Ten Mile Canal Filter Marsh Final Report

Prepared by Lee County Division of Natural Resources

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1 INTRODUCTION

1.1 EXECUTIVE SUMMARY

The Ten Mile canal was constructed in the 1920's to control flooding in South Fort Myers. In the 1970's the Canal was deepened and widened, and control structures were installed to maintain the water table and to protect saltwater intrusion. The Ten Mile canal watershed covers an area of 13 square miles and flows into Mullock Creek, an outstanding Florida Water which is designated as impaired, and subsequently into Estero Bay, Florida's first aquatic preserve. The existing predominant land use includes commercial and industrial. The watershed is affected by heavy urban development, cropland, and some pastureland along the banks.

Construction of an approximately 6,000-foot long filter marsh was completed in December 2005. The filter marsh is located approximately at the half-way point along the canal length. The construction involved excavating approximately 400,000 cubic yards of material from a 6,000-foot by 100-foot area adjacent to the canal and routing the canal water into the filter marsh through two (2) 30-inch diameter pipes. A maintenance road and a recreation bike path have been constructed to separate the canal from the filter marsh. The inlet with a controllable screw type sluice gate system is installed upstream of a weir. Water flow into the filter marsh system is regulated through the gate system. The filter marsh system is divided into four (4) different cells connected through three (3) 30-inch diameter pipes. Water depths in cells vary from 18 inches to 5 feet. The first cell acts as a settling basin with limited wetland vegetation. The second cell is shallow and planted with wetland vegetation. The third cell is deeper than any other cell and has wetland vegetation suitable for deeper water. The last cell is shallow and also has a lot of shallow water wetland vegetation. Each cell is outfitted with an outflow riser regulated by flash boards. This structure allows excess water flow back into the canal. Further, this structure is being used to lower the water level in the cells during maintenance events.

The long term goal is to implement dynamic, effective water quality enhancement for Lee County's designated impaired water bodies. Nutrient reduction is the primary focus of this project. In order to monitor the effectiveness of the system, Lee County Environmental Lab is collecting water quality samples on a monthly basis at stations established within the filter marsh in addition to established sampling stations in the canal proper. Flow and stage data within the marsh is collected to coincide with the water quality sample collection. Water quality data collected show some improvements from inflow to outflow conditions. However, data collected so far is not sufficient at this time to formulate definitive conclusions. The maintenance of the filter marsh includes harvesting wetland vegetation on a regular basis. The construction cost of the filter marsh was approximately 1.6 million dollars. Florida Department of Environmental Protection provided $507,000 in grant funding. The filter marsh was constructed along with a contiguous linear park to the east of the filter marsh. Both the filter marsh and the linear park were included in a single construction project.

1.2 BACKGROUND

The Ten Mile Canal, located in Lee County, Florida, is a 68-square-mile watershed, of which approximately 55 square miles are located within the Six Mile Cypress Slough basin that was constructed in the 1920's as part of the Iona Drainage District (IDD) flood control project. The population in the Iona/McGregor and downtown Fort Myers area has grown significantly since the original construction of the canal, leading to unexpected water quality problems. Given the canal's relative position in the landscape and its constituent drainage area being primarily of pre-regulatory developments comprised of intensely developed industrial, commercial and urban areas, it is has been suspected as being a primary contributor to the high pollutant levels in both Estero Bay and its tributary, Mullock Creek.

There have been many driving forces since the 1950's that have brought attention to water quality in the Ten Mile Canal basin and throughout Lee County. In the late 1950's the Lee County Conservation Association, Inc. garnered the support of the community to preserve much of the Estero Bay watershed. Their efforts lead to the designation of the Estero Bay and its tributaries as Outstanding Florida Waters in 1966. This special designation affords more stringent regulatory protections under Florida Administrative Code 62-302 (Florida's State water quality standards).

In 1999, the Environmental Protection Agency (EPA) was issued a federal consent decree to develop total maximum daily loads (TMDLs) in all states. (TMDLs are the capacity of each water body to assimilate pollution before sustaining ecological damage.) TMDLs require a subsequent watershed restoration plan, known as Basin Management Action Plans (BMAPs) that are designed at the State and local level, implemented at the local government level and regulated by FDEP and EPA. TMDLs for the Estero Bay Basin will be set in 2008.

In addition, the South Florida Water Management District (SFWMD) is concurrently developing a Surface Water Improvement and Management Plan (SWIM Plan) and the Estero Bay is a basin of interest by the Army Corps of Engineers and the SFWMD for the Southwest Florida Feasibility Study to support the Comprehensive Everglades Restoration Plan. These efforts being undertaken by State and local government should yield water quality and quantity improvement over the next several years in this basin.

In response to these government initiatives, local initiatives led by concerned civic and business leaders helped to accelerate the design and construction of the Ten Mile Canal Filter Marsh project by hiring a engineering consultant by the Lee County Board of County Commissioners in December 2001 and later by the Florida Department of Environmental Protection (FDEP) and the South Florida Water Management District (SFWMD) by way of stormwater restoration grant funding.

Environmental Consulting & Technology, Inc (ECT) was the engineer of record during design permitting and construction and continued their services through the first monitoring cycle during 2006. Johnson Engineering replaced the responsibilities of ECT beginning the year 2007. The present contract with Johnson Engineering extends until the end of 2009.

1.3 PURPOSE

The objective of this report, prepared by Lee County Division of Natural Resources, is to provide the Lee County Board of County Commissioners and the Florida Department of Environmental Protection (FDEP) with the final report of project with an update to our water quality assessment, as to the status of the Ten Mile Filter Marsh system. For regulatory purposes related to the Environmental Resource Permit (ERP) issued by the Florida Department of Environmental Protection (FDEP), this report represents the final report to the permittee, the Lee County Board of Commissioners, and is the compilation of the final operating report due to the FDEP.

