EAST MULLOCH DRAINAGE DISTRICT
FACILITY ANALYSIS REPORT
Volume 1

LEE COUNTY
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SECTION 1 – EXECUTIVE SUMMARY

The purpose of this study is to evaluate financial considerations for transferring the ownership and management of the East Mulloch Drainage District to Lee County. This report presents an assessment of the current status of the East Mulloch Drainage District drainage system and summarizes the financial implications for taking over the ownership of the system by Lee County.

In order to accomplish the above purpose, the study has been divided into two main objectives.

The primary objective of the study was to assess the physical condition of the drainage system within the District, evaluate historical flooding within the District and to determine if returning the system to original conditions would resolve the flooding issues.

Findings include:

- Interviews with District representatives and residents indicate that historical flooding has occurred and is prevalent in the vicinity of the intersection of Constitution Circle and Pebble Beach Boulevard. The elevated railroad track reportedly serves as a weir and also causes flooding in the area along Constitution Drive and in the vicinity of the San Carlos Golf Course.

- An "existing conditions" model was developed and simulated for the 5-yr/24-hr, 25-year/72-hour and 100-yr/ 72-hr design storm events. This model was based on current, surveyed conditions, and was used solely to confirm the reported flood events. The flood plain map generated by the model indicated widespread flooding in the areas east of the railroad, which corroborated historical observations.

- An "original, as built conditions" model was developed by changing certain specific characteristics/parameters of the model to determine if returning the drainage system to original design conditions would significantly reduce flooding. The model indicated that flooding would still be significant in the area east of the railroad, and that rehabilitation of the system to original conditions would not be effective in reducing flooding and would not meet the County's intended level of service.

The secondary objective of the study is to estimate the capital improvement costs required to return the system to original, as built conditions. Annual operation and maintenance costs to properly manage the system were also estimated.

Findings include:

- The District is an independent taxing district formed in 1963 to facilitate land development by building, operating, and maintaining drainage facilities in Lee County, Florida. The District's boundaries cover 3,046 acres of land, of which approximately 2,220 acres have been developed and are taxable. The Florida State Legislature passed House Bill No. 1337 under Chapter 83-455 in June 1983, which enables Lee County to take over operations of the District.

- The District raises average annual revenue of approximately $70,000 per year mainly from assessments on developed properties. Annual expenditures for operation and maintenance activities average approximately $59,000 per year. This generates an annual average reserve of approximately $11,000 per year for system improvements and to address catastrophic and/or other unforeseen events such as hurricanes, structure failures, etc. The District has no capital assets or long-term debts.

- Industrial and Residential areas bordering the District discharges stormwater into the District's system. These areas shall be incorporated into the legal boundaries of the system and/or an agreement shall be formed with appropriate fees to be paid to the District for the discharges.

- Drainage systems within the District include approximately 21 miles of canals, 20 retention ponds, and 9 drainage structures. The canals are generally overgrown and will require substantial rehabilitation to bring them up to original conditions. Approximately twenty-five percent of the drainage structures will also require extensive rehabilitation or replacement. Initial capital improvement costs are estimated to be $4.8 million.

- The current operating budget of $70,000 is inadequate to properly maintain the system. Estimates indicate the budget should be doubled to approximately $140,000 per year to develop and implement a systematic, preventive maintenance program.

The modeling results indicate that upgrading the system to original, as built conditions will not alleviate flooding issues. Additional system improvements will have to be implemented to meet this ultimate goal. However, rehabilitation of the system would be required as a minimum, to facilitate proper operation and maintenance if the County took over ownership of the District. This will include removal of heavy vegetation within the drainage swales, stabilization of the banks, and replacement/rehabilitation of drainage pipes, culverts, and weirs. This would also minimize the potential for catastrophic failure of the system during extreme weather events such as hurricanes, tropical storms etc.

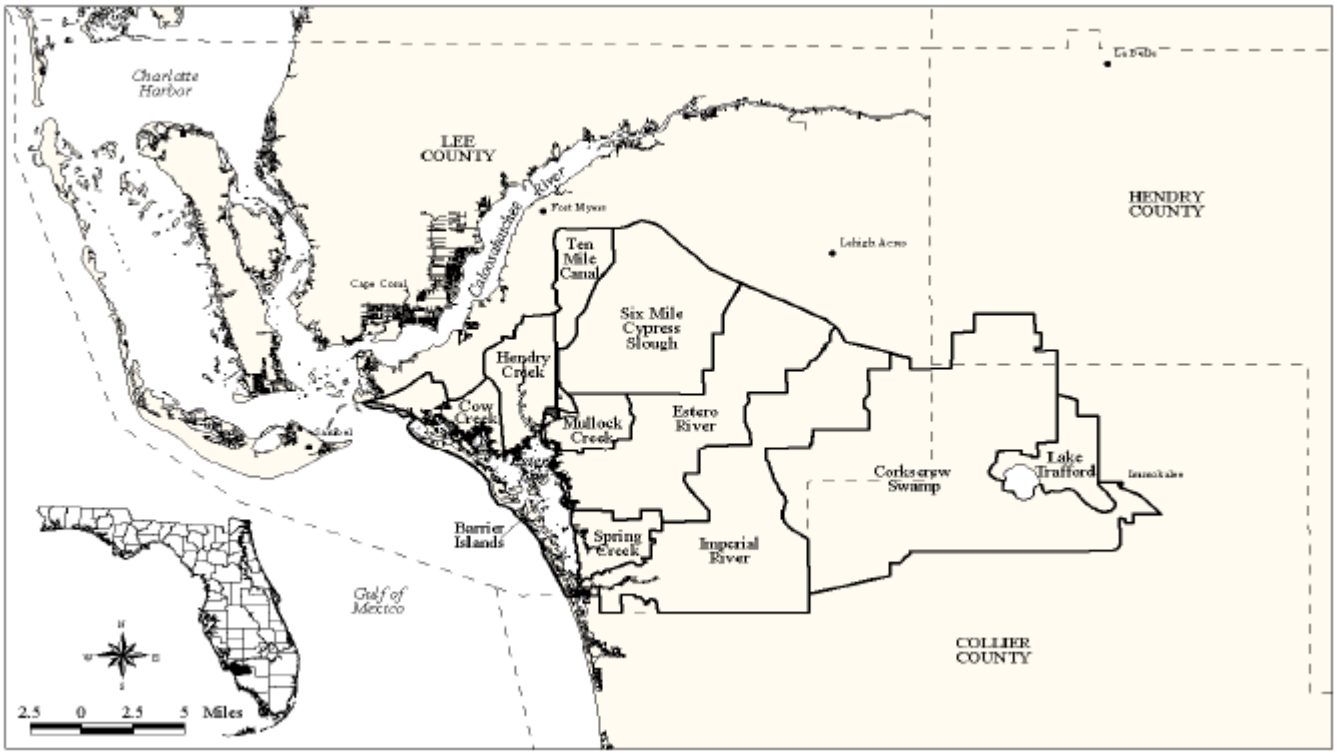
It is recommended that the existing conditions model prepared under this study be utilized to perform a more detailed neighborhood level of analysis to identify proposed drainage system improvements that would be required to reduce localized flooding to acceptable levels of service throughout the District. Downstream impacts of the recommended improvements should also be considered.

