this option is outside the scope of the current project, but is recommended for additional investigation.

Table 6-3. Event Mean Concentrations by Land Use

	Land Use							
	Agriculture - Row Crop[1]	Harper and Baker, 2007	Medium-Density Residential[2]	Harper and Baker	Pine Flatwoods[2]	Harper and Baker	Pasture[2]	Harper and Baker
TN (mg/L)	4.99	2.65	1.87	2.07	1.02	1.15	1.02	3.47
TP (mg/L)	2.44	0.59	0.39	0.33	0.16	0.06	0.16	0.62
NO_3 (mg/L)	1.00		0.37		0.20		0.20	
NH_3 (mg/L)	1.00		0.36		0.20		0.20	
TKN (mg/L)	3.99		1.50		0.82		0.82	

[1] Source: CDM Deep Creek SW Conceptual Design (September 1993)
[2] Source: Sarasota Countywide Model (Literature review of statewide EMCs).

Table 6-4. Nutrient Load for the Existing Land Use Condition

Drainage Area	TP	TKN	NO3	NH3	N
Canal 4	599	1,070	280	267	1,350
Canal 5	2,598	4,605	1,158	1,148	5,780
Canal 4 North	463	782	196	196	979
Total	**3,660**	**6,457**	**1,635**	**1,610**	**8,109**

Table 6-5. Possible Reductions in Nutrient Load as the Result of Future Land Use Changes

	Ag to pine flatwoods	Ag to pasture	Ag to residential
Drainage Area			
Canal 4	948	916	133
Canal 5	4,174	4,026	390
Canal 4 North	767	738	43
Total Reduction in lb of total nitrogen	**5,888**	**5,680**	**566**

7.0 EVALUATION OF TREATMENT TECHNOLOGIES

Treatment technologies were evaluated based on literature values of removal rates as presented in Table 7-1. The application of each technology to the Master's Tract RST design is discussed in the subsequent sections.

Table 7-1. Literature Values of Removal Rates for Selected Stormwater Treatment Removal Technologies

Treatment Technology	Total Nitrogen Mass Removal Rate	Performance for TKN	Performance for Nitrate Nitrogen	Performance Dependant On	Source
Wet Detention	20-40%	Poor	Good	Detention Time	Harper, 2007
Retention Pond	80%	Good	Good	Retention Volume & First Flush Effects	Harper, 2007
Sand Filter	40%	65%	Poor	Maintenance	Leszczynska, 1997
Delaware Sand Filter	45%	70%	Poor	Maintenance	Leszczynska, 1997
Constructed Wetlands	36%	Good	Good	Hydraulic Loading Rate	Calculated using Kadlec & Knight Eqn
Enhanced Vegetated Swale	40%	*	Good (50%)	Hydraulic Loading Rate	(Georgia Stormwater Management Manual, 2001)
Riparian Restoration Forested Wetland (Subsurface flow)	80%	*	*	Hydraulic Loading Rate, ability to maintain dry season	EPA, 2005 (based on high TN in runoff, >10 mg/L)
Riparian Restoration Wetland (surface flow)	40%	*	*	Hydraulic Loading Rate	EPA, 2005 (based on high TN in runoff, >10 mg/L)
Alternative Irrigation Water Supply	40-85%	*	*	Amount of Irrigation Used (REV Curves)	(Wanielista, 2006)

* No information found.

7.1 WET DETENTION

The literature review of the performance of wet detention ponds revealed a lower-than-expected removal rate, only 20 to 40% of total nitrogen. Removal performance was shown to increase with a detention time greater than 40 days. Under these conditions, wet ponds can remove

virtually the entire inorganic nitrogen load. Performance is also increased by providing a littoral zone that is equal to 20% or more of the surface area and by adjusting the depth of the pond to maximize algal productivity. A typical wet detention pond cross section is shown in Figure 7-1.

Canal 5 has a base flow of 1.5 cfs and an average storm flow of 16 cfs. The storm flow for Canal 5 also has the highest amount of NOx. The appropriate treatment technology for this canal is either retention or detention as these technologies provide attenuation of the storm flow events and provide good removal rates for NOx. The topography, canal system, and shallow groundwater table at the Master's Tract require a wet detention or a retention pond with elevated berms; therefore, the stormwater must be pumped. The nitrogen removal rate for the pond is limited by the amount of water that can be captured and successfully pumped into the pond.

Wet detention is recommended to treat the storm flow for Canal 5 because the operation is more reliable than a retention pond, and the construction of the wet pond will provide the County with needed fill material. The pond can effectively treat the largest component of the nitrogen load, i.e., the inorganic nitrogen carried by the storm flow. A wet detention pond may be used in conjunction with other technologies such as sand filters or stormwater harvesting to increase the removal efficiency.

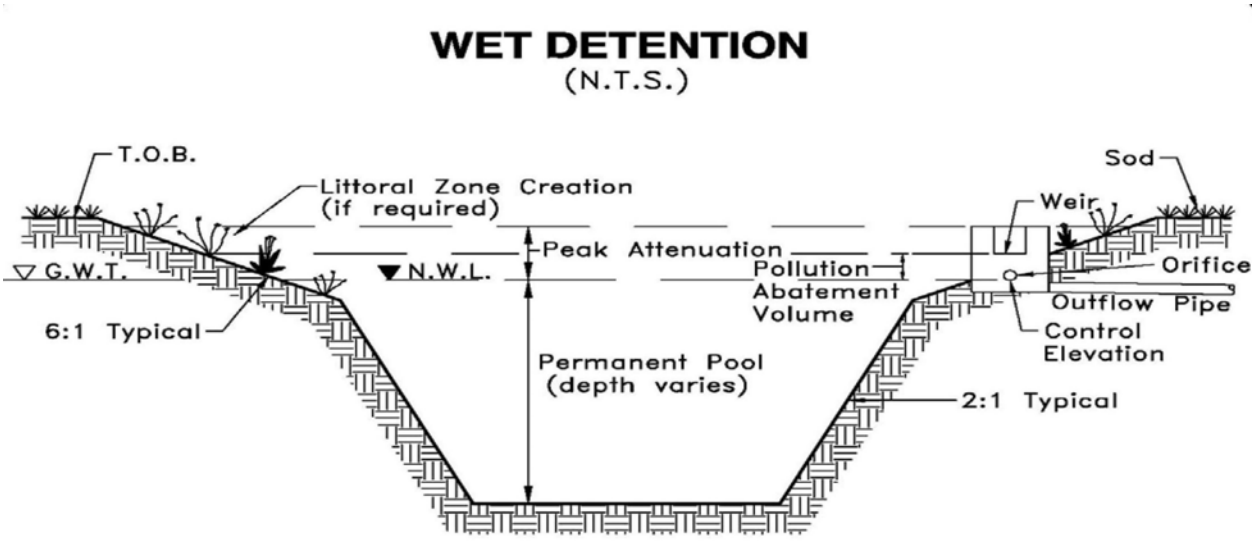


Figure 7-1. Typical Wet Detention Pond Cross Section (SJRWMD, 2006)

7.2 RETENTION

As mentioned in the previous section, wet detention or dry retention is recommended for Canal 5 because these technologies provide peak flow attenuation and good removal performance for NOx. Retention ponds can remove up to 80% of the total nitrogen. The geology of the Master's Tract requires an elevated system with underdrains, or essentially a sand filter. Retention ponds with underdrains are known to have significant maintenance issues which can lead to poor performance. For this reason, a wet detention pond is recommended over a retention pond.

7.3 SAND FILTER

Sand filters can remove 45% of the total nitrogen load and 75% of total kjehldahl nitrogen. Sand filters have significant head losses. In the case of the Master's Tract RST, they are recommended as they provide additional organic nitrogen removal for the wet detention pond effluent. Using a sand filter on the effluent of the wet detention pond will increase the overall performance of the treatment train. The sand filter could be in the form of a gravity flow Delaware sand filter or a pumped side bank filter or underdrain.

Delaware sand filters are frequently used for parking lot runoff. The filter consists of a long, horizontal concrete vault containing sand and a perforated pipe wrapped in filter fabric. They are designed to accommodate maintenance of the sand filter and pipe. In this application a configuration similar to a Delaware sand filter could be used as the outlet to the wet detention pond.

7.4 CONSTRUCTED WETLANDS

Constructed wetlands are frequently used in Florida to provide additional nutrient removal for treated wastewater. The reported removal rates for constructed wetland used to treat stormwater runoff were surprisingly low. The reasons for this seem to be related to the variability in the flows and loads reported in the BMP studies. The removal rate reported in Table 7-1 was therefore calculated based on the first-order rate equation:

$$\left(\frac{C_2 - C^*}{C_1 - C^*}\right) = \left(1 + \frac{k}{Pq}\right)^{-P}$$

Equation 1

Where:

C_1	=	average inlet concentration, mg/L	2.3
C_2	=	average outlet concentration, mg/L	
C*	=	background concentration, mg/L	1.1
K	=	first-order, area-based rate constant, m/y	22
Q	=	average hydraulic loading rate, m/y	15
P	=	apparent number of tanks-in-series	3

The calculated outlet concentration is 1.5 mg/L, which is a 36% removal based on the inlet concentration for Canals 4 and/or 4N. The equation shows that the removal efficiency depends on the influent concentration and the irreducible concentration. The calculated total of pounds of nitrogen removed is a product of the reduction in concentration and the flow routed through the wetland. A constructed wetland is recommended as a treatment method for Canal 4.

7.5 VEGETATED SWALE (WETLAND CHANNEL)

Vegetated swales are typically used as BMPs for parking lot or neighborhood runoff. A typical cross-section of a vegetated swale is shown in Figure 7-2. Transforming the canals to a wide wetland channel could remove 40% of the nitrogen load without requiring pumping. EPA design guidance suggests sizing the swale with a surface area equal to 1% of the drainage area. In the

case of Canal 4, this criterion results in a 400-foot-wide "swale." Canal 4N has a smaller drainage area but also a shorter length, resulting in a greater width. The flow and velocity criteria could be met by a narrower channel. This option should be investigated with the HDD and the conditions of the easement.