1.4 WATERSHED DESCRIPTION

Ten Mile Canal, located in Lee County, Florida, is a 68-square-mile watershed, of which approximately 55 square miles are located within the Six Mile Cypress Slough basin. Located within the northern portion of the Ten Mile Canal Watershed, the Ten Mile Canal Filter Marsh project area is roughly bounded by Hansen Street to the north, the former Seaboard Coast railroad right of way to the west, the Benjamin C. Pratt/Six Mile Cypress Parkway to the east and Daniels Parkway to the south. Since the canal's original construction as a flood control project in the 1920's as part of the Iona Drainage District (IDD), the population of the surrounding area has grown, as have the canal's discharges and subsequent pollutant loads. Given the canal's relative position in the landscape and its constituent drainage area being primarily of pre-regulatory developments comprised of intensely developed industrial, commercial and urban areas, it is has been suspected as being a primary contributor to the high pollutant levels in both Estero Bay and its tributary, Mullock Creek.

Local initiatives lead by concerned civic and business leaders led to the adoption and funding of the filter marsh project by the Lee County Board of County Commissioners in December 2001 and later by the Florida Department of Environmental Protection (FDEP) and the South Florida Water Management District (SFWMD) by way of stormwater restoration grant funding.

2 PROJECT DESIGN

Construction of a filter marsh along Ten Mile Canal was originally identified in the Surface Water Management Master Plan adopted by the county in early 1990's.
Site selection for the project was primarily based on two factors: use of available right-of-way and ability draw without a pump system. The selected site was chosen because of the upstream Daniels Weir to the north and sufficient right-of-way east of the Ten Mile canal. No funding was available for acquiring additional land. The design was intended to use potential head of water upstream of the weir as the driving force of water through the filter marsh.

Upon completion of the boundary survey it was revealed that the county's right-of-way was approximately half the available space between the canal and the rail road track. The county intends to expand the filter to the east during the 2nd phase after acquiring land from the rail road authorities. The design allows drawing 30 cubic feet per second (cfs) from upstream of the weir upon completion of the 2nd phase of the filter marsh. Currently, approximately 8 to 10 cfs is permitted through the controllable screw type gate system.
The engineer of record for the design and construction of the project was Environmental Consulting and Technology, Inc (ECT). In May, 2002, the ECT was awarded the design and permitting of the project. After several months into the preliminary design, the county's Parks and Recreation Department brought the idea of incorporating a linear park into the design along with the filter marsh. This new idea expanded the scope of the design and delayed the schedule of the filter marsh project. The linear park consisted of a bike path and a trail system contiguous to the filter marsh on the west side. The linear park runs on both sides of the Ten Mile Canal connected through a bridge across the canal.

The filter marsh which is approximately 6,000-foot long is located at the mid point along the canal length between two major roadway arteries called Daniels Parkway and Six Mile Cypress Parkway. The project was designed to take water upstream of the existing Daniels Weir and transporting canal water underneath the Daniels Parkway into the filter marsh through two (2) 30-inch diameter pipes. The width of the filter marsh varies from 60 feet at the north to about 100 feet on the south. A maintenance road and a recreation bike path have been constructed to separate the canal from the filter marsh. The bike path on the east side of the canal connects to the west side of the canal through a bridge at the half way point of the filter marsh. The inlet with a controllable screw type sluice gate system is installed upstream of a weir. Water flow into the filter marsh system is regulated through the gate system. The filter marsh system is divided into four (4) different cells connected through three (3) 30-inch diameter pipes. Water depths in cells vary from 18 inches to 5 feet.

The first cell is about 400 feet long by 55 feet wide. It is about 10 feet deep with an average water depth of 5 feet. The first cell receives water from the Canal and acts as a settling basin with limited vegetation, where water changes its conveyance from pipe flow to channel flow, reducing flow velocity. The second cell is approximately 2100 feet long by 60 feet wide and planted with wetland vegetation. The second cell is about 5 feet deep with an average water depth of 2 feet. The third cell is 1350 long by 60 feet wide. This is deepest cell with a depth of 8 feet and an average water depth of 5 feet and has wetland vegetation planted that is suitable for deeper water. The last cell is 2200 feet long by 75 feet wide. It is about 5 feet deep with an average water depth of 2 feet and includes a lot of shallow water wetland vegetation. The filter marsh is separated from the Canal proper by a 25-foot wide maintenance road. The invert pipe elevation at intake is set at +5 feet (NGVD). The design water level within the filter marsh is set at +8.5 feet (NGVD). The weir elevation within the Canal proper is at +9.75 feet (NGVD). Embankments within the cells are constructed at 2:1 slope.

Side slopes of all four cells are vegetated with littoral plants; sand Cordgrass and Madencane. Bottom of cells are planted with Fire Flag, Bulltongue Arrowhead, Softstem Bulrush, Pickelweed, and Knotted Spikerush.

Each cell is fitted with a flashboard riser pipe to allow discharge of excess water flow from the cell back into the Canal by-passing the filter marsh. Additionally, water from cell to cell is controlled with flash boards riser pipes connecting cells. During maintenance events, each cell is isolated by raising flash boards interconnecting cells and water is discharged to the canal to lower the water level in the cell. Normal water levels in the cells in the range of 2 to 5 feet have been setback during maintenance operation. Lowering water levels have been helpful in manual harvesting of vegetation during maintenance events.

3 PROJECT CONSTRUCTION

The permit for construction was issued by the Florida Department of Environmental Protection in October of 2004. Solicitation of bids for construction of both the filter marsh and the linear park as a single project was advertised in November of 2004. There were four successful bidders with a total construction cost varying from $2.7 million to $3.2 million. The bid tabulation is attached. On January 18, 2005, the Board of County Commissioners approved the recommendation of the staff to award the construction of the project to the low bidder, Wright Construction. The contractor was given 240 days to complete the project starting March 1, 2005. The project was expected to be complete by October of 2005.