The costs required for these additional improvements can be added to the estimates provided in this report to determine ultimate capital costs that would be required for the system.

Also, easements listed as "unconfirmed' in Section 4 should be further evaluated to determine if additional right-of-ways will need to be acquired prior to a potential transfer of ownership.

SECTION 2 – INTRODUCTION

Lee County, located on the west coast of Florida, is characterized by high rainfall amounts and flat topography typical of Southwest and South Florida. The southern region of Lee County consists of the Estero Bay Watershed, which is composed of eleven secondary basins: Estero River, Ten Mile Canal, Spring Creek, Cow Creek, Hendry Creek, Corkscrew Swamp, Mulloch Creek, Lake Trafford, Six-Mile Cypress Slough, Imperial River and the Barrier Islands. The Estero Bay Watershed includes the area in Lee County south of the Caloosahatchee River, parts of northeastern Collier County and a small portion of Hendry County, for a total of 295,620 acres. The Estero Bay Watershed is relatively flat and ranges in elevation from sea level to a maximum of 30 (+) feet NGVD in the eastern portion of Lee County.



Estero Bay Watershed *Source: South Florida Water Management District – Estero Bay Watershed Assessment, August 1999.*

The Mulloch Creek basin within the Estero Bay watershed totals 6,995 acres, with 3,026 acres located within the East Mulloch Drainage District, EMDD. Approximately 2,200 acres within the District consist of residential homes. The drainage features that are currently being maintained by the district consist of the following:

- 21 linear miles of canals
- 20 Retention Ponds (Total of 68.05 acres)
- 9 Drainage Structures, currently owned by the district

Drainage structures that are located under a roadway or within the roadway's right of way are reported to be maintained by Lee County Department of Transportation (Lee County DOT). The District is responsible for maintaining the main drainage structures and swales leading to and including Mulloch Creek.

The lands within the District are generally referred to as San Carlos Park, a residential development, near the intersection of U.S. Highway 41 and Alico Road. Mulloch Creek, the main drainage path for the District, begins on the east side of the District; travels to the west under the Atlantic Coast Line Railroad bridge and U.S. Highway 41; connects with two southern branches that also drain portions of the District; and continues west until it outfalls to Estero Bay. This area is influenced by tidal activities that impact the performance of this system.

BACKGROUND OF THE EAST MULLOCH DRAINAGE DISTRICT

The Drainage District was formed on May 29, 1963 as an independent political subdivision through a special act defined in Chapter 63-930 and 65-912, Laws of Florida. This act created the East Mulloch Drainage District, EMDD, to maintain drainage within the district through property assessment taxes. Since limited information concerning the original design and construction is documented, the "Plan of Reclamation, East Mulloch Drainage District", prepared for Board of Supervisors of East Mulloch Drainage District by Gee & Jenson Consulting Engineers, in November 1964, will be used as the reference point. A copy of the Plan of Reclamation is attached as part of Appendix A. The intent of the Plan of Reclamation was to assess the existing condition of the District in 1964, identify problems, and recommend improvements to increase the performance and capacity of the drainage system.

Originally EMDD was to include only a residential subdivision, San Carlos Park, which was developed in the mid 1950's. The master plan for this area included approximately 8,000 homes on 2,200 acres. When the area was initially developed and permitted, only 240 homes were constructed. The current district boundary contains the following developments:

6,118	Residential Homes
741	Vacant Residential Lots
505	Multi Family Units
24	Warehouses
63	Vacant Commercial Lots
4	Vacant Industrial Lots
5	Agriculture Lots
5	Shopping Centers
15	Small Businesses (Convenience Stores, Daycare, Repair Garages, etc.)
1	Motel
7	Government Owned Buildings (Offices, Schools, Libraries, etc.)
1	Golf Course

Residents were initially taxed $15 an acre for the maintenance of the system. The current rate is $30.10 an acre, which generates average revenue of $67,000 per year, with $58,700 going towards maintenance of the system. The balance is held in reserve.

District representatives and residents report that flooding is prevalent at the intersection of the railroad tracks and Constitution Drive during heavy rain events, and the Gee and Jenson report indicated that system improvements would be required to minimize flooding in this area.

Also, drainage swales and culverts are not properly maintained due to the District's budget constraints, and many of the swales are overgrown with heavy vegetation and/or have sloughed off due to improper maintenance. The District concentrates on the operation and maintenance efforts for retention ponds, and addresses other maintenance issues on an as needed basis.

The District requested for Lee County to "look into the feasibility of taking over the responsibilities of the operation of the East Mulloch Drainage District" on November 10, 1997. Lee County subsequently determined that it would not be in the County's best interest.

The residents within the District voted on November 7, 2006 in a referendum as to whether the Lee County Board of County Commissioners should become the governing body in place of the East Mulloch Drainage District. The referendum also included a clause that the funding would be through a dedicated community tax, but did not include the potential financial implication of such a transfer. However, the referendum still failed with 55% of the voters rejecting the proposal.

The purpose of this study is to evaluate financial considerations for transferring the ownership and management of the East Mulloch Drainage District to Lee County. This report presents an assessment of the East Mulloch Drainage District ("District") and summarizes financial considerations for taking over ownership of the system.

Capital expenditures in this study are based on returning the system to "original, as-built" conditions, and do not take into consideration any major system improvements that may be required to improve flooding and/or water quality issues. The cost for proposed improvements shall be addressed in subsequent studies as applicable.

SECTION 3 – STUDY AREA

The study area, shown in Figure 3.1, for this project includes a portion of the Mulloch Creek basin, which is contained within the Estero Bay watershed, east of US 41. The portion of the Mulloch Creek basin that drains San Carlos Park was the focus of this study, and includes approximately 3,096 acres. The study area is bound on the north by Alico Road, on the east by I-75, on the south by Estero Parkway and on the west by US 41.

Industrial and residential areas to the south of Alico Road (i.e., Alico Industrial Park, The Vines Golf and Country Club Subdivision and the San Carlos Acres Subdivision) also discharge directly into the District's drainage system. This increases the total drainage area of the basin to approximately 4,136 acres.

Figure 3.2 provides the Landuse Map for the study area. Landuse map for the study area consists predominantly of the following land uses: residential development, range land in poor condition, golf course and parks, wooded areas, and industrial development. The main drainage pathways through the area are small canals that are typically overgrown with heavy vegetation and trees. The roads in the area are paved with asphalt and have an open drainage system consisting of roadside swales. The drainage structures include a combination of concrete and corrugated metal culverts and were mainly found under roadways, although a few control structures were found in retention ponds and within the canals.