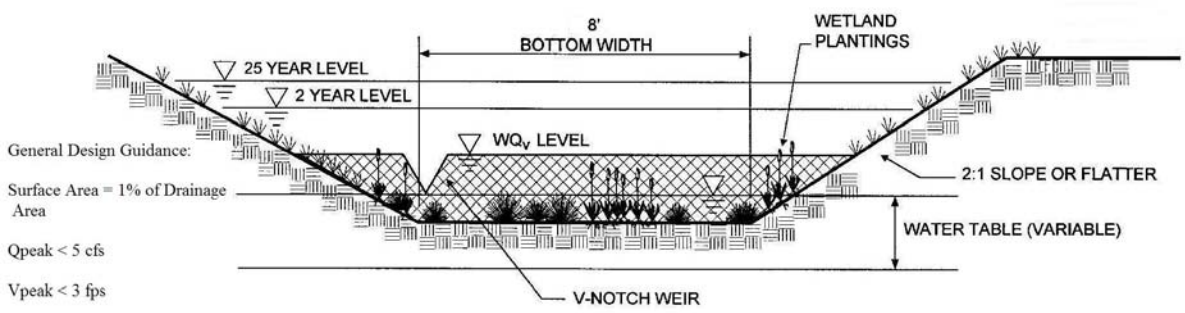


Figure 7-2. Cross Section of a Vegetated Swale

7.6 RIPARIAN RESTORATION

EPA studies show that riparian buffers can remove a significant amount of nitrogen through surface and subsurface flow. Section 8.0 discusses other benefits of the project, one of which is restoring the forested floodplain along Deep Creek. One option that was investigated was using the restored area to provide additional treatment. SJRWMD staff stated that the stormwater must be treated to District standards before being routed to the restoration site. The restored floodplain is expected to receive the water it requires from Deep Creek. Additional water from the RST may be detrimental to the success of the restoration area. For these reasons, Jones Edmunds recommends providing the means to supply treated water to the restoration area only if it is needed to ensure the success of the project, but the restoration area will not be counted as a treatment area.

7.7 ALTERNATIVE WATER SUPPLY

As mentioned in Section 7.1, a wet detention pond can also be used as a water supply for irrigation. The wet detention pond creates a mound of groundwater. Horizontal or vertical wells placed near the banks of the pond draw irrigation water from the mound. The sand material in the bank of the pond acts as a sand filter to remove possible contaminants such as coliform bacteria, blue green algae, and *giardia* or *cryptosporidium.* The harvested stormwater is similar to reuse water in that it can be used in excess of SJRWMD water restrictions. The Master's Tract includes a field within a ½-mile of the proposed location for the wet detention pond that can be used as a demonstration project.

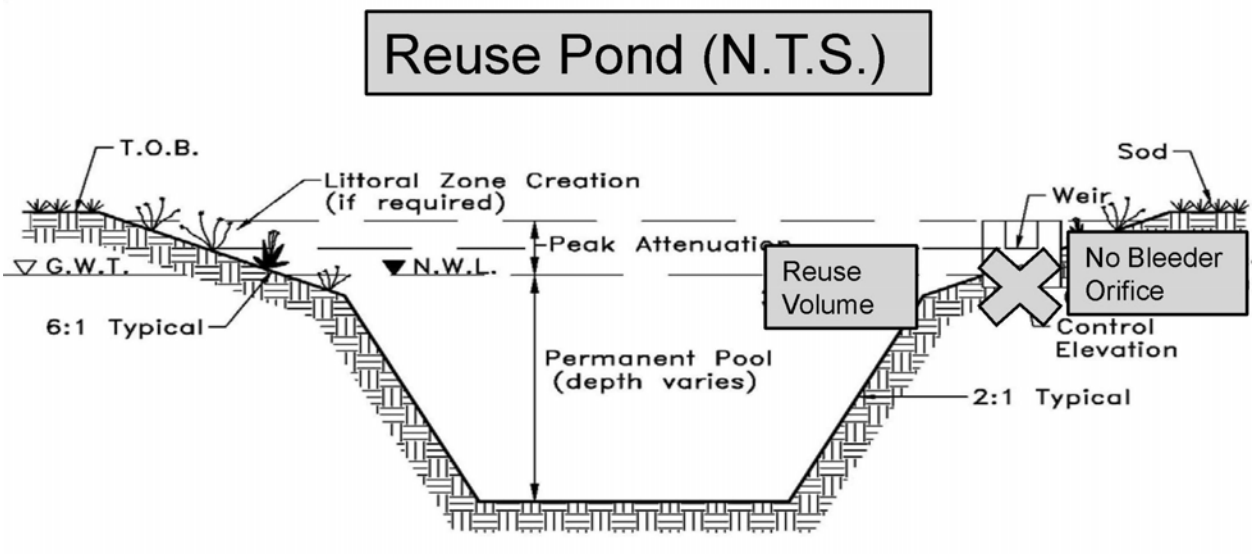


Figure 7-3. Cross Section of a Wet Detention Pond Modified for Harvesting (Wanielista, 2007)

7.8 CHEMICAL ADDITION

Typically, nitrogen is not removed by chemical addition; rather it is moved between two bodies, or concentrated, using selective ion exchange, reverse osmosis, electrodialysis, and distillation. These processes are energy and maintenance intensive and create a concentrated waste stream that must be disposed of in some manner.

The literature search found one report of a bench-scale laboratory test using powered aluminum to reduce nitrate to ammonia, nitrogen, and nitrite. The process occurs in a pH range of 9.1 to 9.3. Due to the pH range, the possible discharge of aluminum to the environment, and the new and unproven nature of this option, it is not recommended. (Murphy, 1991).

8.0 OTHER BENEFITS EVALUATED

The County is in the planning stage of a road project that will require wetland mitigation and a source of fill material. Ideally the final recommended treatment train will remove a significant portion of the BMAP nitrogen removal requirement and provide the required wetland mitigation credits and fill material. Additionally, Jones Edmunds evaluated the possibility of harvesting the collected stormwater as an alternative irrigation supply to an adjacent property as a demonstration project.

8.1 WETLAND MITIGATION

As previously mentioned, the Master's Tract is bounded on the east side by Deep Creek. The flood plain of Deep Creek could be restored to provide wetland mitigation credits. In a separate task Jones Edmunds was asked to evaluate the Master's Tract to determine if the site could be restored to provide 25 wetland mitigation credits. Preliminary meetings indicate that the area near Deep Creek could be restored to a forested wetland by repairing the flood plain to the creek. Initial discussions with the SJRWMD indicate that the mitigation area could not be used to treat

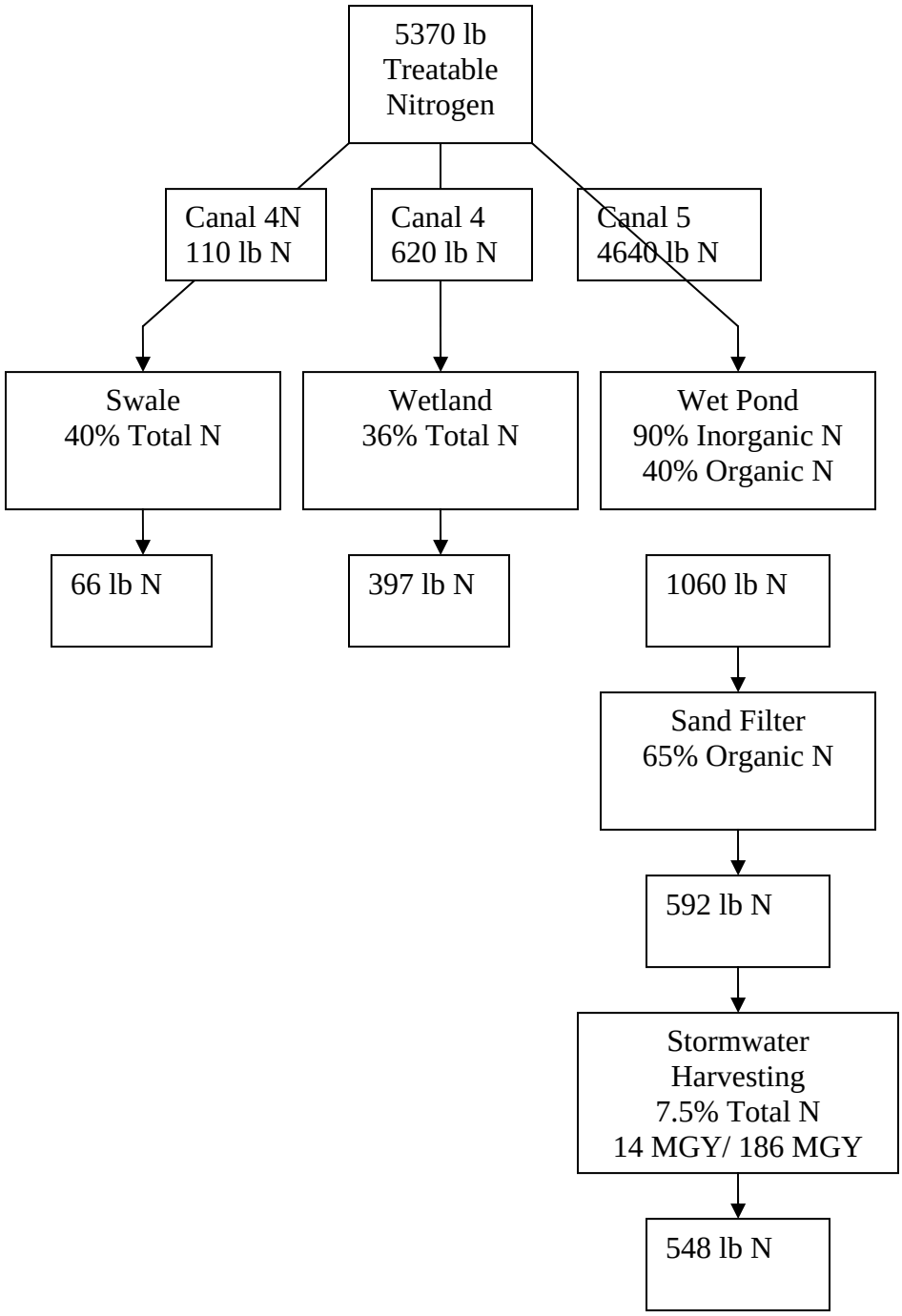
stormwater. Therefore any stormwater routed to the area must be treated in accordance with SJRWMD rules regarding water quality and attenuation.