The construction involved excavating approximately 400,000 cubic yards of material from a 6,000-foot by 100-foot area adjacent to the canal. On March 14, 2005, the contractor started excavating the cells within the filter marsh. One week into the earth moving operation, the contractor abandoned the excavation operation upon discovery of construction trash, rubble and debris buried on the filter marsh site. Apparently, the contractor had made arrangements to sell the excavated material as structural fill to his clients. The contractor claimed that the discovery of latent subsurface conditions does not fall within the scope of work and requested a change order to haul material out of the site. Geotechnical investigations had been performed on the site and the reports were provided to all contractors as a part of the bid documents. None of the geotechnical borings revealed the conditions discovered on the site. The county did not agree with the contractor's claim. Negotiating of this change order delayed the project by about 2 months. The construction was finally completed in December of 2005. Another significant change to the project was the method of conveyance of water from upstream of the Daniels Weir to the filter marsh. The original design required the contractor to perform directional boring under the Daniels Parkway to make a straight line connection from upstream of the existing Daniels Weir to the filter marsh. Instead of this design, the as-built includes two (2) 30-inch diameter partially buried pipes with two bends crossing under the Daniels Parkway bridge into the filter marsh.

4 PROJECT COST

Project Funding Activity	FDEP Grant Funding	Matching Funds by Source
Project Management		$ 117, 718 (Lee County)
Equipment & Instrumentation		$ 17,353.39 (Lee County)
Design and Permitting		$ 172,977 (Lee County) $ 150,000 (SFWMD)
Construction	$ 454,800	$1,099,738 (Lee County) $ 191,000 (SFWMD)
Monitoring	$ 30,000	$ 35,000 (Lee County)
Public Education and Reporting	$ 5,203.01	
Total	**$ 490,003.01**	**$ 1,989,419.89**
Total by Entity	**$ 490,003.01**	**$ 1,648,419.89 (Lee Co.)** **$ 341,000 (SFWMD)**
Percentage by Entity	**19.76%**	**66.49% (Lee County)** **13.75% (SFWMD)**
TOTAL PROJECT COST	**$2,479,422.90**	**% Match 80.24%**

5 FILTER MARSH MANAGEMENT

Lee County and ECT established seven sample sites at the Ten Mile Canal Filter Marsh under the original monitoring contract in accordance with the DEP permit and monitoring plans. The filter marsh water quality sampling began in late January 2006. The filter marsh is constructed as alternating settling and marsh treatment cells starting at the northern end with an initial settling area. Monitoring is conducted at the inflow point of the northern most settling cell and then on the downstream side of each discharge point for the subsequent treatment cells. ECT monitored both flow at each monitoring station as well as flow at the Lee County canal gauging station north of the Daniels Parkway weir to obtain data on the contributing flow from Ten Mile Canal until July 2006. Johnson Engineering took over these monitoring tasks in late February 2007. Water quality and flow are being monitored at the system outfall from the southernmost treatment marsh as water is returned to Ten Mile Canal to determine the net effects of the filter marsh. In addition, samples are collected in the Ten Mile Canal at the pedestrian bridge to assess changes in the canal water quality as a result of reduced canal flow caused by the diversion of flow into the treatment system.

5.1 DATA COLLECTION AND WATER QUALITY MONITORING

ECT staff collected flow and stage data monthly in 2006 while Johnson Engineering, Inc (JEI) collected data during 2007 coincident with the LCEL sampling and storm event data quarterly to provide the information necessary to determine pollutant loadings until December 2006. Johnson Engineering took over these tasks in late February 2007. The collection of this data will give Lee County staff information for managing the system properly and quantifying the system's performance.

At the present time water quality samples for the Filter Marsh Project are being collected by Lee County Environmental Laboratory staff in conjunction with flow and stream gauge data collection by JEI personnel. In addition, JEI staff is collecting sediment samples and a minimum of one qualifying rainfall event water quality samples quarterly. LCEL is supplying the equipment and supplies needed for sample collection and is analyzing the water and sediment samples for those parameters required by the FDEP permit as well as for other parameters indicated in the Filter Marsh monitoring plan to evaluate the system's progress. LCEL is also continuing to collect its monthly water quality samples from their network within the basin. Water quality samples and physical parameters are collected in accordance with DEP-SOP-0l/001 and stream flow and discharge measurements are collected using methods from the USGS "General Field and Office Procedures for Indirect Discharge Measurements".

5.2 MAINTENANCE ACTIVITIES

Date	Contractor	Work Type	Quantities		TSI Staff	Equipment
			Upstream of Weir	Inside Filter Marsh		
8/26/2006	TSI, Inc.	Aquatic Plant Removal	80 cy water lettuce	80 cy cattail		
10/20/2006	TSI, Inc.	Aquatic Plant Removal	160 cy water lettuce	160 cy cattail	14 men	2 canoes
10/20/2006	TSI, Inc.	Aquatic Plant Removal		850 cy chara		
5/14/2007	TSI, Inc.	Aquatic Plant Removal	160 cy water lettuce	90 cy mixed	14 men	2 canoes
		Subtotal:	400 cy water lettuce	240 cy cattail, 850 cy chara & 90 cy mixed		
		Total: Upstream & Downstream		**1580 cy bio mass removed to date**		

5.3 MANAGEMENT ACTIVITIES

Johnson Engineering began evaluation of field conditions at the Ten Mile Filter Marsh project site in February 2007. On February 15, 2007, Johnson Engineering representatives met with Lee County Environmental Laboratory staff to observe surface water quality sampling. Since March 8, 2007, Johnson Engineering staff has visited the project site on twelve occasions for monthly water level and riser board elevation monitoring, sampler and water level monitoring equipment installation, and collection of stage data. Harvesting of the vegetation in each of the four cells was observed during the week of May 14, 2007. Riser boards were temporarily removed during the vegetation removal, but were replaced after harvesting. From the beginning of the monitoring period in February 2007 until May 18, 2007, there was an absence of water in the south filter marsh. Efforts were made to try and promote flow through the filter marsh by removal of riser boards in the upstream cells. However, the south filter marsh remained dry until a large rain event on May 18, 2007 generated flow into the cell. No discharge from the filter marsh into Ten Mile Canal occurred during the 2nd quarter monitoring period except for a brief time from June 19, 2007 to June 24, 2007. Therefore, no quarterly water quality samples were collected during the monitoring period.