Soil Map for the study area, shown in Figure 3.3 consists predominately of fine sand variations such as Immokalee and Pompano Fine Sands. These soils are classified under the hydraulic soil groups of B/D, D and C.

Insert figure 3.1

Insert Figure 3.2

Insert Figure 3.3

SECTION 4 – DISTRICT BOUNDARY AND DRAINAGE EASEMENTS

The Plan of Reclamation prepared on September 22, 1964 contained a boundary map of the district as well as a map of the right of ways reportedly owned by the district. This document was used as a reference point in establishing current drainage easements within the district as well as the boundary of the district.

The boundary and right of way limits shown on the Plan of Reclamation were compared against records from the Lee County Property Appraiser, the Lee County Clerk of Court, and the Lee County GIS Department, attached as part of Appendix B. The intent was to compare information shown on the Plan of Reclamation with current records to corroborate the boundaries and right-of ways.

It should be noted that the research was limited to a records review and is subject to any facts that may be disclosed by a full and accurate title search and/or field survey.

DISTRICT BOUNDARY

The developed parcels within the boundary of the district pay an assessed fee to the EMDD for the maintenance of the drainage system. The dedicated assessed fee is noted on the tax bill for each parcel. Tax records for properties on the perimeter of the reported boundary of the District were reviewed to confirm that taxes were being paid to the district, which would indicate that the properties are included within the District's boundaries. This iterative process was repeated until the outer boundaries of the District were defined.

The tax records indicated that the boundaries of the district were expanded since the creation of the EMDD to include lands west of Three Oaks Parkway. This includes the Three Oaks Subdivision, and the Caloosa Trace Subdivision. District representatives confirmed that these subdivisions do pay taxes to the District since they discharge into the District's drainage system, and the District maintains their respective drainage systems. However, these areas are not included within the District's official boundaries.

Portions of land west of US-41, including the Woodsmoke Trailer Park, were not confirmed to ever have been part of the EMDD, as was stated in the Gee & Jenson report. The revised boundary according to this research is graphically shown in Figure 4.1.

DRAINAGE EASEMENTS

The drainage right-of-ways presented in the Plan of Reclamation were compared against Lee County land records to determine if the right-of ways were legally recorded. Land records such as plat maps, individual parcel legal descriptions, and official records were used as the basis of research. The legal status of the easements was divided into confirmed and unconfirmed easements.

For the purposes of this study, unconfirmed easements are easements that were presented in the Gee & Jenson report but were not legally recorded. Confirmed easements are easements that are legally recorded and may or may not have been presented in the Gee & Jenson report.

Confirmed easements were further subdivided into platted and unplatted easements. Platted easements are easements that have been recorded in plat books, P.B., and unplatted easements are those that have been recorded only through the Official Records Book, O.R. Figure 4.2 shows the confirmed and unconfirmed easements contained within the district. Appendix B provides the location that these records were found as well as the description and width of the easements in the area.

The easements were originally dedicated to the public for drainage and utility purposes, but were subsequently dedicated to EMDD through a deed dated May 28, 1963 in the Official Records Book. The document dedicated all canals, lakes and water control installations that were owned by title and mortgage companies to EMDD. Easements that are contained within the Three Oaks Subdivision are dedicated to the homeowner's association, not EMDD, which matches the information provided by the District representative.

Figure 4.1

Figure 4.2

SECTION 5 – PREVIOUS STUDIES AND RECORDS RESEARCH

Previous drainage studies were reviewed and a records search of South Florida Water Management District's Environmental Resource Permits was performed to evaluate permitting and compliance issues. Previous engineering reports and studies were also used to develop a preliminary footprint of the drainage system.

Lee County Surface Water Management Plan

Johnson Engineering conducted a study of all watersheds in Lee County in 1991 and prepared surface water management plans for individual watersheds. These plans provided information on various surface water control structures in respective watersheds and included right-of-way maps. The details of surface water control structures were gathered from various sources including the floodplain study prepared by United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) and additional information provided by Lee County and other local governments. This Plan did not provide any relevant information for this study, except for illustrating the boundaries of the Mulloch Creek watershed.

Plan of Reclamation, East Mulloch Drainage District

Gee & Jenson Consulting Engineers conducted a study in 1964 for the East Mulloch Drainage District Board of Supervisors. This study provided an evaluation of the condition of the district at that time (1964) and gave recommendations for improvement.

Recommendations were given to improve the capacity of the system, restore the perimeter berm to prevent water from entering the system through sheet flow from the east, and to obtain additional right of ways. The study concluded that the single railroad bridge crossing the Atlantic Coastline Railroad for the area was inadequate and three additional culverts, 34"- 42" corrugated metal pipes, needed to be added to the north of the crossing to offer some relief to the system. The culverts were not added due to budget constraints.

The Proposed Water Control Plan, provided as part Appendix A and presented as Figure 5.1, was used as the basis for developing a preliminary map of the District's boundaries, right-of way, and drainage features.

South Florida Water Management District (General Files)

A review of the South Florida Water Management District files did not indicate any permitting or compliance issues with the District.

South Florida Water Management District Environmental Resource Permits

Permits were researched to identify flows that were authorized to enter the District from sources outside the District's boundary. A summary of those permits are provided below:

Permit No. 36-00909-S

Date: October 27, 1988

Permitee: David Swor for Alico Industrial Center

Description: This permit authorized permitee to construct a drainage system consisting of inlets and swales that are to be directed to a dry detention area with a bottom elevation of 12.5 feet NGVD 1929 at the south end of the project. Excess runoff will then be discharged through a control structure into an existing EMDD district canal. The proposed development was accepted by the EMDD subject to the industrial development being incorporated into the legal boundaries of the district. This area remains unincorporated to date.

Figure 5.1

Permit No. 36-01081-S

Date: March 29, 1989

Permitee: County of Lee (Lee County Engineering, Inc.)

Description: This permit authorized permitee to construct a drainage system consisting of swales and inlets directed to a dry detention area. Excess runoff will then be discharged through a control structure into an existing EMDD canal. The proposed development was reviewed by the EMDD and documentation from PBS&J was in the SFWMD's permit file that expressed concern for water quality and quantity from this 90 acre site. A response from Lee County Engineering, Inc. was not located in the file, but the permit was approved and this area remains unincorporated to date.

Permit No. 36-02723-S

Date: February 25, 1994

Permitee: Friday Richard for Harlequin Nature Graphics Subdivision

Description: This permit authorized permitee to construct a drainage system that consists of: Catch Basins, Culverts and Swales which will outfall to a wet detention pond. The pond has a control structure which is designed to outfall to the canals within EMDD. No documentation was found in the SFWMD permit file in which EMDD agreed to the proposed drainage system.

NPDES Compliance Reports

A review of the current NPDES Compliance Report did not indicate any compliance issues for the District.