8.2 FILL PROVIDED BY WET DETENTION

The area north of Canal 5 and south of Canal 4 is the location of the proposed wet detention pond. The pond is approximately 25 acres and could potentially supply the County with 500,000 cubic yards of soil. The NRCS soil survey indicates that the soil type in this area is predominately Winder fine sand, which is rated as "fair" as a source for sand and "poor" as a source of road fill material due to its wetness and shrink/swell potential. A geotechnical subcontractor will provide further information regarding the suitability of the soil.

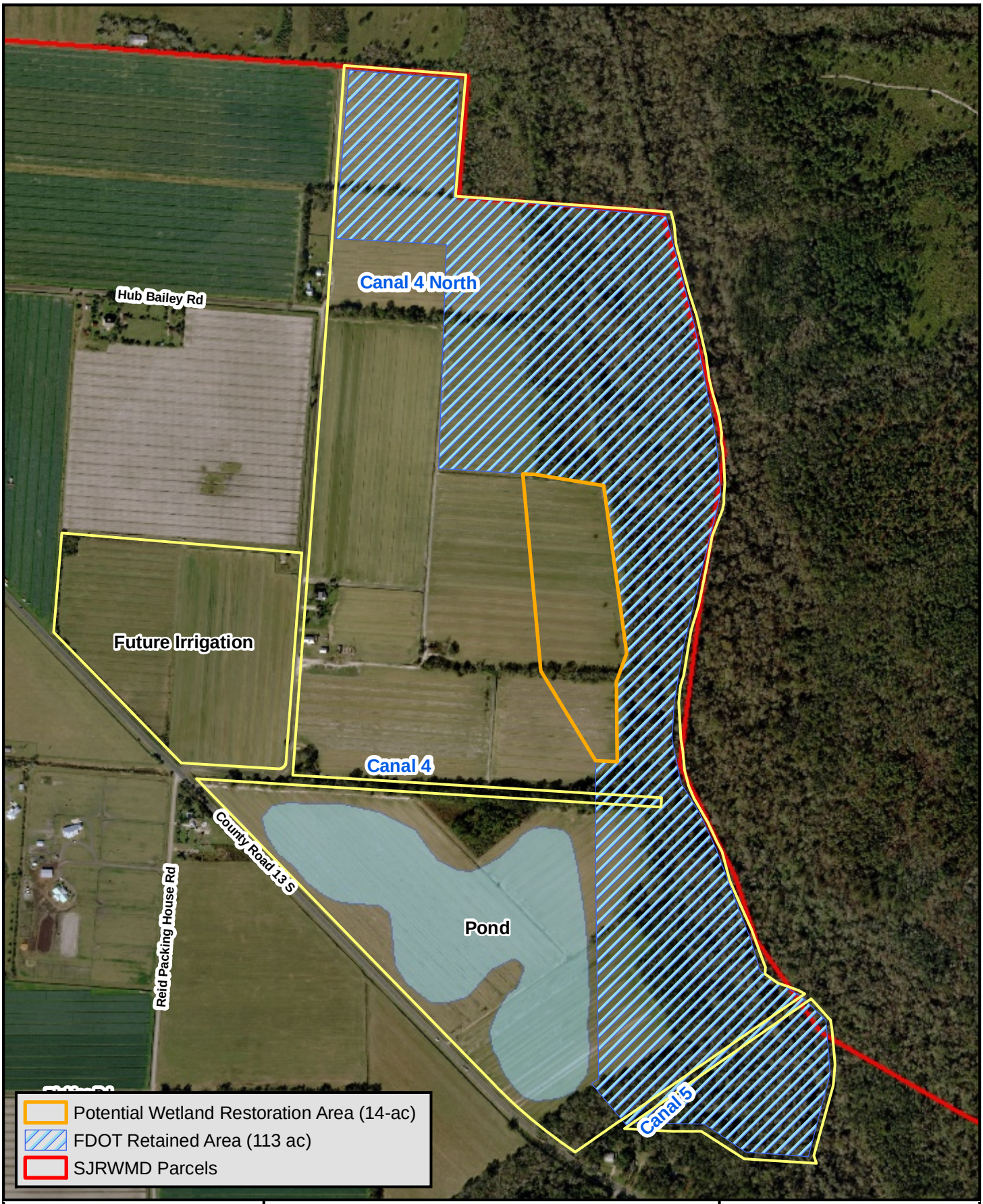
9.0 RECOMMENDED TECHNOLOGIES

The recommended treatment train of Master's Tract is to maximize the nitrogen removal for Canal 5. Canal 5 receives most of the water and most of the nitrogen load. A wet detention pond typically removes 40% of the total nitrogen load and almost the entire inorganic nitrogen load (Harper, 2007). The wet detention pond for Canal 5 has the potential to remove 3500 to 4800 lb of nitrogen annually. The water will need to be diverted from the canal to a pump station and into the pond. Wells adjacent to the pond can pump water through a sand filter to irrigate the fallow cropland on the west side of the property and to the north of Canal 4. A schematic of the proposed treatment train is presented in Figure 9-1, while a proposed site plan is presented in Figure 9-2.



Total Reduction from 5370 lb N to 1011 lb N = 4359 lb or 81%

Figure 9-1. Recommended Treatment Train



JONES EDMUNDS

Figure 9-2

Preliminary Site Plan

Masters Tract

0 350 700

Feet

1:8,400

N

Q:\19270_st_johns_co\048_Masters_BDM\mxd\Figure8_1_PreliminarySitePlan.mxd MCL 8/18/2009

For Informational Purposes Only

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APPENDIX D

WET DETENTION POND CALCULATIONS

JONES EDMUNDS

19270-048
Master's Tract RST
Amy Goodden
10/6/2009

Master's Tract RST Stormwater Reuse Pond Design - Using Criteria from SJRWMD

Design Criteria: Design to capture base flow and storm flow from Canal 5.
Base flow = 1.5 cfs
Storm flow = 16 cfs
Residence time = 40 days (21 days minimum)
Recovery time = 48 to 72 hours
Side Slope = 4:1 minimum
Littoral Zone = 20% of pond surface
Max Depth < 10 ft or the anticipated depth of anoxia
Assume SHGWT = 2.75 NAVD 88 based on wetland vegetation and observed water depth in Deep Creek

Step 1: Determine the Permanent Pool Volume

Permanent Pool Volume (PPV) = Residence Time (RT) * Average Flow Rate (FR)
where, PPV is in acre-ft
RT is in days
FR is in acre-ft/day

Annual volume from the SIMPLE model using data from the Southwest Regional Model

Runoff volume Dry season =	135.13	acre - ft/ year	
Runoff volume Wet season =	435.90	acre - ft/ year	
Base flow volume Dry season =	446.80	acre - ft/ year	
Base flow volume Wet season =	638.60	acre - ft/ year	
Total annual volume =	1656.43	acre - ft/ year	
Annual Average Flow Rate =	4.54	acre - ft/ day	
Total Wet Season volume =	1074.50	acre -ft/ year	
Wet Season Average Flow Rate =	7.02	acre -ft/ day	
Residence Time =	40	days	
PPV =	280.92	acre-ft	Wet Season

Step 2: Calculate the Equivalent Impervious Area

FLUCCS code	Area	Dry_C	Wet_C	Annual C	(Annual C) * Area	Description
1100	82.0	0.0527	0.1329	0.1856	15.2249	Residential, low density - less
1200	0.3	0.0999	0.1865	0.2863	0.0824	Residential, medium density - 2-
1510	9.6	0.1229	0.2247	0.3476	3.3211	Food processing
2110	77.1	0.0277	0.0937	0.1214	9.3563	Improved pastures (monocult,
2120	15.3	0.0277	0.0937	0.1214	1.8521	Unimproved pastures
2140	4.0	0.0277	0.0937	0.1214	0.4897	Row crops
2143	661.8	0.0277	0.0937	0.1214	80.3366	Potatoes and cabbage
2150	42.4	0.0277	0.0937	0.1214	5.1529	Field crops
2510	9.3	0.0277	0.0937	0.1214	1.1263	Horse farms
2600		0.0224	0.0825	0.1049	0.0000	Other open lands - rural
2610	40.5	0.0277	0.0937	0.1214	4.9169	Fallow cropland
3100	6.4	0.0224	0.0825	0.1049	0.6682	Herbaceous upland nonforested
3200	7.6	0.0224	0.0825	0.1049	0.7998	Shrub and brushland (wax
3300	14.4	0.0224	0.0825	0.1049	1.5142	Mixed upland nonforested
4110	13.9	0.0224	0.0825	0.1049	1.4573	Pine flatwoods
4340	18.8	0.0224	0.0825	0.1049	1.9720	Upland mixed
5300		0.4400	0.5600	1.0000	0.0000	Reservoirs - pits, retention
6170	19.1	0.0224	0.0825	0.1049	2.0087	Mixed wetland hardwoods
6460	9.7	0.0224	0.0825	0.1049	1.0202	Mixed scrub-shrub wetland

Total	1032	Acres	131
Effective C =			0.13
Estimated Pond Area =			33.20 acres
Total EIA =			164.50 acres

Step 3: Determine the Reuse Volume.