Johnson Engineering developed an additional list of water level and water quality monitoring equipment which would best accomplish the objective of the project and permit requirements. In May 2007, two ISCO Avalanche automated water quality samplers and accessory equipment were installed. Infinities water level dataloggers were installed on May 11, 2007. The dataloggers were installed at the south filter marsh just before water exits into Ten Mile Canal and in Ten Mile Canal adjacent to the south filter marsh. The water level readings in Ten Mile Canal from the upstream datalogger provided by Lee County and the downstream datalogger provided by Johnson Engineering were verified by Johnson Engineering using a Lee County benchmark as a reference.

Water levels and riser board elevations were recorded on March 16, April 16, May 4, and June 14, 2007. Water level elevations were read directly from staff gauges installed on the drains of each cell. Riser board elevations were obtained by using a 10 foot NGVD notch cut into the metal sidebars of the drainage structures as a reference mark. Data was collected in the field and transferred to an electronic spreadsheet. The water level dataloggers have been downloaded monthly in conjunction with the water level and riser board monitoring.

5.4 LIMITING CONDITIONS

Some of the data collected during 2006 by ECT is not available at this time therefore there is a data gap that will make analysis of the filter marsh performance for 2006-2007 challenging. Future limitations of the system's effectiveness are expected to be low water levels in dry season that will preclude out-flow and measurable nutrient load reduction as well as variable weather patterns with unexpected results. In addition, the filter marsh attracts a large population of migrating as well as residential wading birds. These naturally occurring fauna do contribute to fecal coliform and ammonia to the filter marsh which may represent some data analysis "background noise".

6 RESULTS AND DISCUSSION

The construction of the Ten Mile Filter Marsh was completed late 2005. The review of the as-built documents show little deviation from the design plans and are within acceptable limits. In January 2006, ECT commenced stream flow, stage measurements and water quality sampling. At that time, the filter marsh was very dry and was lacking flow in some portions due to the normal seasonal weather pattern. The vegetation at this time looked dormant, albeit still alive.

In January and February the discharge and flow measurements indicated that there was enough water flowing through the system that the filter marsh was capable of nutrient uptake and/or settling. Through out the driest part of this past dry season in 2006 (March/April) the system was not receiving enough flow from the canal to be functional. There was no contribution from the filter marsh back into the canal in some cells and it is doubtful that there would have been any meaningful decrease in nutrients as a result of the filter marsh at that time. The system was functionally dormant and relying on base flow for hydration.

The conditions for this past dry season were unusually dry; however there was enough contribution from the groundwater table to keep the first and second cell and part of the third cell hydrated and to keep the soils in the marsh moist enough to support the aquatic vegetation.

Beginning in late May 2006, the rainfall events became more frequent, but the volume and flow were only slightly higher in the filter marsh as compared to previous quarter. The wet trend continued to increase as a result of the onset of the wet season. ECT staff observed flow and discharge trends that indicated an unusually wet season in 2006.

The aquatic vegetation looked more lush and showed signs of propagation due to the normal increase in rainfall for this time of year. In addition, there was a large population of invasive native aquatic plants such as cattail that became established throughout the filter marsh. Lee County Division of Natural Resources harvested the cattails and other unwanted species after they bloomed and before they could create a monoculture and the intended species are thriving.

Although, cattails do cycle nutrients more rapidly than other less opportunistic aquatic species, the presence of this quick-cycling macrophyte will translate into a less effective sequestration of phosphorus from the system than a species (such as pickerel weed) that also sequesters phosphorus but has a longer life-cycle. (USGS, 2006) The presence of cattails may require more frequent harvesting to maintain nutrient load reduction efficacy and avoid degradation of the filter marsh system in the future.

Emerging from the dry season, the filter marsh water body appeared eutrophic and displayed typical algae growth given the season and location. Filamentous, epiphytic and detached algae were present. There was emergent *Hydrilla verticillata* present in the first filter marsh cell (Settling Area North). This is an invasive exotic species and has a tendency to out-compete native submerged aquatic vegetation. The annual dry season and system draw-down for routine maintenance should control propagation by drying out the marsh temporarily and killing the less tolerant exotic submerged aquatic vegetation (SAV) species.

ECT noted in the first quarter 2006 that upland vegetation planted as a project buffer was in decline apparently due to lack of rainfall. Since that time, the upland vegetation looks better as it has been established for two rainy seasons now; however there are nuisance weed species such as smart weed, rag weed and dog fennel present that are harvested frequently. The County's regular harvesting of the nuisance species from the banks of the filter marsh have helped the native species to become better established and flourish.

There is a minor data gap between January 4 and January 24, 2006 due to the fact that the filter marsh sampling did not actually begin until January 24, 2006 and did not coincide with the normally scheduled Lee County sampling event that occurred on January 4, 2006. This gap is visible in the graph figures at the beginning of the dataset analyzed in this report. There are also apparent data gaps at the filter marsh stations because there was no water to sample during the driest months. In addition, there are two rainfall sampling events recorded; one on March 24, 2006 and May 17, 2006. The additional data from these events may appear to create a gap in the graphical displays as well. In order to better illustrate concentration over time trends at these sites, a monthly average at each station was used to graph the results. Loading for this system has not been calculated yet due to significant data gaps from unintended sampling shortfall from July 2006 to February 2007.

The water quality trend for all heavy metals sampled is far below the state water quality standard (values based on hardness-based calculations from F.A.C. 62-302.530). There are few instances of periodic spikes that may be due to rainfall events (possible first flush

effects from urban run-off) or re-suspension from sediment; however the peak values are still well below the State standards in all cases with the majority of readings below the County's method detection limit (MDL). There is no visible trend over time aside from seasonal fluctuations or a change in MDL depending on the analysis method used.