SECTION 6 – DRAINAGE SYSTEM INVENTORY

As part of the study, field reconnaissance of the project area was conducted to physically locate and visually assess drainage features within the District. The purpose was to field verify the presence and approximate locations of drainage swales as indicated by the Plan of Reclamation. This was done by overlapping information contained in the Plan of Reclamation with current aerial photographs and topographic maps, and walking the length of the system. It should be noted that locations are approximate based on field observations and are not based on field surveys.

All field data has been compressed into a GIS database, which is provided in a CD ROM. The CD ROM is included as part of this report. The GIS database should be referred to for the complete description of the drainage system inventory, including photographs, field notes, etc. A summary of the drainage system is provided below:

CONVEYANCE ELEMENTS

An inventory of existing conveyance elements such as culverts, weirs, and drop structures within the study area was incorporated in to a GIS database. The intent is for the database to eventually serve as a tool in developing an asset management and operation/maintenance program for the District and to facilitate use in future hydraulic modeling. Table 6.1 summarizes the inventory of conveyance elements including inverts, lengths, diameters/dimensions, and materials. The structures are maintained by four entities: FDOT, Lee County DOT, EMDD, and ACL Railroad.

Insert Table 6.1

CHANNEL CROSS-SECTIONS

Channel cross-sections were obtained from a field survey. A typical cross section was taken for each channel for the purpose of developing hydrologic/hydraulic models and also to perform cost estimates for returning the channels to original as-built conditions. Appendix C presents the surveyed cross-sections of these channels and the estimated original channel cross-sections. The original cross-section widths were based on surveyed conditions and/or the diameter of downstream culverts. The GIS database includes more details of the cross sections.

STRUCTURES LOCATED ALONG MAIN CHANNEL OF MULLOCH CREEK

Elevations of structures located along the main channel of Mulloch Creek were also surveyed for the existing conditions hydraulic model. A brief description and photograph of each structure along the creek are summarized below:

Culvert EM-065P – Pipe Across Oriole Road

The structure is located at the headwaters of Mulloch Creek and consists of 2-18" reinforced concrete pipes that are being maintained by Lee County DOT. The pipes are in good structural condition with some moderate silting. This structure is draining an estimated area of 102.58 acres.

Culvert EM-055P – Pipe Across Lee Road

The structure is located downstream of EM-065P and consists of 3-60”x36” elliptical reinforced concrete pipes that are being maintained by Lee County DOT. The pipes are in good structural condition with no silting observed. This structure is draining an estimated area of 410.34 acres.

Culvert EM-045P – Pipe Across Phlox Drive

The structure is located downstream of EM-055P and consists of 2-48” reinforced concrete pipes, that are being maintained by Lee County DOT. The pipes are in good structural condition with no silting observed. This structure is draining an estimated area of 533.61 acres.

Culvert EM-035P – Pipe across Wood Drive

The structure is located downstream of EM-045P and consists of 3-72" corrugated metal pipes, that are being maintained by Lee County DOT. The pipes have corrosion appearing on 45% of the surface in which corrective actions, such as coating with asphalt, needs to be taken to slow the degradation. No silting was observed, but the sacked concrete end treatment is not holding up and is being deposited into the channel. This structure is draining an estimated area of 2,346 acres.

ACL Railroad Bridge

The structure is located downstream of EM-035P and consists of a timber trestle bridge that is located under the railroad. This structure is being maintained by ACL Railroad. The structure is in fair condition with no major deficiencies observed that would result in a failure. This structure is draining an estimated area of 2,652 acres.

Culvert EM-015P – Across Constitution Circle

The structure is located downstream of EM-025B and consists of 3-66" and 1-54" high-density polyethylene pipes that are being maintained by Lee County DOT. The pipes are in good condition and have recently been lined with a dense plastic material to maintain the integrity of the structure and increase capacity. This structure is draining an estimated area of 2,802 acres.

Weir EM-004W – East of US 41, Outfall for EMDD Retention Pond

The structure is located downstream of EM-015P and consists of a concrete weir that controls the water elevation in the retention pond. The structure is being maintained by EMDD. The structure is in poor condition due to water overtopping the entire structure and eroding the banks of the channel. Wood planks, which are in need of replacement, have been inserted into the structure to increase the elevation of the water in retention pond. This structure is draining an estimated area of 3,195 acres. The hydraulic model assumes that the wooden flash boards, which are shown in the photograph below, remain in place for the entire event as this is the worst case scenario.

Culvert EM-001P – Across US 41

The structure is located downstream of EM-004W and consists of a 2-10'x6' concrete box culvert, which is being maintained by FDOT. The structure is in good condition and does not appear to have been overtopped based on the observed high water marks. This structure is draining an estimated area of 3,195 acres.

Refer to the GIS database for information on additional structures on the secondary swales discharging into Mulloch Creek.

SECTION 7 – DATA COLLECTION AND DEVELOPMENT

A variety of data is required to develop the hydrologic/hydraulic model for the EMDD watershed, define the model-parameters, and develop a model characteristic of the watershed. These include, but are not limited to, existing and future landuse characteristics, soil characteristics, topography, rainfall and stream flow data, and details of existing water control and conveyance facilities and structures.

The data used for this project were obtained from a number of different resources. A list of data used for the study and development of this report are summarized below:

Year	Title of Document	Source	Format
1964	Plan of Reclamation, East Mulloch Drainage District	Gee & Jenson, Consulting Engineers, Inc.	Hardcopy
1984	USDA-NRCS Soils Map	SFWMD	GIS-Arc/INFO
1998	Spot Elevations	Lee County	GIS Shape file
1998	Contour Lines (2-foot)	Lee County	GIS Shape file
2004	Landuse Map	SFWMD	GIS-Arc/INFO
2005	Aerial Photographs (0.5' resolution)	Lee County	MRSID GIS
Various	Environmental Resource Permits	SFWMD	Hardcopy

The model information for this project is provided in NAD 1983 State plane Florida West FIPS 0902, whereas the vertical datum is based on NAVD 1988.

GIS DATA DEVELOPMENT

Landuse Map for the Study Area

The existing conditions landuse data for Lee County was obtained from SFWMD and was processed in GIS to develop a landuse shape file of the study area. The attribute table of this shape file included the three levels of Florida Land Use / Cover Classification System (FLUCCS) code.

FLUCCS Level 2 landuse cover description and classification scheme obtained from SFWMD was added to the attribute table of the landuse shape file. Table 7.1 provides the landuse codes and descriptions.

Soils Map for the Study Area

The data obtained from SFWMD were processed in GIS to develop the soils map of the study area. The SFWMD soils database included soil description, but not the hydrologic soil group. Hydrologic soils groups from the SWFWMD database were assigned to the corresponding soil descriptions in SFWMD

database. For those soils not present in SWFWMD portion of the study area, the hydrologic soil group of a surrounding soil type was assigned. Table 7.2 provides the codes and descriptions of the soil types present in the study area.