As an initial estimate, assume the Reuse Volume = Treatment Volume for a wet pond.
The District requires a treatment volume of either 1 inch of runoff or 2.5 inches times the impervious area, whichever is greater.

One in. over the drainage basin =	86.0	acre-ft	6.27 inches over the EIA
2.5 inches over the EIA =	34.3	acre-ft	see step 2 for EIA calculation

Size pond to provide 86.0 acre-ft of treatment volume. The initial size of the pond is 33.2 acres. At this size the reuse volume is approximately 2.6 ft deep and the permanent pool is 8.5 ft deep.

Step 4 : Estimate the Reuse Rate

Initially the pond will be used to demonstrate the ability to reuse stormwater to grow sod.
Adjacent to the pond is a 30 acre field planted in sod.
The irrigation system used is a flush irrigation system.
The irrigation rate is assumed to be 2-inches per week.

Convert the reuse volume (V) to inches over the EIA

R = 30 acres * (2 -inches/ week) * (1 week/ 7 days) / 164.5 acres

R = 0.05 in/ day over the EIA

Step 5: Determine the efficiency from the Gainesville REV chart.

From the REV chart the initial efficiency is approximately 50%
The system will be designed to allow more acreage to be added to the irrigation system, which will improve the efficiency.

		TV = 34.2 acre-ft For V = 2.5 in/EIA		TV = 86.0 acre-ft For V = 6.5 in/EIA	
Eff. %	in/ week	R	acreage required	R	acreage required
50	2	0.06	34.5	0.06	34.5
60	2	0.08	46.1	0.07	40.3
70	2	0.10	57.6	0.09	51.8
80	2	0.14	80.6	0.10	57.6
90	2	0.22	126.7	0.13	74.8

Step 6: Size the orifice weir to recover the treatment volume peak discharge rate.

TV = 86.0 acre-ft
3,746,894 cu ft
t = 30 hrs
Q= TV / (2 * t * 3600)
Q = 17.3 cfs

Q $C A (2 g h)^{1/2}$
where :
C= 0.6
A = orifice area (ft2)
g = 32.2 ft/s2
h = depth of water above the center of the orifice

A = 0.333037432 ft2
h = 0.875
D = 0.651345918 ft = 7.8 in

h = (h1 + h2) / 2
h1 = Depth of water between the top of the treatment volume and the flow line (ft)
h2 = Depth of water between the stage when half the treatment volume has been released and the flow line of the orifice (ft)
h = 0.875

Elevation	Feature
7.5	Control
8.375	Flow line of orifice
8.5	1/2 TV
10.0	Top of Treatment Volume

Step 7: Size the littoral zone.
The following is a list of the design criteria for wet detention littoral zones:

(a) The littoral zone shall be gently sloped (6H:1V or flatter). At least 20 percent of the reuse pond surface area shall consist of a littoral zone. The percentage of littoral zone is based on the ratio of vegetated littoral zone to surface area of the pond at the control elevation.

(b) The treatment volume should not cause the pond level to rise more than 18 inches above the control elevation unless the applicant affirmatively demonstrates that the littoral zone vegetation can survive at greater depths.

(c) Within 24 months of completion of the system, 80 percent coverage of the littoral zone by suitable aquatic plants is required.

(d) Planting of the littoral zone is recommended to meet the 80% coverage requirement. As an alternative to planting, portions of the littoral zone may be established by placement of wetland top soils (at least a four inch depth) containing a seed source of desirable native plants. When utilizing this alternative, the littoral zone must be stabilized by mulching or other means and at least the portion of the littoral zone within 25 feet of the inlet and outlet structures must be planted.

The final grading plan and littoral zone will be based on these criteria.

JONES EDMUNDS

19270-048
Master's Tract RST
Amy Goodden
10/6/2009

Master's Tract RST Wet Detention Pond Design Using Procedure from Harper, 2007

Design Criteria: Design to capture base flow and storm flow from Canal 5.
Base flow = 1.5 cfs
Storm flow = 16 cfs
Residence time = 40 days (21 days minimum)
Recovery time = 48 to 72 hours
Side Slope = 4:1 minimum
Littoral Zone = 20% of pond surface
Max Depth < 9 ft or the anticipated depth of anoxia
Assume SHGWT = 2.75 NAVD 88 based on lichen line observed in floodplain along Deep Creek

Step 1: Calculate the annual inputs to the pond.

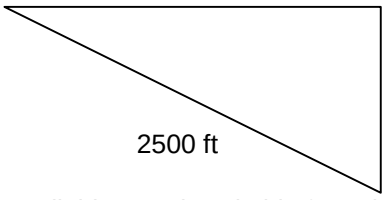
Results are from the SIMPLE model using data from the Southwest Regional Model

Runoff volume Dry season =	135.13	acre - ft/ year
Runoff volume Wet season =	435.90	acre - ft/ year
Base flow volume Dry season =	446.80	acre - ft/ year
Base flow volume Wet season =	638.60	acre - ft/ year
Total annual volume =	1656.43	acre - ft/ year

Step 2: Size the pond for 40-day residence time

$$\text{Pond Volume} = 1656.43 \frac{\text{acre - ft}}{\text{year}} \frac{1 \text{ year}}{365 \text{ days}} \frac{40 \text{ days}}{} = 181.53 \text{ acre - ft}$$

Step 3: Provide initial estimate for size and depth



Area ~=	33.2	acres
at EL ~=	7.5	ft
Mean depth needed =	5.5	ft

Available area is suitable for volume requirement

Step 4: Calculate the max. depth of the anoxic zone using procedure from Harper, 2007.

a. Determine annual TP (total phosphorus) load using SIMPLE

Dry Season Runoff load, TP	598	lb/ year
Wet Season Runoff load, TP	1999	lb/ year
Total (Base + Runoff), TP	3954	lb/ year

b. Calculate the TP remaining in the water column following treatment in the wet pond.

TP removal efficiency = $40.13 + 6.372 * \ln(td) + 0.213 [\ln (td)]^2$
where td = residence time in days

TP removal efficiency for 40 day residence time = 66.5 %
TP remaining in water column = 3954 lb/ yr * (1 - 0.665) = 1323 lb/ year

c. Calculate the TP concentration in the water column.

The remaining TP is assumed to be evenly distributed in the pond volume and the annual outflow from the pond. = 181.53 acre-ft + 726.66 acre-ft/ yr = 908.19 acre-ft/ yr

$$[TP] = \frac{1323 \text{ lb}}{\text{year}} \frac{\text{kg}}{2.2 \text{ lb}} \frac{\text{yr}}{908 \text{ acre-ft}} \frac{\text{acre}}{43560 \text{ ft}^2} \frac{\text{ft3}}{7.48 \text{ gal}} \frac{1 \text{ gal}}{3.785 \text{ L}} \frac{106 \text{ mg}}{\text{kg}}$$

[TP] = 0.265355 mg/L
[TP] = 265 ug/L

d. Calculate the mean chlorophyll-a concentration in the pond.

$\ln (\text{chyl-a}) = 1.058 * \ln (TP) - 0.934$
where [TP] is in ug/L and [chyl-a] is in mg/m^3

ln(chyl-a) = 4.97
[chyl-a] 144 mg/m^3

e. Calculate the mean Secchi depth in the pond.

$$SD = \frac{24.2386 + [(0.3041) * (\text{chyl-a})]}{[6.0632 + (\text{chyl-a})]}$$ This equation is not valid for chyl-a conc > 332 mg/m^3

SD = 0.45 m
SD = 1.49 ft

f. Calculate the anoxic depth of the pond.

Anoxic Depth= 3.035 * Secchi Disk Depth (m) - 0.004979 * TP (ug/L) + 0.02164 * chyl-a (mg/m^3)
where 0.25 m < anoxic depth < 9.0 m
0.09 m < Secchi disk depth < 3.49 m
I ug/L < Total P < 498 ug/L
1 mg/m^3 < chyl-a < 332 mg/m^3

Anoxic Depth = 3.17 m
Anoxic Depth = 10.4 ft

Proposed maximum depth of 10 ft should provide sufficient aeration

APPENDIX E

MEMORANDUM: REVIEW OF THE DEEP CREEK REGIONAL STORMWATER TREATMENT FACILITY

Master's Tract RST Stormwater Reuse Pond Design - Using Criteria from SJRWMD

Design Criteria: Design to capture base flow and storm flow from Canal 5.
Base flow = 1.5 cfs
Storm flow = 16 cfs
Residence time = 40 days (21 days minimum)
Recovery time = 48 to 72 hours
Side Slope = 4:1 minimum
Littoral Zone = 20% of pond surface
Max Depth < 10 ft or the anticipated depth of anoxia
Assume SHGWT = 2.75 NAVD 88 based on wetland vegetation and observed water depth in Deep Creek

Step 1: Determine the Permanent Pool Volume

Permanent Pool Volume (PPV) = Residence Time (RT) * Average Flow Rate (FR)
where, PPV is in acre-ft
RT is in days
FR is in acre-ft/day

Annual volume from the SIMPLE model using data from the Southwest Regional Model

Runoff volume Dry season =	135.13	acre - ft/ year	
Runoff volume Wet season =	435.90	acre - ft/ year	
Base flow volume Dry season =	446.80	acre - ft/ year	
Base flow volume Wet season =	638.60	acre - ft/ year	
Total annual volume =	1656.43	acre - ft/ year	
Annual Average Flow Rate =	4.54	acre - ft/ day	
Total Wet Season volume =	1074.50	acre -ft/ year	
Wet Season Average Flow Rate =	7.02	acre -ft/ day	
Residence Time =	40	days	
PPV =	280.92	acre-ft	Wet Season