Sediment quality is an important consideration when determining the health of aquatic systems. The impact on micro and macro invertebrates may determine the efficacy of the system with respect to overall metabolism. Another aspect of sediment quality is re-suspension of contaminates. Given the history of the project site of the filter marsh as a former DOT debris disposal and stockpile site, LCEL collected sediment samples on July 15, 2005 as an initial screening of the project site. ECT has since collected sediment data starting on the April 19, 2006 to determine 1) if there are parameters of concern that would potentially impair the functioning of the filter marsh and 2) if so, are there signs of impairment by way of systemic failure or contribution from sediment to the water column. The sediment samples collected July 2005 do not exceed the probable effects concentration for any of the measured parameters however, being that no aluminum or iron was collected with this particular dataset, there is no way to run an analysis by regression as was done for the April 2006 dataset. Therefore it is not possible to characterize the July 2005 measurements as being at background levels or levels indicative of anthropogenic impacts. When comparing the two data sets (April 2006 and July 2005) the contaminant concentrations found (albeit not at the exact same locations) looks very similar for each parameter measured at both sites.

Metals are a naturally occurring component of soils and sediment. There is a measurable difference in the levels of these components found in sediments as a result of anthropogenic impacts. Most urban settings such as that of the filter marsh have elevated copper from pesticide run-off or elevated zinc from brake pad run-off to name a couple. In order to characterize the difference between naturally occurring levels in sediment at this project site and levels resulting from anthropogenic impact, DEP's "Development of An Interpretive Tool for Assessment of Metal Enrichment in Florida Freshwater Sediment" report and associated spreadsheet tool was utilized for data analysis. This tool evaluates the parameters of concern by comparing Aluminum levels at the site with the other metal constituents. Since Aluminum is reliably found at background levels in the region for which this tool is designed it is a good surrogate by ratio. (Lee County is included in the region for which DEP studied reference values and constructed guidance by consensus.) Graphics for this data analysis have been omitted for the sake of brevity.

The parameters monitored are as follows: Arsenic, Copper, Lead, Zinc, Aluminum, Cadmium, Chromium, Mercury, and Nickel. It appears that many of these constituents are present at background levels for most samples collected in July 2006. There were many exceptions to this being that some samples were well above the upper 95^{th} percentile prediction limits; particularly for Mercury. Lead, Zinc and Copper also notably appear above this threshold at most sample sites. What this signifies is that for many of these sample sites, these particular parameters were found at levels indicating that these are not background or natural levels. Another very important consideration is, however, that none of the samples had levels high enough to exceed the FDEP established probable effects concentration (PEC) for any of the parameters of concern. That being said, there is

definite evidence of human impact on the sediments in the filter marsh system (most likely from urban run-off), but the levels of contamination are not having deleterious effects on the habitat or water column at this time. For the sake of brevity, graphics for sediment analysis have been omitted.

The performance of the filter marsh system is difficult to quantify at this time due to the fact that while monitoring has been underway for one and ½ years, there are data gaps present due to seasonal water levels as well as unexpected shortfalls in data collection. Ongoing monitoring will yield enough data to have a better assessment of performance within a few years. Upon inspection of the January 2006 to May 2007 dataset it appears that there is a decrease in concentration of TP, NOX and NO3. Data graphs for OPO4, NO2 and TKN are flat showing no trend and TN and NH3 are very slightly increasing at the downstream station (10MIGR20) from the filter marsh system. These same trends hold true of the filter marsh outfall. This overall decrease in nutrients is not a uniform pattern at all stations upstream to downstream within the filter marsh. A comparison of the annual averages from the station immediately upstream of the filter marsh (10MIGR50), the filter marsh outfall (10MIFM06) and the immediate downstream station (10MIGR20) show a decrease in nutrients across the board from upstream to downstream as well as visible decreases in most nutrients when comparing 2005 to 2007. The results thus far seem promising, however this is most likely not the peak efficacy for the filter marsh system due to aquatic vegetative density that should increase over time, slowing flow, increasing nutrient uptake as well as binding nutrients in sediment. This of course is dependent upon many variables, but primarily inflow quality and growing conditions. The nutrient trend analysis is available in graphical form in Appendix F, Figures 1 through 4.

7 REFERENCES

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APPENDIX B – PRE CONSTRUCTION PHOTOS