Insert table 7.1

Insert Table 7.2

SECTION 8 – HYDROLOGIC AND HYDRAULIC MODEL DEVELOPMENT

Hydrologic and hydraulic analyses were performed for the District using ICPR Version 3.0 developed by Streamline Technologies, Inc., Florida. The purpose of this analysis was to evaluate historical flooding within the District and to determine if returning the system to original as-built conditions would resolve the flooding issues. In order to accomplish the purpose, "Existing" and "Original, as-built" conditions models was developed and these models were compared for flooding improvements and also analyzed for meeting level of service criteria requirements.

Two models were developed to represent the existing conditions as surveyed and the original design conditions, as represented in the Plan of Reclamation. The existing and original conditions model includes the wooden flash board in the weir located near US 41 to remain in place throughout the design storm. The original conditions model was based on restoring drainage structures and clearing/grubbing the channels back to the original designed conditions, with changes made to the manning's "n" as applicable. No improvements were proposed in the original conditions model and the drainage structures have the same geometry as surveyed.

The work effort required to accomplish the modeling analyses included the following:

WATERSHED BOUNDARY AND SUBBASIN DELINEATION

The District's watershed was divided into three principal drainage areas that contribute to the three discharge culverts under US 41. The drainage areas are referred to as Basins I, II and III in the Plan of Reclamation as well as in this study. The boundary of Basins I, II and III within the project area is graphically represented in Figure 8.1. The boundary of Basins I, II, and III vary slightly from the Plan of Reclamation and the SFWMD basin for Mulloch Creek. This variation is due to developments such as, Alico Industrial Park, the Vines Golf and Country Club Subdivision, San Carlos Acres subdivision and Three Oaks subdivision. Three Oaks Parkway were also upgraded from an open ditch drainage system to a closed system with curb and gutter, thus eliminating sheet flow into the system and making the roadway the boundary of the watershed.

BASIN I

This basin is the largest of the three and generates runoff from approximately 88% of the total lands contained within the district. The runoff from the basin drains to a 2.0 ac retention pond with a vertical weir located near the intersection of Constitution Circle and US 41. The runoff is controlled by the vertical weir before it finally discharges through a Concrete 2-10'x6' box culvert across US-41. During normal rainfall events, the weir has wooden board inserts to raise the elevation of the pond and increase detention time in the pond to improve water quality for Mulloch Creek.

During extreme rainfall events these boards are intended to be added or removed to control the capacity of the system. The development of this basin consists of some industrial areas to the south of Alico and to the east of US 41, but the majority of the land is utilized for residential development. The area of the basin measures approximately 3,195 acres.

BASIN II

This basin generates runoff from approximately 1.5% of the lands contained within the district. The runoff from Basin II is discharged through 2-42" concrete pipes that run under US 41 to a branch of Mulloch Creek that runs for 5,370 feet before merging with the main creek.

BASIN III

This basin generates runoff from approximately 7.2% of the lands contained within the district and consists of residential developments and some commercial development along US 41. The basin also generates runoff from the Vines Golf and County Club, which is a combination of residential development and a golf course, the Woodsmoke Trailer Park and some commercial development near US 41. It measures approximately 561 acres and the runoff from the basin is discharged through two 8'x 32' concrete box culverts located across US 41 to a branch of Mulloch Creek that runs 10,786 feet in length before merging with the main creek.

The three main basins were further subdivided into several subbasins for model development, so that the performance of the culverts along the main drainage pathways could be accurately analyzed. In total, Fifty seven subbasins were delineated and the areas of the subbasins ranged from 6.8 acres to 300.1 acres, as shown in Table 8.1. The total drainage area was calculated to be 3,812.4 acres or 6.0 square miles. Figure 8.1 also shows the divided subbasins within the project area.

Insert Figure 8.1

Insert table 8.1

EXISTING/ORIGINAL CONDITIONS MODEL PARAMETER CHARACTERIZATION

The runoff curve number for each subbasin was developed based on the existing landuse and the hydrologic soil group of various soil types within the subbasin. The area is essentially built out. The standard Soil Conservation Service (SCS) table of curve numbers identifies the values for specific combinations of landuses and the hydrologic soil groups, namely B, C, or D. The original conditions hydrologic characterization shall be based on the existing conditions since the drainage in this area was originally designed to for residential development and the existing use in the area corresponds to the original master plan.

Runoff Curve Number:

GIS tools were utilized to calculate the runoff curve numbers using the landuse and soils GIS layers developed by the SFWMD. Table 8.2 provides the details of runoff curve number calculations for the existing landuse conditions.

Time of Concentration:

The time of concentration for surface flow was calculated for each subbasin using the TR-55 methodology. The maximum sheet flow length considered was 300-ft and a 2-year/24-hour rainfall depth of 4.5-inches was used for sheet flow travel time calculations. In open lands with shallow concentrated flow for long distances and variable vegetation and terrain, the following criteria were used:

- Establish slope over the entire shallow concentrated flow path if the terrain is generally flat (slopes less than or equal to 0.005 ft/ft). Otherwise, actual slopes were used with each segment.

- Extend the standard shallow concentrated flow calculation from TR-55 methodology to vary Manning's "n" value to account for varying terrain and vegetation. Calculate time of concentration for each segment and sum for composite shallow concentrated flow time.

For open channel flow travel time, an average flow velocity of 2.0 ft/sec was used and the open channel flow length was divided by the average flow velocity to get the travel time component for each subbasin. The time of concentration for each subbasin is the sum of travel times for the three flow components namely sheet flow, shallow concentrated flow, and open channel flow. Table 8.3 provides the Time of Concentration Summary for the entire study area.

Insert Table 8.2

Insert Table 8.3

NODE-LINK CONFIGURATION

The existing conditions hydraulics of the study area along with the inventory of the conveyance elements were used to develop the node-link configuration for the ICPR model. Figure 8.2 depicts the node-link diagram for the existing conditions. There are 100 nodes, 49 pipes, 48 channels, 58 weirs, and 3 drop structures in the ICPR model. Further, there are 62 cross-sections representing various swale/channel dimensions.

Insert Figure 8.2

UNIT HYDROGRAPH SELECTION

The flat topography of the study area poses a unique situation to determine the appropriate unit hydrograph for the study watersheds. The most widely used unit hydrographs have a peak factor of 256 or 323. But these peak factors are not appropriate for very flat watersheds. SFWMD has recommended the use of a peak factor of 100 for watersheds with slopes less than 5 feet per mile through a technical memorandum dated June 25, 1993. A copy of that memorandum is included in Appendix D. Overall slopes in the study watersheds are about 2.6 feet per mile based on the spot elevations.