Step 2: Calculate the Equivalent Impervious Area

FLUCCS code	Area	Dry_C	Wet_C	Annual C	(Annual C) * Area	Description
1100	82.0	0.0527	0.1329	0.1856	15.2249	Residential, low density - less
1200	0.3	0.0999	0.1865	0.2863	0.0824	Residential, medium density - 2-
1510	9.6	0.1229	0.2247	0.3476	3.3211	Food processing
2110	77.1	0.0277	0.0937	0.1214	9.3563	Improved pastures (monocult,
2120	15.3	0.0277	0.0937	0.1214	1.8521	Unimproved pastures
2140	4.0	0.0277	0.0937	0.1214	0.4897	Row crops
2143	661.8	0.0277	0.0937	0.1214	80.3366	Potatoes and cabbage
2150	42.4	0.0277	0.0937	0.1214	5.1529	Field crops
2510	9.3	0.0277	0.0937	0.1214	1.1263	Horse farms
2600		0.0224	0.0825	0.1049	0.0000	Other open lands - rural
2610	40.5	0.0277	0.0937	0.1214	4.9169	Fallow cropland
3100	6.4	0.0224	0.0825	0.1049	0.6682	Herbaceous upland nonforested
3200	7.6	0.0224	0.0825	0.1049	0.7998	Shrub and brushland (wax myrtle
3300	14.4	0.0224	0.0825	0.1049	1.5142	Mixed upland nonforested
4110	13.9	0.0224	0.0825	0.1049	1.4573	Pine flatwoods
4340	18.8	0.0224	0.0825	0.1049	1.9720	Upland mixed
5300		0.4400	0.5600	1.0000	0.0000	Reservoirs - pits, retention
6170	19.1	0.0224	0.0825	0.1049	2.0087	Mixed wetland hardwoods
6460	9.7	0.0224	0.0825	0.1049	1.0202	Mixed scrub-shrub wetland

Total 1032 Acres 131

Effective C = 0.13
Estimated Pond Area = 33.20 acres
Total EIA = 164.50 acres

Step 3: Determine the Reuse Volume.

As an initial estimate, assume the Reuse Volume = Treatment Volume for a wet pond.
The District requires a treatment volume of either 1 inch of runoff or 2.5 inches times the impervious area, whichever is greater.

One in. over the drainage basin = 86.0 acre-ft 6.27 inches over the EIA
2.5 inches over the EIA = 34.3 acre-ft see step 2 for EIA calculation

Size pond to provide 86.0 acre-ft of treatment volume. The initial size of the pond is 33.2 acres. At this size the reuse volume is approximately 2.6 ft deep and the permanent pool is 8.5 ft deep.

Step 4 : Estimate the Reuse Rate

Initially the pond will be used to demonstrate the ability to reuse stormwater to grow sod.
Adjacent to the pond is a 30 acre field planted in sod.
The irrigation system used is a flush irrigation system.
The irrigation rate is assumed to be 2-inches per week.

Convert the reuse volume (V) to inches over the EIA

R = 30 acres * (2 -inches/ week) * (1 week/ 7 days) / 164.5 acres

R = 0.05 in/ day over the EIA

Step 5: Determine the efficiency from the Gainesville REV chart.

From the REV chart the initial efficiency is approximately 50%
The system will be designed to allow more acreage to be added to the irrigation system, which will improve the efficiency.

		TV = 34.2 acre-ft For V = 2.5 in/EIA		TV = 86.0 acre-ft For V = 6.5 in/EIA	
Eff. %	in/ week	R	acreage required	R	acreage required
50	2	0.06	34.5	0.06	34.5
60	2	0.08	46.1	0.07	40.3
70	2	0.10	57.6	0.09	51.8
80	2	0.14	80.6	0.10	57.6
90	2	0.22	126.7	0.13	74.8

Step 6: Size the orifice weir to recover the treatment volume peak discharge rate.

TV =	86.0	acre-ft
	3,746,894	cu ft
t =	30	hrs
Q=	TV / (2 * t * 3600)	
Q =	17.3	cfs

Q $C A (2 g h)^{1/2}$

where :

C= 0.6

A = orifice area (ft2)

g = 32.2 ft/s2

h = depth of water above the center of the orifice

A =	0.333037432	ft2	
h =	0.875		
D =	0.651345918	ft =	7.8 in

h = (h1 + h2) / 2

h1 = Depth of water between the top of the treatment volume and the flow line (ft)

h2 = Depth of water between the stage when half the treatment volume has been released and the flow line of the orifice (ft)

h = 0.875

Elevation	Feature
7.5	Control
8.375	Flow line of orifice
8.5	1/2 TV
10.0	Top of Treatment Volume

Step 7: Size the littoral zone.
The following is a list of the design criteria for wet detention littoral zones:

(a) The littoral zone shall be gently sloped (6H:1V or flatter). At least 20 percent of the reuse pond surface area shall consist of a littoral zone. The percentage of littoral zone is based on the ratio of vegetated littoral zone to surface area of the pond at the control elevation.

(b) The treatment volume should not cause the pond level to rise more than 18 inches above the control elevation unless the applicant affirmatively demonstrates that the littoral zone vegetation can survive at greater depths.

(c) Within 24 months of completion of the system, 80 percent coverage of the littoral zone by suitable aquatic plants is required.

(d) Planting of the littoral zone is recommended to meet the 80% coverage requirement. As an alternative to planting, portions of the littoral zone may be established by placement of wetland top soils (at least a four inch depth) containing a seed source of desirable native plants. When utilizing this alternative, the littoral zone must be stabilized by mulching or other means and at least the portion of the littoral zone within 25 feet of the inlet and outlet structures must be planted.

The final grading plan and littoral zone will be based on these criteria.

JONES EDMUNDS

19270-048
Master's Tract RST
Amy Goodden
10/6/2009

Master's Tract RST Wet Detention Pond Design Using Procedure from Harper, 2007

Design Criteria: Design to capture base flow and storm flow from Canal 5.
Base flow = 1.5 cfs
Storm flow = 16 cfs
Residence time = 40 days (21 days minimum)
Recovery time = 48 to 72 hours
Side Slope = 4:1 minimum
Littoral Zone = 20% of pond surface
Max Depth < 9 ft or the anticipated depth of anoxia
Assume SHGWT = 2.75 NAVD 88 based on lichen line observed in floodplain along Deep Creek

Step 1: Calculate the annual inputs to the pond.

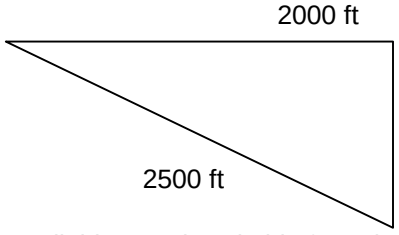
Results are from the SIMPLE model using data from the Southwest Regional Model

Runoff volume Dry season =	135.13	acre - ft/ year
Runoff volume Wet season =	435.90	acre - ft/ year
Base flow volume Dry season =	446.80	acre - ft/ year
Base flow volume Wet season =	638.60	acre - ft/ year
Total annual volume =	1656.43	acre - ft/ year

Step 2: Size the pond for 40-day residence time

$$\text{Pond Volume} = 1656.43 \frac{\text{acre - ft}}{\text{year}} \frac{\text{1 year}}{\text{365 days}} \frac{\text{40 days}}{} = 181.53 \text{ acre - ft}$$

Step 3: Provide initial estimate for size and depth



Area ~=	33.2	acres
at EL ~=	7.5	ft
Mean depth needed =	5.5	ft

Available area is suitable for volume requirement

Step 4: Calculate the max. depth of the anoxic zone using procedure from Harper, 2007.

a. Determine annual TP (total phosphorus) load using SIMPLE

Dry Season Runoff load, TP	598	lb/ year
Wet Season Runoff load, TP	1999	lb/ year
Total (Base + Runoff), TP	3954	lb/ year

b. Calculate the TP remaining in the water column following treatment in the wet pond.

TP removal efficiency = $40.13 + 6.372 * \ln(td) + 0.213 [\ln (td)]^2$
where td = residence time in days

TP removal efficiency for 40 day residence time = 66.5 %
TP remaining in water column = 3954 lb/ yr * (1 - 0.665) = 1323 lb/ year

c. Calculate the TP concentration in the water column.

The remaining TP is assumed to be evenly distributed in the pond volume and the annual outflow from the pond. = 181.53 acre-ft + 726.66 acre-ft/ yr = 908.19 acre-ft/ yr

[TP] =	1323 lb / year	kg / 2.2 lb	yr / 908 acre-ft	acre / 43560 ft^2	ft3 / 7.48 gal	1 gal / 3.785 L	106 mg / kg

[TP] = 0.265355 mg/L
[TP] = 265 ug/L

d. Calculate the mean chlorophyll-a concentration in the pond.

$\ln (\text{chyl-a}) = 1.058 * \ln (TP) - 0.934$
where [TP] is in ug/L and [chyl-a] is in mg/m^3

ln(chyl-a) = 4.97
[chyl-a] 144 mg/m^3

e. Calculate the mean Secchi depth in the pond.

$SD = \frac{24.2386 + [(0.3041) * (\text{chyl-a})]}{[6.0632 + (\text{chyl-a})]}$ This equation is not valid for chyl-a conc > 332 mg/m^3

SD = 0.45 m
SD = 1.49 ft

f. Calculate the anoxic depth of the pond.