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APPENDIX D – WATER QUALITY REFERENCE VALUES

Table 1: USEPA Nutrient Guidance Values for Water

Table 2: Environment Canada Compendium Nutrient Guidance Values for Water

Table 3: USEPA Nutrient Guidance Values for Sediment Nutrient Eco-region XII

Table 4: Environment Canada Compendium Nutrient Guidance Values for Sediment

APPENDIX E – FILTER MARSH W.Q. MONITORING LOCATION MAP

APPENDIX F – NUTRIENT DATA GRAPHS

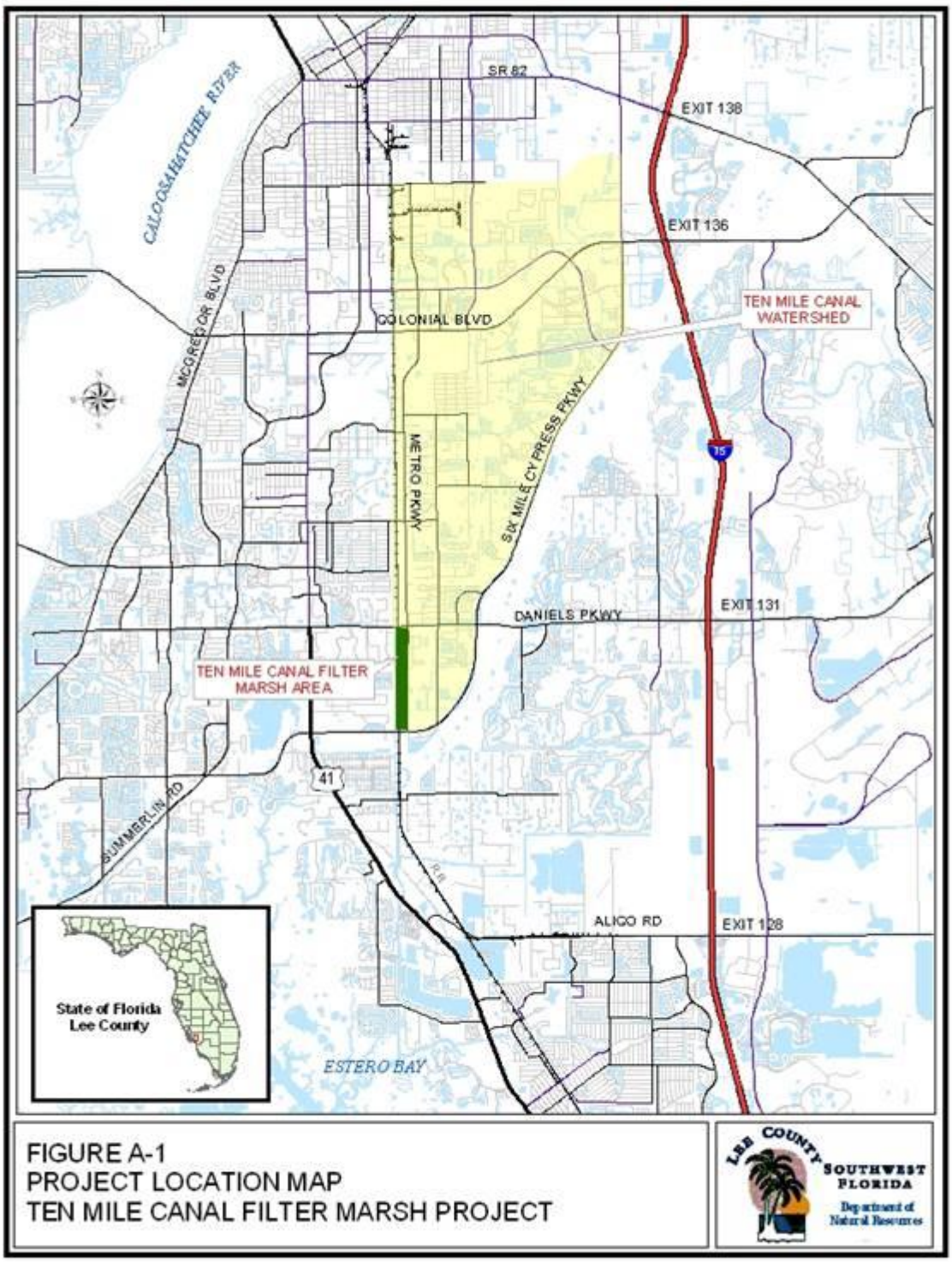
Figure F1. Total Nitrogen as a Function of Time Upstream, Downstream and in the Filter Marsh for Jan 2006 - May 2007 (MDL = 0.01 mg/L)

Figure F2. Total Phosphorus as a Function of Time Upstream, Downstream and in the Filter Marsh for Jan 2006 - May 2007 (MDL = 0.05 mg/L)

Figure F3. Comparison of **TN** Annual Averages from Upstream (10MIGR50) of Filter Marsh to Downstream (10MIGR20).

Figure F4. Comparison of **TP** Annual Averages from Upstream (10MIGR50) of Filter Marsh to Downstream (10MIGR20).

APPENDIX A – PROJECT LOCATION MAP



APPENDIX B
PRE CONSTRUCTION PHOTOS

May 13, 2005
Preconstruction view from south to north.

March 16, 2005
Preconstruction view from Daniels Parkway looking south.

APPENDIX C
CONSTRUCTION PHOTOS

June 2, 2003
Soil borings north of Daniels Parkway.

March 28, 2005
Excavation of filter marsh cells and discovery of buried debris.
Looking north. Ten Mile Canal is to the left.

March 28, 2005
Excavation of the filter marsh cells and hauling dirt.

April 4, 2005
The bridge foundation on the east side of the canal. Filter Marsh site to the east of the canal prior to excavation. Looking north.

June 6, 2005
Filter Marsh discharge back into canal through 3 pipes from Cell No.4.
Looking southwest.

July 11, 2005
Laying pipes that convey water from one cell to the other.
Looking south.

August 2, 2005
Preparing for laying foundation for pipes under the bridge.
Looking north.

August 2, 2005
Cell No. 2 during construction. Maintenance access ramp is to the right.
Looking north.

August 2, 2005
Cell No. 3 during construction. Maintenance access ramp is to the right.
Looking north.

August 4, 2005
Side slopes of Cell No.4 under construction. Looking northwest
From the south end of the filter marsh.

August 17, 2005
Foundation for two (2) 30-inch diameter pipes under the bridge, being constructed to support the pipe. Looking south under Daniels Parkway Bridge.

August 17, 2005
Settling basin to the south with over flow riser in the foreground, which discharges to the west into Ten Mile Canal.

August 17, 2005
First Cell looking south with over flow riser to the west.
Note side slope plantings of spartina bakeri. (sand cordgrass)

August 18, 2005
Laying sod on side slopes (typical) to stabilize excavation.

August 18, 2005
Cell No. 3 excavation complete. Sod laying operations on the berm Maintenance road between the filter marsh (to the left) and Ten Mile Canal (to the right).

August 18, 2005
Preparation for excavation for pipe foundation. Looking north towards Daniels Parkway Bridge.

August 18, 2005
Turbidity control in the canal. A clear difference from canal water from turbid water around construction area. Looking north towards Daniels Parkway Bridge.

August 18, 2005
Solis stabilization and spartina bakeri (sand cordgrass) plantings along east bank of Cell No. 2.

August 24, 2005
Two (2) 30-inch pipes installed on top of concrete foundation under the Daniels Parkway Bridge. Tie down straps are in place prior to securing pipes in concrete.

August 24, 2005
Culvert preparation at the staging area.

August 24, 2005
Emergent wetland plants being installed by hand.

August 30, 2005
Preparing concrete forms to secure two (2) 30-inch diameter pipes on the foundation.

September 7, 2005
Construction of the two (2) 30-inch diameter cast iron steel pipes completed under the Daniels Parkway Bridge. Looking north.

September 21, 2005
Controllable screw type sluice gates under construction.
Looking northwest north of Daniels Parkway.

October 24, 2005
The control structure connecting Cell No. 2 to Cell No. 3.
Looking south. The maintenance ramp to Cell No.2 is on the left.

October 24, 2005
Cell No. 4 immediately after construction is complete. Looking north.

August 15, 2006
Celebration! With bikers in the background.

April 29, 2007
Post-Construction: Looking south at the Daniels Parkway entrance.
Cell No.1 on the left and the canal to the right with the bike path in the middle.

April 29 2007
Post-Construction: The south end of the Cell No. 2 with a lot of wetland vegetation. The pedestrian bridge is in the background. Looking southwest.

April 29 2007
Post-Construction: South entrance to the filter marsh and the linear path. Looking north. The Cell No.4 (the last cell) in the background in dry condition.

April 29, 2007
Post-Construction: Educational signage at the Daniels Parkway entrance to the Filter Marsh. Educating the public about the significance of maintenance of high water quality.

APPENDIX D – WATER QUALITY REFERENCE VALUES

Table 1: USEPA Nutrient Guidance Values for Water

Parameter	Eco-region XII - Southern Coastal Plain
Total Phosphorus (ug/L)	40.00
Total Nitrogen (mg/L)	0.9
Chlorophyll a (ug/L)	0.40

Table 2: Environment Canada Compendium Nutrient Guidance Values for Water

Parameter	Source	Value
Total Ammonia (mg/L)	Russia	2
Total Phosphorus (ug/L)	British Columbia, Japan, Ontario	10 *High level protection std.
Total Phosphorus (ug/L)	Ontario, New York State, Quebec	20 *Level necessary to limit algal growth
Total Phosphorus (ug/L)	Alberta, Ontario, Quebec, Japan	30 *Level necessary to limit excess plant growth & algal blooms
Total Nitrogen (mg/L)	Japan	0.2
Chlorophyll a (ug/m2)	British Columbia	50000

Table 3: USEPA Nutrient Guidance Values for Sediment Nutrient Eco-region XII

Parameter	Thresholds
Total Kjeldahl Nitrogen (mg/kg)	Non-polluted; 1000, Moderate; 1000-2000, Heavy; >2000
Phosphorus (mg/kg)	Non-polluted; 420, Moderate; 420-650, Heavy; >650

Table 4: Environment Canada Compendium Nutrient Guidance Values for Sediment

Parameter	Source	Value
Ammonia (Total) mg/kg	Ontario	100
Ammonia (Total) mg/kg	Washington State	340-930
Total Kjeldahl Nitrogen (mg/kg)	Ontario	Lowest effect level; 550
Phosphorus (mg/kg)	Chicago	Light Pollution; 100, Moderate; 200, Heavy; 300

APPENDIX E – FILTER MARSH W.Q. MONITORING LOCATION MAP

Station_ID	Station Description
10MIFM01	Lee Co Stage Recorder N of Daniels Pkwy Weir
10MIFM02	North end of North Settling Area (Cell # 1)
10MIFM03	North end of North Filter Marsh (Cell # 2)
10MIFM04	North end of South Settling Area (Cell # 3)
10MIFM05	North end of South Filter Marsh (Cell # 4)
10MIFM06	South end of South Filter Marsh at Discharge
10MIGR50	Upstream Face of Daniels Rd

FIGURE E-1
FILTER MARSH WATER QUALITY MONITORING LOCATION MAP
TEN MILE CANAL FILTER MARSH PROJECT

APPENDIX F – NUTRIENT DATA GRAPHS

Figure 1. Total Nitrogen as a Function of Time Upstream, Downstream and in the Filter Marsh for Jan 2006 - May 2007 (MDL = 0.01 mg/L)

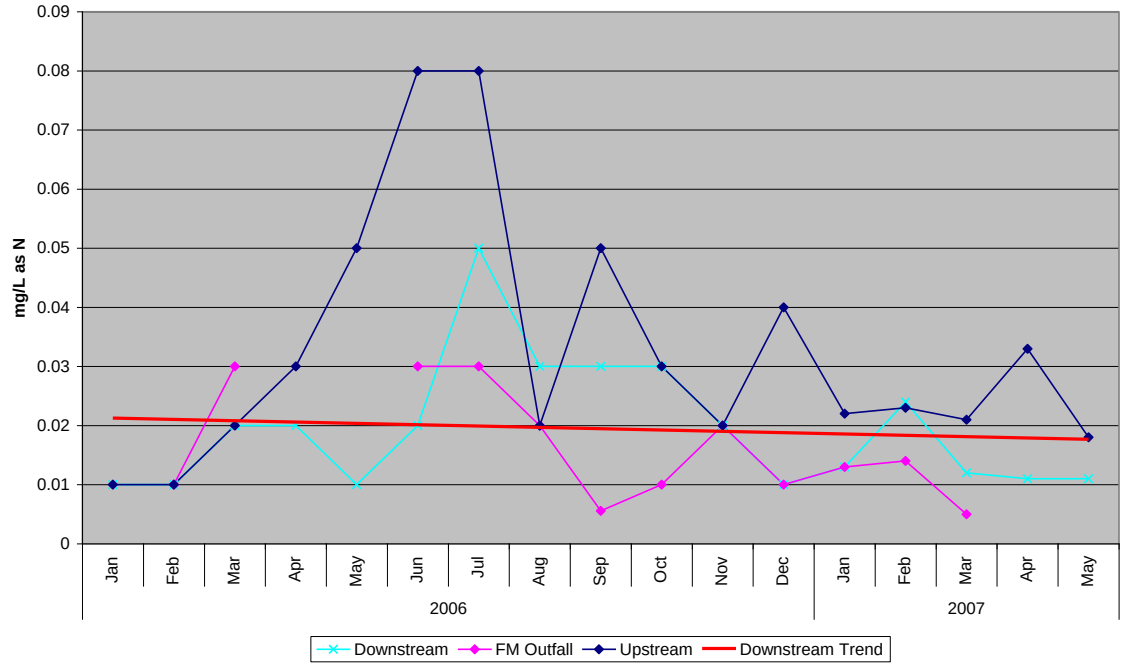
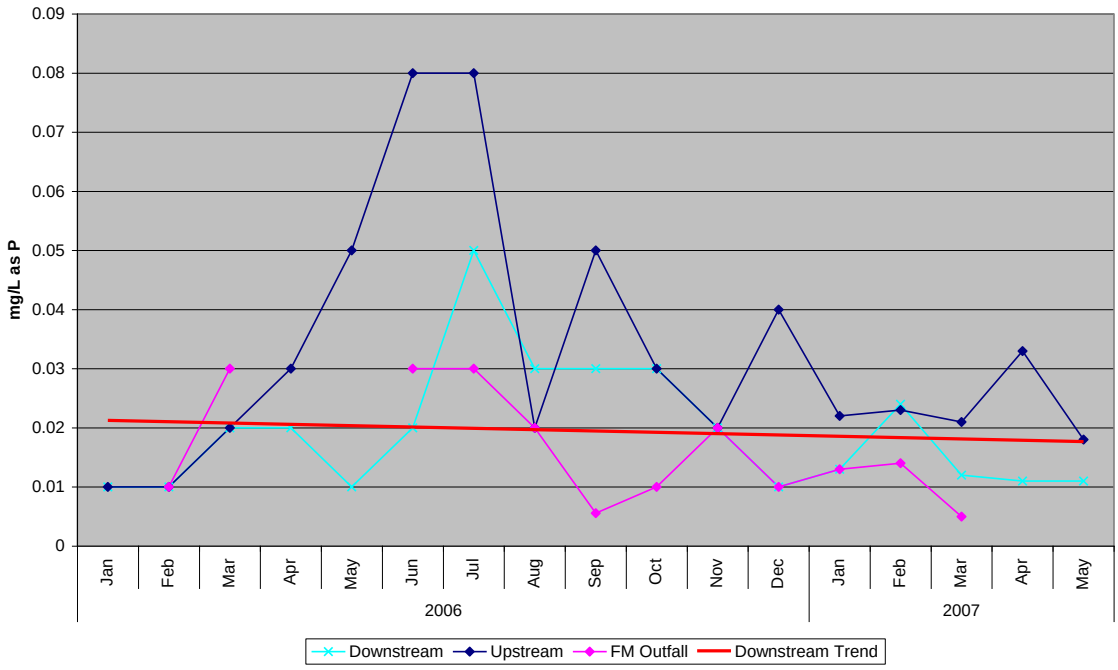


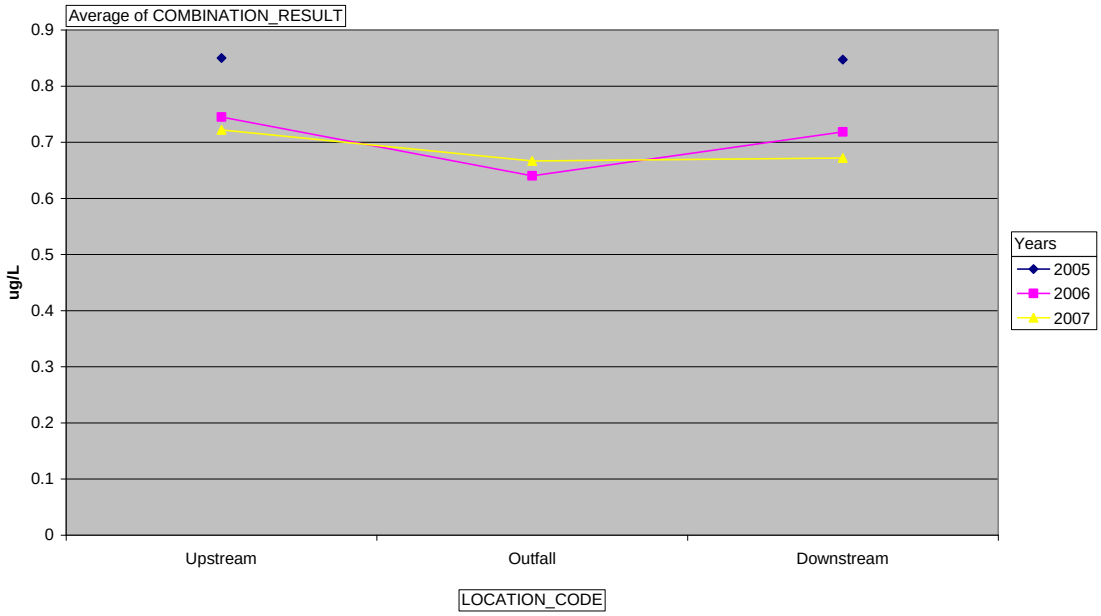
Figure 2. Total Phosphorus as a Function of Time Upstream, Downstream and in the Filter Marsh for Jan 2006 - May 2007 (MDL = 0.05 mg/L)



APPENDIX F – NUTRIENT DATA GRAPHS (CON'T.)

ANALYSIS_CODE TN

Figure 3. Comparison of Annual Averages from Upstream (10MIGR50) of Filter Marsh to Downstream (10MIGR20).



ANALYSIS_CODE T-PO4

Figure 4. Comparison of Annual Averages from Upstream (10MIGR50) of Filter Marsh to Downstream (10MIGR20).