Hence, a peak factor of 100 was used for modeling. A triangular dimensionless unit hydrograph with a time base of 12.91, as given below, was recommended by the author of ICPR modeling software (Peter Singhofen) to be used with the peak factor of 100.

t/tp	**q/qp**
0	0
1	1
12.91	0

TAILWATER CONDITIONS DETERMINATION

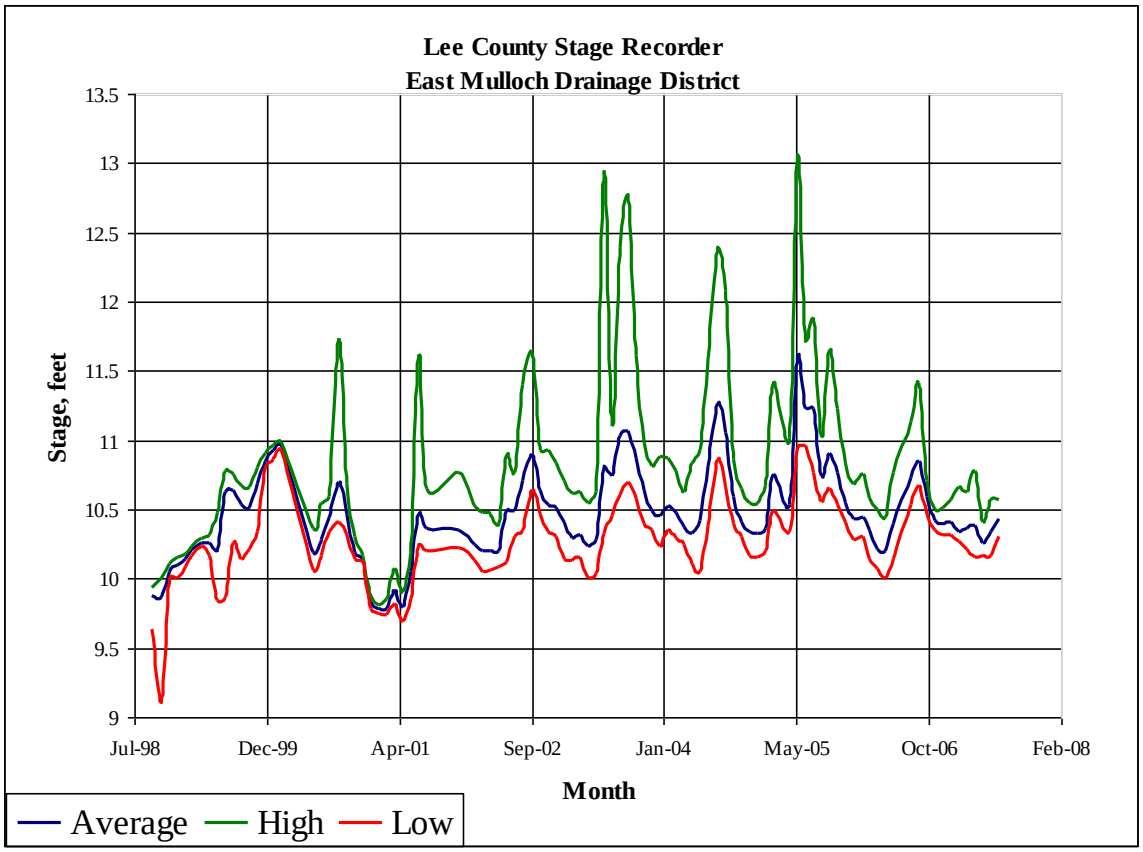
Tailwater conditions of the study area are influenced by the daily tide level fluctuations. Lee County has a stage recorder at the intersection of Mulloch Creek and Constitution Circle, which was the preferred monitor for use in setting tailwater conditions. The data from the monitor for a 10-year period was used with a low of 7.926' NAVD 88 and a record high of 11.866' NAVD 88, as shown in the graph below.

Summary of Stage recording from October 1998 to July 2007 (Elevations in NGVD 29):

Average Stage Elevation: 10.47'

Maximum Stage Elevation: 13.05'

Minimum Stage Elevation: 9.11'



Lee County Stage Recorder for EMDD (1998-2007) *Source: Lee County Department of Natural Resources (Note: Elevations are given in NGVD 1929.)*

The monitor is located 2,493 feet from the main outfall, EM-001P, and is separated by the control structure EM-004W and 1,800 feet of channel. In order to use the data recorded at this station and apply as the tailwater condition for EM-001P, the hydraulic grade line was estimated by surveying the water elevation at the monitor and at the three outfalls for the system simultaneously for two different events. One time occurred during a minor rainfall event, the other occurred during normal conditions. The difference in elevation was applied to the monitor elevation to estimate the stage at the three outfalls. Since the peak of the design storms for 1-day and 3-day duration usually occurs around 12.5 and 60 hours from the commencement of the storm, the tailwater conditions for those durations are estimated and are provided in the tables given below. Elevations are given in NAVD 1988.

The tailwater condition for all the storm events used for simulation is provided in the following table given below:

5yr-24hr design storm event:

Time (hr)	Outfall for Basin #1	Outfall for Basin #2	Outfall for Basin #3
0	1.4852	4.8599	9.0192
12.5	4.2252	5.6752	11.7592
36	1.4852	4.8599	9.0192

25yr-72hr design storm event:

Time (hr)	Outfall for Basin #1	Outfall for Basin #2	Outfall for Basin #3
0	1.4852	4.8599	9.0192
60	4.7252	6.1752	12.2592
100	1.4852	4.8599	9.0192

100yr-72hr design storm event:

Time (hr)	Outfall for Basin #1	Outfall for Basin #2	Outfall for Basin #3
0	1.4852	4.8599	9.0192
60	5.4252	6.8752	12.9592
100	1.4852	4.8599	9.0192

Three design storm events were considered for modeling simulations in this study. Their durations, rainfall depths and recurrence intervals obtained from South Florida Water Management District Environmental Resource Permit manual are given below:

1. 5-year 24-hour event (Rainfall depth: 5.3”)
2. 25-year 72-hour event (Rainfall depth: 10.5”)
3. 100-year 72-hour event (Rainfall depth: 13.3”)

SECTION 9 – MODELING RESULTS AND LEVEL OF SERVICE ANALYSIS

LEVEL OF SERVICE CRITERIA

Level of Service Criteria for both roadway and structural flooding has been determined per South Florida Water Management District (SFWMD) ERP and Lee County rules and regulations.

Level of Service Criteria for Roadway Flooding:

Lee County:

- No roadway flooding on the Hurricane Evacuation Route for the 25yr-72hr design storm event

SFWMD:

- No roadway flooding for the 5yr-24hr design storm event

Level of Service Criteria for Structural Flooding:

Lee County:

- No criteria established for this study

SFWMD:

- No structural flooding for the 100yr-72 hr design storm event

In this study, both the existing and original conditions model was evaluated for the following:

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS

Based on the results provided in Table 9.1, only portions of Oriole Rd. did not meet the SFWMD roadway level of service criteria. The depth of flooding increase for the 5yr-24hr design storm event at those locations ranged from 0.05’ to 0.24’. In addition, Lee County roadway level of service criteria is also met since stage at US-41, a hurricane evacuation route, is below the road elevation for the 25-yr 72-hr design storm event.