Anoxic Depth= 3.035 * Secchi Disk Depth (m) - 0.004979 * TP (ug/L) + 0.02164 * chyl-a (mg/m^3)
where 0.25 m < anoxic depth < 9.0 m
0.09 m < Secchi disk depth < 3.49 m
I ug/L < Total P < 498 ug/L
1 mg/m^3 < chyl-a < 332 mg/m^3

Anoxic Depth = 3.17 m
Anoxic Depth = 10.4 ft

Proposed maximum depth of 9 ft should provide sufficient aeration

APPENDIX F

WATER QUALITY FLOW-WAY CALCULATIONS

JONES EDMUNDS

19270-048
Master's Tract RST
Amy Goodden
10/6/2009

Master's Tract RST Water Quality Swale Design Using Procedure from Harper, 2007

Design Criteria: Design to capture base flow and storm flow from Canal 4.
Base flow = 0.35 cfs
Storm flow = 4.7 cfs (mean annual storm)
Drainage Area = 161.1 acres
Assume SHGWT = 2.75 NAVD 88 based on wetland vegetation and observed water depth in Deep Creek

Step 1: Determine the drainage basin area and C.

FLUCCS code	Canal 4	Dry_C	Wet_C	Annual_ C	Annual C * Area	Description
2610	0.00	0.0277	0.0937	0.1214	0.00	Fallow cropland
2150		0.0277	0.0937	0.1214	0.00	Field crops
1510		0.1229	0.2247	0.3476	0.00	Food processing
3100		0.0224	0.0825	0.1049	0.00	Herbaceous upland
2510	25.12	0.0277	0.0937	0.1214	3.05	Horse farms
2110	32.41	0.0277	0.0937	0.1214	3.93	Improved pastures
6460		0.0224	0.0825	0.1049	0.00	Mixed scrub-shrub
3300		0.0224	0.0825	0.1049	0.00	Mixed upland
6170		0.0224	0.0825	0.1049	0.00	Mixed wetland
4110		0.0224	0.0825	0.1049	0.00	Pine flatwoods
2143	161.15	0.0277	0.0937	0.1214	19.56	Potatoes and cabbage
5300	3.12	0.4400	0.5600	1.0000	3.12	Reservoirs - pits,
1100	18.69	0.0527	0.1329	0.1856	3.47	Residential, low
1200		0.0999	0.1865	0.2863	0.00	Residential, medium
2140	0.00	0.0277	0.0937	0.1214	0.00	Row crops
3200		0.0224	0.0825	0.1049	0.00	Shrub and brushland
2120	1.49	0.0277	0.0937	0.1214	0.18	Unimproved pastures
4340		0.0224	0.0825	0.1049	0.00	Upland mixed
Total	241.98 acres				33.32	
Effective C	0.14					
EIA =	33.32 acres					

Step 2: Calculate the peak runoff rate and volume.

Assume the drainage basin time of concentration < the duration of the storm event.
Use the average rainfall intensity for the 3-year, 1-hour event

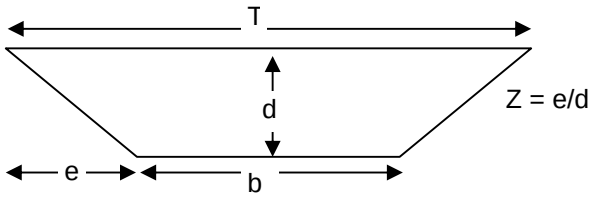
Calculate the peak runoff using the rational method.
Q = C I A

C =	0.14		
I =	2.6	in/hr	From the FDOT IDF curves for Zone 5 (Hastings)
A =	241.98	acres	

Q =	87	acre-in/hr			
Q =	87	cfs	Qm =	4.7	cfs
Vr =	314,452	ft^3	Vm =	16,920	ft^3

Step 3: Determine swale dimensions.

Assume a trapezoidal channel cross section



Cross sectional area (A) = Zd^2+bd
Hydraulic Radius R = $(Zd^2 + bd) / [b + 2d (Z^2+1)^{1/2}]$
Wetted Perimeter (P) = $b+2d(Z^2+1)^{1/2}$
Top width (T) = b+ 2dZ

Start :

Q	87	cfs	
S	0.001	ft/ft	
n	0.04	mowed bahia	
Z	6	ft	
b	300	ft	
depth =	6	ft	Existing canal
d	0.432	ft	initial guess for water depth

R2/3A=	(Qn) / (1.49 $S^{1/2}$)	From Manning's Eqn
$R^{2/3}A$=	74.2	

Calculate $R^{2/3}A$ based on swale geometry. Interatively vary to depth to obtain solution.

A =	130.7	ft^2	
R=	0.4	ft	
$R^{2/3}A$=	74.3		initial guess for d is OK

Top Width =	372	
P =	305	ft
Length =	2300	ft
Length > EL 2.5 =	1650	ft
Infiltration Area =	503,672	ft^2

Step 4. Estimate vertical unsaturated flow

The total volume of water required to saturate the soil below the basin bottom (Vu) can be calculated as follows:

$V_u = A_i * h_b f$

Ai = Infiltration Area

h_b = Height of basin bottom above the groundwater table

f = Fillable porosity (generally 0.2 to 0.3)

SHGWT =	2.5	ft			
Normal GW =	0	ft			
Swale bottom @ CR =	4	ft			
Swale bottom @ Creek	1	ft			
Wet Season:			Dry Season:		
H_b =	1.5	ft	H_b =	2	ft
V_u =	151,101	ft^3	V_u =	280,835	ft^3
Vr =	314,452		*Vr* =	314,452	
Vm =	16,920	ft^3	*Vm* =	16,920	ft^3

Approximately	48%	of the runoff volume infiltrates during the wet season
Approximately	89%	of the runoff volume infiltrates during the dry season
Approximately	100%	of the mean annual flow infiltrates during the wet and dry seasons

Step 5. Estimate the velocity in the swale.

Using Manning's Eqn

V=	(1.49/ n) *	$R^{2/3}$ *	$S^{1/2}$	
	37.25	0.57	0.03	
	0.67	fps		

JONES EDMUNDS

19270-048
Master's Tract RST
Amy Goodden
10/6/2009

Master's Tract RST Water Quality Swale Design Using Procedure from Harper, 2007

Design Criteria: Design to capture base flow and storm flow from Canal 4N.
Base flow = 0.22 cfs
Storm flow = 1 cfs (Average Daily Rainfall of 0.2 inches)
Drainage Area = 151.8 acres
Assume SHGWT = 2.75 NAVD 88 based on wetland vegetation and observed water depth in Deep Creek

Step 1: Determine the drainage basin area and C.

FLUCCS code	Canal 4N	Dry_C	Wet_C	Annual_ C	Annual C * Area	Description
2610	13.3	0.0277	0.0937	0.1214	1.62	Fallow cropland
2150		0.0277	0.0937	0.1214	0.00	Field crops
1510		0.1229	0.2247	0.3476	0.00	Food processing
3100		0.0224	0.0825	0.1049	0.00	Herbaceous upland
2510	0.1	0.0277	0.0937	0.1214	0.01	Horse farms
2110	0.1	0.0277	0.0937	0.1214	0.01	Improved pastures
6460		0.0224	0.0825	0.1049	0.00	Mixed scrub-shrub
3300		0.0224	0.0825	0.1049	0.00	Mixed upland
6170	1.1	0.0224	0.0825	0.1049	0.11	Mixed wetland
4110		0.0224	0.0825	0.1049	0.00	Pine flatwoods
2143	129.9	0.0277	0.0937	0.1214	15.77	Potatoes and cabbage
5300		0.4400	0.5600	1.0000	0.00	Reservoirs - pits,
1100	7.2	0.0527	0.1329	0.1856	1.34	Residential, low
1200		0.0999	0.1865	0.2863	0.00	Residential, medium
2140		0.0277	0.0937	0.1214	0.00	Row crops
3200	0.2	0.0224	0.0825	0.1049	0.02	Shrub and brushland
2120		0.0277	0.0937	0.1214	0.00	Unimproved pastures
4340		0.0224	0.0825	0.1049	0.00	Upland mixed
Total	151.80	acres			18.87	
Effective C	0.12					
EIA =	18.87	acres				

Step 2: Calculate the peak runoff rate and volume.

Assume the drainage basin time of concentration < the duration of the storm event.
Use the average rainfall intensity for the 3-year, 1-hour event

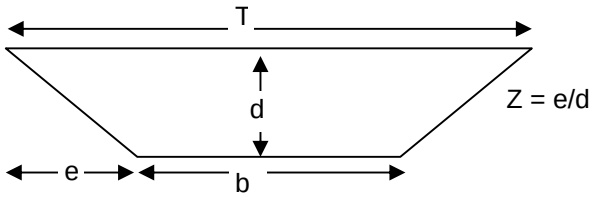
Calculate the peak runoff using the rational method.
Q = C I A

C =	0.12		
I =	2.6	in/hr	From the FDOT IDF curves for Zone 5 (Hastings)
A =	151.80	acres	

Q =	49	acre-in/hr			
Q =	49	cfs	Qm =	1	cfs
Vr =	178,119	ft^3	Vm =	3600	ft^3

Step 3: Determine swale dimensions.

Assume a trapezoidal channel cross section



Cross sectional area (A) = Zd^2+bd
Hydraulic Radius R = $(Zd^2 + bd) / [b + 2d (Z^2+1)^{1/2}]$
Wetted Perimeter (P) = $b+2d(Z^2+1)^{1/2}$
Top width (T) = b+ 2dZ

Start :

Q	49	cfs	
S	0.001	ft/ft	
n	0.04	mowed bahia	
Z	6	ft	
b	200	ft	
depth =	4	ft	Existing canal
d	0.39	ft	initial guess for water depth

R2/3A=	(Qn) / (1.49 $S^{1/2}$)	From Manning's Eqn
$R^{2/3}A$=	42.0	

Calculate $R^{2/3}A$ based on swale geometry. Interatively vary to depth to obtain solution.