Insert Table 9.1

EXISTING CONDITIONS FLOODPLAIN MAPPING

Existing conditions floodplain map for the 25-yr 72-hr design storm were digitized in ArcGIS software to determine the extent of flooding in the study watersheds. Figure 9.1 shows the existing conditions floodplain map for this design storm. The map was created using the simulated node maximum stages, the spot elevations and 2-foot contour maps provided by the County.

The results of the floodplain map were compared with the complaints observed by the residents in the area and flooding as observed by Lee County personnel. In comparing these sources, the results of the model corroborate reported flooding in the area.

ORIGINAL CONDITIONS LEVEL OF SERVICE ANALYSIS

The results provided in Table 9.1 for original Conditions model show some increase in stages when compared to the existing conditions model for all design storm events. This is due to change in cross-sections that causes increase in flow downstream and thereby resulting in downstream stage increase. This is not acceptable per SFWMD level of service criteria, because of increase in structural flooding. However, the roadway level of service criteria for both SFWMD and Lee County is met except for Oriole Rd. The depth of flooding increase for the 5yr-24hr design storm event at that location is only 0.04’.

Figure 9.2 shows the locations of roadway flooding for both Existing and Original, as-built conditions model.

ORIGINAL CONDITIONS FLOODPLAIN MAPPING

Original conditions floodplain map for the 25-yr 72-hr design storm were digitized in ArcGIS software to determine the extent of flooding in the study watersheds. Figure 9.1 shows the overlap of original, as-built conditions model over the existing conditions floodplain map for this design storm. The map was created using the simulated node maximum stages, the spot elevations and 2-foot contour maps provided by the County.

The results of the floodplain map for the original, as-built conditions model indicated that the extent of flooding depth in certain locations is more in comparison to the existing conditions model. However, there are other parts within the district that shows decrease in flooding.

A comparison of node maximum stages between the existing and original, as-built conditions models over the entire study area indicate that upgrading the original conditions model to original, as built conditions does not completely eliminate the flooding within the district, and in fact causes an increase in structural flooding in certain locations. Approximately 50% of the nodes show increase in stages with a maximum increase ranging from 0.5’ to 0.7’. Appendix E and F provides the existing and original, as-built conditions model input and output results for all design storm events.

Insert figure 9.1

Insert Figure 9.2

SECTION 10 – OPERATION AND MAINTANENCE PLAN

EXISTING CONDITION OF DRAINAGE STRUCTURES

During the field reconnaissance, the current conditions of structures within the main drainage pathways were evaluated. The intent was to assess the current condition of the structures, determine initial actions required to increase the life of the structures, and to create a 30 year maintenance plan for the drainage network.

The current condition of each structure was assessed by estimating the remaining service life, which was determined by the following method:

Remaining Service Life (RSL) Scale	Description
0	Structure needs immediate replacement. High failure potential.
1	Structure currently needs moderate rehab, such as: replace end treatments, repair major cracks, correct separation in joints, etc.
2	Structure currently needs minor rehab, such as: repairing minor/moderate cracks, removal of silting, seal joints, coating structure with bituminous lining, etc.)
3	Structure currently does not require maintenance.

According to the Handbook of Steel Drainage and Highway Construction Products, *American Iron and Steel Institute, 2002*, even with a 25% metal loss, which occurs long after first perforation, structural factors of safety are reduced by only 25%. For corrugated metal culverts, the corrosion was noted to be: minor (no perforation has occurred), moderate (perforation has occurred, but structure is still sound), or severe (excessive perforation has occurred, integrity of the structure is uncertain and a risk of collapsing exists). In the event the structure will need replacement, but currently retains its strength, cost effective methods such as: slip lining and concrete lining, was used, where possible.

Table 10.1 shows the existing condition of the drainage structures and the corrective or proactive measures recommended in years 0, 10, 20 and 30. It is recommended that all structures are cleaned every ten years to ensure that no system capacity is lost. It is recommended that all metal structures be coated with a bituminous lining every 20 years to slow the effects of corrosion and increase the life span.

Table 10.2 shows the cost estimate associated with these activities based on bid tabulations that were published from the 2006 Florida Department of Transportation lettings for projects within the region requiring similar work was used.

Insert Table 10.1

Insert Table 10.2

EXISTING CONDITION OF CANALS

The channels that are within the main drainage network for the system were surveyed and cross-sections were created using the survey data to determine the amount of excavation and embankment needed to restore each channel to original conditions. The original width was estimated to be the width of the downstream culvert, since the structures will limit the conveyance capacity of the system. The cross-sections are provided in Appendix C. The approximate easement location has also been shown for informational purposes only.

The channels within the district have excessive overgrowth on the banks consisting of native trees, Melaleuca Gum Eucalyptus, and brush. In order to restore maintenance accessibility to the channels, the costs associated with clearing and grubbing were estimated. The estimates for clearing and grubbing are summarized as follows:

A. Excessive amount of trees, brush and obstructions. ($22,000/acre)

B. Moderate amount of trees, brush and obstructions. ($17,000/acre)

C. Light amount of trees, brush and obstructions. ($12,000/acre)

Table 10.3 shows the estimated costs associated with clearing, grubbing, and returning the channels back to original as-built conditions. Costs also include clearing the researched drainage easements. It should be noted that some of the swales have limited access, and that additional right-of way may be required to facilitate maintenance. Costs associated with purchasing additional right of way are not included in this report.

Insert Table 10.3

MAINTENANCE OF RETENTION PONDS

The Retention ponds within the district are currently being maintained by Lake Ecology of Florida, Inc. at a rate of $3,000 per month. The maintenance of the ponds consists of mowing and maintenance of cattails on an as needed, rotating basis. The level of service should be increased and the associated maintenance costs are anticipated to double.

BASIS OF COST ESTIMATE

The maintenance plan that is recommended is for preventive maintenance at specified intervals. In order to estimate the costs associated with these activities, bid results that were published from the 2006 Florida Department of Transportation projects within the region requiring similar work was used. To account for the costs associated with maintenance activities in the future, inflation needs to be accounted for. The rate of inflation shall be estimated to be 3.0% per year. (Source: U.S. Consumer Price Index, inflation index http://www.bls.gov/cpi)

Since the drainage structures are owned by Florida Department of Transportation, Lee County Department of Transportation, East Mulloch Drainage District and ACL Railroad, the cost estimate has been separated. The structures owned by Florida Department of Transportation have been excluded from this estimate, since a maintenance plan is already in place and no further action is required. Table 10.4 shows the annual costs associated with the Operation and Maintenance Plan for a 30-year term.

Table 10.4 indicates that an initial cost of $5,003,079 is required to bring the district back to the original conditions; however the investment will not solve the flooding issues. Instead, the Original conditions model shows some increase in flooding in certain locations as evidenced by the 25-yr/72-hr floodplain map. This is due to the change in cross-sections of the swales/channels that impacts link maximum flows and node maximum stages. If County or the District decides to make the initial investment, a total annual operation and maintenance cost is required to maintain the District, which was estimated to be $140,000.

Insert Table 10.4

SECTION 11 – LEGAL AND FINANCIAL REVIEWS

LEGAL REVIEW

The Drainage District was formed on May 29, 1963 as an independent political subdivision through a special act defined in Chapter 63-930 and 65-912, Laws of Florida. This act created the East Mulloch Drainage District, EMDD, to maintain drainage within the district through property assessment taxes.

The Florida State Legislature passed Chapter 83-455 House Bill No. 1337 in June 1983 to enable Lee County to take over the District functions. Specifically, the Bill states:

> *An act relating to Lee County; providing that the Board of County Commissioners of Lee County may assume responsibility for the debts and obligations of the East Mulloch Drainage District and for the operation and maintenance of drainage control structures and systems of the district; providing for the repeal of chapters 63-930 and 65-912, Laws of Florida, and for the abolition of the district upon the assumption of such responsibility; providing an effective date.*
>
> *Be it enacted by the Legislature of the State of Florida:*
>
> *Section 1: Chapters 63-930 and 65-912, Laws of Florida, shall stand repealed and the East Mulloch Drainage District shall bed abolished upon the adoption of an ordinance by the Board of County Commissioners of Lee County whereby the Board assumes responsibility for debts and obligations of the district, if any, and for the operation and maintenance of the drainage control structures and systems of the district, or upon the creation of a municipal services taxing unit which assumes such responsibility.*
>
> *Section 2: This act shall take effect upon becoming a law.*
>
> *Became a law without the Governor's approval. Filed in Office Secretary of State June 27, 1983.*

Based on the above, the County would be able to take over the District upon passing an ordinance, or by creating a municipal services taking unit (MSTU).

FINANCIAL REVIEW

Property assessments are currently fixed at $30.10 per acre, and account for approximately 95 percent of the District's revenue. The balance of the revenue is associated with interest income.

The District's Balance Sheets for years 2002 through 2006 were reviewed. The records indicate the District had average annual revenue of $69,999, with average annual expenditures of $58,662.

Net assets typically serve as a useful indicator of a government's financial position. Assets exceeded liabilities by $137,400 as of September 30, 2006 (latest audit). The reserve is available for use on

maintenance work, system repairs/upgrades, or for other unforeseen or catastrophic events such as heavy tropical storms, hurricanes etc.

The District has no capital assets or long-term debt. The District subcontracts all maintenance work, and has no full-time employees.

SECTION 12 – SUMMARY OF FINDINGS AND RECOMMENDATIONS

The following conditions were observed for East Mulloch Drainage District as a result of this study:

1. The drainage district, which was formed in 1963, is responsible for maintaining 21 linear miles of drainage channels, 20 retention ponds, 9 drainage structures and the railroad bridge as it pertains to the capacity of the system.

2. The San Carlos Park area, which was contained in the original boundary of the district, had a drainage system constructed which was originally designed to service approximately 8,000 homes. The system is currently serving 6,118 homes as well as commercial development and a golf course.

3. The Plan of Reclamation, which was prepared for the drainage district by Gee & Jenson Consulting Engineers, Inc. in November 1964, recommended that additional drainage right of way be purchased, additional drainage pathways be added that includes three culverts to the north of the railroad bridge, and a berm constructed around the district. Although some of these improvements were completed, the critical improvement of adding additional culverts to the north of the railroad bridge was not completed. The inadequate downstream conveyance along with improper maintenance of main channels resulted in severe flooding issues as indicated by the modeling results and floodplain maps.

4. The boundary of the drainage district has been expanded since the original boundary was determined.

5. Drainage easements for the channels are not being properly maintained and have obstructions such as: storage buildings, cars, fences, heavy vegetation and trees, etc. This has resulted in access restrictions to these channels for proper maintenance. This inadequate maintenance has contributed to flooding issues for the residents of the district.

6. Two hydraulic models were created in ICPR to determine the level of service of the drainage system. Once was developed for existing conditions and one for the original, as built conditions

6a. The models are based on the best available information from: Lee County, South Florida Water Management District, and historical records. The original condition model assumes that the channels and structures are in good condition and are free from silting and debris.

6b. Existing Conditions model indicates only portions of Oriole Rd. did not meet the SFWMD roadway level of service criteria. The depth of flooding increase for the 5yr-24hr design storm event at those locations ranged from 0.05’ to 0.24’. In addition, Lee County roadway level of service criteria is also met since stage at US-41, a hurricane evacuation route is below the road elevation for the 25-yr 72-hr design storm event.

6c. The results provided in Table 9.1 for Original Conditions model shows some increase in stages when compared to the existing conditions model for all design storm events. This is due to change in cross-sections that causes increase in flow downstream and thereby resulting in downstream stage increase. This is not acceptable per SFWMD level of service criteria, because

of increase in structural flooding. However, the roadway level of service criteria for both SFWMD and Lee County is met except for Oriole Rd. The depth of flooding increase for the 5yr-24hr design storm event at that location is only 0.04'.

6d. Based on the comparison of node maximum stages between the existing and original, as-built conditions model over the entire study area indicated that the original conditions model does not completely eliminate the flooding within the district and in fact causes increase in structural flooding in certain locations. Approximately 50% of the nodes show increase in stages with a maximum increase ranging from 0.5' to 0.7'. However, there are other parts within the district that shows decrease in flooding.

7. The capital improvement cost estimate and the 30-year maintenance cost estimate were intended to estimate the cost associated in bringing the condition of the system back to original, as built conditions and maintaining the system for a period of thirty years.. The cost estimate for the initial work is based on 2006 FDOT average bid prices, which is the most recent published currently, and future work was estimated with an inflation rate of 3%.

8. Table 10.4 indicates that an initial cost of $5,003,079 is required to bring the district back to the original, as built conditions. However the improvements will not solve the flooding issues. In fact, the original, as built conditions model indicates an increase in flooding in certain locations as evidenced by the 25-yr/72-hr floodplain map. This is due to the change in cross-sections of the swales/channels that impacts link maximum flows and node maximum stages. However, rehabilitation of the system would be required as a minimum, to facilitate proper operation and maintenance if the County took over ownership of the District. This would minimize the potential for catastrophic failure of the system during extreme storm events. If County or the District decides to make the initial investment, a total annual operation and maintenance cost is required to maintain the District, which was estimated to be $140,000.

9. The preliminary model prepared as part of this report should be finalized and neighborhood level of analysis should be performed to optimize the drainage system and to identify system improvements required to reduce localized flooding to acceptable levels of service. Cost estimates provided in this report can then be revised to reflect ultimate capital improvement costs.