A =	78.9	ft^2	
R=	0.4	ft	
$R^{2/3}A$=	41.8		initial guess for d is OK

Top Width =	248	
P =	205	ft
Length =	650	ft
Length > EL 2.5 =	650	ft
Infiltration Area =	133,084	ft^2

Step 4. Estimate vertical unsaturated flow

The total volume of water required to saturate the soil below the basin bottom (Vu) can be calculated as follows:

$V_u = A_i * h_b f$

Ai = Infiltration Area

h_b = Height of basin bottom above the groundwater table

f = Fillable porosity (generally 0.2 to 0.3)

SHGWT =	2.5	ft			
Normal GW =	0	ft			
Swale bottom @ CR =	4	ft			
Swale bottom @ Creel	1	ft			
Wet Season:			Dry Season:		
H_b =	1.5	ft	H_b =	2	ft
V_u =	39,925	ft^3	V_u =	53,234	ft^3
Vr =	178,119	ft^3	*Vr* =	178,119	ft^3
Vm =	3,600	ft^3	*Vm* =	3,600	ft^3

Approximately	22%	of the runoff volume infiltrates during the wet season
Approximately	30%	of the runoff volume infiltrates during the dry season
Approximately	100%	of the mean annual flow infiltrates during the wet and dry seasons

Step 5. Estimate the velocity in the swale.

Using Manning's Eqn

V=	(1.49/ n) *	$R^{2/3}$ *	$S^{1/2}$	
	37.25	0.53	0.03	
	0.62	fps		

APPENDIX G

COST ESTIMATE

UNIT COST SHEET

OWNER:	ESTIMATED BY:
St. Johns County	**Amy Goodden**
CLIENT:	CHECKED BY:
St. Johns County	**Walt Nickel**
PROJECT TITLE:	APPROVED BY:
Masters Tract RST	**Brett Goodman**
PROJECT NUMBER:	DATE:
19270-048-03	**11/9/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Budget	**PROJECT - Preliminary Engineering Report**

Item No.	Description	Estimated Quantity	Unit	Bid Unit Price	Bid Price
General Project					
	Hauling - Excess Excavation	586471	CY	$ 5.00	$ 2,932,355.50
	Well Abandonment	1	LS	$ 37,000.00	$ 37,000.00
Canal 5 Intake and Pump Station					
	Diversion Weir - concrete	30	CY	$ 527.00	$ 15,810.00
	Clearing and Snagging	1.48	acre	$ 4,343.75	$ 6,428.75
	Excavation	7060	CY	$ 3.58	$ 25,274.16
	Fill	526	CY	$ 2.97	$ 1,560.94
	Dewatering	30	day	$ 710.00	$ 21,300.00
	Fine Grading	1.48	acre	$ 6,969.60	$ 10,315.01
	Pump Station - Concrete	520	CY	$ 527.00	$ 274,040.00
	control panel	1	LS	$ 221,264.00	$ 221,264.00
	Pump Station - Valves	6	LS	$ 1,200.00	$ 7,200.00
	Pump Station - Ductile Iron Piping	225	LF	$ 57.00	$ 12,825.00
	Access Road - Limerock	49	CY	$ 46.67	$ 2,304.69
	Grass	1.48	acre	$ 1,050.00	$ 1,554.00
	Sediment Erosion Control	1	LS	$ 900.00	$ 900.00
Canal 5 Wet Detention Pond					
	Clearing and Grubbing - light	41.43	acre	$ 3,475.00	$ 143,969.25
	Clearing and Snagging	2.30	acre	$ 4,343.75	$ 9,990.63
	Excavation	484108	CY	$ 3.58	$ 1,733,106.64
	Fill	34324	CY	$ 2.97	$ 101,943.68
	Dewatering	15	day	$ 710.00	$ 10,650.00
	Fine Grading	13.99	acre	$ 6,969.60	$ 97,504.70
	Wetland Buffer Enhancment	2.25	acre	$ 3,881.00	$ 8,732.25
	Sediment Erosion Control	1	LS	$ 3,240.00	$ 3,240.00
	Water Control Structure	1	LS	$ 30,000.00	$ 30,000.00
	HDPE Pipe	1000	LF	$ 51.00	$ 51,000.00
	Littoral Zone Planting	6.03	acres	$ 4,259.00	$ 25,681.77
Stormwater Harvesting					
	Horizontal Well Installation	1	LS	$ 5,000.00	$ 5,000.00
	Pump	1	LS	$ 1,500.00	$ 1,500.00
	Discharge Piping	2000	LF	$ 36.00	$ 72,000.00
Canal 4 Water Quality Swale					
	Clearing and Grubbing - light	9.25	acre	$ 3,475.00	$ 32,143.75
	Clearing and Snagging	4.10	acre	$ 4,343.75	$ 17,809.38
	Excavation	95975	CY	$ 3.58	$ 343,590.71
	Fill	5484	CY	$ 2.97	$ 16,287.72
	Dewatering	7	day	$ 710.00	$ 4,970.00
	Fine Grading	13.35	acre	$ 6,969.60	$ 93,044.16
	Flow-way enhancement vegetation	12.86	acre	$ 7,187.00	$ 92,424.82
	Sediment Erosion Control	1	LS	$ 2,100.00	$ 2,100.00
	Water Control Structure	2	LS	$ 10,000.00	$ 20,000.00
Canal 4 North Water Quality Swale					
	Clearing and Grubbing - light	3.98	acre	$ 3,475.00	$ 13,830.50
	Clearing and Snagging	1.90	acre	$ 4,343.75	$ 8,253.13
	Excavation	19477	CY	$ 3.58	$ 69,728.84
	Fill	1456	CY	$ 2.97	$ 4,325.54
	Dewatering	7	day	$ 710.00	$ 4,970.00
	Fine Grading	5.88	acre	$ 6,969.60	$ 40,981.25
	Flow-way enhancement vegetation	5.88	acre	$ 7,187.00	$ 42,259.56
	Sediment Erosion Control	1	LS	$ 10,683.66	$ 10,683.66
	Water Control Structure	1	LS	$ 10,000.00	$ 10,000.00
Wetland Cell #1					
	Clearing and Grubbing - light	16.20	acre	$ 3,475.00	$ 56,295.00
	Clearing and Snagging	1.90	acre	$ 4,343.75	$ 8,253.13
	Excavation	11681	CY	$ 3.29	$ 38,429.93
	Fill	19104	CY	$ 2.97	$ 56,738.26
	Dewatering	7	day	$ 710.00	$ 4,970.00
	Fine Grading	18.10	acre	$ 6,969.60	$ 126,149.76

JONES EDMUNDS

UNIT COST SHEET	
OWNER:	ESTIMATED BY:
St. Johns County	**Amy Goodden**
CLIENT:	CHECKED BY:
St. Johns County	**Walt Nickel**
PROJECT TITLE:	APPROVED BY:
Masters Tract RST	**Brett Goodman**
PROJECT NUMBER:	DATE:
19270-048-03	**11/9/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Budget	**PROJECT - Preliminary Engineering Report**

Item No.	Description	Estimated Quantity	Unit	Bid Unit Price	Bid Price
	Wetland Buffer Enhancement	13.30	acre	$ 3,881.00	$ 51,617.30
	Forested Wetland Creation	17.90	acre	$ 8,673.00	$ 155,246.70
	Sediment Erosion Control	1	LS	$ 2,481.70	$ 2,481.70
	Water Control Structure	2	LS	$ 10,000.00	$ 20,000.00
Wetland Cell #2					
	Clearing and Grubbing - light	15.77	acre	$ 3,475.00	$ 54,800.75
	Clearing and Snagging	1.00	acre	$ 4,343.75	$ 4,343.75
	Excavation	11310	CY	$ 3.58	$ 40,488.15
	Fill	8622	CY	$ 2.97	$ 25,606.54
	Dewatering	7	day	$ 710.00	$ 4,970.00
	Fine Grading	16.77	acre	$ 6,969.60	$ 116,880.19
	Wetland Buffer Enhancement	2.22	acre	$ 3,881.00	$ 8,615.82
	Forested Wetland Creation	15.90	acre	$ 8,673.00	$ 137,900.70
	Sediment Erosion Control	1	LS	$ 2,941.52	$ 2,941.52
	Water Control Structure	1	LS	$ 10,000.00	$ 10,000.00
Wetland Cell #3					
	Clearing and Grubbing - light	14.06	acre	$ 3,475.00	$ 48,858.50
	Clearing and Snagging	1.30	acre	$ 4,343.75	$ 5,646.88
	Excavation	29628	CY	$ 3.58	$ 106,066.66
	Fill	3251	CY	$ 2.97	$ 9,655.44
	Dewatering	7	day	$ 710.00	$ 4,970.00
	Fine Grading	15.36	acre	$ 6,969.60	$ 107,053.06
	Forested Wetland Creation	16.50	acre	$ 8,673.00	$ 143,104.50
	Sediment Erosion Control	1	LS	$ 2,639.40	$ 2,639.40
	Water Control Structure	3	LS	$ 10,000.00	$ 30,000.00
Monitoring Equipment					
	PV monitoring platform	7	each	$ 40,000.00	$ 280,000.00
					$ -

	Subtotal	$ 8,356,578

JONES EDMUNDS

PROJECT NAME: Tatum Tract Mitigation Area

PROJECT No.: 19270-048-01
DATE: 18 November 2009
SUBMITTAL:

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

PROJECT SEGMENT: WETLAND MITIGATION
ESTIMATE TYPE: CONSTRUCTION COST
CLIENT: ST. JOHNS COUNTY
PREPARED BY: H2B
CHECKED BY: JLD

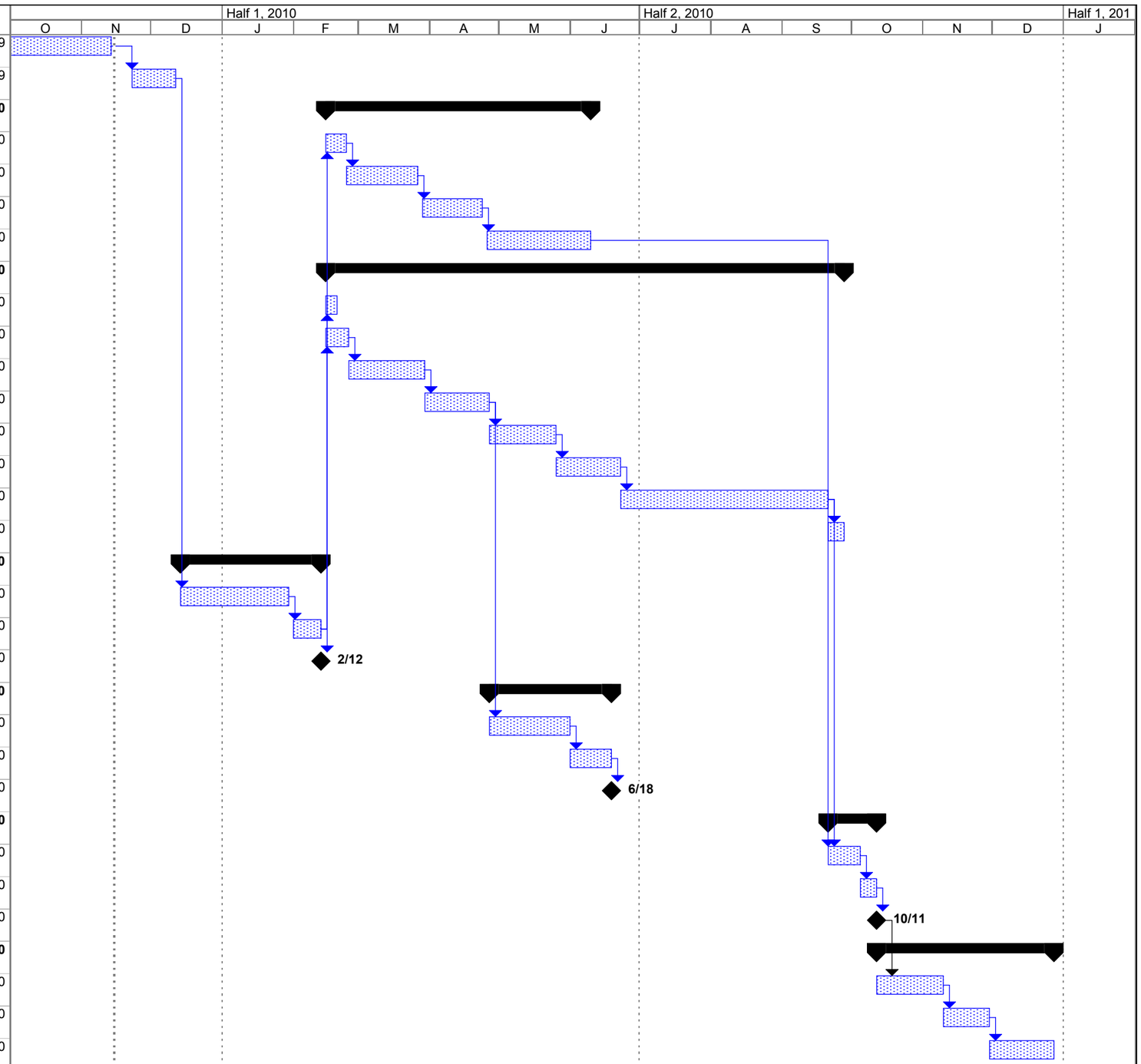
FDOT ITEM NUMBER	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST	NOTES
BERM BREACH						
101-1	MOBILIZATION (10%)	LS	1	$ 891.55	$ 892	
104-13-1	SILT FENCE STAKED (TYPE III)	LF	360	$ 0.83	$ 299	1
110-1-1	CLEARING AND GRUBBING	AC	0.46	$ 10,692.88	$ 4,909	2
120-1	EXCAVATION REGULAR	CY	93	$ 3.58	$ 331	3
145-1	GEOSYNTHETIC REINFORCED SOIL SLOPE	SF	1,800	$ 0.30	$ 540	4
145-71-1	GEOSYNTHETIC REINF FND OVER SOFT SOIL (MATTING)	SY	741	$ 3.74	$ 2,770	2
162-1-11	PREPARED SOIL LAYER, FINISH SOIL, 12" (GRADED)	SY	67	$ 0.98	$ 65	4
999-25	INITIAL CONTINGENCY AMOUNT (15%)	LS	1	$ 1,471.05	$ 1,471	
				SUBTOTAL	**$ 11,278**	
DITCH BLOCK						
101-1	MOBILIZATION (10%)	LS	1	$ 419.40	$ 419	
104-13-1	SILT FENCE STAKED (TYPE III)	LF	40	$ 0.83	$ 33	5
120-73	GRAVEL FILL	CY	34	$ 42.64	$ 1,461	6
Pinellas Quote	VINYL SHEET PILE	SF	150	$ 18.00	$ 2,700	7
999-25	INITIAL CONTINGENCY AMOUNT (15%)	LS	1	$ 692.01	$ 692	
				SUBTOTAL	**$ 5,305**	
PLANTING AND MAINTENANCE						
101-1	MOBILIZATION (10%)	LS	1	$ 17,100.00	$ 17,100	
N/A	PLANTS AND INSTALLATION	LS	1	$ 38,000.00	$ 38,000	
N/A	EXOTIC PLANT REMOVAL	AC	38	$ 3,500.00	$ 133,000	8
999-25	INITIAL CONTINGENCY AMOUNT (15%)	LS	1	$ 28,215.00	$ 28,215	
				SUBTOTAL	**$ 216,315**	
				TOTAL	**$ 232,898**	

Note:
1. Assumed Silt Fencing Approximately 60 feet across on both sides of Berm Breach
2. Assumed 20' Wide Path 1,000 feet long to allow access from existing road to project areas
3. Assumed 833 CF of Excavation per Berm Breach based on 4:1 interior slopes, 5' tall berm and 20' wide spillway
4. Assumed 10' x 60' Total Affected Spillway Area
5. Assumed Silt Fencing Approximately 10' across both sides of Ditch Block
6. Assumed 262.5 CF of gravel fill for Ditch Block based on 4' deep swale 10' wide top 5' wide bottom 3' high Ditch Block and 4:1 slopes
7. Assumed 3' High Ditch Block with 4.5' Embedment and 10' wide ditch. Unit Cost based on Installed Vinyl Sheet Pile Quotes from: Pinellas County Utilities Slurry Wall Relocation Bridgeway Acres Landfill Bid Number: 089-0184-C(DM), Dated 8/29/2008
8. Assumes 3 treatments 1st year, followed by semi-annual treatments for two subsequent years @ $500/Acre. Unit Cost based on Quote from: Environmental Services Inc., Dated Oct 2009

APPENDIX H

DETAILED PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish
1	PER	75 days	Mon 8/3/09	Fri 11/13/09
2	Stakeholder Coordination	15 days	Mon 11/23/09	Fri 12/11/09
3	**ACOE Permit Nationwide**	**83 days**	**Mon 2/15/10**	**Wed 6/9/10**
4	Prepare Application	7 days	Mon 2/15/10	Tue 2/23/10
5	RAI No. 1	23 days	Wed 2/24/10	Fri 3/26/10
6	Respond to RAI No. 1	20 days	Mon 3/29/10	Fri 4/23/10
7	Notice of Agency Action	33 days	Mon 4/26/10	Wed 6/9/10
8	**Individual ERP**	**161 days**	**Mon 2/15/10**	**Mon 9/27/10**
9	Preapplication Meeting	5 days	Mon 2/15/10	Fri 2/19/10
10	Prepare Application	8 days	Mon 2/15/10	Wed 2/24/10
11	RAI No. 1	23 days	Thu 2/25/10	Mon 3/29/10
12	Response to RAI No.1	20 days	Tue 3/30/10	Mon 4/26/10
13	RAI No. 2	21 days	Tue 4/27/10	Tue 5/25/10
14	Response to RAI No. 2	20 days	Wed 5/26/10	Tue 6/22/10
15	Notice of Agency Action	64 days	Wed 6/23/10	Mon 9/20/10
16	Issuance of Permit	5 days	Tue 9/21/10	Mon 9/27/10
17	**50% Design Production**	**45 days**	**Mon 12/14/09**	**Fri 2/12/10**
18	50% Design	35 days	Mon 12/14/09	Fri 1/29/10
19	50% Design Review	10 days	Mon 2/1/10	Fri 2/12/10
20	50% Final	0 days	Fri 2/12/10	Fri 2/12/10
21	**90% Production**	**39 days**	**Tue 4/27/10**	**Fri 6/18/10**
22	90% Design Production	25 days	Tue 4/27/10	Mon 5/31/10
23	90% Design Review	14 days	Tue 6/1/10	Fri 6/18/10
24	90% Final	0 days	Fri 6/18/10	Fri 6/18/10
25	**Final Production**	**15 days**	**Tue 9/21/10**	**Mon 10/11/10**
26	Final Design Production	10 days	Tue 9/21/10	Mon 10/4/10
27	Final Design Review	5 days	Tue 10/5/10	Mon 10/11/10
28	Final Construction Drawings	0 days	Mon 10/11/10	Mon 10/11/10
29	**Bidding Services**	**55 days**	**Tue 10/12/10**	**Mon 12/27/10**
30	Advertising	21 days	Tue 10/12/10	Tue 11/9/10
31	Bidding	14 days	Wed 11/10/10	Mon 11/29/10
32	Award Recommendation and NTP	20 days	Tue 11/30/10	Mon 12/27/10



Project: ScheduleofDesign_10-29-09.r
Date: Sun 11/15/09

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline