CDM

South Florida Water Management District

Nutrient Load Assessment
Estero Bay and Caloosahatchee River Watershed

January 2007

Final Report

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Section 1
Final Work Plan

1.1 Introduction

The Estero Bay and Caloosahatchee River Watershed is characterized by a complex system of fresh and estuarine wetland and water resources. Water flow regimes, water supply, and critical ecosystems may be impacted by rapid development in the area. The Study Area is approximately 1,800 square miles and is shown in **Figure 1-1**. For the purposes of this Statement of Work (SOW), the terms SFWMD and/or District refer to the South Florida Water Management District, and the term Consultant refers to Camp Dresser & McKee Inc. (CDM) and its Subconsultant Team.

Figure 1-1. Study Area Estero Bay and Caloosahatchee River Watersheds

1.2 Objectives

The overall project goal is to develop a relative nutrient load assessment model that will allow planners, regulators, and local stakeholders to evaluate various management plan alternatives for protecting and enhancing water quality within the Study Area. Previous efforts have collected, compiled, and evaluated a variety of data and models in the Study Area for potential consideration in these analyses. This

database was used as the foundation for this Scope of Services to avoid duplication of effort. To this end, the available data resources within the Study Area and how that information can be utilized in the development of the assessment model are critical components of the proposed project.

The assessment model will be used by the Consultant to evaluate existing and future water quality (WQ) and Best Management Practices (BMPs) within the Study Area. The Consultant shall perform alternatives analysis of potential management practices and projects to support the objective of reducing nutrient and sediment loadings and implementing cost-effective BMPs.

1.3 Scope of Services

For this Scope of Services, the SFWMD used the public domain Watershed Management Model (WMM) to provide hydrologic and water quality modeling to aid in estimating both the relative levels of pollutant loads increases (impacts) and effectiveness of potential improvements (BMPs). WMM uses a simple database platform to estimate annual or wet-dry seasonal pollutant loads from many available data sources within a watershed. Data required to use the WMM include stormwater Event Mean Concentrations (EMCs) for each pollutant type and land use, land use and associated imperviousness, pervious and impervious runoff coefficients, areas served by septic systems and septic system failure rates, average annual and monthly precipitation, annual-monthly baseflow and average baseflow concentrations, wastewater treatment plant (WWTP) point source flows and pollutant concentrations, and other stream flows and concentrations.

WMM produces estimates of annual and seasonal flow volumes, pollution loads, and concentrations for nutrients (total phosphorus, dissolved phosphorus, total nitrogen, ammonia plus organic nitrogen), heavy metals (lead, copper, zinc, cadmium), and oxygen demand and sediment (BOD, COD, total suspended solids, total dissolved solids). WMM will also be used to estimate stormwater runoff pollution load reduction due to partial or full scale implementation of onsite or regional BMPs. WMM will be used to estimate and compare annual and seasonal pollution loads from stream baseflow and point source loads for comparison with relative magnitude of the other watershed pollution loads from stormwater and septic tanks.

WMM does not directly simulate physical, chemical, and/or biological growth or decay. For simplicity, WMM applies a delivery ratio from 0 to 1 to account for reduction in runoff pollution load due to uptake, transformation, and/or removal in the stream courses based on available stream flow and concentration data. Pollution control strategies that may be identified and evaluated using the WMM include: Nonstructural controls (e.g., land use controls and buffer zones); and Structural controls (e.g., onsite and regional wet detention ponds, grassed swales, dry detention basins, and retention-infiltration basins and buffers).

As discussed, WMM provides a basis for planning-level evaluations of the long-term (annual or seasonal) watershed pollution loads and the relative benefits of pollution

management strategies to reduce these loads. The WMM evaluates alternative management strategies (combinations of source and treatment storm water controls) to aid in the development of proposed watershed management plans. Within a given watershed, multiple hydrologic units (subbasins) can be evaluated. Subbasins are typically subdivided by drainage areas to various tributaries, outfalls, or other receiving water bodies within a watershed. For this Study, subbasins have been delineated by SFWMD and others based on Water Body Identification (WBID) designations consistent with the FDEP TMDL program. This relative loading model provides practitioners with information to make decisions for implementation of BMP projects and management criteria based on the relative contribution of pollution loadings from various areas within a watershed (e.g., pre MSSW-ERP development). In this way, the District's existing database and GIS coupled with information gathered from monitoring programs carried out by cities, counties, and other entities can be used for targeting control measures to those areas which are responsible for generating the majority of the pollutant load.

As discussed, the model will consider available data and models for the Study Area including available continuous simulation models and time series data inputs such as rainfall, stream flows and pollutant concentrations and loadings. The following parameters will be included in WMM:

1. Biochemical Oxygen Demand (BOD)
2. Chemical Oxygen Demand (COD)
3. Total Suspended Solids (TSS)
4. Total Dissolved Solids (TDS)
5. Total Phosphorus (TP)
6. Dissolved Phosphorus (DP)
7. Total Kjeldahl Nitrogen (TKN)
8. Nitrite plus Nitrate (NO2 + NO3)
9. Lead (Pb)
10. Copper (Cu)
11. Zinc (Zn)
12. Cadmium (Cd)

Definitions

Consultant. The term Consultant shall be used to refer to any individual or group of individuals that are employed by the prime Consultant (CDM) and all Subconsultants on the team.

Final Deliverable. Any final deliverable required for this Work Order must have been approved by the Project Manager. The Project Manager shall give approval only after the drafts have undergone appropriate reviews and acceptable responses to comments have been made by the Consultant.

Project Manager. Unless otherwise specified in this SOW, Project Manager refers to the SFWMD Project Manager. The Project Manager shall be the primary point of contact with the Consultant and shall assist in identifying appropriate technical points of contact. Final acceptance of Work Order deliverables shall be provided only by the Project Manager. The designated SFWMD Project Manager for this study is Clyde Dabbs.

Study Area. The Study Area for the 1,764 square mile Estero-Caloosahatchee system is shown on Figure 1-1.

1.4 Progress Report Format

1.4.1 Accomplishments to Date

A. Scheduled Tasks

In this part of the progress report, a short and general description of the scheduled tasks of the current report period is first presented describing the major objectives and components of the tasks. One paragraph per task is sufficient. A more detailed description of task components will follow summarizing accomplishments to date.

B. Progress on Tasks

A thorough review of the ongoing accomplishments per task is expected in this part of the report. Summary results are included.

C. Difficulties Encountered

Difficulties in meeting task goals or departures from the proposed schedule are addressed. Solutions to overcome these difficulties should also be discussed here.

D. Preliminary Data

Pertinent tables, figures and graphs related to the presentation of accomplished tasks are included here.

1.4.2 Tasks and Activities for the Next Reporting Period

A. Tasks to be Performed

A summary of scheduled tasks and expected accomplishments during the next reporting period.

B. Proposed Approach

Brief description of the approach to be used to accomplish next period's tasks.

1.5 Work Breakdown Structure

1.5.1 Task 1. Work Plan Development, Meetings, and Progress Reports

Task 1.1 Draft Work Plan Development

The Consultant shall develop a draft work plan that shall expand upon this Scope of Services, further detailing descriptions of the tasks, methods, and schedule for each task. The Nutrient Load Assessment, WMM Development, and Application Report for Estero Bay and Caloosahatchee River Watershed shall be the final product of this project. The outline of this report shall be used by the Consultant to format all deliverables so they can be directly integrated into the final report as successive report sections with minimal modifications. A quality control plan shall be incorporated into the schedule that includes internal quality control of deliverables and the mechanisms for incorporating review comments.

Task 1.2 Meetings

The Consultant will be required to attend three meetings: kickoff, progress review, and final presentation. Three key team members from the Consultant and Subconsultants shall attend a project kickoff meeting at the SFWMD offices in Fort Myers. The draft work plan shall be delivered one week prior to the kickoff meeting, which the Project Manager shall schedule for the third week of the project. The Consultant shall plan and organize the meeting in consultation with the SFWMD Project Manager. The purpose of the meeting shall be to clarify work elements defined in the Work Plan.

Task 1.3 Final Work Plan

The Consultant shall revise the work plan based on comments, discussions, and decisions made at the kickoff meeting. This Document shall serve as the official meeting record and shall document other critical project information provided by the Project Manager. The Final Work Plan shall comprise Section 1 of the report.

Task 1.4 Progress Reports

The Consultant shall provide the Project Manager with brief monthly progress reports describing the status of each task scheduled for the reporting period, including proposed start/finish dates and actual and/or anticipated start/finish dates. Departures from the proposed schedule and problems that have been encountered shall be discussed and proposed solutions and any other relevant information shall be presented. The proposed format for the progress reports shall be provided in the Work Plan. The final Work Plan shall constitute the first progress report. It is anticipated that progress reports shall be prepared and submitted monthly up to a total of six (6) reports (including the final Work Plan).

Deliverables

D-1. Draft Work Plan

D-2. Project Kickoff Meeting

D-3. Final Work Plan as a Report Section

D-4. Up to Six Progress Reports

1.5.2 Task 2. Development Data Review and Compilation

Application of WMM requires that watershed data be compiled and analyzed. In some cases, data from adjacent or neighboring watersheds may be applicable to the Study Area watershed. Data collection, management and assessment are critical components to the overall goals of the pollution loading and abatement analysis in the Study Area. Water quality data have been compiled, evaluated, and archived for the Southwest Florida Feasibility Study (SWFFS) by TetraTech, May 2004. This report and the water quality database will be provided to the Consultant by the SFWMD**.** Other data are available from the SFWMD, Parsons ES, CDM, USGS, USACE, FDEP, and counties offices as noted in **Table 1-1**.

The Consultant will assess data availability, format, and limitations relative to the model requirements. This effort entails having accomplished the following subtasks:

1. Select and compile NCDC or SFWMD rainfall data for three to five stations;
2. Identify NRCS soils classification by hydrologic group within each hydrologic unit;
3. Compile present and build-out future land use (year 2050) from SFWMD coverages. From this, the Consultant will estimate impervious areas based on ranges as shown in **Table 1-2**.
4. Topography from USGS, USACE, or SFWMD;
5. Collect survey, and stage-flow-volume for up to five USGS and/or SFWMD stations. These stations will be agreed upon calibration points.

Table 1-1. Data Input for WMM

Data Type	Data	Source
Watershed Characteristics	Tributary Area	District GIS
	Land Use	District GIS
	Topography and Soils	District GIS
	Aerial Photography	LABINS, USGS, District
	BMP Coverage/Efficiency	FDEP, District, CDM
Rainfall / Runoff	Avg Annual and Monthly Rainfall	DBHYDRO, NCDC
	Annual and Monthly	DBHYDRO
	Stream Stage and Flow	
	Runoff coefficients	Handbook of Hydrology, DBHYDRO flow data
	Impervious Cover %	(See **Table 1-2**), land use, photos
Watershed Water Quality Data	Event Mean Concentrations	PSI, Janicki, ERD, CDM
	Ambient WQ Monitor Data	Tetra Tech database
WWTP Discharges	Volumes, loading	FDEP
Septic Tanks	Service area	FDEP, District
	Failure rate and concentrations	FDEP, District
Delivery Ratio / Travel Time	Channel geometry	Regional Mike-11 Models
	Mean storm event and travel time	Regional Mike SHE-11 Models

Table 1-2. Initial Land Use Impervious Values

FLUCCS Code	Land Use Description	% Imperviousness Range
100	Urban	50
110	Residential Low Density	15-May
120	Residential Medium Density	20 to 35
130	Residential High Density	60 to 70
140	Commercial and Services	80 to 90
150	Industrial	80 to 90
160	Extractive Mining	50
170	Institutional	30 to 50
180	Recreation	5
200	Agricultural	0 to 5
810-830	Transportation	80 to 90

6. Collect water quality data from the TetraTech database provided by SFWMD, the DBHydro Database and the County monitoring programs and develop a final water quality database using record length, collected parameters, and spatial location as selection criteria.

Using available data, a systematic process will be used by the Consultant to:

1. Complete an assessment of available information needed to support scientifically defensible relative estimates of point and non-point source pollutant loads. This is expected to include all subtasks mentioned above.
2. Develop the WMM mass balance model inputs that will be used to estimate loads from the 100 defined hydrologic units (subbasins) within the Study Area, for the year 2000 and year 2050 land uses.
3. Develop proposed calibration criteria for long-term annual flows and loads at up to five locations, including S-78, S-79 and up to three tributary locations to be determined.

The Consultant will also evaluate use of its Southeastern US Event Mean Concentration (EMC) database as a basis for standard concentrations, which will be approved by the District before proceeding to Task 3. The Consultant will produce a draft report section summarizing the data evaluation as well as a summary of the proposed model inputs.

As necessary for WMM completion, the Consultant will list data gaps and a plan to work around them.

Deliverables

D-5. Draft report section summarizing proposed WMM input and proposed calibration criteria

D-6. Final report section summarizing WMM input and calibration criteria

1.5.3 Task 3. Application of the Watershed Management Model to the Study Area

The WMM shall be set-up and applied to the Study Area. This will include up to 100 hydrologic units (**Table 1-3**), which are locations for separate load and flow volume estimates. WMM flow volumes will be calibrated to the data sets used for calibration of the sub-regional hydrologic and hydraulic models being developed for the Southwest Florida Feasibility Study (SWFFS) for up to five surface water gage locations as applicable. The agreed upon calibration points will be included in the final Work Plan developed by the Consultant. The development of load estimates based on WMM mass balance inputs for the year 2000 and year 2050 land uses entails the following specific subtasks:

1. Calculate the annual runoff volumes based on soil properties, land use coverage, and the percent imperviousness associated with each land use for each hydrologic unit.
2. Define the non-point pollution EMC for the different pollutants to be considered as loading factor in the model.

Table 1-3. Hydrologic Units (Subbasins) in the Study Area

Watershed Name		
1. 30-foot Canal	2. Flaghole	3. Nicodemus Slough
4. 42-foot Canal	5. Franklin Run	6. Ninemile Canal
7. Able Canal	8. Ft. Denaud	9. North Central Cape Coral
10. Alva	11. Ft. Simmons	12. Northwest Cape Coral
13. Banana Branch	14. Gator Slough	15. Olga
16. Bayshore Creek	17. Grassy Marsh	18. Okaloacoochee Slough
19. Bedman Creek	20. Greenbriar Swamp	21. Orange River
22. Bee Branch	23. Halfway Creek	24. Owl Creek
25. Billy's Creek	26. Hancock Creek	27. Palm Creek
28. Bronson	29. Hendry Canal	30. Park Branch
31. C-19	32. Hendry Creek	33. Pollywog
34. C20 Canal	35. Hendry Hilliard WCD	36. Popash Creek
37. Canal 1	38. Hickey's Creek	39. Port LaBelle
40. Canal 2	41. Hicpochee	42. Powell Creek
43. Canal 3	44. Hilliard	45. Rangeline Ditch
46. Carlos Waterway	47. Imperial River	48. Roberts
49. Carrol Canal	50. Industrial Canal	51. S-236
52. Chapel Branch	53. Iona	54. S-5A
55. Citrus Center	56. Jacks Branch	57. Six Mile Cypress
58. City Ditch	59. Kickapoo Creek	60. Southeast Cape Coral
61. Clewiston	62. LaBelle	63. Southwest Cape Coral
64. County Line Drainage District	65. LaBelle Private Drainage District	66. Spanish Creek
67. Cow Slough	68. Linden Pens Marsh	69. Spring Creek
70. Crawford Canal	71. Lochmoor County Club	72. Stroud Creek
73. Cypress Branch	74. Mackeral Canal	75. Sugarland WCD
76. Cypress Creek	77. Manuel's Branch	78. Telegraph Creek
79. Daugherty Creek	80. Marsh Point	81. Ten Mile Canal (North)
82. Deadmans Branch	83. Meander Ditch	84. Ten Mile Canal (South)
85. Deep Lagoon	86. Messer	87. Townsend Canal
88. Disston Island WCD	89. Moore Haven	90. Trout Creek
91. Dog Canal	92. Mullock Creek	93. Upper Countyline
94. East Olga	95. Myrtle Slough	96. Whiskey Creek
97. Estero River	98. Miller's Gulley	99. Winkler Canal
100. Fichter Branch	101. Mirror Lakes	102. Yellow Fever Creek

3. Determine the rainfall-runoff relationships in terms of non-point pollution loads by land use category and hydrologic unit.

4. Identify point sources of pollution and calculate their pollutant loadings.
5. Estimate failing septic tank loadings.
6. Develop delivery ratio/travel time relationships.

By using the above estimates, preliminary calibration efforts will be performed by the Consultant. The watershed water quality assessment model will be calibrated to match existing annual and seasonal water quality and flow data and in the context of the overall goals of the modeling effort. Calibration will include qualitative and quantitative evaluation of model results with respect to the physical features and dynamics in the system and the goals of the scenario testing.

A major input to the Caloosahatchee Watershed is inflows from Lake Okeechobee. These will be included in the model as annual and seasonal (wet-dry) point source flows and concentrations at S-77 and S-235, for comparison with flows and loads from the Estero Bay and Caloosahatchee River watersheds. Similar analysis will also be implemented between S-78 and S-79 where agricultural land use dominates the area. Accurate relative simulation of the pollutant loading and system dynamics requires experience in the simulation of nutrient and water quality loads, receiving water quality dynamics, and interactions with sediments, the atmosphere and adjacent wetlands. Drawing on experience with south Florida systems and water quality modeling, model development will include assessment of the loading characteristics of various land use and agricultural practices.

WMM will support rapid scenario testing and stakeholder analysis of future alternatives. The model will capture the seasonal variation in loads as well as the estimated annual load. The model will produce absolute total loads as well as loading rate per acre.

The Consultant will develop a draft report section summarizing the WMM set-up and comparison of preliminary WMM results to measured flows and loads for annual and wet-dry seasonal data for the Study Area. Wet and dry season will be defined by rainfall data, and the same EMCs will be applied. The model input file and code will be provided in a District compatible format.

D-7. Draft WMM development report section

D-8. Final WMM development report section

1.5.4 Task 4. Model Calibration

The Consultant will calibrate WMM at up to five locations where water quality data is available (e.g., flows and measured concentrations). A sensitivity analysis for up to 10 key model parameters will be performed by the Consultant and the model responses will be verified under varied conditions (by comparison to average annual, wet season, and dry season conditions). The sensitivity analysis may include changes to runoff coefficients, nutrient EMCs, septic tank failure rates, and BMP effectiveness.

The Consultant will use WMM to calculate nutrient loads for the selected "calibration" period, which shall be the period of record for existing available data. The Consultant shall compare and document "observed/estimated" nutrient loads with predicted WMM loads in a table. The Consultant shall adjust runoff coefficients, EMCs and/or other WMM inputs to refine WMM results compared to measured data, so that results are consistent with the criteria established in Task 2.

Results of the model calibration and sensitivity analysis will be summarized for District review and comment in a draft report section. Suggested sources for comparison include the ERD study and analyses performed by Lee County as made available by the District.

D-9. Draft Model Calibration report section

D-10. Final Model Calibration report section

1.5.5 Task 5. Alternative Scenario Analyses

The Consultant will apply WMM to forecast future conditions flow volumes and loads and recommendations for BMPs. Future conditions will be a build-out condition as of year 2050, and the SFWMD will provide the Consultant a GIS coverage of these land uses. The baseline model will be run for two future land use and/or water management scenarios, to be determined by the District but not to include extensive model alterations or changes to modeling code. The projected simulations will be compared to baseline conditions to demonstrate potential changes in pollutant loading, flow volumes, spatial distribution of loading, and potential impacts to resultant water quality in receiving bodies in tabular form.

A report section will be prepared to document future land use, existing BMP assumptions, and scenario projection results for District review. BMP efficiencies for mass removal will be based upon published data from SFWMD, CDM, ASCE, and FDEP as applicable. Comments will be addressed and incorporated in a final report section. The model input file and code will be provided in a District compatible format.

D-11. Draft Scenario Analyses report section

D-12. Final Scenario Analyses report section

1.5.6 Task 6. BMP Evaluations for Current and Future Land Use

The Consultant, in consultation with District staff, will review the effectiveness of proposed BMPs to control or reduce nutrient loads and will develop recommendations for basin-specific BMPs. This analysis will be developed for current and projected future build-out land use scenarios. This BMP development will consider the watershed hydrologic-ecologic system and practical methods, within

existing and proposed future land uses, to decrease pollutant loading and maintain hydrologic regimes. The recommended BMPs will be reviewed and prioritized by the District and other stakeholders within the watershed. The highest priority BMPs will be incorporated in the model as features that can be selected or turned 'on and off' by users in scenario testing. The predicted relative effect of the BMPs, singularly and collectively, will be evaluated in the scenario analysis and summary report. For the purposes of this SOW, the number or array of changes in model features to be evaluated is limited to two future lands use and management (BMP) scenarios in addition to those listed in task 5 (for a total of four land use and management plan scenarios for this assignment) with up to 20 subbasin modifications (actual number dependent on complexity) within each scenario. The Consultant will develop draft and final report sections summarizing BMP recommendations. The proposed District Basin Rule for Southwest Florida may serve as a guide for future land use BMP implementation.

D-13. Draft BMP report section

D-14. Final BMP report section

1.5.7 Task 7. Summary Report

The Consultant will prepare a report to summarize WMM data evaluations, set-up, application, calibration, and the BMP evaluations, and scenario testing. A presentation of current baseline conditions and selected future scenarios will be prepared for District review and comment. The presentation is intended to inform stakeholders of current conditions, to demonstrate the potential effect of projected land use changes, and to demonstrate the potential effectiveness of BMP implementation, permit modifications, or other hydrologic alterations proposed. The presentation should also briefly describe the model development and calibration. The consultant will conduct one stakeholder presentation.

- Prepare draft summary report and User's Documentation/Manual(s)
- Provide 2 days of on-site training
- Revise draft report and User's Documentation

The model input file and code will be provided in a District compatible format (run as a dll in Windows). The Consultant will provide all modeling datasets and the modeling code/spreadsheets. The Consultant will provide two-day onsite training in the use of the model.

D-15. Conduct presentation to stakeholder

D-16. Prepare draft summary report and User's Documentation/Manual(s)

D-17. Provide on-site training

D-18. Revise draft report and User's Documentation

Section 2
Task 1. Work Plan Development, Meetings, and Progress Reports

2.1 Task 1. Work Plan Development, Meetings, and Progress Reports

2.1.1 Task 1.1 Draft Work Plan Development

A work plan was developed by CDM describing further in detail the tasks, methods, and schedule for each task. The Nutrient Load Assessment, WMM Development, and Application Report for Estero Bay and Caloosahatchee River Watershed shall be the final product of this project.

2.1.2 Task 1.2 Meetings

Key team members from CDM and RCT Engineering (Subconsultant) attended the project kickoff meeting at the SFWMD's office in West Palm Beach. CDM team members attendees were: David Collins, Michael Schmidt, Richard Wagner, Patrick Gleason, Ana DeMelo, and Gabriel Bacca-Cortes. Christopher J. Roschek attended the meeting as Subconsultant's representative.

Progress review meetings and teleconferences were conducted and a final project presentation will be made.

2.1.3 Task 1.3 Final Work Plan

CDM submitted on January 6, 2006, as scheduled, the Final Work Plan including comments, discussions, and decisions made at the kickoff meeting. This Document served as the official meeting record and documented other critical project information provided by the Project Manager. The Final Work Plan comprises Section 1 of the report.

2.1.4 Task 1.4 Progress Reports

Progress reports and draft versions of reports were submitted in the following order:

- The first progress report was submitted to the SFWMD on February 10. This report included preliminary findings on securing the WMM required information. The SFWMD provided comments and suggestions during the meeting on March 7, 2006, held at the SFWMD's Fort Myers office, that are being included in the present report.

- The final progress report for Section 3 (WMM Input Criteria Report) was submitted on March 15, 2006.

- The draft report for Section 4 (WMM Development Report) was submitted on April 28, 2006.
- The final report for Section 4 was submitted on May 25, 2006.
- The draft report for Section 5 (WMM Calibration Report) was submitted on June 20, 2006.
- The final report for Section 5 was submitted on August 1, 2006.
- The draft report for Section 6 (Including Task 5 and 6) was submitted on September 15, 2006.
- The final report for Section 6 was submitted on October 5, 2006.

Section 3
Task 2. Development Data Review and Compilation

Data collection, management, and assessment are critical components to the overall goals of the pollution loading and abatement analysis in the Study Area. Application of WMM requires that watershed data be compiled and analyzed. Table 1-1 lists a summary of the required data and source. A detailed description of the compiled data follows.

3.1 Watershed Characteristics

3.1.1 Tributary Area

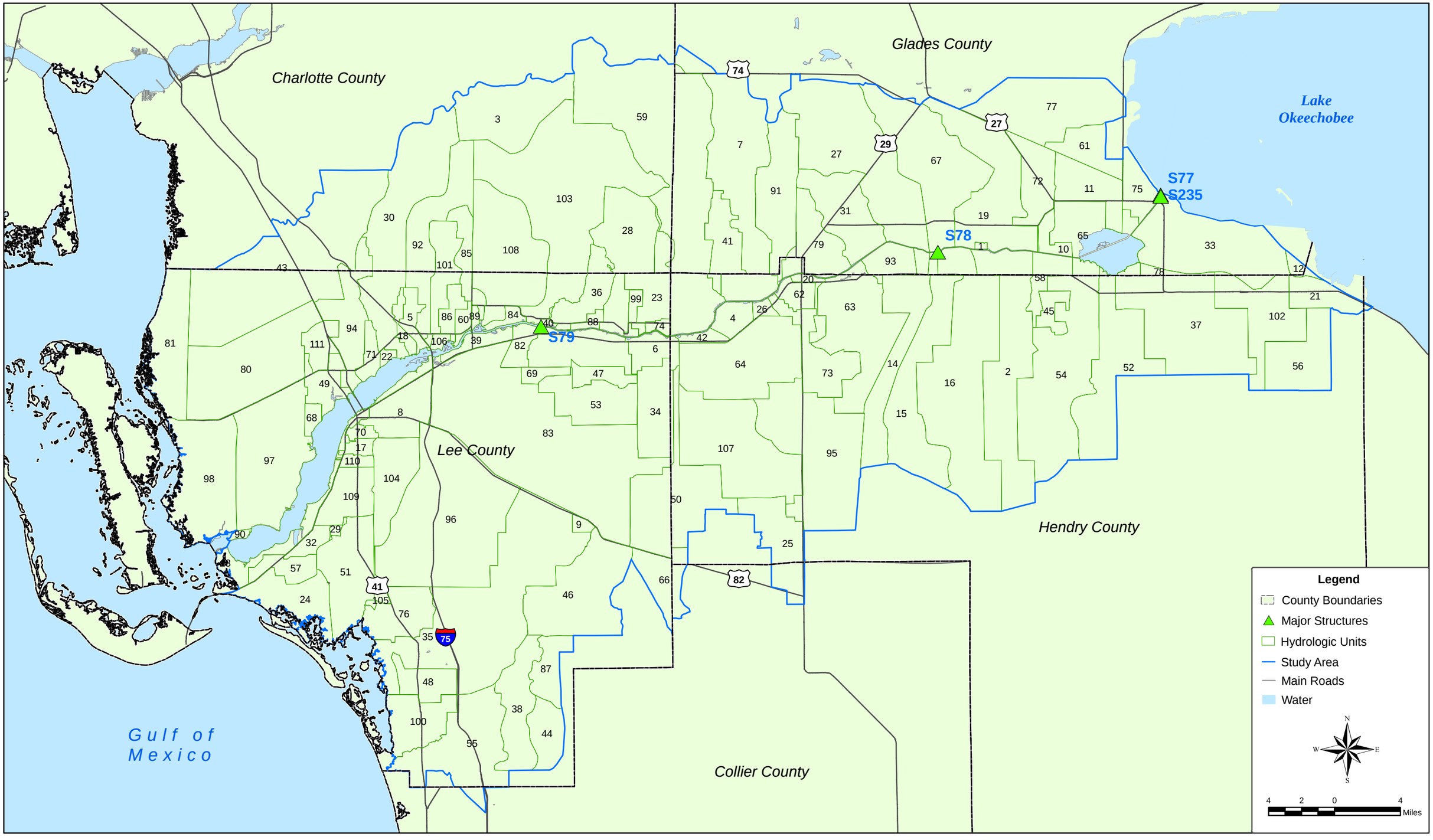
The Estero Bay-Caloosahatchee River Watershed is located in central and southwest Florida and covers an area of approximately 1,764 mi^2 (4,568 km^2) over Lee, Charlotte, Glades, Hendry and Palm Beach counties. The Franklin Lock (S-79) separates the freshwater upstream portion of the Caloosahatchee River Basin from the saline downstream portion.

The basin is relatively flat with little topographical relief. Canals and sloughs serve much of the Study Area. The canals were constructed for flood control and agricultural development.

The Caloosahatchee River (a.k.a. C-43 canal) Basin is encompassed by three major subbasins namely the East Caloosahatchee, delimited by the land that drains into the C-43 canal between Lake Okeechobee (Moorehaven Lock, S-77) and Ortona Lock (S-78); the West Caloosahatchee, delimited by the land that drains into the C-43 canal between the Ortona Lock and the Franklin Lock (S-79); and Tidal Caloosahatchee, delimited by the land that drains downstream from the Franklin Lock.

The Estero Bay-Caloosahatchee River Watershed was defined by initially including all the 102 hydrologic units listed in Table 1-3. Hydrologic units not listed in Table 1-3 but that make part of either the Estero Bay or the Caloosahatchee River basins were also included as the study progressed. The GIS shapefile for the project was created based on the SFWMD's shapefile titled "Subbasins for Southwest Florida Feasibility Study" available in the SFWMD GIS Catalog website (http://spatial1.sfwmd.gov/sfwmdxwebdc/dataview. asp), and it was last updated on November 11, 2005**.** **Figure 3-1** shows the 111 hydrologic units included in the final water quality model (refer identification numbers to **Table 3-1**)**.** Some considerations need to be addressed about the hydrologic units defined in this shapefile:

- Able Canal, Alva, Carlos Waterway, and S-5A were not depicted in this shapefile as part of the Study Area, because they were not found with these names.



C:\Projects\Estero-Caloosahatchee\GIS Data\ EC_Hydro_Units_Labeled.mxd 09/12/06 baccacortesgf

CDM

Figure 3-1
Study Area and Hydrologic Units
Project Area

- In addition to LaBelle, North LaBelle (located across the Caloosahatchee River), and East LaBelle were considered as separated hydrologic units.
- Myrtle Slough is labeled as Jack Spratt in this shapefile.
- L-41 and S-236 were found to discharge to Lake Okeechobee, and therefore, were not included in this study.

There are several important subbasins with ambiguous flow direction from which the Caloosahatchee River receives flow; the C-21 basin (a.k.a the S-4 and S-235 basin), located in the East Caloosahatchee Basin surrounding the southwest side of Lake Okeechobee, discharges to the C-43 canal through the S-235 structure when level in the Lake Okeechobee is greater than 15.5 ft NGVD or the level exceeds the lake regulation schedule (Flaig and Capece, 1998) making the flow direction in this basin bi-directional. It comprises the basins: Industrial Canal, Clewiston, and Disston Water Control District. The Nicodemus Slough Basin, located in the north portion of the East Caloosahatchee Basin, discharges to Lake Hicpochee through the C-19 canal when the conveyance capacity of L-19 and L-21 canals is exceeded, otherwise, it discharges to the Lake Okeechobee.

There are three subbasins for which the ambiguity in their flow direction is determined by surrounding vegetative conditions or/and storm intensity. In Okaloacoochee Slough (headwater of Canal 1 and Canal 2 basins) may flow to the C-43 canal or the Fakahatchee Strand Basin. It is poorly drained and its boundary is uncertain. The Cecil Webb Wildlife Management Area (Babcock basin and Daughtrey and Popash Creek headwaters) drains during low flow conditions towards the west into the Matlacha Pass. Conversely, during strong or high-level storm events, water drains to the southeast (Flaig and Capece, 1998). The Corkscrew Swamp and Lake Trafford basins, located southeast in the Estero Bay Basin, drain under normal conditions south and only under strong storm event flows towards the east (Estero Bay).

3.1.2 Land Use

Existing land use (year 2000) acreages for the Study Area are presented in Table 3-1 and future land use (year 2050) acreages are presented in **Table 3-2**, both distributed in 13 categories. Both the existing and future land use data presented in this document are from the 2000 and 2050 District land use data, respectively. SFWMD land use data are based on the Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS). **Figure 3-2** and **Figure 3-3** present the 2000 and 2050 land use coverage, respectively.

In the data presented here, agricultural land use also includes golf courses and rangeland; recreational land use includes urban open land; wetlands land use includes water; and, upland forests includes barren land.

Table 3-1. Distribution of Existing Land Use per Hydrologic Unit

Hydrologic Unit	LAND USE CATEGORY													Total Area (Acres)
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, Communication, and Utilities	
1 . 30-foot Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.9%	16.8%	7.6%	11.7%	210
2 . 42-foot Canal	0.1%	2.4%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	57.1%	22.3%	14.9%	0.9%	22,029
3 . Babcock	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	36.0%	45.6%	18.1%	0.0%	13,880
4 . Banana Branch	0.0%	8.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%	62.0%	18.9%	5.0%	3.6%	2,707
5 . Bayshore Creek	0.9%	15.5%	8.5%	0.0%	0.0%	3.4%	0.0%	0.0%	0.9%	20.5%	24.1%	22.7%	3.6%	2,071
6 . Bedman Creek	0.0%	4.9%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	56.0%	16.5%	15.9%	3.9%	3,734
7 . Bee Branch	0.1%	3.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	41.6%	30.4%	23.9%	0.3%	22,663
8 . Billy's Creek	3.0%	2.2%	31.3%	1.6%	5.8%	16.5%	0.0%	1.0%	11.4%	5.2%	13.0%	6.2%	2.8%	6,732
9 . Blackstone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	69.3%	1.1%	9.7%	14.9%	4.9%	695
10 . Bronson	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	76.1%	4.4%	14.3%	2.8%	1,848
11 . C-19	0.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	93.3%	1.2%	3.5%	1.5%	6,783
12 . C20 Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	32.9%	66.4%	0.7%	911
13 . Caloosahatchee South Shore	0.8%	1.6%	42.3%	7.2%	6.0%	0.2%	0.0%	0.5%	2.3%	6.5%	1.6%	27.8%	3.0%	6,427
14 . Canal 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	72.1%	10.2%	17.0%	0.3%	12,190
15 . Canal 2	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	62.1%	7.2%	28.4%	0.2%	16,664
16 . Canal 3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.4%	70.9%	4.5%	18.7%	0.5%	31,874
17 . Carrol Canal	0.3%	0.0%	42.7%	10.6%	7.1%	14.0%	0.0%	6.5%	0.7%	17.0%	0.0%	0.1%	1.0%	1,075
18 . Chapel Branch	6.6%	12.7%	3.1%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	22.6%	31.8%	19.1%	2.5%	1,369
19 . Citrus Center	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	56.2%	27.8%	14.2%	1.5%	17,905
20 . City Ditch	0.0%	39.6%	0.5%	0.0%	5.0%	0.0%	0.0%	0.0%	0.4%	38.9%	9.1%	2.5%	4.0%	1,521
21 . Clewiston	6.4%	3.5%	25.5%	0.0%	3.2%	0.8%	0.0%	3.8%	6.1%	26.8%	10.4%	8.6%	4.9%	4,509
22 . Cohn Branch	0.0%	5.2%	26.5%	3.8%	0.0%	0.0%	0.0%	0.0%	4.8%	11.9%	24.0%	23.1%	0.6%	472
23 . County Line Drainage District	0.5%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	18.4%	18.5%	59.6%	1.7%	6,155
24 . Cow Creek	6.7%	0.8%	2.6%	6.4%	3.1%	0.2%	0.0%	0.0%	1.5%	4.6%	2.7%	68.6%	2.8%	8,165
25 . Cow Slough	0.1%	1.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.1%	79.6%	4.9%	13.9%	0.0%	9,192
26 . Crawford Canal	2.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	55.3%	29.4%	7.8%	4.2%	836
27 . Cypress Branch	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	39.8%	39.4%	20.1%	0.3%	27,329
28 . Cypress Creek	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	47.4%	26.7%	23.9%	0.5%	13,057
29 . Cypress Lakes	0.0%	0.0%	34.2%	21.5%	9.4%	0.0%	0.0%	0.0%	0.0%	28.0%	0.7%	4.2%	1.9%	351
30 . Daughtrey Creek	0.5%	5.4%	1.7%	0.0%	0.0%	0.1%	0.0%	0.1%	0.3%	29.4%	35.2%	26.3%	1.1%	23,263
31 . Deadmans Branch	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	44.9%	38.8%	15.4%	0.8%	10,437
32 . Deep Lagoon	0.0%	0.0%	13.9%	20.1%	5.5%	0.1%	0.0%	4.4%	13.7%	13.5%	15.5%	12.8%	0.6%	1,777
33 . Disston Island WCD	0.1%	0.3%	0.9%	0.0%	0.2%	0.2%	0.0%	0.0%	0.1%	93.0%	2.8%	1.5%	0.7%	19,674
34 . Dog Canal	0.0%	19.6%	3.2%	0.3%	0.2%	0.0%	0.0%	0.0%	8.5%	29.1%	30.4%	8.8%	0.0%	7,855
35 . Estero River	0.7%	3.7%	1.2%	0.7%	0.2%	0.1%	9.0%	0.5%	1.5%	24.1%	23.0%	33.6%	1.7%	39,169
36 . Fichter Branch	0.0%	0.4%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	43.8%	19.7%	33.5%	0.4%	5,508
37 . Flaghole WCD	0.0%	1.5%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	84.5%	2.6%	8.9%	2.2%	23,840
38 . Flint Pen	0.5%	0.4%	0.0%	0.0%	0.0%	0.1%	0.6%	0.0%	0.2%	1.8%	16.3%	80.0%	0.0%	9,009
39 . Fort Myers Shores	0.0%	1.6%	42.0%	0.9%	2.3%	0.0%	0.0%	0.0%	0.8%	7.5%	3.9%	27.5%	13.4%	2,072
40 . Franklin Run	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	48.5%	0.7%	11.9%	27.2%	10.0%	324
41 . Ft. Denaud Branch	0.0%	10.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	44.0%	30.5%	14.0%	0.8%	7,156
42 . Ft. Simmons	0.0%	10.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	56.8%	8.3%	16.3%	5.9%	1,244
43 . Gator Slough	1.8%	0.8%	0.2%	0.5%	0.0%	0.0%	0.6%	0.2%	3.2%	19.4%	40.0%	31.1%	2.0%	39,333
44 . Gordon Swamp	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.2%	21.2%	73.2%	0.0%	4,806
45 . Grassy Marsh	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	92.0%	0.2%	7.8%	0.0%	2,186
46 . Green Meadows	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.1%	43.3%	24.6%	30.4%	0.7%	17,132
47 . Greenbriar Swamp	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	75.9%	0.2%	6.2%	17.6%	0.0%	2,490
48 . Halfway Creek	0.1%	1.5%	6.2%	3.7%	0.0%	0.1%	0.0%	0.2%	6.6%	47.6%	13.0%	19.4%	1.5%	4,255
49 . Hancock Creek	4.1%	12.4%	23.8%	1.5%	10.6%	1.1%	0.0%	2.2%	7.2%	9.7%	16.8%	8.5%	2.1%	3,984
50 . Hendry Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	44.8%	36.9%	4.1%	14.3%	0.0%	17,127
51 . Hendry Creek	2.2%	4.7%	8.6%	7.2%	4.9%	3.8%	0.0%	0.1%	2.1%	7.7%	18.3%	38.6%	1.9%	11,518
52 . Hendry Hilliard WCD	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	76.5%	7.0%	15.7%	0.6%	16,882
53 . Hickey's Creek	0.0%	16.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	33.7%	32.6%	11.6%	1.7%	16,963
54 . Hilliard	0.0%	0.5%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	69.7%	12.8%	16.4%	0.4%	26,341
55 . Imperial River	4.1%	2.7%	21.4%	3.7%	2.7%	0.3%	3.2%	0.6%	2.3%	17.2%	19.0%	20.1%	2.7%	16,679
56 . Industrial Canal	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.0%	0.0%	0.0%	85.7%	0.5%	9.4%	1.9%	9,505

Table 3-1. Distribution of Existing Land Use per Hydrologic Unit (continued)

Hydrologic Unit	LAND USE CATEGORY													Total Area (Acres)
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, Communication, and Utilities	
57 . Iona	11.7%	5.7%	14.6%	4.4%	9.2%	2.8%	0.0%	2.1%	5.0%	15.2%	10.4%	18.3%	0.6%	3,285
58 . Jack Spratt (Myrtle Slough)	0.0%	1.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	80.6%	7.5%	9.4%	1.2%	3,340
59 . Jacks Branch	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	47.5%	30.5%	20.4%	0.4%	46,734
60 . Kickapoo Creek	0.0%	36.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.4%	12.4%	19.8%	17.2%	4.7%	956
61 . L-42	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	90.5%	0.8%	8.6%	0.0%	4,829
62 . LaBelle	1.6%	25.1%	20.3%	0.0%	10.4%	0.0%	0.0%	0.4%	3.6%	10.4%	19.9%	2.2%	6.1%	2,267
63 . LaBelle East	0.0%	2.2%	2.1%	0.8%	0.0%	0.0%	0.0%	0.5%	22.8%	36.2%	15.5%	19.0%	0.9%	17,085
64 . LaBelle Private Drainage District	0.0%	0.7%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	95.3%	0.4%	2.7%	0.6%	17,761
65 . Lake Hicpochee	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	53.4%	2.1%	42.4%	1.8%	10,345
66 . LeHigh SE	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	5.1%	55.7%	11.2%	23.7%	1.2%	6,055
67 . Linden Pens Marsh	0.1%	0.5%	0.4%	0.0%	0.2%	0.0%	2.1%	0.0%	0.1%	35.5%	38.3%	22.5%	0.3%	20,869
68 . Lochmoor County Club	0.0%	2.2%	5.6%	45.8%	1.8%	1.2%	0.0%	0.0%	1.8%	18.9%	8.4%	9.7%	4.5%	1,053
69 . Mackeral Canal	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	46.4%	26.4%	25.9%	0.4%	0.0%	1,369
70 . Manuel's Branch	0.9%	0.0%	49.5%	3.9%	4.6%	28.0%	0.0%	8.6%	2.1%	0.0%	0.0%	0.3%	2.1%	885
71 . Marsh Point	40.9%	12.0%	15.6%	3.9%	1.5%	0.0%	0.0%	0.1%	2.0%	3.0%	5.8%	13.4%	1.8%	1,961
72 . Meander Ditch	0.3%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	84.3%	5.0%	7.8%	1.4%	6,549
73 . Messer	0.6%	4.6%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	51.8%	6.9%	33.2%	1.2%	7,576
74 . Miller's Gulley	0.0%	15.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	47.7%	9.7%	27.0%	0.4%	708
75 . Moore Haven	2.2%	2.6%	11.7%	0.0%	1.0%	0.4%	0.0%	5.2%	2.5%	60.1%	7.6%	3.6%	3.2%	3,934
76 . Mullock Creek	1.8%	1.3%	36.6%	1.5%	0.5%	2.4%	0.0%	0.6%	2.8%	9.6%	16.7%	24.3%	1.8%	7,012
77 . Nicodemus Slough	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.6%	17.1%	18.9%	0.4%	17,298
78 . Ninemile Canal	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.3%	93.3%	0.7%	4.7%	0.9%	913
79 . North LaBelle	0.4%	9.8%	2.1%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	48.5%	26.1%	10.7%	1.6%	7,895
80 . Northcentral Cape Coral	1.5%	7.8%	2.0%	0.0%	0.3%	0.6%	0.1%	0.6%	67.9%	2.9%	8.6%	1.6%	5.9%	21,020
81 . Northwest Cape Coral	0.0%	2.2%	2.0%	2.6%	0.0%	0.0%	3.2%	0.0%	36.1%	1.2%	18.2%	25.8%	8.7%	11,735
82 . Olga	0.1%	9.2%	6.4%	0.0%	1.6%	0.0%	0.0%	0.2%	1.6%	51.7%	8.7%	18.5%	2.0%	2,370
83 . Orange River	0.4%	27.3%	6.8%	0.7%	0.9%	0.2%	0.0%	0.4%	20.4%	16.5%	14.1%	10.3%	2.0%	50,340
84 . Otter Creek	0.0%	14.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	65.1%	5.2%	13.8%	1.3%	1,051
85 . Owl Creek	0.0%	11.8%	0.6%	0.0%	0.0%	0.0%	4.8%	0.0%	0.5%	45.7%	18.9%	17.5%	0.3%	3,870
86 . Palm Creek	0.0%	34.9%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.6%	34.9%	9.4%	3.4%	1,969
87 . Panther Island W	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.4%	18.7%	20.4%	0.1%	4,393
88 . Park Branch	0.0%	17.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.9%	31.2%	30.5%	7.2%	877
89 . Piggot Bridge	0.0%	7.7%	0.0%	3.0%	1.0%	0.0%	0.0%	0.0%	10.9%	19.9%	7.5%	45.2%	4.7%	586
90 . Piney Point	0.0%	0.0%	7.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.8%	71.2%	0.0%	357
91 . Polywog	0.4%	4.1%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.5%	42.4%	19.0%	0.1%	11,725
92 . Popash Creek	0.0%	8.4%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	25.9%	37.3%	27.0%	1.0%	11,357
93 . Port LaBelle	0.0%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	39.2%	14.1%	8.1%	1.3%	3,475
94 . Powell Creek	17.7%	13.3%	4.4%	0.0%	1.8%	0.5%	0.3%	0.5%	1.0%	12.7%	32.1%	14.0%	1.6%	8,550
95 . Roberts	0.0%	1.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.3%	66.9%	6.8%	24.8%	0.0%	24,499
96 . Six Mile Cypress Slough	0.0%	5.0%	4.5%	1.2%	0.6%	1.2%	0.1%	0.1%	2.3%	24.4%	30.5%	21.9%	8.3%	35,579
97 . Southeast Cape Coral	0.0%	0.7%	66.5%	5.0%	4.7%	0.5%	0.0%	1.0%	2.8%	1.5%	0.9%	5.3%	11.1%	20,216
98 . Southwest Cape Coral	0.1%	1.1%	42.5%	0.5%	0.5%	0.0%	0.0%	0.4%	7.2%	4.2%	4.3%	31.1%	8.1%	17,495
99 . Spanish Creek	0.0%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	48.6%	5.5%	43.2%	0.3%	1,140
100 . Spring Creek	3.2%	5.8%	15.6%	1.4%	2.3%	4.0%	0.0%	0.0%	6.3%	18.5%	14.7%	27.3%	0.9%	7,084
101 . Stroud Creek	0.0%	19.7%	0.0%	0.0%	0.0%	0.0%	6.3%	0.0%	0.0%	24.0%	26.4%	22.3%	1.3%	5,591
102 . Sugarland WCD	0.4%	1.3%	3.5%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	91.0%	0.3%	2.5%	1.0%	11,202
103 . Telegraph Creek	0.0%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	20.1%	51.4%	28.1%	0.1%	39,309
104 . Ten Mile Canal (North)	0.0%	6.4%	4.4%	3.6%	1.7%	8.7%	0.0%	0.7%	10.2%	21.4%	24.9%	14.0%	3.9%	7,929
105 . Ten Mile Canal (South)	7.9%	2.6%	19.8%	0.7%	3.5%	1.8%	0.0%	0.0%	1.1%	13.5%	15.6%	30.8%	2.7%	838
106 . Thompson Cutoff	1.5%	7.6%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%	11.5%	11.1%	57.2%	4.4%	583
107 . Townsend Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	88.4%	1.1%	10.5%	0.1%	20,723
108 . Trout Creek	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	46.4%	34.4%	15.4%	0.0%	18,373
109 . Whiskey Creek	1.0%	1.3%	28.2%	23.4%	15.8%	1.6%	0.0%	4.2%	2.8%	4.1%	1.5%	1.8%	14.2%	5,817
110 . Winkler Canal	0.0%	0.0%	31.5%	9.3%	24.7%	15.9%	0.0%	6.8%	7.4%	0.0%	0.0%	0.0%	4.4%	977
111 . Yellow Fever Creek	18.8%	0.4%	4.5%	0.0%	7.6%	0.3%	0.1%	0.7%	3.4%	10.8%	38.1%	11.9%	3.4%	3,116
Entire Watershed	**0.7%**	**3.9%**	**4.7%**	**0.8%**	**0.7%**	**0.5%**	**0.6%**	**0.2%**	**5.2%**	**41.1%**	**19.8%**	**19.9%**	**1.8%**	**1,128,710.0**

Table 3-2. Distribution of Future Land Use per Hydrologic Unit

Hydrologic Unit	LAND USE CATEGORY													Total Area (Acres)
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, Communication, and Utilities	
1 . 30-foot Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.9%	16.8%	7.6%	11.7%	210
2 . 42-foot Canal	0.0%	0.6%	16.8%	0.0%	0.8%	0.2%	0.0%	0.9%	0.7%	49.8%	14.2%	14.9%	0.9%	22,029
3 . Babcock	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	36.0%	45.6%	18.1%	0.0%	13,880
4 . Banana Branch	0.0%	69.3%	19.2%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	3.6%	2,707
5 . Bayshore Creek	0.3%	23.0%	29.5%	0.0%	4.5%	4.8%	0.0%	1.6%	0.1%	5.2%	4.7%	22.7%	3.6%	2,071
6 . Bedman Creek	0.0%	30.8%	30.0%	2.0%	0.0%	0.0%	0.0%	1.0%	0.0%	11.7%	5.1%	15.6%	3.9%	3,734
7 . Bee Branch	0.1%	9.2%	11.3%	0.5%	0.2%	0.0%	0.0%	0.4%	0.2%	28.5%	25.5%	23.9%	0.3%	22,663
8 . Billy's Creek	1.1%	0.1%	7.5%	32.0%	16.5%	25.3%	0.0%	2.0%	2.9%	0.4%	3.2%	6.2%	2.8%	6,732
9 . Blackstone	0.0%	0.0%	63.2%	0.0%	0.0%	0.0%	0.0%	0.0%	13.8%	0.2%	3.0%	14.9%	4.9%	695
10 . Bronson	0.0%	0.0%	0.0%	0.0%	14.8%	0.0%	0.0%	0.0%	2.4%	63.7%	1.9%	14.3%	2.8%	1,848
11 . C-19	0.1%	0.0%	5.4%	0.0%	8.5%	0.1%	0.0%	0.0%	0.0%	79.8%	1.2%	3.5%	1.5%	6,783
12 . C20 Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.0%	90.2%	0.7%	911
13 . Caloosahatchee South Shore	0.6%	0.2%	37.6%	13.4%	9.6%	0.2%	0.0%	0.5%	1.3%	5.0%	0.8%	27.8%	3.0%	6,427
14 . Canal 1	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	74.0%	6.4%	17.0%	0.3%	12,190
15 . Canal 2	0.1%	0.0%	1.7%	0.0%	0.0%	0.0%	1.0%	0.0%	1.0%	61.3%	6.4%	28.4%	0.2%	16,664
16 . Canal 3	0.0%	0.0%	8.9%	0.0%	0.2%	0.0%	0.0%	0.2%	0.2%	66.8%	4.4%	18.7%	0.5%	31,874
17 . Carrol Canal	0.0%	0.0%	14.9%	26.5%	24.1%	14.0%	0.0%	6.5%	0.0%	12.8%	0.0%	0.1%	1.0%	1,075
18 . Chapel Branch	6.5%	40.5%	17.2%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	11.7%	19.1%	2.5%	1,369
19 . Citrus Center	0.1%	2.9%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	53.7%	26.2%	14.2%	1.7%	17,905
20 . City Ditch	0.0%	19.9%	5.4%	0.0%	40.2%	0.0%	0.0%	0.0%	0.0%	27.9%	0.1%	2.5%	4.0%	1,521
21 . Clewiston	5.0%	0.0%	9.0%	5.1%	47.5%	2.1%	0.0%	3.8%	4.1%	4.2%	1.4%	12.9%	4.9%	4,509
22 . Cohn Branch	0.0%	0.7%	67.2%	3.8%	0.0%	0.0%	0.0%	0.0%	0.5%	0.2%	3.8%	23.1%	0.6%	472
23 . County Line Drainage District	0.5%	11.0%	2.7%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	60.4%	16.4%	7.1%	1.7%	6,155
24 . Cow Creek	6.6%	0.0%	4.8%	8.2%	3.1%	0.5%	0.0%	0.0%	0.2%	3.7%	1.5%	68.6%	2.8%	8,165
25 . Cow Slough	0.1%	14.8%	1.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.2%	64.4%	4.5%	13.9%	0.0%	9,192
26 . Crawford Canal	2.0%	25.6%	5.3%	0.0%	41.2%	0.0%	0.0%	3.3%	10.4%	0.0%	0.0%	8.0%	4.2%	836
27 . Cypress Branch	0.0%	0.1%	6.1%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	33.5%	39.1%	20.1%	0.3%	27,329
28 . Cypress Creek	0.0%	8.3%	1.4%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	40.6%	26.3%	22.8%	0.5%	13,057
29 . Cypress Lakes	0.0%	0.0%	0.0%	53.1%	12.8%	0.0%	0.0%	0.0%	0.0%	28.0%	0.0%	4.2%	1.9%	351
30 . Daughtrey Creek	0.5%	13.6%	4.5%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%	24.3%	29.6%	26.3%	1.1%	23,263
31 . Deadmans Branch	0.0%	0.2%	1.2%	0.0%	1.5%	0.1%	0.0%	0.0%	0.0%	42.7%	38.2%	15.4%	0.8%	10,437
32 . Deep Lagoon	0.0%	0.0%	0.2%	66.1%	5.5%	0.1%	0.0%	4.5%	0.4%	6.8%	3.1%	12.8%	0.6%	1,777
33 . Disston Island WCD	0.1%	5.3%	4.1%	2.5%	1.3%	5.2%	0.0%	0.0%	0.4%	76.9%	1.8%	1.7%	0.7%	19,674
34 . Dog Canal	0.0%	0.2%	85.0%	5.2%	0.2%	0.0%	0.0%	0.0%	0.6%	0.0%	0.1%	8.8%	0.0%	7,855
35 . Estero River	0.7%	13.1%	13.1%	4.1%	0.6%	0.1%	3.6%	0.7%	0.4%	15.8%	11.6%	33.6%	2.6%	39,169
36 . Fichter Branch	0.0%	12.3%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	34.7%	18.1%	33.5%	0.4%	5,508
37 . Flaghole	0.0%	3.4%	0.0%	0.0%	0.1%	9.1%	0.0%	0.0%	0.1%	73.9%	2.4%	8.9%	2.2%	23,840
38 . Flint Pen	0.5%	0.5%	2.7%	0.0%	0.0%	0.1%	0.0%	0.1%	0.2%	1.7%	14.3%	80.0%	0.0%	9,009
39 . Fort Myers Shores	0.0%	0.0%	50.6%	1.3%	2.3%	0.0%	0.0%	2.6%	0.6%	1.6%	0.2%	27.5%	13.4%	2,072
40 . Franklin Run	0.0%	58.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.5%	0.0%	0.4%	27.2%	10.0%	324
41 . Ft. Denaud Branch	0.0%	30.5%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	27.0%	26.9%	14.0%	0.8%	7,156
42 . Ft. Simmons	0.0%	0.5%	25.5%	17.7%	25.6%	0.0%	0.0%	0.0%	8.2%	0.1%	0.0%	16.5%	5.9%	1,244
43 . Gator Slough	1.8%	4.4%	1.8%	0.5%	0.2%	0.0%	0.6%	1.4%	0.2%	18.0%	36.9%	31.1%	3.0%	39,333
44 . Gordon Swamp	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	21.1%	73.2%	0.0%	4,806
45 . Grassy Marsh	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	92.0%	0.2%	7.8%	0.0%	2,186
46 . Green Meadows	0.0%	4.1%	0.3%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	41.6%	22.7%	30.4%	0.7%	17,132
47 . Greenbriar Swamp	0.0%	1.0%	63.9%	0.0%	0.0%	0.0%	0.0%	0.0%	13.5%	0.1%	4.0%	17.6%	0.0%	2,490
48 . Halfway Creek	0.1%	2.5%	41.3%	16.4%	0.0%	0.2%	0.0%	0.2%	0.0%	14.8%	3.4%	19.4%	1.5%	4,255
49 . Hancock Creek	0.0%	0.3%	35.2%	14.7%	23.0%	6.6%	0.0%	3.1%	5.4%	0.9%	0.3%	8.5%	2.1%	3,984
50 . Hendry Canal	0.0%	0.0%	40.8%	4.8%	0.0%	0.0%	0.0%	0.2%	1.1%	30.3%	2.4%	13.3%	7.2%	17,127
51 . Hendry Creek	0.0%	0.1%	14.1%	22.7%	8.8%	3.9%	0.0%	0.2%	0.5%	3.2%	6.0%	38.6%	1.9%	11,518
52 . Hendry Hilliard WCD	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	76.5%	7.0%	15.7%	0.6%	16,882
53 . Hickey's Creek	0.0%	13.8%	50.3%	15.7%	0.0%	0.0%	0.0%	0.0%	0.1%	3.3%	3.4%	11.6%	1.7%	16,963
54 . Hilliard	0.0%	0.4%	2.3%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	69.6%	10.8%	16.4%	0.4%	26,341
55 . Imperial River	4.0%	2.5%	27.6%	24.5%	7.0%	0.4%	0.0%	0.6%	0.8%	5.3%	4.5%	20.1%	2.7%	16,679
56 . Industrial Canal	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.0%	0.0%	0.0%	85.6%	0.4%	9.4%	1.9%	9,505

Table 3-2. Distribution of Future Land Use per Hydrologic Unit (continued)

Hydrologic Unit	LAND USE CATEGORY													Total Area (Acres)
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, Communication, and Utilities	
57 . Iona	6.4%	0.0%	20.8%	33.9%	9.2%	4.1%	0.0%	3.5%	1.2%	1.7%	0.2%	18.3%	0.6%	3,285
58 . Jack Spratt (Myrtle Slough)	0.0%	1.1%	0.6%	0.0%	0.0%	0.1%	0.0%	2.1%	0.0%	78.3%	7.3%	9.4%	1.2%	3,340
59 . Jacks Branch	0.0%	9.6%	1.7%	0.0%	0.1%	0.0%	0.0%	0.2%	0.0%	40.0%	27.6%	20.4%	0.4%	46,734
60 . Kickapoo Creek	0.0%	64.4%	0.3%	0.0%	0.0%	0.0%	0.0%	0.1%	9.3%	3.8%	0.3%	17.2%	4.7%	956
61 . L-42	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	90.1%	0.8%	8.6%	0.0%	4,829
62 . LaBelle	0.0%	0.4%	17.4%	0.0%	68.7%	2.9%	0.0%	1.0%	1.3%	0.0%	0.0%	2.1%	6.1%	2,267
63 . LaBelle East	0.0%	3.4%	26.7%	1.3%	1.3%	0.0%	0.0%	0.5%	3.6%	32.3%	11.2%	19.0%	0.9%	17,084
64 . LaBelle Private Drainage District	0.0%	0.0%	37.7%	1.3%	0.1%	0.3%	0.0%	58.6%	0.0%	0.1%	0.0%	1.5%	0.3%	17,761
65 . Lake Hicpochee	0.1%	0.0%	0.1%	0.1%	9.9%	0.0%	0.0%	0.0%	0.0%	43.7%	1.8%	42.4%	1.8%	10,345
66 . LeHigh SE	0.0%	3.0%	5.4%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	55.6%	11.0%	23.7%	1.2%	6,055
67 . Linden Pens Marsh	0.1%	0.1%	3.9%	0.0%	2.1%	0.0%	3.7%	0.0%	0.2%	30.5%	36.6%	22.5%	0.3%	20,869
68 . Lochmoor County Club	0.0%	0.0%	16.5%	45.8%	1.8%	0.0%	0.0%	1.2%	1.8%	18.6%	0.0%	9.7%	4.5%	1,053
69 . Mackeral Canal	0.0%	1.0%	98.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	1,369
70 . Manuel's Branch	0.1%	0.0%	12.9%	36.1%	9.8%	28.0%	0.0%	8.6%	2.1%	0.0%	0.0%	0.3%	2.1%	885
71 . Marsh Point	29.8%	2.7%	18.8%	29.1%	1.5%	0.0%	0.0%	0.1%	0.6%	2.1%	0.0%	13.4%	1.8%	1,961
72 . Meander Ditch	0.3%	2.1%	2.4%	0.0%	5.7%	0.2%	0.0%	1.1%	0.2%	74.0%	4.8%	7.8%	1.4%	6,549
73 . Messer	0.6%	4.5%	9.3%	0.0%	4.1%	0.0%	0.0%	0.0%	0.5%	41.6%	5.0%	33.2%	1.2%	7,576
74 . Miller's Gulley	0.0%	19.3%	51.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	1.1%	26.5%	0.4%	708
75 . Moore Haven	1.0%	46.0%	0.2%	8.8%	17.5%	9.2%	0.0%	5.4%	1.4%	0.3%	3.3%	3.9%	3.2%	3,934
76 . Mullock Creek	1.8%	0.8%	30.2%	21.8%	0.5%	3.5%	0.0%	0.6%	0.4%	5.5%	8.8%	24.3%	1.8%	7,012
77 . Nicodemus Slough	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.6%	17.1%	18.9%	0.4%	17,298
78 . Ninemile Canal	0.1%	0.0%	0.0%	0.0%	0.1%	23.6%	0.0%	0.0%	0.1%	70.2%	0.4%	4.7%	0.9%	913
79 . North LaBelle	0.0%	27.0%	8.3%	6.0%	12.8%	0.4%	0.0%	2.2%	0.1%	14.8%	16.2%	10.7%	1.6%	7,895
80 . Northcentral Cape Coral	1.4%	17.5%	58.6%	0.8%	5.9%	1.0%	0.0%	2.9%	0.3%	1.9%	1.1%	1.6%	7.0%	21,020
81 . Northwest Cape Coral	0.0%	29.4%	19.8%	2.3%	2.0%	0.0%	0.0%	1.9%	0.9%	0.9%	8.4%	25.8%	8.8%	11,735
82 . Olga	0.1%	0.1%	74.4%	0.0%	1.6%	0.0%	0.0%	1.0%	0.3%	1.5%	0.4%	18.5%	2.0%	2,370
83 . Orange River	0.4%	15.5%	41.5%	21.8%	1.2%	1.6%	0.0%	1.3%	0.6%	2.1%	1.8%	10.3%	2.0%	50,340
84 . Otter Creek	0.0%	74.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%	3.5%	13.8%	1.3%	1,051
85 . Owl Creek	0.0%	13.3%	2.4%	0.0%	0.6%	0.0%	4.7%	0.0%	0.5%	43.0%	17.8%	17.5%	0.3%	3,870
86 . Palm Creek	0.0%	65.2%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.1%	8.0%	9.4%	3.4%	1,969
87 . Panther Island W	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.4%	18.7%	20.4%	0.1%	4,393
88 . Park Branch	0.0%	22.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.1%	29.7%	30.5%	7.2%	877
89 . Piggot Bridge	0.0%	29.4%	13.6%	3.0%	1.0%	0.0%	0.0%	0.0%	0.7%	2.4%	0.0%	45.2%	4.7%	586
90 . Piney Point	0.0%	0.0%	28.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	71.2%	0.0%	357
91 . Polywog	0.4%	32.5%	2.5%	0.4%	0.6%	0.0%	0.0%	0.0%	0.0%	16.9%	27.7%	19.0%	0.1%	11,725
92 . Popash Creek	0.0%	6.7%	5.9%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	24.5%	34.4%	27.0%	1.0%	11,357
93 . Port LaBelle	0.0%	0.3%	44.4%	0.0%	1.4%	0.0%	0.0%	1.2%	4.1%	34.4%	4.7%	8.1%	1.3%	3,475
94 . Powell Creek	12.0%	2.7%	16.0%	17.5%	4.0%	0.5%	0.0%	0.9%	0.0%	10.3%	20.5%	14.0%	1.6%	8,550
95 . Roberts	0.0%	0.5%	1.3%	0.0%	0.0%	0.2%	0.0%	0.1%	0.3%	66.3%	6.5%	24.8%	0.0%	24,499
96 . Six Mile Cypress Slough	0.0%	0.7%	21.0%	12.2%	9.3%	5.9%	0.0%	0.2%	0.7%	6.5%	4.8%	21.9%	16.9%	35,579
97 . Southeast Cape Coral	0.0%	0.0%	63.3%	4.1%	12.7%	0.6%	0.0%	1.2%	0.8%	1.0%	0.1%	5.3%	11.1%	20,216
98 . Southwest Cape Coral	0.1%	0.2%	51.6%	2.5%	2.4%	0.0%	0.0%	1.1%	0.9%	1.6%	0.4%	31.1%	8.1%	17,495
99 . Spanish Creek	0.0%	7.6%	13.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	2.3%	43.1%	0.3%	1,140
100 . Spring Creek	3.0%	14.8%	7.7%	19.0%	2.3%	5.2%	0.0%	0.1%	1.1%	16.2%	2.4%	27.3%	0.9%	7,084
101 . Stroud Creek	0.0%	17.0%	9.5%	0.0%	0.0%	0.0%	6.2%	0.0%	0.0%	21.9%	21.8%	22.3%	1.3%	5,591
102 . Sugarland WCD	0.1%	0.2%	9.3%	3.5%	4.2%	0.3%	0.0%	0.0%	0.5%	78.3%	0.2%	2.5%	1.0%	11,202
103 . Telegraph Creek	0.0%	2.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.6%	51.0%	28.1%	0.1%	39,308
104 . Ten Mile Canal (North)	0.0%	0.2%	1.7%	28.3%	22.5%	17.7%	0.0%	1.2%	1.7%	5.3%	3.5%	14.0%	3.9%	7,927
105 . Ten Mile Canal (South)	7.1%	0.0%	12.5%	40.5%	4.2%	1.8%	0.0%	0.0%	0.0%	0.2%	0.1%	30.8%	2.7%	838
106 . Thompson Cutoff	1.5%	0.3%	19.7%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%	5.2%	8.0%	57.2%	4.4%	583
107 . Townsend Canal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	86.8%	1.0%	10.1%	0.1%	20,723
108 . Trout Creek	0.0%	3.5%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	43.6%	34.4%	15.4%	0.0%	18,373
109 . Whiskey Creek	0.6%	0.0%	16.9%	21.4%	35.0%	1.8%	0.0%	4.9%	1.0%	2.3%	0.0%	1.8%	14.2%	5,817
110 . Winkler Canal	0.0%	0.0%	22.2%	6.9%	43.8%	15.9%	0.0%	6.8%	0.0%	0.0%	0.0%	0.0%	4.4%	977
111 . Yellow Fever Creek	0.6%	0.0%	15.6%	41.7%	7.6%	7.0%	0.0%	0.8%	0.0%	6.7%	4.6%	11.9%	3.4%	3,116
Entire Watershed	**0.5%**	**5.9%**	**14.0%**	**4.5%**	**2.8%**	**1.2%**	**0.3%**	**1.5%**	**0.5%**	**32.5%**	**14.3%**	**19.6%**	**2.3%**	**1,128,706.1**

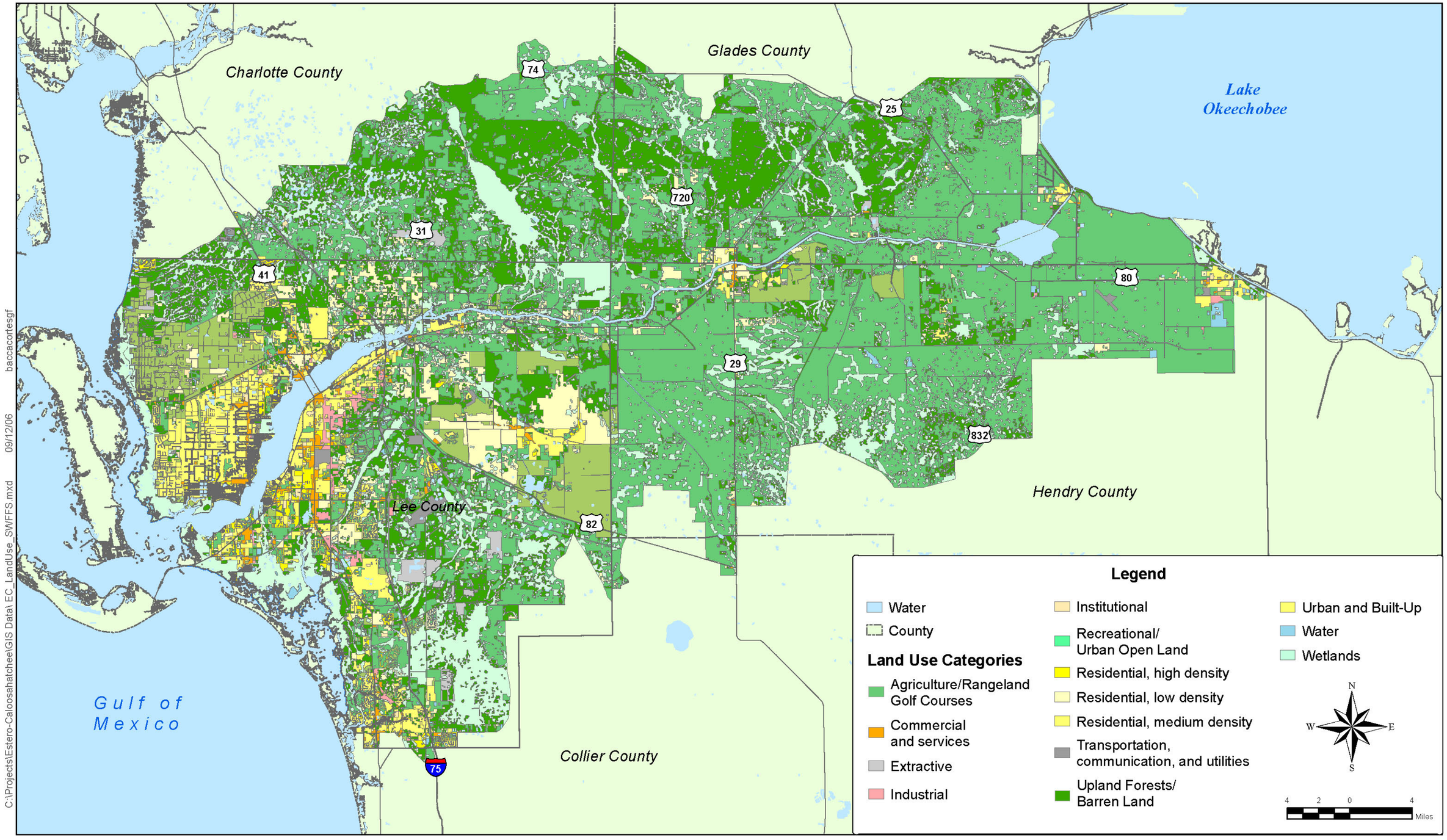


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Figure 3-2
2000 Land Use Coverage
Project Area

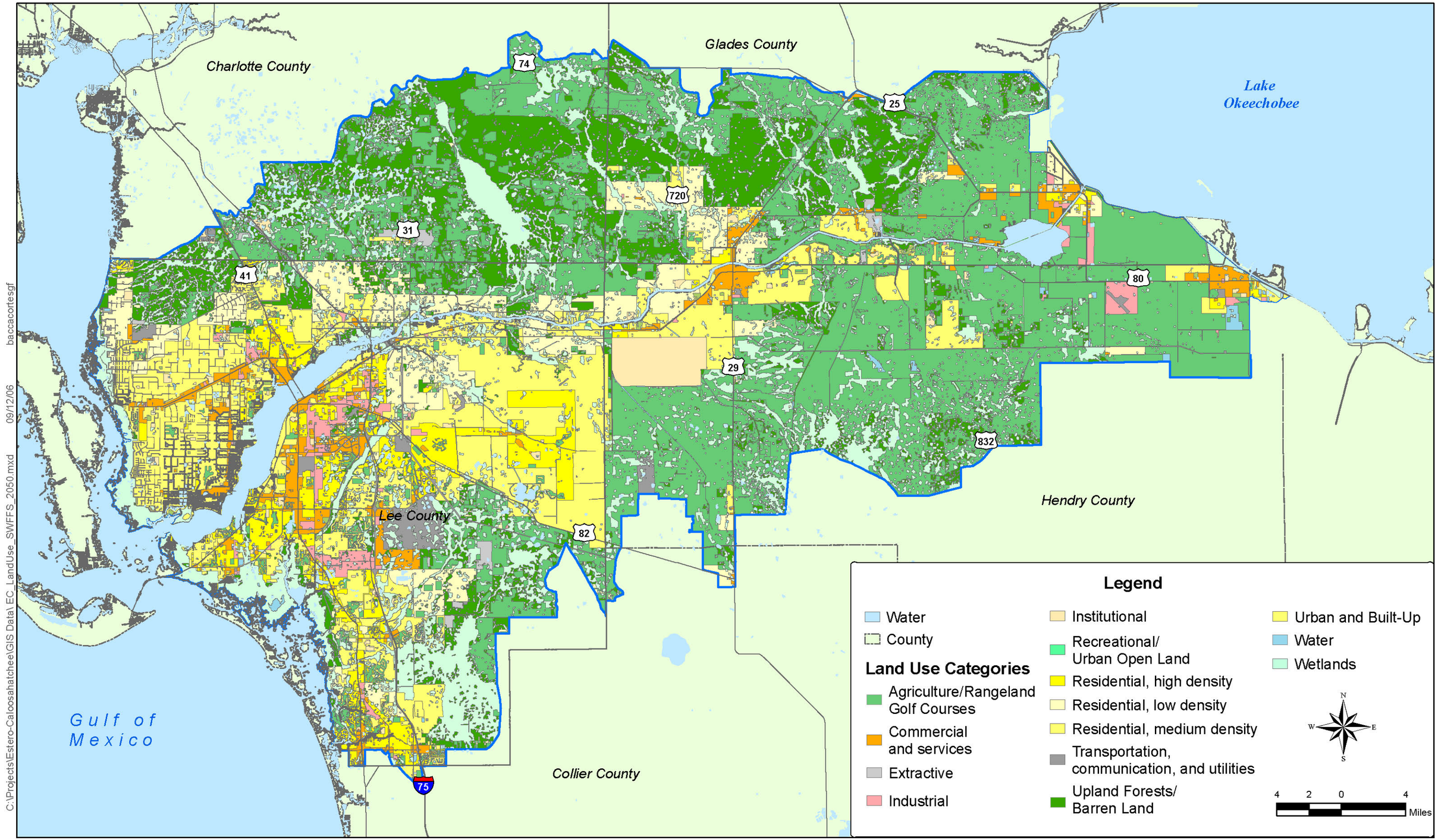

Figure 3-3
2050 SWFFS Land Use Coverage
Project Area

CDM

The distribution of land use for the entire watershed is dominated by agriculture (41.1% of the watershed area) generally located in the East Caloosahatchee Basin, followed by undeveloped land uses such as wetlands (19.9%) and upland forests (19.8%) mostly present in Telegraph Creek Basin, Popash Creek Basin, Daughtrey Creek Basin , and Babcock Basin. Land use categories associated with urban development are more remarkable relative to the watershed area in the Tidal Caloosahatchee and the Estero Bay basins around Fort Myers and Cape Coral, reaching its highest dominance level in the Southeast (92.3%) and Southwest (60.3%) Cape Coral hydrologic units.

Developed land uses in the Estero Bay Basin are concentrated between S.R. 41 and I-75 throughout the basin as well as along Spring Creek and Imperial River, east along Bonita Beach Drive and across the bay to barrier islands.

A rapid urban development is projected for the period 2000-2050. **Table 3-3** provides a summary of the projected changes in the residential and urban non-residential land uses in this period. From this table, the future urban land use will correspond to a 76 percent increase in urban coverage, with a consequent reduction of 21 percent and 28 percent in the existing agricultural and upland forested lands, respectively.

Table 3-3. Projected Changes in Urban Land Use

Land Use Category	Existing Coverage (Year 2000)	Future Coverage (Year 2050)
Residential	9.4%	24.5%
Urban Non-Residential	9.7%	9.1%
Total Urban	**19.1%**	**33.6%**

3.1.3 Topography and Soils

The Study Area is relatively flat with little topographical relief. Topography is available for the Study Area in the format of LiDAR data developed for the Southwest Florida Feasibility Study (SWFFS). **Figure 3-4** shows the LiDAR topographical map for the project area.

Elevations in the Study Area ranges from sea level to a maximum of 75 ft NGVD northwest from LaBelle. Elevations gradually increase away from the coastline and the Caloosahatchee River and peak along the northern boundary of the watershed about halfway between Lake Okeechobee and the tidal river.

Soils surveys for Lee (19894), Charlotte (1984), Hendry (1990), Glades (2000), Collier (1998) and Palm Beach (1978) counties were reviewed for the project. An analysis based on the hydrologic soil group (HSG) classification was performed for the Study Area. The GIS soil coverage files for these counties were obtained for the analysis.

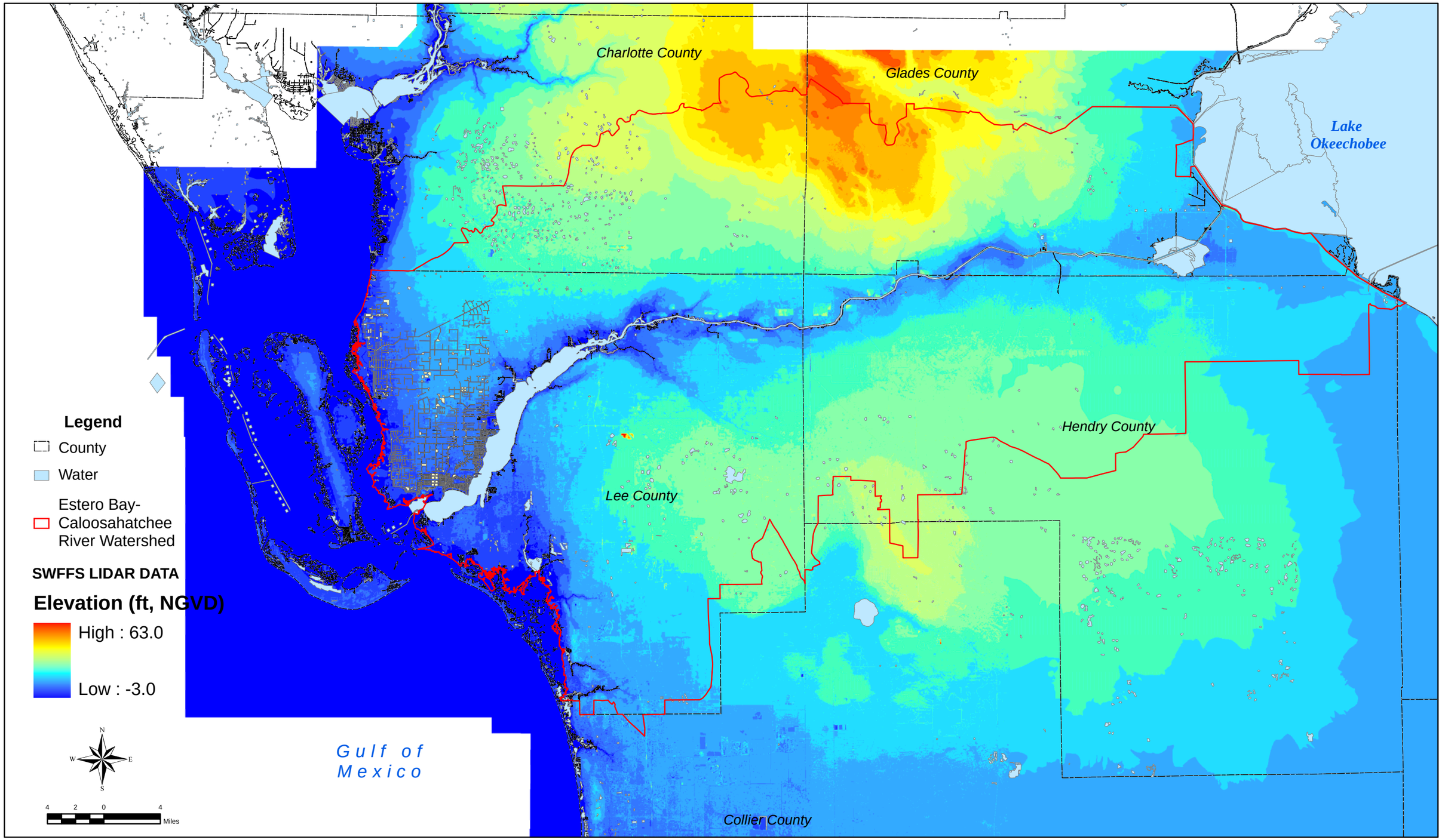

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Figure 3-4
LiDAR Topographic Map
Project Area

They are a digital representation of County Soils Survey Maps published by the United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) as the Soils Service Geographic (SSURGO) data set. **Figure 3-5** shows the soil distribution by hydrologic group. **Table 3-4** presents the soil classification by hydrologic group for each hydrologic unit.

In general, sands are the dominant surficial soil in the watershed. According to the HSG classification B/D and D soil types cover the majority of the Study Area, indicating that low to moderate runoff potential (moderate to high infiltration capacity) predominates in the area during storm events. Less-permeable peat deposits are expected to be found in swamps, marshes, ponds, and sloughs.

3.1.4 Aerial Photography

Natural color aerial photography coverage for the Study Area was obtained from the LABINS website for the year 2004. Lee County areas for which LABINS aerial photography coverage was missing were provided by SFWMD. These latter aerial photographs were taken by USGS in 2005 (JPG format).

3.1.5 BMP Coverage and Efficiency

Ideally, the information to be implemented in the WMM would be areas with BMPs for determination of area served and BMP type to be related to efficiency of pollutant removal for existing conditions. In addition to identifying developed lands with BMPs and types, it is also important to be able to differentiate which developed and undeveloped areas do not have BMPs. However, the information that is available in the SFWMD's database does not allow identifying BMP served areas and types. An alternative procedure was agreed upon during the meeting carried out in the SFWMD's office in Fort Myers on March 7, 2006. Considering that urban BMPs were made part of Southwest Florida stormwater regulations in 1984, a historic land use coverage (1988) was compared with current coverage (2000) to identify new developments that occurred in the study area during this elapsed time. Therefore, the areas defined under these conditions were considered as urban BMP served areas.

A great variety of BMPs are being implemented in agricultural lands in the Study Area, according to personal communication with the National Resources Conservation Service's office in the City of LaBelle. Dan Rutledge, from NRCS, spatially identified these areas in a map to be incorporated as part of an overall BMP tributary area coverage in developed lands depicted in **Figure 3-6.** Agricultural BMPs are incorporated in associated activities namely irrigation, fertilizer management, stormwater management, etc. However, the described coverage does not differentiate from these BMPs, therefore, for the purpose of this study their combined nutrient removal efficiencies are expected to be those for wet detention.

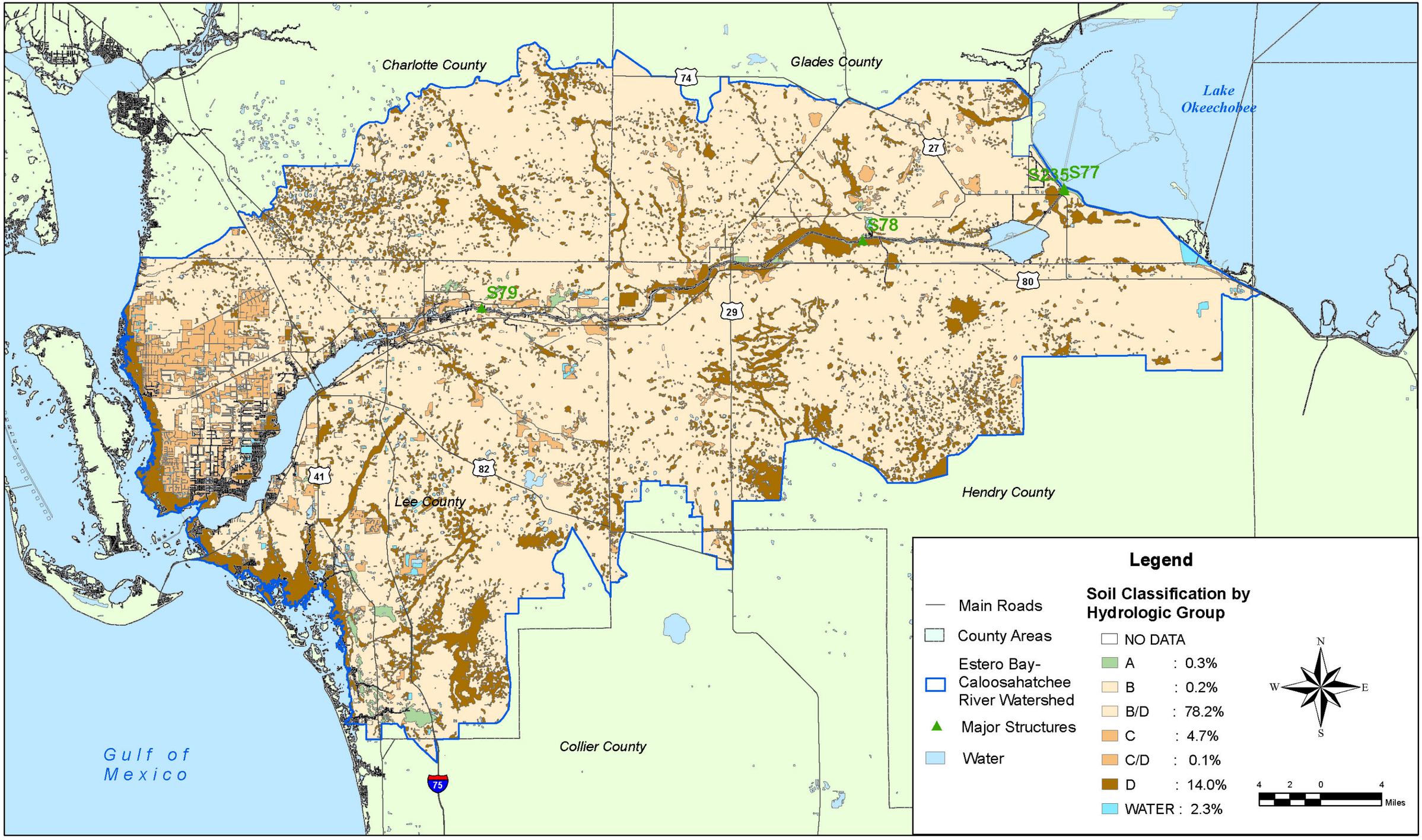


Figure 3-5
Soil Classfication by Hydrologic Group
Project Area

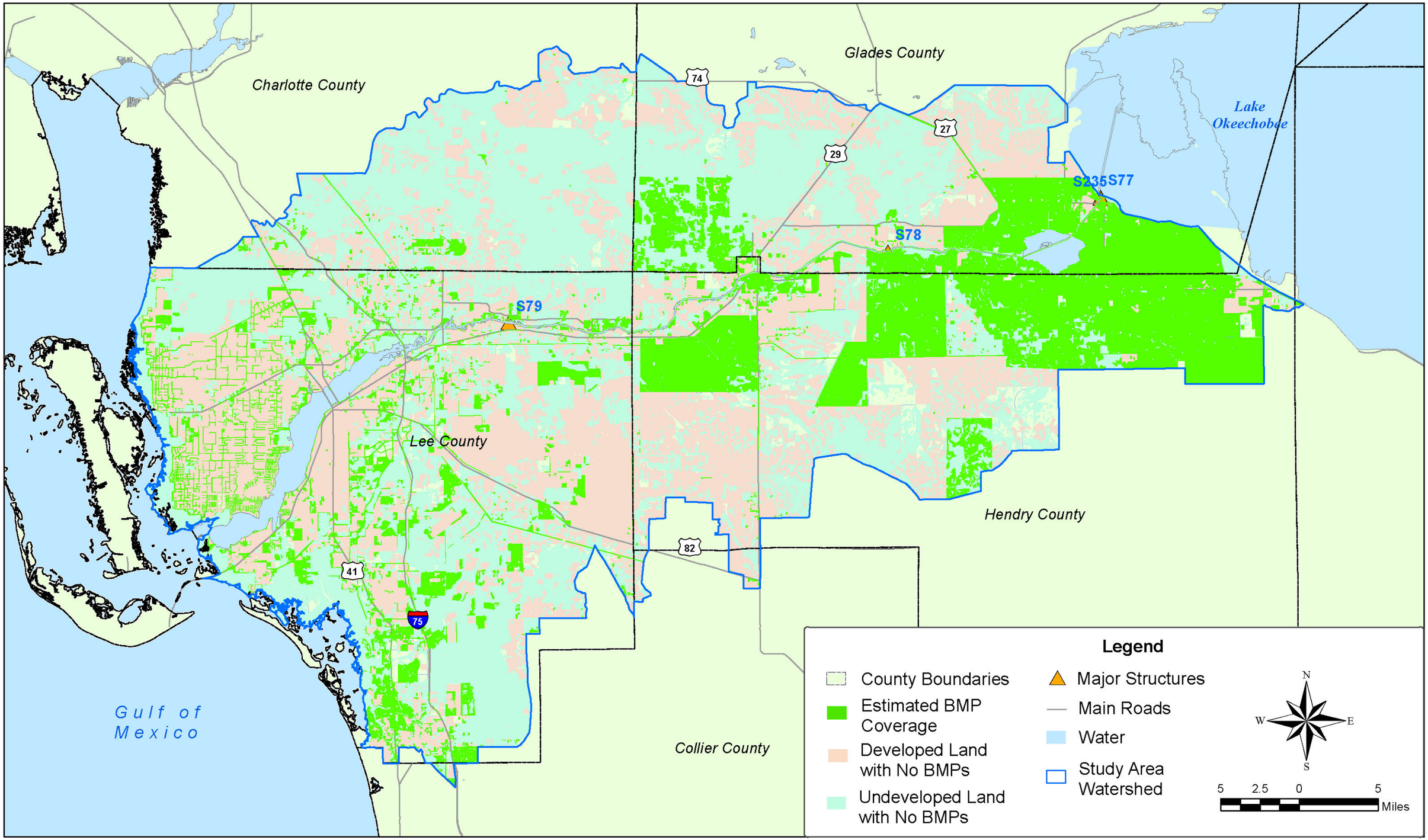
CDM

Table 3-4. Hydrologic Group Soil Classification per Hydrologic Unit

Hydrologic Unit	Hydrologic Group								Total
	NoData	A	B	B/D	C	C/D	D	NA	Area (Ac)
1 . 30-foot Canal	0.0%	15.3%	0.0%	73.5%	0.0%	0.0%	0.0%	11.2%	210
2 . 42-foot Canal	0.0%	0.5%	0.0%	82.7%	0.0%	0.5%	15.6%	0.6%	22,029
3 . Babcock	0.0%	0.0%	0.0%	89.0%	0.0%	0.0%	10.9%	0.1%	13,880
4 . Banana Branch	0.0%	0.0%	0.0%	65.8%	4.4%	0.0%	25.2%	4.6%	2,707
5 . Bayshore Creek	0.0%	0.0%	0.0%	83.1%	3.9%	0.0%	11.4%	1.6%	2,071
6 . Bedman Creek	0.0%	0.0%	3.2%	68.9%	16.4%	1.3%	7.4%	2.7%	3,734
7 . Bee Branch	0.0%	0.0%	0.0%	82.0%	4.0%	1.0%	12.7%	0.3%	22,663
8 . Billy's Creek	0.0%	0.0%	0.5%	87.7%	2.1%	0.0%	7.9%	1.8%	6,732
9 . Blackstone	0.0%	0.0%	0.0%	85.4%	0.0%	0.0%	14.6%	0.0%	695
10 . Bronson	0.0%	4.1%	0.0%	76.1%	0.0%	0.0%	17.0%	2.8%	1,848
11 . C-19	0.0%	0.0%	0.0%	90.1%	7.1%	0.0%	1.6%	1.2%	6,783
12 . C20 Canal	0.0%	0.2%	3.4%	0.6%	0.0%	0.0%	0.0%	95.8%	911
13 . Caloosahatchee South Shore	0.0%	0.0%	2.5%	54.9%	9.4%	0.0%	25.7%	7.5%	6,427
14 . Canal 1	0.0%	0.4%	0.0%	87.4%	0.0%	0.0%	12.0%	0.1%	12,190
15 . Canal 2	0.0%	0.3%	0.0%	86.5%	0.0%	0.3%	12.9%	0.0%	16,664
16 . Canal 3	0.0%	0.2%	0.1%	87.4%	0.0%	0.1%	12.0%	0.2%	31,874
17 . Carrol Canal	0.0%	0.0%	0.0%	60.9%	12.0%	0.0%	27.1%	0.0%	1,075
18 . Chapel Branch	0.0%	0.0%	0.0%	84.2%	0.7%	0.0%	14.8%	0.3%	1,369
19 . Citrus Center	0.0%	1.0%	0.0%	89.6%	2.2%	0.0%	6.1%	1.1%	17,905
20 . City Ditch	0.0%	0.0%	0.7%	63.3%	5.2%	2.8%	24.2%	3.9%	1,521
21 . Clewiston	0.0%	0.0%	1.3%	93.4%	4.1%	0.0%	0.4%	0.7%	4,509
22 . Cohn Branch	0.0%	0.0%	4.7%	82.3%	1.3%	0.0%	10.4%	1.3%	472
23 . County Line Drainage District	0.0%	0.5%	3.7%	79.1%	7.9%	0.0%	5.4%	3.4%	6,155
24 . Cow Creek	0.0%	0.0%	0.0%	31.5%	4.0%	0.0%	60.4%	4.0%	8,165
25 . Cow Slough	0.0%	0.0%	0.0%	87.5%	2.3%	0.0%	10.1%	0.1%	9,192
26 . Crawford Canal	0.0%	0.0%	0.0%	32.5%	0.0%	12.5%	50.6%	4.4%	836
27 . Cypress Branch	0.0%	0.3%	0.0%	88.6%	1.3%	0.0%	9.5%	0.2%	27,329
28 . Cypress Creek	0.2%	3.4%	0.8%	88.7%	1.8%	0.0%	4.5%	0.6%	13,057
29 . Cypress Lakes	0.0%	0.0%	0.0%	51.1%	46.0%	0.0%	0.3%	2.5%	351
30 . Daughtrey Creek	0.0%	0.0%	0.2%	78.1%	4.7%	0.0%	14.0%	3.0%	23,263
31 . Deadmans Branch	0.0%	0.9%	0.0%	82.5%	1.5%	0.0%	14.3%	0.8%	10,437
32 . Deep Lagoon	0.0%	0.0%	0.5%	76.2%	14.9%	0.0%	6.8%	1.6%	1,777
33 . Disston Island WCD	0.0%	1.9%	0.0%	86.4%	0.0%	0.0%	10.5%	1.2%	19,674
34 . Dog Canal	0.0%	0.0%	0.0%	95.7%	2.6%	0.0%	1.4%	0.3%	7,855
35 . Estero River	0.0%	2.1%	0.3%	71.9%	3.3%	0.0%	20.6%	1.8%	39,169
36 . Fichter Branch	0.0%	0.0%	0.0%	87.2%	8.3%	0.0%	3.9%	0.5%	5,508
37 . Flaghole WCD	0.0%	0.0%	0.0%	94.9%	0.0%	0.2%	4.6%	0.3%	23,840
38 . Flint Pen	0.0%	0.0%	0.0%	41.0%	0.0%	0.0%	58.8%	0.2%	9,009
39 . Fort Myers Shores	0.0%	0.0%	0.0%	53.6%	28.4%	0.0%	11.8%	6.2%	2,072
40 . Franklin Run	0.0%	0.0%	0.0%	69.6%	10.6%	0.0%	0.4%	19.4%	324
41 . Ft. Denaud Branch	0.0%	0.0%	0.0%	87.0%	1.2%	0.4%	10.9%	0.5%	7,156
42 . Ft. Simmons	0.0%	0.0%	0.0%	74.8%	0.0%	7.5%	12.0%	5.7%	1,244
43 . Gator Slough	0.5%	0.0%	0.0%	81.0%	2.4%	0.0%	15.8%	0.3%	39,333
44 . Gordon Swamp	0.0%	0.0%	0.0%	63.6%	0.0%	0.0%	36.4%	0.0%	4,806
45 . Grassy Marsh	0.0%	0.0%	0.0%	57.7%	0.0%	0.0%	42.3%	0.0%	2,186
46 . Green Meadows	0.0%	0.0%	0.0%	86.6%	0.0%	0.0%	13.4%	0.0%	17,132
47 . Greenbriar Swamp	0.0%	0.0%	0.0%	76.5%	1.5%	0.0%	19.9%	2.1%	2,490
48 . Halfway Creek	0.0%	4.8%	0.1%	77.0%	0.5%	0.0%	17.1%	0.4%	4,255
49 . Hancock Creek	0.0%	0.3%	4.5%	79.5%	3.4%	0.0%	8.5%	3.8%	3,984
50 . Hendry Canal	0.0%	0.0%	0.0%	82.4%	0.2%	0.0%	17.3%	0.1%	17,127
51 . Hendry Creek	0.0%	0.0%	0.0%	58.4%	3.6%	0.0%	33.2%	4.8%	11,518
52 . Hendry Hilliard WCD	0.0%	0.0%	0.0%	84.3%	1.5%	0.3%	13.8%	0.1%	16,882
53 . Hickey's Creek	0.0%	0.3%	0.4%	88.0%	3.3%	0.0%	5.6%	2.3%	16,963
54 . Hilliard	0.0%	0.0%	0.0%	82.7%	0.0%	0.4%	16.8%	0.1%	26,341
55 . Imperial River	0.0%	8.7%	1.2%	74.8%	1.8%	0.0%	11.0%	2.6%	16,679
56 . Industrial Canal	0.0%	0.0%	0.0%	94.1%	0.0%	0.0%	3.6%	2.3%	9,505

Table 3-4. Hydrologic Group Soil Classification per Hydrologic Unit (continued)

Hydrologic Unit	Hydrologic Group								Total
	NoData	A	B	B/D	C	C/D	D	NA	Area (Ac)
57 . Iona	0.0%	0.0%	0.0%	84.8%	2.7%	0.0%	6.6%	5.9%	3,285
58 . Jack Spratt (Myrtle Slough)	0.0%	2.5%	0.0%	90.0%	0.0%	0.0%	6.0%	1.5%	3,340
59 . Jacks Branch	0.0%	0.0%	0.0%	84.8%	0.2%	0.7%	13.9%	0.4%	46,734
60 . Kickapoo Creek	0.0%	0.0%	0.0%	82.9%	8.4%	0.0%	5.8%	2.9%	956
61 . L-42	0.0%	0.0%	0.0%	94.7%	0.4%	0.0%	4.9%	0.0%	4,829
62 . LaBelle	0.0%	1.7%	0.0%	77.9%	0.8%	1.7%	17.0%	1.0%	2,267
63 . LaBelle East	0.0%	0.0%	1.1%	76.3%	0.2%	2.0%	19.8%	0.6%	17,085
64 . LaBelle Private Drainage District	0.0%	0.0%	0.6%	96.9%	0.0%	0.1%	2.4%	0.0%	17,761
65 . Lake Hicpochee	0.0%	0.7%	0.0%	48.6%	0.1%	0.0%	45.6%	5.0%	10,345
66 . LeHigh SE	0.0%	0.0%	0.0%	81.2%	2.5%	0.0%	16.3%	0.0%	6,055
67 . Linden Pens Marsh	0.0%	1.7%	0.0%	80.7%	7.6%	0.0%	9.0%	1.0%	20,869
68 . Lochmoor County Club	0.0%	0.2%	0.0%	39.2%	49.0%	0.0%	4.5%	7.1%	1,053
69 . Mackeral Canal	0.0%	0.0%	0.0%	97.6%	0.0%	0.0%	2.4%	0.0%	1,369
70 . Manuel's Branch	0.0%	0.0%	0.0%	85.9%	4.3%	0.0%	9.8%	0.0%	885
71 . Marsh Point	0.0%	2.5%	3.7%	75.7%	3.0%	0.0%	13.8%	1.3%	1,961
72 . Meander Ditch	0.0%	0.1%	0.0%	93.0%	4.7%	0.0%	1.6%	0.6%	6,549
73 . Messer	0.0%	0.0%	0.0%	69.9%	0.0%	0.0%	29.9%	0.2%	7,576
74 . Miller's Gulley	0.0%	0.0%	16.2%	75.2%	7.9%	0.0%	0.4%	0.2%	708
75 . Moore Haven	0.0%	6.3%	0.0%	72.4%	0.0%	0.0%	17.6%	3.8%	3,934
76 . Mullock Creek	0.0%	3.2%	3.0%	66.1%	5.0%	0.0%	19.2%	3.5%	7,012
77 . Nicodemus Slough	0.0%	1.6%	0.0%	80.6%	2.4%	0.0%	15.4%	0.1%	17,298
78 . Ninemile Canal	0.0%	0.0%	0.0%	85.4%	0.0%	0.0%	13.2%	1.4%	913
79 . North LaBelle	0.0%	0.0%	3.3%	80.0%	1.8%	1.6%	11.8%	1.5%	7,895
80 . Northcentral Cape Coral	0.0%	0.0%	0.0%	39.5%	53.4%	0.0%	2.0%	5.0%	21,020
81 . Northwest Cape Coral	0.0%	0.0%	0.7%	31.3%	37.1%	0.0%	21.6%	9.3%	11,735
82 . Olga	0.0%	0.0%	1.6%	86.2%	3.8%	0.0%	8.1%	0.3%	2,370
83 . Orange River	0.0%	0.0%	0.1%	84.8%	5.4%	0.0%	8.8%	0.8%	50,340
84 . Otter Creek	0.0%	1.2%	0.0%	50.4%	40.5%	0.0%	5.8%	2.2%	1,051
85 . Owl Creek	0.0%	0.0%	0.0%	83.2%	0.5%	0.0%	15.1%	1.2%	3,870
86 . Palm Creek	0.0%	0.0%	0.8%	94.8%	0.2%	0.0%	2.9%	1.5%	1,969
87 . Panther Island W	0.0%	0.0%	0.0%	90.5%	0.4%	0.0%	9.0%	0.1%	4,393
88 . Park Branch	0.0%	1.1%	0.0%	61.1%	16.5%	0.0%	14.3%	7.0%	877
89 . Piggot Bridge	0.0%	0.0%	0.0%	34.6%	34.0%	0.0%	27.4%	4.0%	586
90 . Piney Point	0.0%	0.0%	0.0%	17.2%	7.3%	0.0%	74.2%	1.3%	357
91 . Polywog	0.0%	0.0%	0.0%	89.4%	1.4%	0.0%	9.1%	0.1%	11,725
92 . Popash Creek	0.0%	0.0%	0.1%	77.4%	0.8%	0.0%	21.4%	0.4%	11,357
93 . Port LaBelle	0.0%	3.0%	0.0%	56.7%	0.9%	0.0%	37.0%	2.3%	3,475
94 . Powell Creek	0.0%	0.0%	0.0%	86.6%	1.9%	0.0%	10.7%	0.8%	8,550
95 . Roberts	0.0%	0.0%	0.0%	70.1%	0.0%	1.4%	28.5%	0.1%	24,499
96 . Six Mile Cypress Slough	0.0%	0.0%	0.0%	77.9%	3.9%	0.0%	16.3%	1.9%	35,579
97 . Southeast Cape Coral	0.0%	0.1%	0.0%	31.7%	45.3%	0.0%	5.1%	17.9%	20,216
98 . Southwest Cape Coral	0.0%	0.0%	0.0%	28.4%	34.6%	0.0%	28.4%	8.6%	17,495
99 . Spanish Creek	0.0%	5.3%	3.7%	69.8%	3.2%	0.0%	14.9%	3.0%	1,140
100 . Spring Creek	0.0%	7.3%	4.9%	63.3%	2.9%	0.0%	20.0%	1.7%	7,084
101 . Stroud Creek	0.0%	0.0%	0.0%	78.9%	1.1%	0.0%	19.4%	0.7%	5,591
102 . Sugarland WCD	0.0%	0.0%	0.0%	95.4%	0.0%	0.0%	4.3%	0.4%	11,202
103 . Telegraph Creek	0.2%	0.4%	0.1%	87.6%	0.2%	0.0%	11.6%	0.1%	39,309
104 . Ten Mile Canal (North)	0.0%	0.0%	0.0%	86.2%	2.1%	0.0%	9.3%	2.4%	7,929
105 . Ten Mile Canal (South)	0.0%	0.0%	0.0%	55.1%	19.2%	0.0%	10.3%	15.4%	838
106 . Thompson Cutoff	0.0%	0.0%	0.0%	48.5%	44.6%	0.0%	4.9%	2.0%	583
107 . Townsend Canal	0.0%	0.0%	0.0%	90.1%	0.0%	1.2%	8.6%	0.0%	20,723
108 . Trout Creek	0.1%	1.6%	0.0%	85.1%	1.2%	0.0%	11.8%	0.1%	18,373
109 . Whiskey Creek	0.0%	1.7%	0.0%	81.4%	7.1%	0.0%	8.5%	1.3%	5,817
110 . Winkler Canal	0.0%	0.0%	0.0%	64.6%	2.0%	0.0%	33.0%	0.4%	977
111 . Yellow Fever Creek	0.0%	0.0%	0.0%	81.1%	7.0%	0.0%	9.9%	2.0%	3,116
Total Area	**0.0%**	**0.3%**	**0.2%**	**78.2%**	**4.7%**	**0.1%**	**14.0%**	**2.3%**	**1,128,710**



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CDM

Figure 3-6
Estimated Existing (2000) BMP Served Areas
Project Area

This figure also presents the areas where no BMPs have been implemented in developed and undeveloped lands. This map was created by intersecting and joining the estimated BMP coverage, and the year 2000 developed and undeveloped land use coverage, accordingly.

The future BMP coverage for the Study Area was developed as described before for the existing scenario, based on that the agricultural BMP coverage (percentage of any given land use) remain the same for the year 2050. **Figure 3-7** depicts the estimated BMP coverage for the year 2050 in the Study Area.

In general, and after consulting different sources and documents, wet detention systems are the type of BMPs comprising the vast majority of permitted and constructed stormwater BMPs in Southwest Florida (Johnson Engineering, 2006). Dry detention systems are less common in the area due to their reduced effectiveness because of high water tables. **Table 3-5** shows the removal efficiencies of common BMPs for different pollutants as presented as part of the Regional Facility BMP Treatment Decision Matrix developed by CDM for the St. Johns River Water Management District (SJRWMD).

Table 3-5. Recommended Values of Average Annual Removal Rates for Common BMPs.

Pollutant	Dry Detention	Wet Detention	Retention and Exfiltration
BOD5	20%	30%	90%
COD	20%	30%	90%
TSS	80%	85%	90%
TDS	0%	30%	90%
Total-P	20%	50%	90%
Dissolved-P	0%	65%	90%
TKN	10%	25%	90%
NO_2+NO_3	0%	35%	90%
Lead	70%	75%	90%
Copper	50%	65%	90%
Zinc	40%	45%	90%
Cadmium	70%	75%	90%

1. CDM et al, 1993 (Appendix B) California Storm Water Best Management Practice Handbooks for the Stormwater Quality Task Force (SWQTF)
2. CDM, 2003, Water Quality Regional Facility BMP Treatment Decision Matrix for the St Johns River Water Management District
3. Hartigan, J., "Retention Ponds (Wet)", Chapter 5 in Urban Runoff Quality Management, WEF Manual of Practice No. 23 and ASCE Manual and Report on Engineering Practice No. 87, Water Environment Federation, Alexandria, VA, 1998.
4. Versar Inc and CDM, 1989, Retention, Detention, and Overland Flow For Pollutant Removal From Highway Stormwater Runoff: Volume II Design Guidelines for the Federal Highway Administrat5ion Office of Research Development and Technology.

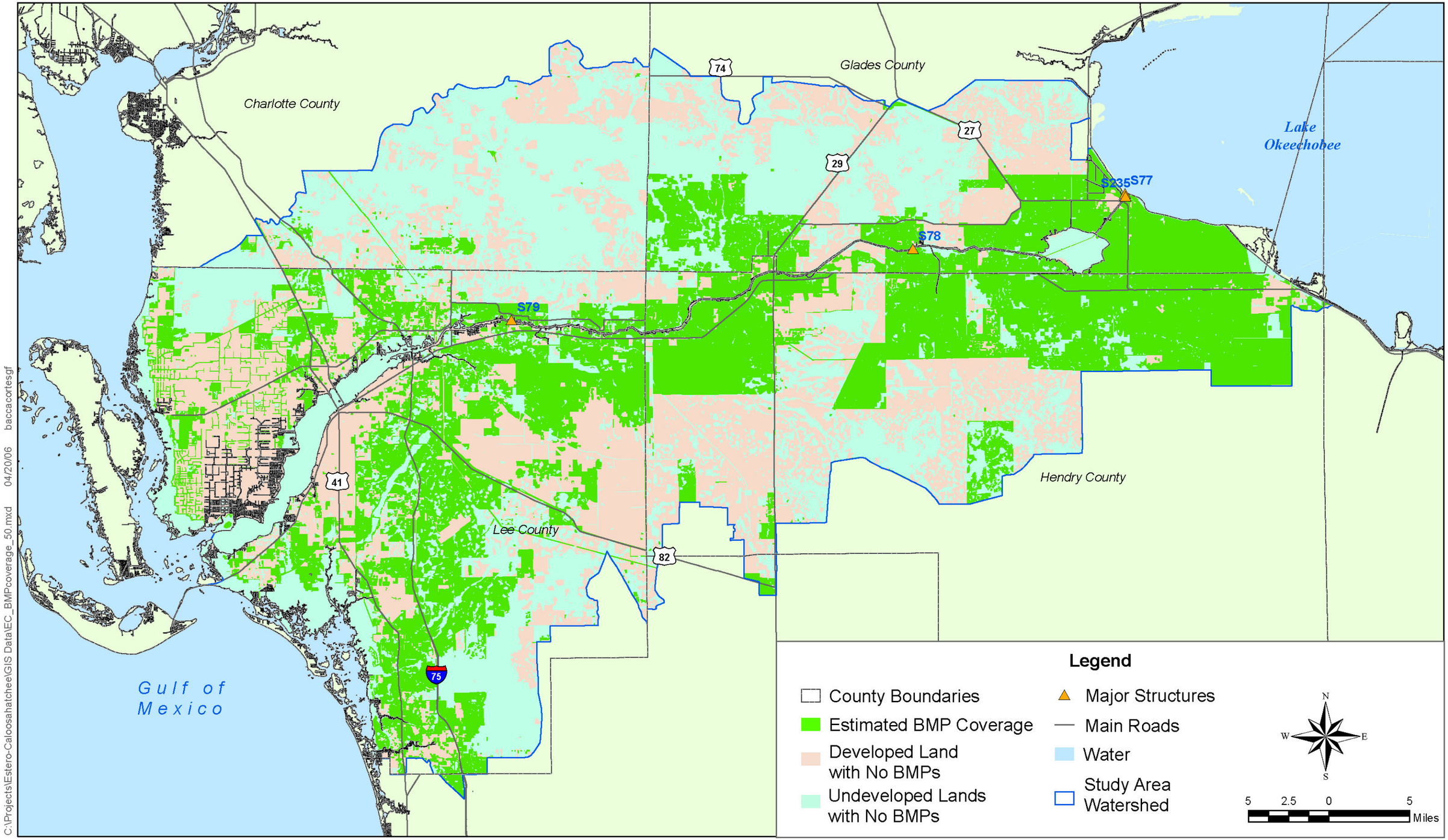

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Figure 3-7
Estimated Future (2050) BMP Served Areas
Project Area

CDM

3.2 Rainfall/Runoff

3.2.1 Average Annual and Monthly Rainfall

Figure 3-8 shows the location of 10 rainfall stations that have been collected for the project. They constitute the set of rainfall stations with a record period that ranges between 15 and 90 years. The data for these stations were collected by NOAA (NCDC), SFWMD, and Lee County's Hydrological Monitoring Program. Three stations stand out in terms of the longest records and location in the watershed: Page Field, Fort Myers (DBKEY: 06193, 88 years of record), LaBelle (DBKEY: 06158, 73 years of record), and HGS1_R, Moore Haven (DBKEY: 06154, 87years of record). Annual rainfall statistics of these three gages are exhibited in **Figure 3-9**.

Applying analysis-of-variance (ANOVA) to the time series of total annual precipitation for these stations, first, to all three and then in pairs, a significant difference between the Page Field (53.8 inches) and HGS1_R (48.4 inches) time series was detected. This difference became not significant (for α=0.05) for the pairs Page Field-LaBelle. These results indicate that precipitation spatially varies along the watershed. The Page Field gage (Fort Myers), unlike the one in Moore Haven, seems to be more influenced by coastal rain from the Gulf of Mexico.

ANOVA analysis was also applied to the group of rainfall stations located in Lee County: 06193 (Page Field, Fort Myers), BS (Bonita Springs Utilities), LF (Lake Fairways), and LP (Lakes Park). Its result suggested that there is no significant difference between their total annual precipitation values for the period 1992-2004. Therefore, the 06193 (Page Field, Fort Myers) station, with the longest record of this group, was used as the representative station for this area.

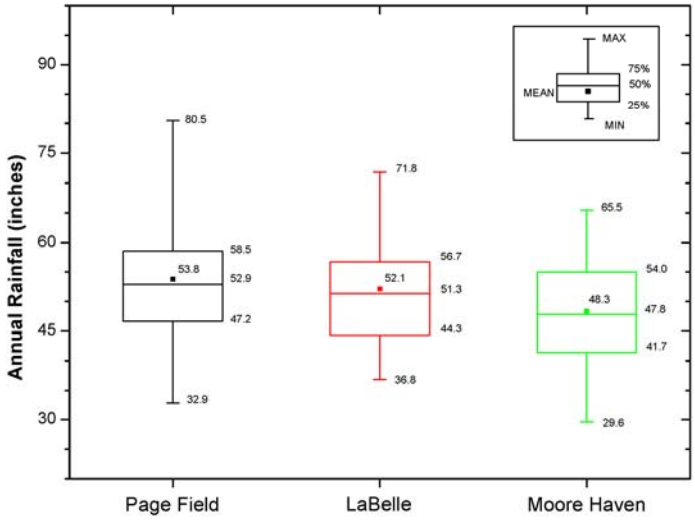


Figure 3-9. Annual Rainfall Time Series Statistics for Stations located at Page Field, LaBelle, and Moore Haven.

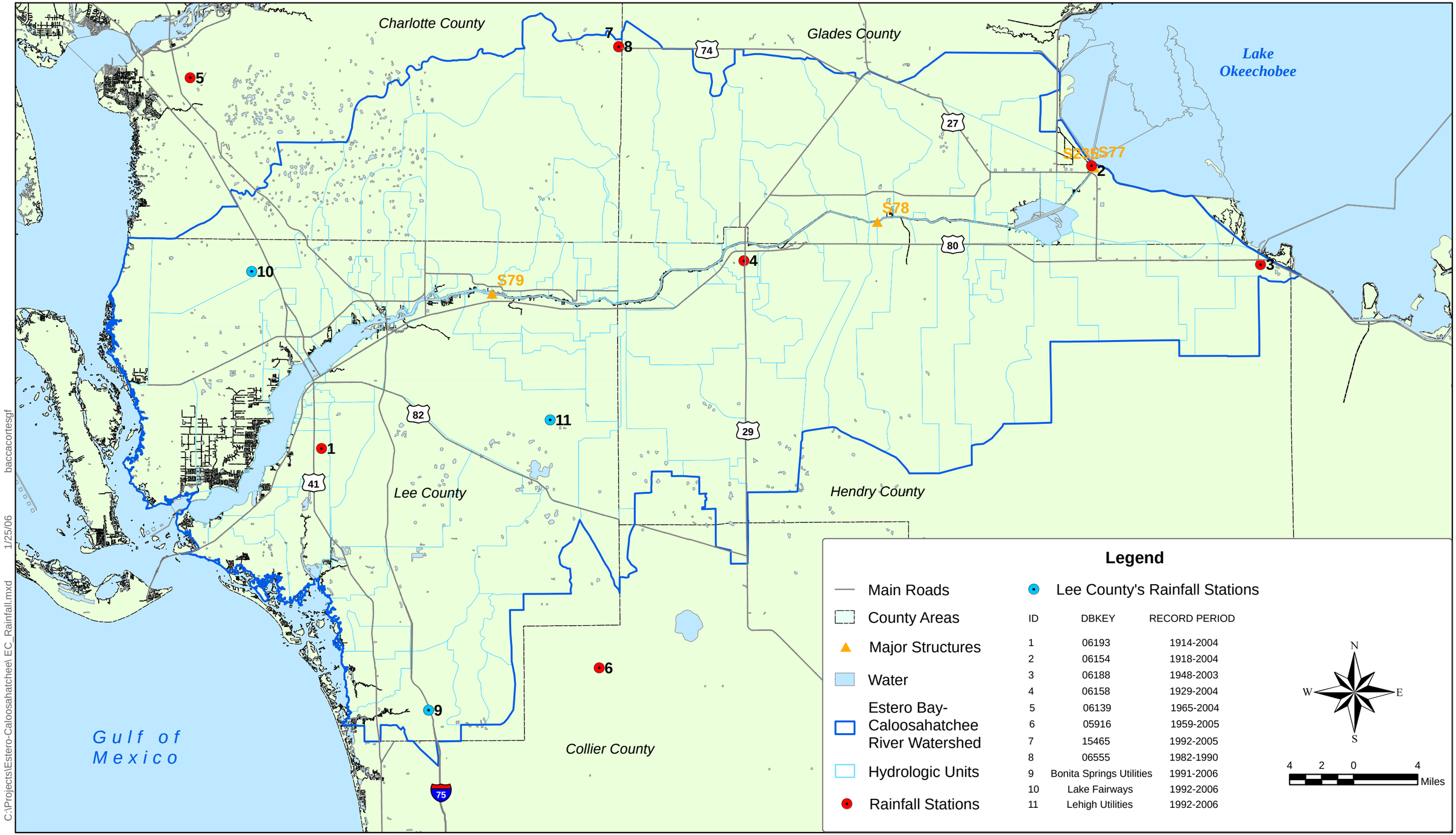


Figure 3-8
Rainfall Gages in the Study Area
Location Map

CDM

Similar results, as the ones described above, have been reported in different studies. Thiessen polygons were used for annual average rainfall in a regional study for Central and South Florida (SFWMD WRE-371, Figure 3-5 pg 13, 1999), where Lee County and west of Lake Okeechobee are defined by different precipitation patterns (polygons). An isohyetal map for the average annual rainfall developed for the Central and South Florida (SFWMD DRE-170 Figure 1 pg 13, 1983) also agrees on the existence of a gradient between inland and coastline annual precipitation values in the Study Area increasing westward from Lake Okeechobee.

In order to represent the annual rainfall variability of the Study Area, the WMM separately evaluated the inland portion of the watershed comprised by the East Caloosahatchee Basin (from S-77 to S-78) using the rainfall gage at Moore Haven (HGS1_R), and the coastal and mid-inland portion of the watershed comprised by the Estero Bay and Tidal Caloosahatchee basins and the West Caloosahatchee Basin (from S-78 to S-79), respectively, using the rainfall gage at Fort Myers (Page Field). The average annual precipitations were incorporated into the WMM as noted in **Table 3-6**.

The WMM evaluates the variability of the loads in a seasonal scale. **Figure 3-10** depicts in a box-and-whisker plot the monthly precipitation variability observed in the selected stations. In addition, average dry and wet seasonal precipitation is provided in Table 3-6 for these stations. From these data, it can be pointed out that the wet season accounts for three-quarters of the total precipitation observed in an average year.

Table 3-6. Average Dry and Wet Seasonal Rainfall at Selected Stations.

Station Located At / Used in WMM Hydrologic Units	Dry Season (Nov-April)	Wet Season (May-Oct)	Annual
Page Field / West Caloosahatchee and Estero Bay-Tidal Caloosahatchee	11.5	42.3	53.8
Moore Haven / East Caloosahatchee	12.0	36.4	48.4

3.2.2 Annual and Monthly Stream Stage and Flow

The SFWMD database (DBHYDRO) was the main source of information for streamflow data. Stations that recorded stage and flow data at different frequencies (daily and random interval) and record periods were initially considered. In addition to the DBHYDRO Database, flow measurements for a period of three years were taken at tributary streams to the Caloosahatchee River with a frequency of one 30-day period in the wet season and one 30-day period in the dry season. This monitoring network was part of the Caloosahatchee Water Quality Data Collection Program (ERD, 2003). However, flow stations to be included in the study as loading calibration points ideally should comply with the following criteria:

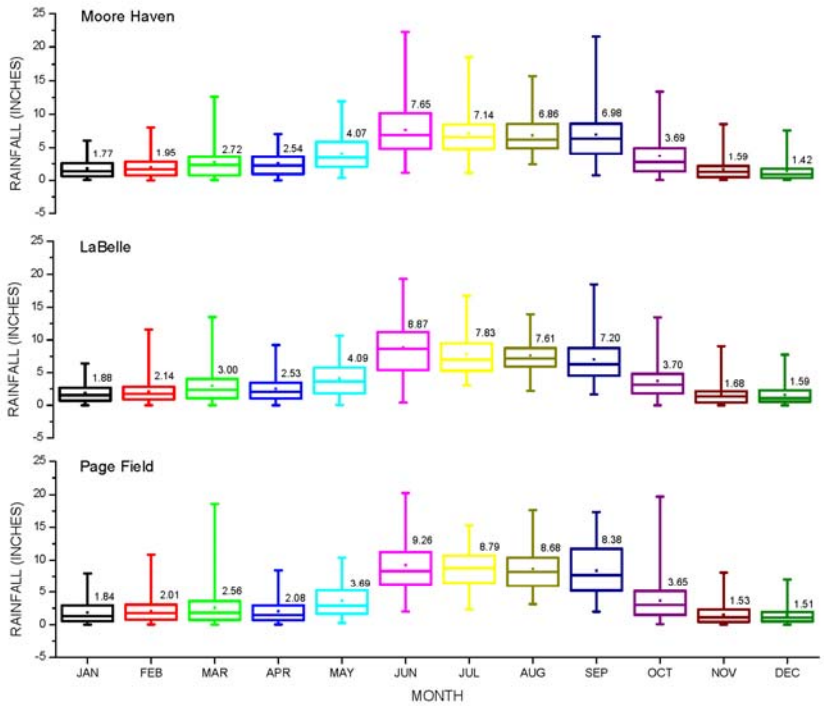


Figure 3-10. Annual Rainfall Distribution for Selected Stations. Monthly Mean Values are shown for Each Month.

- Have at least 5 years of continuous daily flow measurements,
- Be at a location where water quality data is also available for the same flow record period,
- Preferably located at the outlet of a land use-specific hydrologic unit,
- Flow should be unidirectional, (i.e., negative flow values (backflow) are not accepted for loading estimates).

After reviewing all the available flow data in the watershed, few stations fulfill all of these requirements. The C-21 basin, encompassed by S-235, S-4, and Industrial Canal, agriculture–dominated land use and with significant industrial and urban loadings, is characterized by an ambiguous network system where backflow conditions occur throughout the year. The flow recorded at the S4_P station is regulated by a pump, thereby is all positive; however long periods of no flow prevent

using this station as a calibration point for the C20 Canal subbasin. All flow stations in this hydrologic unit with ambiguous flow recorded both positive and negative values regardless of whether wet or dry conditions are present. Backflow conditions also occur in the C-19 basin when receiving water from Lake Hicpochee. If not for the backflow conditions, these hydrologic units were the most likely to be selected for an agriculture-specific loading calibration.

Table 3-7 lists the selected stations in the Study Area. These stations are referenced in **Figure 3-11** using their DBKEY code.

In Table 3-7, undeveloped and developed land uses are well represented by the Gator_S2 and SanCarlo stations, respectively. However, the Estero_N station records drainage from a mixed land use distribution. There were no other flow stations located at a hydrologic unit with either wetland or agriculture dominant land use. The S79_T station constitutes a calibration point that drains over 50 percent of the entire watershed including a mixture of all land uses, but primarily agriculture and undeveloped (upland forests and wetlands).

Table 3-7. Selected Flow Stations for Loading Calibration.

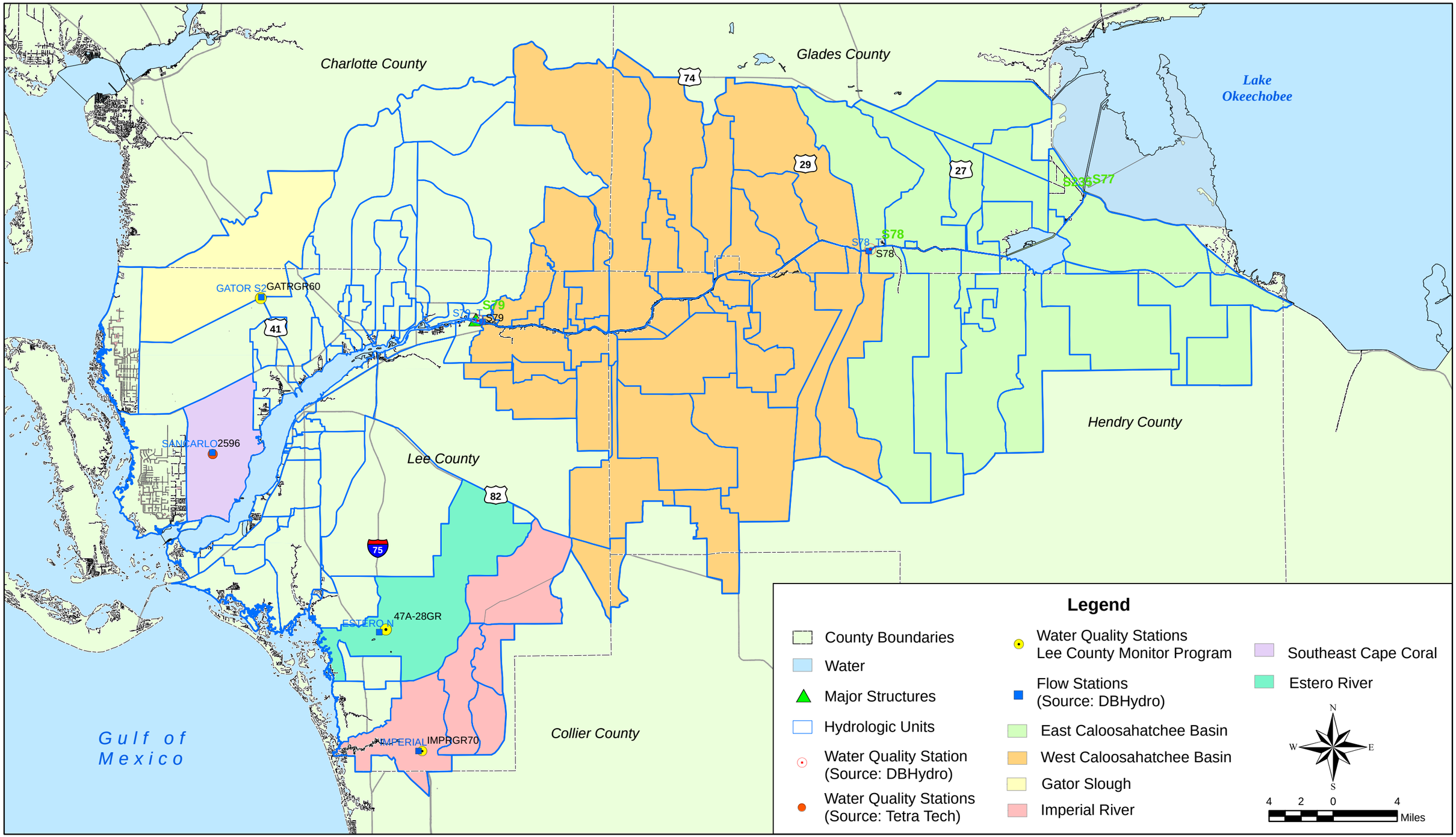
Station Name	Hydrologic Unit	DBKEY	Record Period	Primary Land Use
1. S78_T	East Caloosahatchee	00857	1971-2003	Agriculture (71%) Wetlands (13%)
2. S79_T	West Caloosahatchee	00865	1966-2005	Agriculture (60%) Upland Forests (16%)
3. Gator_S2	Gator Slough	06845	1984-2005	Upland Forest (40%) – Wetlands (30%
4. Imperial	Imperial River	00849	1987-1999	Wetland (68%) – Upland Forest (22%)
5. SanCarlo	Southeast Cape Coral	12797	1986-2005	Urban/Residential (72%)
6. Estero_N	Estero River	12807	1987-1999	Wetland (33%) – Agriculture (21%)

3.2.3 Impervious Cover %

As urban and suburban development increases, the amount of impervious land also increases. Imperviousness is a useful indicator with which to measure the impact that nonpoint source pollution exerts on waterbodies. In general, for developed lands, imperviousness is mostly defined by roadways drainage and rooftops. In **Table 3-8**, land use impervious cover percentage values recommended by CDM for this project, based on references therein, are presented.

3.2.4 Runoff Coefficients

Runoff coefficients were determined based on soil types, land uses, and the estimated amount of runoff volume coming out from a parcel during a storm event. CDM recommends the runoff coefficients listed in **Table 3-9** under the column titled "WMM Composite Value" as a result of the relationship between the recommended pervious and impervious runoff coefficients associated with a particular land use**.**



C:\Projects\Estero-Caloosahatchee\GIS Data\ EC_WQ&FLOW.mxd 02/06/06 baccacortesgf

CDM

Figure 3-11
Selected Water Quality and Flow Stations for Loading Calculations Location Map

However, this list constitutes initial input values to WMM, which are evaluated and adjusted during the calibration process.

Table 3-8. Land Use Impervious Cover Percentage

FLUCCS Code	Land Use Description	% Impervious. (CDM) Range	% Impervious. (ERD, 2003)	Recommended Value (%)
100	Urban	50	--	50
110	Residential Low Density	5 to 15	14.7	10
120	Residential Med. Density	20 to 35	28.1	35
130	Residential High Density	40 to 70	67	65
140	Commercial and Services	80 to 90	91.0-97.5	88
150	Industrial	80 to 90	86.8	75
160	Extractive Mining	50	23	30
170	Institutional	30 to 50	--	38
180	Recreation	1 to 5	--	1
200	Agricultural	0 to 5	0	1
400	Forests	0 to 2	1.5	1
600	Wetlands	10 to 50	0	20
810-830	Transportation	80 to 90	76.6	90

3.3 Watershed Water Quality Data

3.3.1 Event Mean Concentrations

The event mean concentration (EMC) is a measure of stormwater runoff concentration based on the stormwater runoff mass loading and stormwater runoff volume. When multiplied by the runoff volume of a given time period the watershed's pollutant loading for the same time period, can be estimated. Local, state, and out-state sources were examined to define the EMC values to be used in this project. **Table 3-10** identifies the parameters, the EMC values for different land use categories and their references. EMC values reported in ERD (2003) and in the CDM's Southeast US EMC Database were the major sources of stormwater EMC values presented in Table 3-10. Other references cited therein were also considered. Water and wetlands EMCs reported in ERD (2003) were considered after incorporating changes suggested by SFWMD's water quality team.

Table 3-9. Runoff Coefficients for Different Land Use Areas

Description of Area	ERD (2003)[a]	PLSM (2003)[b]	Preliminary WMM Composite Value	Preliminary WMM Impervious Runoff Coefficient	Preliminary WMM/Pervious Runoff Coefficient
Commercial					
Downtown	0.89	0.89	0.85	0.95	0.1
Neighborhood	0.86	0.79			
Residential					
Low Density	0.27	0.34	0.19	0.95	0.1
Medium Density	0.33	0.304	0.40	0.95	0.1
High Density	0.67	0.66	0.65	0.95	0.1
Residential (suburban)	--	0.402	0.53	0.95	0.1
Industrial	0.79	0.79	0.87	0.95	0.1
Mining	0.36	0.3	0.36	0.95	0.1
Agricultural	0.32	0.28	0.11	0.95	0.1
Parks, cemeteries	--	0.21	0.11	0.95	0.1
Playgrounds	--	0.22	0.11	0.95	0.1
Transportation	0.69	0.7	0.87	0.95	0.1
Forestland	0.16	0.206	0.11	0.95	0.1
Wetland	0.225[c]	0.228[c]	0.27	0.95	0.1

[a] Evaluation of Alternative Stormwater Regulations for Southwest Florida, Final Report, Environmental Research & Design, Inc., p. 2-13, 2003.
[b] Proposed Total Maximum Daily Load Development For the Northern and Central Indian River Lagoon and Banana River Lagoon, Florida Nutrients, Chl a and DO, EPA, p 19-20, 2003.
[c] Value for Forested Wetland.

Baseflow pollutant concentrations are expected to be lower than runoff EMC values. Baseflow EMC values should be ideally estimated from undeveloped drainage areas. For this purpose, the Gator Slough monitoring station (Lee County monitoring program) was used to determine these concentrations by selecting those sampling events that occurred during baseflow conditions. **Table 3-11** provides a summary of the baseflow EMC values for the NPDES water quality parameters in consideration.

Table 3-11. Baseflow EMC values.

Parameter	Baseflow Concentration Values (mg/L)
BOD	1.2
COD	7.0
TSS	15.0
TDS	135
Total P (TP)	0.08
Dissolved P (DP)	0.06
TKN	0.72
NOx	0.04
Pb	0.001
Cu	0.001
Zn	0.008
Cd	0.0

Table 3-10. Event Mean Concentrations (mg/L) for Annual Load Calculations per Land Use Category

LAND USE CATEGORY	DCIA(1)	BOD	COD	TSS	TDS	Source	TP	DP(2)	TKN	NO2+ NO3	Source	Pb	Cu	Zn	Cd	Source
Forest/Rural Open	1	1	51	11	100	A,D	0.05	0.004	0.86	0.30	A,B	0.001	0.001	0.000	0.001	J,D
Agricultural/Pasture/Golf Course	1	4	51	13	100	A,D,H	0.64	0.26	2.62	0.56	H,C	0.005	0.004	0.023	0.000	I
Recreational	1	13	71	27	117	J,B,E	0.39	0.24	1.39	0.63	C,B,E	0.016	0.012	0.051	0.002	B,E
Low Density Residential	10	13	71	27	117	J,B,E	0.39	0.24	1.39	0.63	C,B,E	0.016	0.012	0.051	0.002	B,E
Medium Density Residential	35	9	65	59	117	B,E,I	0.39	0.24	1.79	0.55	C,B,E	0.016	0.023	0.073	0.001	B,E
Institutional	38	9	65	59	117	B,E,I	0.39	0.24	1.79	0.55	C,B,E	0.016	0.023	0.073	0.001	B,E
High Density Residential	65	8	53	72	73	B,E	0.37	0.17	1.82	0.63	C,B,E	0.015	0.031	0.065	0.001	B,E
Urban and Built Up	50	10	69	63	120	K	0.37	0.23	1.73	0.52	K	0.017	0.023	0.085	0.001	K
Extractive	30	14	83	77	130	J,E	0.28	0.20	1.47	0.40	E	0.023	0.024	0.132	0.002	J,E
Commercial	88	14	83	77	130	J,E	0.28	0.20	1.47	0.40	E	0.023	0.024	0.132	0.002	J,E
Industrial	75	14	83	77	130	J,E	0.28	0.20	1.47	0.40	E	0.023	0.024	0.132	0.002	J,E
Water/Wetlands	25	2	51	5	100	A,B,G	0.06	0.03	0.72	0.24	A,B,G	0.000	0.000	0.000	0.000	A,B,G
Highways	90	11	99	121	189	J,E	0.40	0.15	1.51	0.61	E	0.040	0.024	0.207	0.002	J,E

Notes

(1) Ag/Golf Course DP estimated from TP as the DP/TP ratio of Forest, Open, Park

(2) Dissolved P concentration for Wetlands and Waterbodied/Watercoursed were estimated as 55 % of the Total P concentrations (Harper, 1992; Florida NPDES data 1992-1993).

(3) TKN and NO2+NO3 concentrations for non-urban land use categories were assumed to be 75 % and 25 % respectively of the TN concentrations (Florida NPDES data 1992-1993)

(4) Average values are derived from parametric statistics with a lognormal distribution. Concentrations reported below the detection limit were assumed to be 50 % of detection limit.

Sources

A - "Estimation of Stormwater Loading Rate Parameters" Table 21. Harvey H. Harper, 1992.

B - "Evaluation of Alternative Stormwater Regulations for Southwest Florida" Table 5, Table 6, and Table 7. Harvey H. Harper, ERD, 2003.

C - "Proposed Total Maximum Daily Load Development For the Northern and Central Indian River Lagoon and Banana River Lagoon, Florida -Nutrients, Chl a and DO" EPA Region 4, Table 7, pg.21, 2003.

D - Nationwide Urban Runoff Program (NURP), 1983.

E - NPDES Part II Stormwater Permit Applications for Sarasota County, Palm Beach County, Jacksonville, St. Petersburg, and Orlando. 1992-93.

F - Washington Metorpolitan Area Urban Runoff Demonstration Project. Northern Virginia Planning District Commission . January 1983, Table 24.

G - Mean wetfall concentration - Tampa NURP Study.

H - Point and Non-Point Source Loading Assessment. Phase II. Sarasota Bay National Estuary Program.

I - CDM Data Compilation of 192 NPDES MS4 Permit Application Results (EMC used - Medium Density TDS)

J - CDM Southeast US EMC Database with 44 Stations in Florida (2001)

K - 80% medium density residential and 20% commercial

3.3.2 Ambient Water Quality Monitoring Data

Several water quality databases have been compiled of surficial waters in the Study Area. Three main sources were chiefly considered: Tetra Tech, DBHYDRO, and Lee County Monitoring Program Databases. Tetra Tech's database consisted of an inventory of most of the water quality monitoring efforts performed in the Southwest Florida region dated before the year 2002. The DBHYDRO and Lee County Monitoring Program databases, also included in Tetra Tech's inventory, were used to complement the period 2002-2005 for stations with ongoing continuous monitoring.

Initially, in order to identify locations that could be used as loading calibration points, water quality and flow stations were sought for each hydrologic unit or group of hydrologic units. Using the selection criteria specified in Section 3.2.2 for the final group of flow stations, this search identified a group of water quality stations at the flow station locations listed in Table 3-7. In **Table 3-12**, selected water quality stations are identified together with their source, record period, and associated flow station.

Their location is shown in Figure 3-11.

Table 3-12. Water Quality and Flow Stations to be Considered as Loading Calibration Locations.

Station Name	Hydrologic Unit	Database	Record Period	Associated Flow Station
1. S78	East Caloosahatchee	DBHYDRO	1979-2006	S-78
2. S79	West Caloosahatchee	DBHYDRO	1981-2006	S-79
3. GATRGR60	Gator Slough	Lee Co. Monitor Program	1990-2005	Gator_S2
4. IMPRGR70	Imperial River	Lee Co. Monitor Program	1990-2003	Imperial
5. 2919 (TT-ID)*	Southeast Cape Coral	Tetra Tech – Cape Coral	1986-2002	SanCarlo
6. 47A-28GR	Estero River	Lee Co. Monitor Program	1992-2005	Estero_N

* TT-ID: Tetra Tech Database ID

All water quality and flow stations are at the same location except for the IMPRGR70 station which is located half a mile downstream from the Imperial flow station. Other sets of stations are separated by longer distances.

A summary of water quality data for parameters of interest is presented in **Table 3-13**. The number of observations per parameter is shown in parenthesis below its mean concentration in the station's record. These are all weather values, no dry-wet separation has been made at this point.

Table 3-13. Mean Concentration Summary for Selected Stations and Parameters of Interest.

Station Name	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	TDS (mg/L)	TP (mg/L)	DP (mg/L)	TKN (mg/L)	NOx (mg/L)	Pb (ug/L)	Cu (ug/L)	Zn (ug/L)	Cd (ug/L)
S78	--	--	4.65 (147)	--	0.13 (161)	0.05 (1)	1.5 (160)	0.27 (162)	0.43 (37)	1.44 (36)	15.7 (36)	0.15 (37)
S79	--	--	3.47 (143)	--	0.14 (158)	--	1.33 (158)	0.4 (158)	0.45 (37)	3.75 (36)	9.9 (37)	0.19 (37)
GATRGR60	1.32 (179)	-	14.9 (179)	--	0.09 (179)	--	0.69 (179)	0.04 (179)	0.9 (172)	1.05 (136)	0.01 (179)	0.3 (23)
47A-28GR	1.51 (91)	--	4.34 (91)	--	0.08 (91)	--	0.57 (91)	0.05 (91)	0.74 (91)	0.7 (91)	0.01 (91)	--
2919 (TT-ID)	1.87 (127)	--	4.79 (154)	--	0.02 (157)	--	0.48 (160)	0.03 (154)	--	--	--	--
IMPRGR70	1.46 (53)		24.6 (53)		0.14 (53)		0.78 (53)	0.10 (53)	3.18 (54)	3.81 (41)	14.0 (54)	0.32 (7)

In order to facilitate the WMM development and calibration, and in concordance with the rainfall variability observed in the Study Area, three modeling areas are defined (see **Figure 3-12**):

- East Caloosahatchee: Including all hydrologic units located between S-77 and S-78. Its associated calibration point and rainfall gage are S-78 and HGS1_R (at Moore Haven), respectively.
- West Caloosahatchee: Including all hydrologic units located between S-78 and S-79. Its associated calibration point and rainfall gage are S-79 and Page Field (at Fort Myers), respectively.
- Estero Bay and Tidal Caloosahatchee: Including all hydrologic units located in the Tidal Caloosahatchee and Estero Bay. There are three calibration point candidates within this modeling area (Gator Slough, Imperial River, and Southeast Cape Coral). The rainfall gage in the Page Field Airport (Fort Myers) was used for this area.

3.4 WWTP Discharges and Septic Tanks

3.4.1 WWTPs Volume and Loading

Point-source pollution has historically come from the millions of gallons of wastewater discharged from the pipes of industrial facilities and municipal sewage treatment plants into rivers, streams, lakes, and the ocean. Their characterization has been the focus of attention since the passage of the 1972 Federal Clean Water Act. For

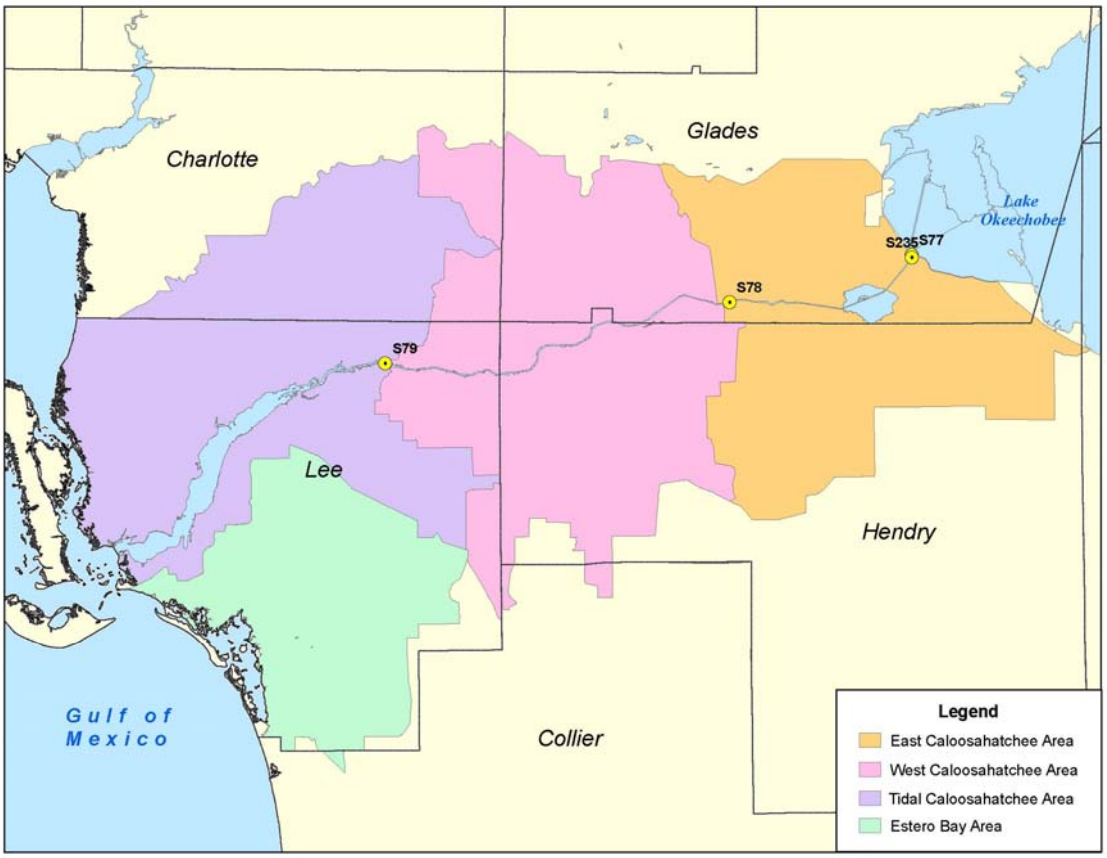


Figure 3.12. WMM Modeling Areas.

this project, measured concentrations at wastewater discharges are necessary to estimate loads for this pollution source and establish a comparison with non-point source pollution. An inventory of NPDES facilities in the Study Area with permitted capacity of 100,000 gallons per day (gpd) or greater are listed in **Table 3-14** together with the hydrologic units in which they are located.

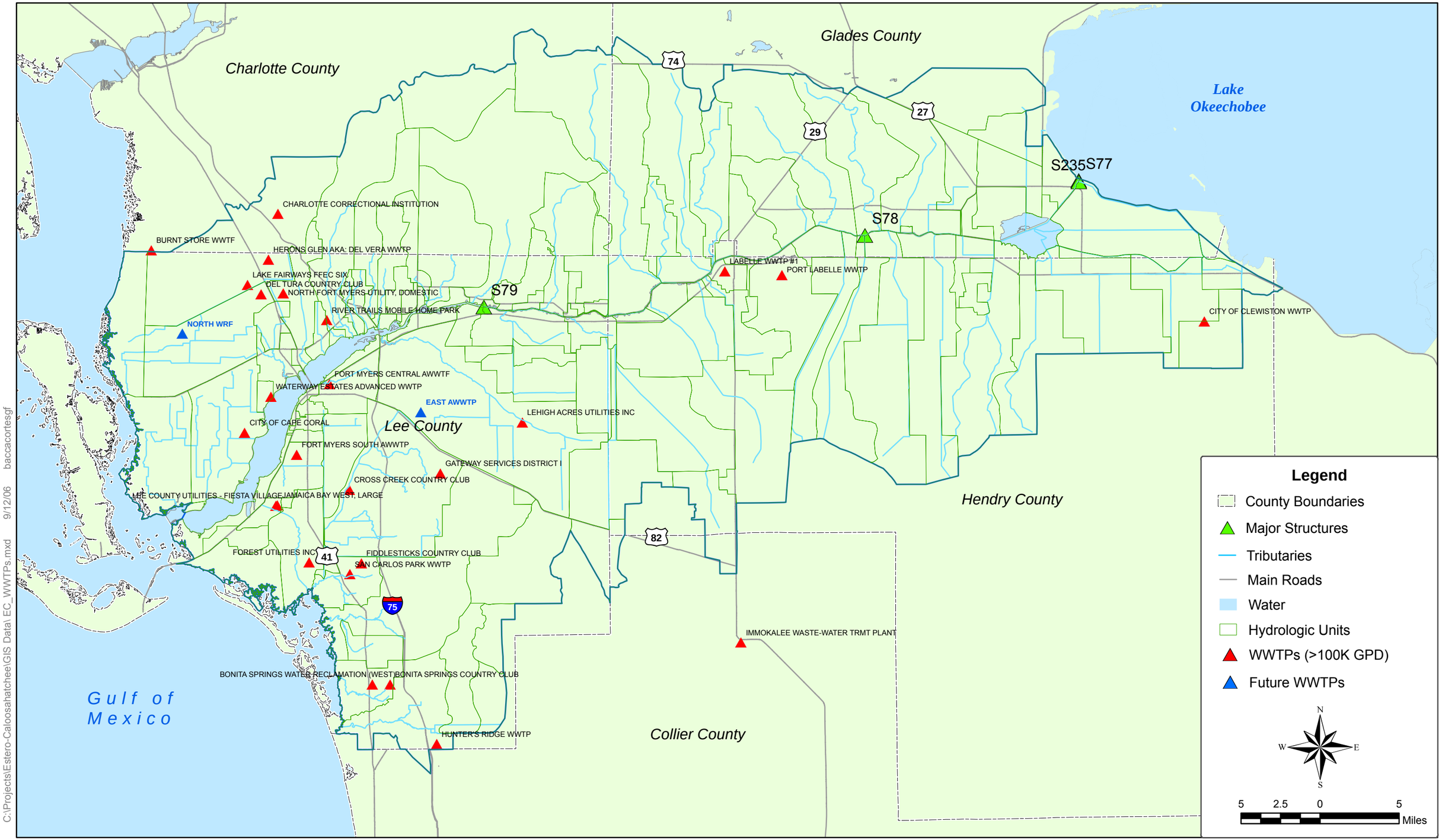
Measured effluent flow and concentration data for municipal WWTPs are available from Monthly Operating Reports (MORs) submitted for each facility to FDEP. Monthly operating reports of the most important facilities were examined for use in estimating the point source pollution contributions of nutrients and metals. Effluent concentrations are also listed in Table 3-14. Three months of wet and dry season of the year 2005 were considered for this estimation (concentration in bold). Discharge permit limits were used for those reports that were not readily available.

The Fort Myers Central and South AWWTP plants are the facilities with the largest capacity in Fort Myers. For future scenarios, their capacities are not enough to treat wastewater for expected demands. Since neither the Central AWWT nor the South AWWTP plant have additional room for plant expansion, the City of Fort Myers will add an additional treatment plant east of Interstate-75 to handle the population growth projected for that area (see Figure 3-2 and **Figure 3-13**). It is planned to be on-

Table 3-14. Wastewater Treatment Plants in the Study Area, Affected Hydrologic Unit and Loading Factor Estimates.

FACILITY	NAME	COUNTY	Installed Capacity (MGD)	Existing Operating Capacity (MGD)	Future Operating Capacity (MGD)	WMM Flow 2000/2050	WMM HUs	BOD (mg/L)	TSS (mg/L)	TDS (mg/L)	TP (mg/L)	TKN (mg/L)	NOX (mg/L)	PB (mg/L)	CU (mg/L)	ZN (mg/L)	CD (mg/L)
FLA014130	CHARLOTTE CORRECTIONAL INSTITUTION	CHARLOTTE	0.18	0.18	0.18	0.72	Gator Slough	5.51	2.94	601	0.30	1.30	3.33	0.0051	0.0022	0.0516	0.0056
FLA014083	BURNT STORE WWTF	CHARLOTTE	0.25	0.25	0.25												
FLA014463	LAKE FAIRWAYS FFEC SIX	LEE	0.16	0.16	0.16												
FLA014618	HERONS GLEN AKA: DEL VERA WWTP	LEE	0.13	0.13	0.13												
FLA014283	LABELLE WWTP #1	HENDRY	0.27	0.27	2.00	0.27 / 2.00	LaBelle	**5.90**	**10.38**	1000	0.50	**0.06**	**0.29**	0.0085	0.0037	0.0860	0.0093
FLA014290	PORT LABELLE WWTP	HENDRY	0.20	0.20	0.50	0.20 / 0.50	LaBelle East	10.00	10.00	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FL0040665	CITY OF CLEWISTON WWTP	HENDRY	1.26	1.26	3.00	1.26 / 3.00	Industrial Canal	**3.53**	**3.82**	1000	**0.12**	**0.46**	**1.39**	0.0085	0.0037	0.0860	0.0093
FL0021261	FORT MYERS CENTRAL AWWTF	LEE	2.00	0.80	2	0.5 / 0.5	Billys Creek	0.50	1.14	160	0.01	0.20	0.03	0.0014	0.0006	0.0138	0.0015
FL0039829	LEE COUNTY UTILITIES - FIESTA VILLAGE	LEE	5.00	3.45	5	14.49 / 26.00	Tidal Caloosahatchee	**Existing (E) and Future (F)**									
FL0021261	FORT MYERS CENTRAL AWWTF	LEE	11.00	6.29	9			2.26 (E)	4.04	896	0.19	2.28	0.49	0.0067	0.0037	0.0877	0.0093
FL0021270	FORT MYERS SOUTH AWWTP	LEE	12.00	6.75	12			2.34 (F)	4.35	916	0.18	2.28	0.49	0.0070	0.0037	0.0873	0.0093
FL0030007	EVEREST PARKWAY WRF	LEE	11.80	15.10	11.8	2.95 / 3.78	Southeast Cape Coral	0.46	0.67	400	0.03	0.20	0.07	0.0034	0.0015	0.0344	0.0037
FL0030325	WATERWAY ESTATES ADVANCED WWTP	LEE	1.50	1.04	1.5	1.04 / 1.50	Lochmoor County Club	**2.69**	**1.49**	1000	**0.21**	**0.78**	**0.27**	0.0085	0.0037	0.0860	0.0093
FLA014658	JAMAICA BAY WEST, LARGE	LEE	0.30	0.18	0.3	0.18 / 0.30	Deep Lagoon	**2.45**	**3.25**	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014442	BONITA SPRINGS COUNTRY CLUB	LEE	0.25	0.25	0.25	4.61 / 7.25	Spring Creek	3.10	1.69	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014443	BONITA SPRINGS WATER RECLAMATION (WEST)	LEE	7.00	4.36	7.00												
FLA014478	FOREST UTILITIES INC	LEE	0.50	0.25	0.5	0.25 / 0.5	Hendry Creek	**2.25**	**0.82**	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014484	FIDDLESTICKS COUNTRY CLUB	LEE	0.15	0.15	0.15	0.37 / 0.37	Mullock Creek	10.00	10.00	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014560	SAN CARLOS PARK WWTP	LEE	0.22	0.22	0.22												
FLA014498	EAGLE RIDGE WWTP	LEE	0.35	0.29	0.35	0.86 / 1.21	Six Mile Cypress Slough	**Existing (E) and Future (F)**									
FLA014505	CROSS CREEK COUNTRY CLUB	LEE	0.24	0.07	0.24			1.44 (E)	0.78	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014542	GATEWAY SERVICES DISTRICT I	LEE	0.62	0.50	0.62			1.93 (F)	0.90	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014541	HUNTER'S RIDGE WWTP	LEE	0.10	0.10	0.1	0.1 / 0.1	Imperial River	2.51	2.66	1000	0.50	2.25	0.75	0.0085	0.0037	0.0860	0.0093
FLA014548	NORTH FORT MYERS UTILITY, DOMESTIC	LEE	1.70	0.57	1.7	0.71 / 1.90	Powell Creek	1.81 (E)	1.00	1000	0.50	2.12	0.71	0.0085	0.0037	0.0860	0.0093
FLA014563	DEL TURA COUNTRY CLUB	LEE	0.20	0.14	0.2			1.89 (F)	1.04	1000	0.50	2.18	0.73	0.0085	0.0037	0.0860	0.0093
FLA014676	RIVER TRAILS MOBILE HOME PARK	LEE	0.10	0.06	0.1	0.06 / 0.10	Daughtrey Creek	**4.31**	**5.25**	1000	0.50	**4.13**	**1.38**	0.0085	0.0037	0.0860	0.0093
FLA014565	LEHIGH ACRES UTILITIES INC	LEE	1.48	1.24	1.48	1.24 / 4.48	Orange River	3.08 (E)	1.81	1000	0.50	0.83	0.55	0.0085	0.0037	0.0860	0.0093
FUTURE	EAST AWWTP -FORT MYERS	LEE	NA	NA	12			3.70 (F)	3.28	598	0.30	0.88	0.38	0.0051	0.0022	0.0514	0.0056
FUTURE	NORTH WRF -CAPE CORAL	LEE	NA	NA	18	NA / 4.5	Northcentral Cape Coral	4.00	4.00	400	0.20	0.90	0.30	0.0034	0.0015	0.0344	0.0037

Notes: 1. Maximum allowed concentrations for discharge were used for parameters not reported in the WWTPs MORs. Measured concentrations are bolded.
2. A flow weighted concentration was used for those hydrologic units with two or more WWTPs.
3. Future concentrations were determined based on projected treatment expansion capacities.
4. Reclaimed application flows and factors for land application were weigthed based on flow with the non-reclaimed flow to determine the concentration to be applied on the hydrologic unit, using the expression: C = 10% (Qr x Ce)/Qa;
where, Qr: reclaimed flow; Ce: effluent concentration; and Qa: land applied flow (interflow) = 25%Qa



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CDM

Figure 3-13
Wastewater Treatment Plants
Project Area

line by 2009 with a recommended initial capacity of 8 mgd that will be expanded to 12 mgd by 2018. The East AWWTP will be 100 percent reclaimed water and be affecting primarily the Orange River Hydrologic unit after 2009. Reclaimed water application is included into WMM by accounting for the reduction in terms of both flow and concentration due to infiltration and transport before reaching the waterbody. Reduction percentages of 75 percent and 90 percent were applied in this project to flow and concentration, respectively, to the expected effluent values of the WRF.

Planning and future scenarios analyses of the City of Fort Myers are limited to the year 2024 (City of Fort Myers, 2005). As per Lee County, the wastewater facility coverage will be increased from 82 percent in 2000 to 86 percent in 2020 (RIDS Master Plan Report, 2002).

The City of Cape Coral is accelerating the schedule for expanding its treatment systems including the wastewater facilities. The Everest Water Reclamation Facility's (WRF) expansion will be completed by 2008 with a final capacity of 10 mgd. This WRF facility shares the NPDES discharge permit with the Southwest WRF plant located in the Southwest Cape Coral hydrologic unit. Their effluents are combined before discharging to the Caloosahatchee River. A North WRF is planned to be online by 2020 with an initial capacity of 4.5 mgd and with a total expansion capacity of 18 mgd. This new facility will be affecting the Northcentral Cape Coral hydrologic unit. This new WRF will be producing 100 percent reclaimed water. Similar flow and concentration reduction factors were applied to these WRFs as described above for the East AWWTP.

The Port LaBelle WWTP serves the area within Port LaBelle, which is a neighborhood in unincorporated Hendry County on the east side of the City of LaBelle. The plant is small and there are no plans to update its capacity. The City of LaBelle will significantly expand its city limits to the southwest where The Bonita Bay Group is planning a 5,000 acre urbanization project. The existing capacity of the plant is 0.27 mgd.

The City of Clewiston's WWTP is currently being upgraded to double its permitted capacity of 1.5 mgd to 3.0 mgd, to account for the development that will take place during a 20-year planning horizon, at the end of which (year 2026) the plant is estimated to be working at full capacity.

When information on planned expansions was not available, it was considered that the WWTPs will work at their full capacity. All the planned expansions discussed above were incorporated in WMM as part of the future scenario.

3.4.2 Septic Tanks Service Area/Failure Rate and Concentrations

Septic tanks, also referred to as onsite sewage treatment and disposal systems (OSTDS), are a frequently used method of wastewater treatment and disposal. OSTDS can be effective in removing organic matter, bacteria and nutrients. Proper design, construction, maintenance, and operation are usually required for proper

functioning of these systems. However, conditions that can interfere or prevent the proper functioning of OSTDs include unsuitable soils, high water tables, system under-design and improper maintenance or use. When these conditions exist, the level of treatment may be insufficient to protect the water quality of receiving waterbodies. Typically, a 10 percent failure rate has been used to represent that portion of installed septic systems that due to their malfunctioning, is impacting waterbodies.

Records of new annually installed septic tank systems per county are kept by the State of Florida Department of Health (DOH). In **Table 3-15**, the number of septic tanks installed since the 1970 census and the expected number of septic systems in the watershed based on a county area-weighted estimation are presented.

Table 3-15. Estimates of Septic Tanks per County and in the Study Area.

County	Number of Septic Tanks in the Entire County (2005)	Estimated Number of Septic Tanks in Study Area
Lee	104,821	99,817
Charlotte	39,640	13,004
Hendry	9,465	3,738
Glades	4,815	1,728

Using a GIS coverage of Lee County's current WWTP served areas provided by the SFWMD; low, medium, and high residential areas that rely on septic tank systems were identified for this County. For the cities of Clewiston and LaBelle, residential areas relying on septic tank systems were spatially identified by contacting their Utilities Directors and Engineering Consultants that are currently working on both the sewer network and WWTP improvements. **Figure 3-14** depicts the existing septic tank coverage for the Study Area.

Urban growth in the future will occur in the vicinities of the existing urban areas. Regardless of the amount of development, there will always be areas that will not be covered by the sewer network. For the future scenario, in order to identify residential areas using septic tanks, it was assumed that the total extension of the WWTP franchise areas will be sewered; thereby the remaining residential developments will be on septic systems. For the cities of Clewiston and LaBelle, where there is either uncertainty or lack of information for the year 2050 future scenario, the septic tank coverage, that in the WMM is expressed in percentage of residential land use, was assumed to remain the same as in the year 2000 (existing scenario). This latter consideration implies that the percentage of a given residential land use on septic tank is not necessarily spatially located in the same area as in year 2000 but somewhere else within the hydrologic unit. **Figure 3-15** depicts the future septic tank coverage for the Study Area, where changes with respect to the year 2000 coverage have been included for Lee County only.

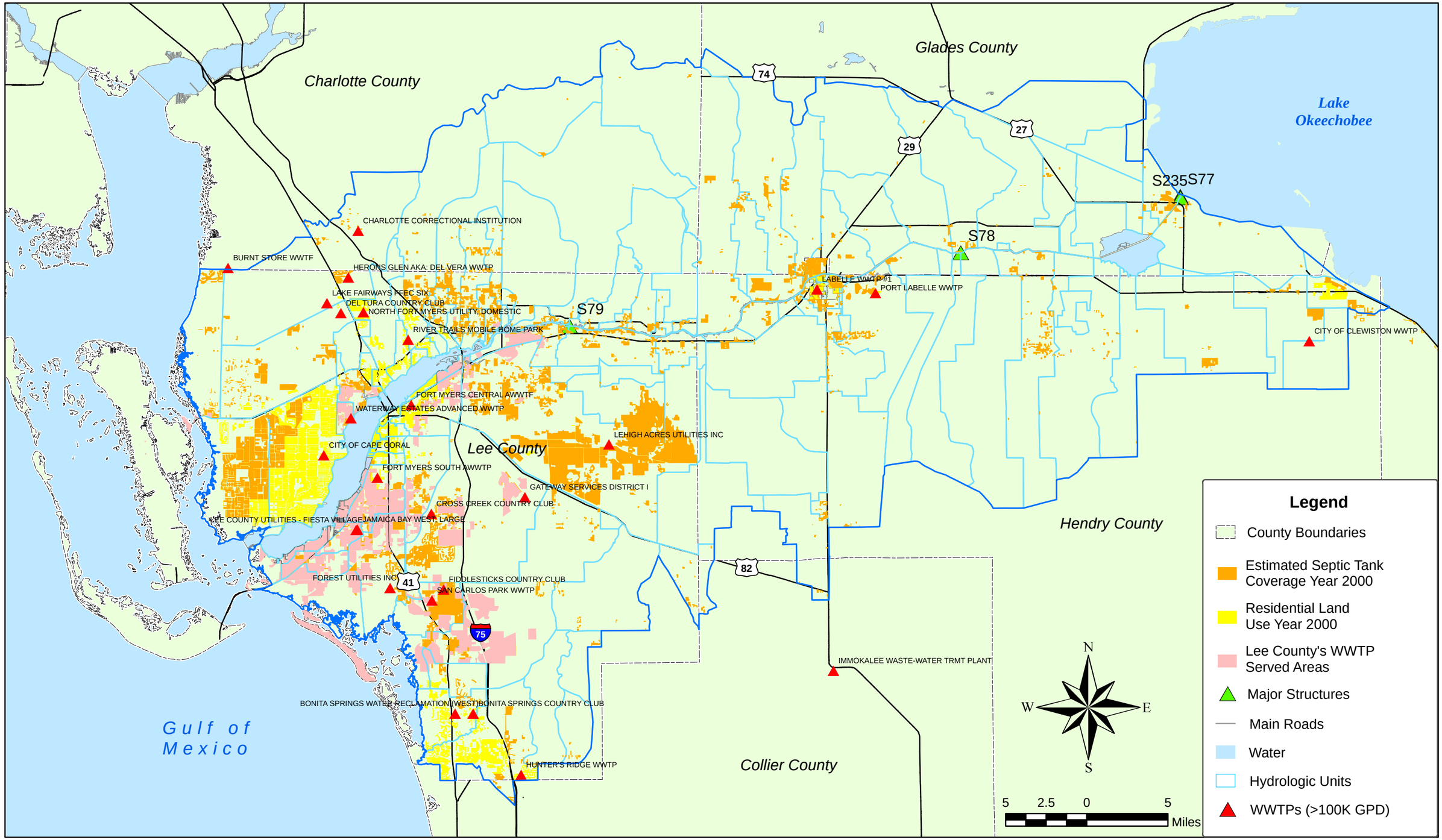

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Figure 3-14
Estimated Septic Tank Coverage Year 2000
Project Area

CDM

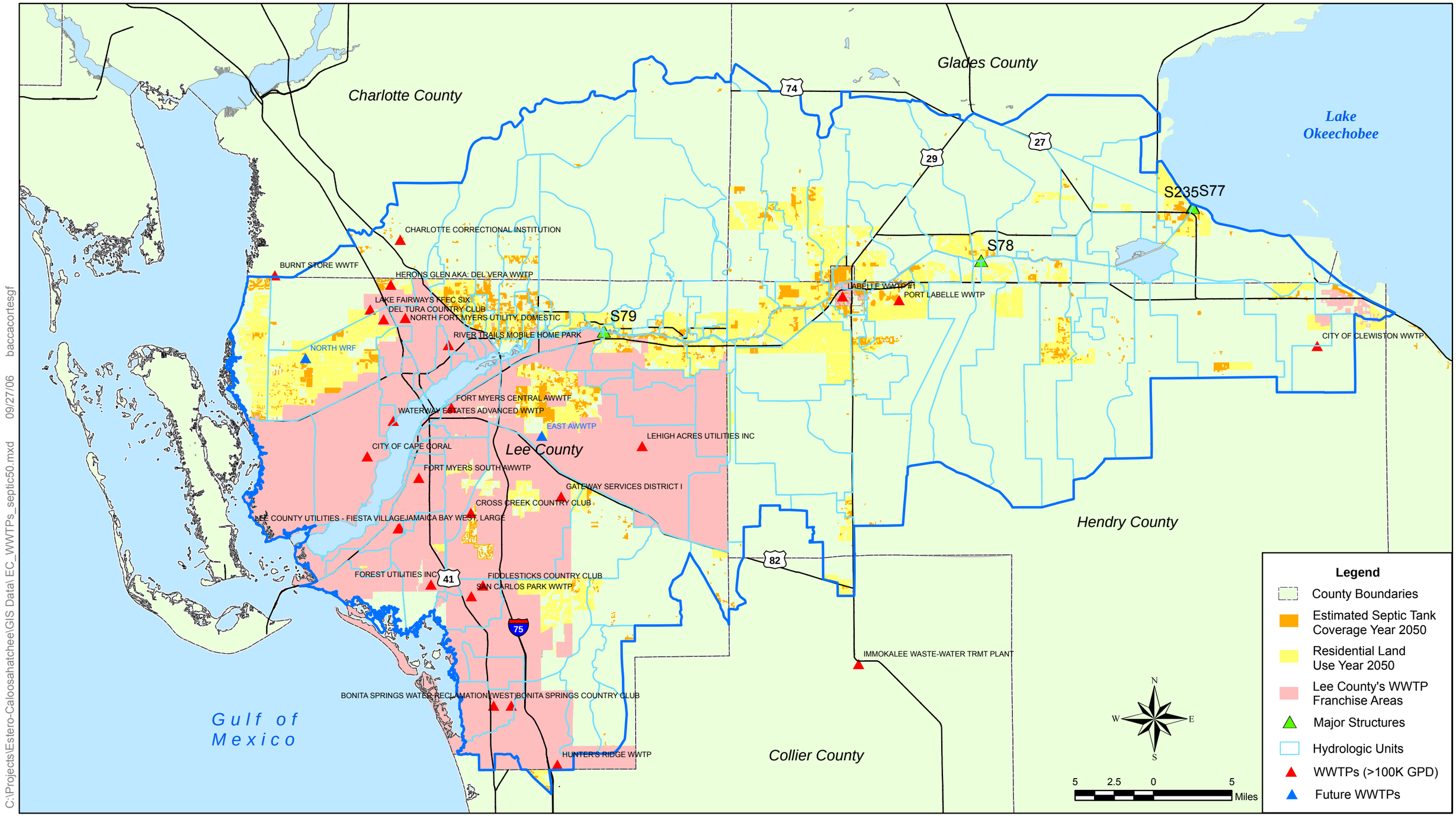

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Figure 3-15
Estimated Septic Tank Coverage Year 2050
Project Area

3.5 Delivery Ratio and Travel Time

The WMM model estimates the runoff loads delivered at the hydrologic unit outlet. In large watersheds, it is anticipated that some fraction of the runoff load is not delivered to the watershed outlet due to settling during its routing through the channel network. The WMM model uses a "delivery ratio" to account for this reduced load at the outlet. It can be set to a value of less than 1 (100 percent delivery). In addition, delivery ratios can be used as a calibration parameter.

Travel time has been used in past studies as an approach to assign delivery ratios to hydrologic units in the watershed. To hydrologic units with travel times greater than a threshold value (e.g. 12 to 24 hours), less than 1 delivery ratios are assigned between 0 and 1. An estimation of travel time is usually done by using the Manning's equation based on channel geometry and slope and a relatively simple estimation of storm flow (e.g., rational method).

A delivery ratio of 1.0 was used for the preliminary application of WMM to the Study Area. This delivery ratio is only related to the travel time within the hydrologic unit (i.e., to its outlet). Delivery ratio values to the hydrologic unit outlet and to calibration points are refined during the model calibration task (Task 4).

Section 4
Task 3. Application of the Watershed Management Model to the Study Area

This section provides a description of WMM, and its application to the Estero Bay and Caloosahatchee River Watershed. CDM applied the WMM to the Study Area for existing (year 2000) and future (year 2050) land use conditions. These simulations included flows and loads from Lake Okeechobee, baseflows, point sources, septic tanks, and stormwater runoff. The stormwater flows and loads consider existing and future required BMPs for current criteria under Chapter 40E-4 FAC. These results do not yet include delivery ratio reduction for in system decay and attenuation, which are refined during the calibration process.

4.1 Watershed Management Model (WMM) and Application to the Study Area

WMM uses a simple database to estimate average annual and seasonal (wet/dry) flow volumes and pollutant loads from many available data sources within a watershed. Input data required by WMM include stormwater EMCs for each pollutant type and land use, land use and associated level of imperviousness, pervious and impervious runoff coefficients, areas served by septic systems and septic system failure rates, average annual and seasonal precipitation, annual/seasonal baseflow rates and average baseflow concentrations, wastewater treatment plant (WWTP) point source flows and pollutant concentrations, BMP types and associated efficiencies, and the areal extent of BMPs implemented throughout the watershed.

WMM does not directly simulate physical, chemical, and/or biological growth or decay; however, these phenomena are approximated by using a pollutant delivery ratio that ranges from 0 to 1 as a WMM input parameter to account for the reduction in stormwater runoff pollutant loads due to settling and other instream processes in the channel system. WMM also estimates stormwater runoff pollutant load reductions due to partial or full-scale implementation of alternative management strategies (combinations of source and treatment storm water BMPs) to aid in the development of proposed watershed management plans.

Significant spatial variation in rainfall amounts across the Study Area made it necessary to divide the single Estero Bay-Caloosahatchee River Watershed into three discrete sub-watersheds with dissimilar average annual rainfall amounts. WMM was then applied to each of the three sub-watersheds. To facilitate quick identification, the sub-watersheds were named East Caloosahatchee, West Caloosahatchee, and Estero-Tidal Caloosahatchee. **Tables 4-1** through **4-3** present the three sub-watersheds by assigned name, and the specific hydrologic units that belong in each sub-watershed, respectively.

Table 4-1 East Caloosahatchee Sub-watershed

Hydrogic Unit Name
1 . 30-foot Canal
2 . 42-foot Canal
10 . Bronson
11 . C-19
12 . C20 Canal
16 . Canal 3
19 . Citrus Center
21 . Clewiston
33 . Disston Island WCD
37 . Flaghole WCD
45 . Grassy Marsh
52 . Hendry Hilliard WCD
54 . Hilliard
56 . Industrial Canal
58 . Jack Spratt (Myrtle Slough)
61 . L-42
65 . Lake Hicpochee
67 . Linden Pens Marsh
72 . Meander Ditch
75 . Moore Haven
77 . Nicodemus Slough
78 . Ninemile Canal
102 . Sugarland WCD

Table 4-2 West Caloosahatchee Sub-watershed

Hydrologic Unit Name
4 . Banana Branch
6 . Bedman Creek
7 . Bee Branch
14 . Canal 1
15 . Canal 2
20 . City Ditch
23 . County Line Drainage District
25 . Cow Slough
26 . Crawford Canal
27 . Cypress Branch
28 . Cypress Creek
31 . Deadmans Branch
34 . Dog Canal
36 . Fichter Branch
40 . Franklin Run
41 . Ft. Denaud Branch
42 . Ft. Simmons
47 . Greenbriar Swamp
50 . Hendry Canal
53 . Hickey's Creek
59 . Jacks Branch
62 . LaBelle (With WWTP)
63 . LaBelle East
64 . LaBelle Private Drainage District
66 . LeHigh SE
69 . Mackeral Canal
73 . Messer
74 . Miller's Gulley
79 . North LaBelle
88 . Park Branch
91 . Polywog
93 . Port LaBelle (With WWTP)
95 . Roberts
99 . Spanish Creek
107 . Townsend Canal

Table 4-3 Estero-Tidal Caloosahatchee Sub-watershed

Hydrologic Unit
3 . Babcock
5 . Bayshore Creek
8 . Billy's Creek
9 . Blackstone
13 . Caloosahatchee South Shore
17 . Carrol Canal
18 . Chapel Branch
22 . Cohn Branch
24 . Cow Creek
29 . Cypress Lakes
30 . Daughtrey Creek (With WWTP)
32 . Deep Lagoon (With WWTP)
35 . Estero River
38 . Flint Pen
39 . Fort Myers Shores
43 . Gator Slough (With WWTP)
44 . Gordon Swamp
46 . Green Meadows
48 . Halfway Creek
49 . Hancock Creek
51 . Hendry Creek (With WWTP)
55 . Imperial River (With WWTP)
57 . Iona
60 . Kickapoo Creek
68 . Lochmoor County Club (With WWTP)
70 . Manuel's Branch
71 . Marsh Point
76 . Mullock Creek (With WWTP)
80 . Northcentral Cape Coral
81 . Northwest Cape Coral
82 . Olga
83 . Orange River (With WWTP)
84 . Otter Creek
85 . Owl Creek
86 . Palm Creek
87 . Panther Island W
89 . Piggot Bridge
90 . Piney Point
92 . Popash Creek
94 . Powell Creek (With WWTP)
96 . Six Mile Cypress Slough (With WWTP)
97 . Southeast Cape Coral
98 . Southwest Cape Coral
100 . Spring Creek (With WWTP)
101 . Stroud Creek
103 . Telegraph Creek
104 . Ten Mile Canal (North)
105 . Ten Mile Canal (South) (With WWTP)
106 Thompson Cutoff
108 . Trout Creek
109 . Whiskey Creek (With WWTP)
110 . Winkler Canal
111 . Yellow Fever Creek

4.1.1 Water Quality Parameters

For this task, average annual loads were estimated for the following water quality parameters:

1. Biochemical Oxygen Demand (BOD)
2. Chemical Oxygen Demand (COD)
3. Total Suspended Solids (TSS)
4. Total Dissolved Solids (TDS)
5. Total Phosphorus (TP)
6. Dissolved Phosphorus (DP)
7. Total Kjeldahl Nitrogen (TKN)
8. Nitrite plus Nitrate (NO2 + NO3)
9. Lead (Pb)
10. Copper (Cu)
11. Zinc (Zn)
12. Cadmium (Cd)

4.1.2 Rainfall/Runoff Relationships

WMM calculates annual runoff volumes for the pervious/impervious areas in each land use category by multiplying the average annual rainfall volume by a runoff coefficient.

The total average annual surface runoff from land use L is calculated by weighting the impervious and pervious area runoff factors for each land use category as follows:

$$R_L = C \times P$$

In which, C (runoff coefficient) can be expressed in terms of composite value of pervious and impervious runoff coefficients as in:

$$R_L = \left[C_P(1 - IMP_L) + C_I \times IMP_L\right] \times P$$

Or as:

$$R_L = \left[C_P + (C_I - C_P)IMP_L\right] \times P$$

Where:

R_L = total average annual surface runoff from land use L (in/yr/unit area);
IMP_L = fractional imperviousness of land use L;

P = long-term average annual and seasonal precipitation (in/yr);
C_P = pervious area runoff coefficient; and
C_I = impervious area runoff coefficient.

Total runoff in a basin is the area-weighted sum of R_L for all land uses.

Pervious and Impervious Runoff Coefficients

For the preliminary application of WMM to the Study Area, the runoff coefficient for impervious areas was set to 0.95, and the runoff coefficient for pervious areas was set to 0.10. These coefficients are refined in the model calibration task (Task 4) by performing a water balance that includes consideration of average annual and seasonal runoff volumes, initial abstraction, evapotranspiration, baseflow and soil type.

Land Use

Table 4-4 through **Table 4-6** present the existing and future land use estimates for the East Caloosahatchee, West Caloosahatchee, and Estero-Tidal Caloosahatchee sub-watersheds, respectively. An estimate of the level of imperviousness in each hydrologic unit and in each sub-watershed as a whole is also provided in these tables. It was estimated by weighting the recommended impervious cover percentage in Table 3-7 with the area of each land use category by the total area of the hydrologic unit. As shown in the tables, the imperviousness for the future condition is 5 to 10 percentage points higher than the existing imperviousness in the three sub-watersheds.

4.1.3 Non-point Pollution Loading Factors

WMM estimates pollutant loadings based upon non-point pollution loading factors (expressed as pounds per acre per year) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor M_L is computed for each land use L by the following equation:

$$M_L = EMC_L * R_L * K$$

Where:

M_L = Loading factor for land use L (lbs/ac/yr);

EMC_L = Event mean concentration of runoff from land use L (mg/L). EMC_L varies by land use and by water quality constituent. Land use EMCs are derived from monitoring data of flow-weighted average concentrations for a storm event from single land use catchments. EMCs are defined as the sum of individual measurements of stormwater constituent loads divided by the storm runoff volume.

Table 4-4a. Distribution of Existing Land Use per Hydrologic Unit for the East Caloosahatchee Basin

Hydrologic Unit	EXISTING LAND USE													Total Area (Acres)	Total % Imperviousness
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, communication, and utilities		
1 . 30-foot Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	133.9	35.1	15.9	24.6	210	12.9%
2 . 42-foot Canal	17.1	531.2	510.9	0.0	0.0	0.0	0.0	0.0	2.1	12,576.3	4,908.8	3,283.1	199.1	22,029	5.7%
10 . Bronson	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.7	1,405.5	81.8	264.1	52.5	1,848	6.2%
11 . C-19	5.2	25.9	0.0	0.0	0.0	0.0	0.0	1.0	0.0	6,330.8	83.2	234.2	102.9	6,783	3.1%
12 . C20 Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	299.5	604.8	6.7	911	14.3%
16 . Canal 3	7.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	1,717.0	22,588.9	1,427.6	5,956.8	166.3	31,874	5.0%
19 . Citrus Center	16.7	27.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10,061.9	4,978.9	2,550.4	270.4	17,905	5.1%
21 . Clewiston	286.5	158.7	1,150.4	0.0	144.3	33.8	0.0	171.6	277.3	1,207.1	470.1	389.0	220.0	4,509	23.9%
33 . Disston Island WCD	24.0	63.3	186.7	0.0	39.0	49.0	0.0	0.0	27.1	18,304.4	557.8	288.3	135.0	19,674	2.7%
37 . Flaghole WCD	1.1	362.9	0.0	0.0	1.6	37.6	0.0	0.0	17.2	20,149.4	618.5	2,127.8	523.5	23,840	4.9%
45 . Grassy Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,011.6	5.0	169.8	0.0	2,186	2.5%
52 . Hendry Hilliard WCD	0.0	17.2	4.9	0.0	0.0	8.1	0.0	0.0	0.0	12,910.3	1,187.8	2,646.8	106.7	16,882	4.6%
54 . Hilliard	0.0	137.1	15.3	0.0	0.0	24.4	0.0	0.0	0.0	18,348.3	3,384.7	4,326.1	104.6	26,341	4.6%
56 . Industrial Canal	0.0	0.0	0.0	0.5	0.0	237.9	0.0	2.9	3.5	8,143.2	43.3	891.8	182.4	9,505	6.7%
58 . Jack Spratt (Myrtle Slough)	0.0	37.0	3.3	0.0	0.0	3.5	0.0	0.0	0.0	2,691.0	252.1	314.5	38.7	3,340	4.0%
61 . L-42	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,369.5	37.8	413.1	0.0	4,829	2.6%
65 . Lake Hicpochee	6.6	2.1	16.4	0.0	0.0	0.0	0.0	0.0	0.7	5,525.6	216.6	4,391.2	186.3	10,345	10.8%
67 . Linden Pens Marsh	14.3	111.6	85.4	0.0	37.7	0.0	442.7	0.0	18.2	7,411.2	7,999.0	4,695.6	53.5	20,869	6.5%
72 . Meander Ditch	18.9	66.1	0.0	0.0	0.0	0.0	0.0	0.0	11.9	5,521.0	327.3	511.2	93.0	6,549	4.0%
75 . Moore Haven	88.3	103.1	460.1	0.0	40.4	14.3	0.0	203.7	97.4	2,362.5	297.4	140.6	126.0	3,934	13.0%
77 . Nicodemus Slough	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11,004.8	2,960.5	3,268.6	63.8	17,298	4.9%
78 . Ninemile Canal	0.7	0.0	0.0	0.0	0.5	0.0	0.0	0.0	2.8	851.8	6.7	42.5	8.5	913	2.8%
102 . Sugarland WCD	44.0	150.4	387.6	0.0	0.0	7.3	0.0	0.0	0.0	10,191.3	32.9	279.6	108.9	11,202	3.9%
TOTAL	**530.5**	**1,811.7**	**2,820.9**	**0.5**	**263.5**	**416.0**	**442.7**	**379.0**	**2,218.9**	**184,100.4**	**30,212.4**	**37,805.7**	**2,773.2**	**263,775**	**5.5%**

Table 4-4b. Distribution of Future Land Use per Hydrologic Unit for the East Caloosahatchee Basin

Hydrologic Unit	FUTURE LAND USE													Total Area (Acres)	Total % Imperviousness
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, communication, and utilities		
1 . 30-foot Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	133.9	35.1	15.9	24.6	210	12.9%
2 . 42-foot Canal	7.1	137.9	3,710.0	0.0	168.6	47.8	0.0	208.5	155.1	10,974.3	3,137.1	3,283.1	199.0	22,029	11.6%
10 . Bronson	0.0	0.0	0.0	0.0	273.9	0.0	0.0	0.0	43.7	1,177.6	35.9	264.1	52.5	1,848	19.1%
11 . C-19	5.2	0.0	367.3	2.2	575.6	4.2	0.0	1.0	0.0	5,410.9	79.7	234.2	102.9	6,783	12.3%
12 . C20 Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.4	821.9	6.7	911	18.8%
16 . Canal 3	7.3	9.6	2,844.1	0.0	68.8	0.0	14.4	68.3	66.9	21,279.9	1,391.2	5,956.8	166.3	31,874	8.3%
19 . Citrus Center	16.7	516.5	0.0	0.0	196.7	0.0	0.0	3.0	0.0	9,617.8	4,699.9	2,550.4	304.4	17,905	6.5%
21 . Clewiston	225.1	0.0	407.8	228.7	2,141.3	96.3	0.0	172.1	183.8	188.0	64.0	581.7	220.0	4,509	61.2%
33 . Disston Island WCD	19.6	1,033.4	814.0	501.2	253.1	1,014.9	0.0	0.0	87.8	15,128.9	355.7	328.8	137.2	19,674	11.2%
37 . Flaghole	1.1	810.5	0.0	0.0	27.3	2,159.0	0.0	0.0	17.2	17,612.0	561.3	2,127.8	523.5	23,840	13.1%
45 . Grassy Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,011.6	5.0	169.8	0.0	2,186	2.5%
52 . Hendry Hilliard WCD	0.0	17.2	4.9	0.0	0.0	8.1	0.0	0.0	0.0	12,910.3	1,187.8	2,646.8	106.7	16,882	4.6%
54 . Hilliard	0.0	107.1	594.4	0.0	0.0	24.4	0.0	0.0	0.0	18,328.7	2,855.1	4,326.1	104.6	26,341	5.4%
56 . Industrial Canal	0.0	0.0	3.3	0.0	2.4	237.9	0.0	2.9	3.5	8,141.3	40.0	891.8	182.4	9,505	6.8%
58 . Jack Spratt (Myrtle Slough)	0.0	37.0	18.4	0.0	0.0	3.5	0.0	69.9	0.0	2,615.3	242.6	314.5	38.7	3,340	5.0%
61 . L-42	0.0	26.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,352.2	37.4	413.1	0.0	4,829	2.7%
65 . Lake Hicpochee	6.1	0.0	11.5	14.5	1,024.4	4.8	0.0	0.0	0.1	4,518.2	188.3	4,391.2	186.3	10,345	19.5%
67 . Linden Pens Marsh	13.1	16.4	820.1	0.0	433.4	0.0	782.2	0.0	45.8	6,372.4	7,636.5	4,695.6	53.6	20,869	9.8%
72 . Meander Ditch	18.9	136.7	158.6	0.0	374.8	11.0	0.0	73.4	11.9	4,846.1	313.8	511.2	93.0	6,549	10.4%
75 . Moore Haven	37.6	1,811.5	8.9	344.6	687.0	360.7	0.0	211.8	53.9	9.9	128.1	153.8	126.0	3,934	40.2%
77 . Nicodemus Slough	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11,004.8	2,960.5	3,268.6	63.8	17,298	4.9%
78 . Ninemile Canal	0.7	0.0	0.0	0.0	0.5	215.2	0.0	0.0	1.1	641.1	3.9	42.5	8.5	913	23.8%
102 . Sugarland WCD	15.8	23.4	1,040.8	388.3	468.7	36.2	0.0	0.0	51.6	8,767.1	21.5	279.6	108.9	11,202	11.7%
TOTAL	**374.2**	**4,683.1**	**10,804.1**	**1,479.5**	**6,696.5**	**4,224.0**	**796.7**	**810.9**	**722.4**	**166,042.6**	**26,062.7**	**38,269.2**	**2,809.5**	**263,775**	**10.5%**

Table 4-5a. Distribution of Existing Land Use per Hydrologic Unit for the West Caloosahatchee Basin

Hydrologic Unit	EXISTING LAND USE													Total Area (Acres)	Total % Imperviousness
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, communication, and utilities		
4 . Banana Branch	0.0	236.6	0.0	0.0	0.0	0.0	0.0	0.0	49.9	1,677.9	510.6	136.1	96.2	2,707	5.9%
6 . Bedman Creek	0.0	183.7	89.2	0.0	0.0	0.0	0.0	0.0	13.5	2,092.7	616.6	594.3	144.5	3,734	8.7%
7 . Bee Branch	31.2	683.2	96.9	0.0	0.0	0.0	0.0	0.0	43.0	9,434.6	6,890.9	5,414.6	68.9	22,663	6.3%
14 . Canal 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	8,795.2	1,244.3	2,072.2	41.5	12,190	4.5%
15 . Canal 2	10.6	5.1	0.0	0.0	0.0	0.0	0.0	0.0	330.4	10,352.9	1,194.9	4,732.2	37.6	16,664	6.6%
20 . City Ditch	0.0	602.8	7.2	0.0	76.8	0.0	0.0	0.0	5.5	591.6	139.1	37.7	60.7	1,521	13.1%
23 . County Line Drainage District	32.1	62.0	0.0	0.0	0.0	0.0	0.0	15.4	0.0	1,132.6	1,141.4	3,669.1	102.5	6,155	14.2%
25 . Cow Slough	6.7	93.1	0.0	0.0	40.7	0.0	0.0	0.0	8.3	7,312.9	453.1	1,276.8	0.0	9,192	4.2%
26 . Crawford Canal	16.8	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	462.5	245.5	64.9	35.1	836	7.3%
27 . Cypress Branch	0.0	127.4	0.0	0.0	0.0	0.0	0.0	0.0	5.7	10,867.3	10,764.4	5,493.4	71.2	27,329	5.1%
28 . Cypress Creek	0.0	175.0	0.0	0.0	0.0	0.0	0.0	23.4	0.0	6,187.0	3,489.7	3,117.3	64.9	13,057	6.2%
31 . Deadmans Branch	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,689.8	4,049.2	1,606.7	83.5	10,437	4.6%
34 . Dog Canal	0.0	1,537.3	251.3	21.8	16.7	0.0	0.0	0.0	671.4	2,284.0	2,384.6	688.0	0.0	7,855	5.9%
36 . Fichter Branch	0.0	20.6	54.6	0.0	0.0	0.0	0.0	0.0	65.3	2,410.5	1,086.2	1,846.4	24.6	5,508	8.1%
40 . Franklin Run	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	157.2	2.2	38.5	88.4	32.4	324	15.2%
41 . Ft. Denaud Branch	0.0	771.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,145.7	2,182.0	1,002.5	54.4	7,156	5.3%
42 . Ft. Simmons	0.0	133.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5	706.2	103.8	202.9	73.8	1,244	10.3%
47 . Greenbriar Swamp	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	1,889.7	4.3	154.7	437.1	0.0	2,490	4.4%
50 . Hendry Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7,670.6	6,311.5	703.0	2,441.8	0.0	17,127	3.7%
53 . Hickey's Creek	0.0	2,775.7	91.8	0.0	0.0	0.0	0.0	0.0	612.4	5,711.2	5,526.5	1,962.3	282.8	16,963	6.3%
59 . Jacks Branch	10.6	579.1	0.0	0.0	5.5	18.4	0.0	0.0	0.0	22,183.2	14,251.2	9,519.5	166.9	46,734	5.4%
62 . LaBelle	37.0	569.0	460.0	0.0	235.0	0.0	0.0	9.0	82.0	236.0	451.0	49.0	139.0	2,267	26.0%
63 . LaBelle East	0.0	379.0	365.0	144.0	0.0	0.0	0.0	79.0	3,901.6	6,176.4	2,654.0	3,238.0	148.0	17,085	7.0%
64 . LaBelle Private Drainage District	0.0	133.1	7.3	0.0	0.0	50.6	0.0	0.0	0.0	16,925.3	68.7	475.3	100.8	17,761	2.3%
66 . LeHigh SE	0.0	180.2	0.0	0.0	0.0	0.0	0.0	6.7	308.2	3,372.6	676.8	1,435.9	74.6	6,055	6.9%
69 . Mackeral Canal	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	635.7	361.3	354.7	5.2	0.0	1,369	1.2%
73 . Messer	42.3	351.4	90.2	0.0	0.0	2.3	0.0	0.0	40.0	3,920.7	524.3	2,512.3	92.0	7,576	9.5%
74 . Miller's Gulley	0.0	107.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	337.7	68.8	190.9	3.1	708	7.9%
79 . North LaBelle	33.0	770.0	164.0	0.0	68.0	0.0	0.0	0.0	0.0	3,832.0	2,058.0	845.0	125.0	7,895	7.0%
88 . Park Branch	0.0	150.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	122.3	273.3	267.9	63.2	877	14.8%
91 . Polywog	43.8	477.7	70.0	0.0	0.0	0.0	0.0	0.0	0.0	3,923.2	4,972.5	2,225.7	12.5	11,725	5.5%
93 . Port LaBelle	0.0	138.2	0.0	0.0	0.0	0.0	0.0	0.0	1,158.4	1,362.5	490.3	280.9	44.7	3,475	4.0%
95 . Roberts	11.8	241.7	0.3	0.0	6.9	40.9	0.0	2.4	74.2	16,383.5	1,670.2	6,066.9	0.0	24,499	6.0%
99 . Spanish Creek	0.5	26.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	554.3	62.7	493.1	3.1	1,140	9.7%
107 . Townsend Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	18,311.3	219.5	2,169.2	14.9	20,723	3.1%
TOTAL	**276.4**	**11,552.3**	**1,747.8**	**165.8**	**449.6**	**112.2**	**0.0**	**135.9**	**17,792.4**	**182,175.2**	**71,714.6**	**66,659.3**	**2,262.3**	**355,043.8**	**5.8%**

Table 4-5b. Distribution of Future Land Use per Hydrologic Unit for the West Caloosahatchee Basin

Hydrologic Unit	FUTURE LAND USE													Total Area (Acres)	Total % Imperviousness
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, communication, and utilities		
4 . Banana Branch	0.0	1,876.5	520.7	0.0	69.5	0.0	0.0	0.0	0.0	0.0	0.0	144.4	96.2	2,707.3	20.2%
6 . Bedman Creek	0.0	1,149.1	1,120.8	73.8	0.0	0.0	0.0	37.9	0.0	438.5	189.6	580.8	143.9	3,734.5	22.0%
7 . Bee Branch	31.2	2,077.6	2,551.4	104.3	39.2	0.0	0.0	100.1	37.4	6,455.8	5,779.9	5,417.4	68.9	22,663.3	11.1%
14 . Canal 1	0.0	0.0	229.5	0.0	0.0	0.0	0.0	1.5	47.1	9,020.1	778.4	2,072.2	41.5	12,190.3	5.2%
15 . Canal 2	10.6	5.1	275.0	0.0	0.0	0.0	162.2	0.0	161.8	10,210.5	1,068.6	4,732.2	37.6	16,663.8	7.5%
20 . City Ditch	0.0	302.7	82.4	0.0	611.9	0.0	0.0	0.0	0.0	424.0	1.3	38.4	60.7	1,521.4	43.7%
23 . County Line Drainage District	32.1	676.1	166.6	0.0	0.0	0.0	0.0	15.6	0.0	3,714.8	1,012.5	435.0	102.5	6,155.0	6.1%
25 . Cow Slough	6.7	1,362.0	93.0	0.0	107.6	0.0	0.0	0.0	20.3	5,916.0	409.2	1,276.8	0.0	9,191.6	6.4%
26 . Crawford Canal	16.8	214.4	44.7	0.0	344.4	0.0	0.0	27.7	86.9	0.0	0.0	66.5	35.1	836.5	48.4%
27 . Cypress Branch	0.0	24.9	1,680.1	0.0	217.1	0.0	0.0	0.0	0.0	9,152.5	10,690.0	5,493.4	71.2	27,329.4	7.8%
28 . Cypress Creek	0.0	1,078.2	179.0	0.0	0.0	0.0	0.0	23.5	0.0	5,304.8	3,430.5	2,976.4	64.9	13,057.3	7.0%
31 . Deadmans Branch	0.0	18.6	122.4	0.0	153.8	12.8	0.0	0.0	0.0	4,456.6	3,982.2	1,606.7	83.5	10,436.7	6.4%
34 . Dog Canal	0.0	14.9	6,674.4	407.3	16.7	0.0	0.0	0.0	43.8	0.6	9.5	688.0	0.0	7,855.2	35.1%
36 . Fichter Branch	0.0	676.8	54.6	0.0	0.0	0.0	0.0	0.0	0.0	1,910.1	995.6	1,846.4	24.6	5,508.1	9.2%
40 . Franklin Run	0.0	191.2	0.0	0.0	0.0	0.0	0.0	0.0	11.2	0.0	1.3	88.4	32.4	324.5	20.4%
41 . Ft. Denaud Branch	0.0	2,183.4	0.0	0.0	0.7	54.4	0.0	0.0	0.0	1,934.0	1,926.8	1,002.5	54.4	7,156.2	7.8%
42 . Ft. Simmons	0.0	6.2	317.4	220.1	318.2	0.0	0.0	0.0	102.4	1.1	0.0	204.9	73.8	1,244.2	51.7%
47 . Greenbriar Swamp	0.0	25.3	1,590.8	0.0	0.0	0.0	0.0	0.0	336.0	2.3	98.7	437.1	0.0	2,490.0	26.1%
50 . Hendry Canal	0.0	0.0	6,980.1	819.1	0.0	0.0	0.0	32.7	196.5	5,185.9	406.3	2,281.3	1,225.1	17,127.0	26.9%
53 . Hickey's Creek	0.0	2,342.7	8,537.6	2,668.6	0.0	0.0	0.0	4.4	12.4	568.2	583.7	1,962.3	282.8	16,962.6	33.1%
59 . Jacks Branch	10.6	4,489.5	776.7	0.0	42.4	18.4	0.0	93.2	0.0	18,689.9	12,919.4	9,527.4	166.9	46,734.3	6.8%
62 . LaBelle	0.4	8.0	394.4	0.0	1,558.2	64.8	0.0	23.6	30.4	0.0	0.0	48.4	139.1	2,267.4	75.5%
63 . LaBelle East	0.0	583.1	4,553.7	220.0	219.2	0.0	0.0	78.8	606.8	5,519.7	1,915.8	3,238.2	148.3	17,083.6	16.9%
64 . LaBelle Private Drainage District	0.0	0.0	6,695.7	227.8	14.0	51.7	0.0	10,414.8	0.0	17.9	3.4	274.0	61.8	17,761.1	37.3%
66 . LeHigh SE	0.0	179.0	324.4	0.0	0.0	0.0	0.0	6.7	1.0	3,364.7	668.8	1,435.8	74.6	6,054.9	8.7%
69 . Mackeral Canal	0.0	13.2	1,350.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	1,368.8	34.7%
73 . Messer	42.3	338.3	703.7	0.0	312.5	2.8	0.0	0.0	39.2	3,152.3	379.1	2,513.4	92.0	7,575.5	15.8%
74 . Miller's Gulley	0.0	136.5	367.2	0.0	0.0	0.0	0.0	0.0	0.0	5.3	8.1	187.9	3.1	708.1	25.8%
79 . North LaBelle	3.1	2,128.1	653.1	471.6	1,014.4	30.1	0.0	174.2	4.4	1,169.7	1,276.2	845.0	124.8	7,894.7	25.9%
88 . Park Branch	0.0	196.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.6	260.7	267.9	63.2	877.2	15.2%
91 . Polywog	42.0	3,810.0	294.1	46.0	70.0	0.0	0.0	0.0	0.0	1,977.7	3,247.3	2,225.7	12.5	11,725.3	9.4%
93 . Port LaBelle	0.0	11.4	1,543.6	0.0	50.2	0.0	0.0	41.5	141.8	1,197.0	163.8	280.9	44.7	3,474.9	20.5%
95 . Roberts	11.8	129.0	317.4	0.0	6.9	40.9	0.0	18.9	72.8	16,251.5	1,582.8	6,066.8	0.0	24,498.8	6.4%
99 . Spanish Creek	0.5	86.4	153.1	0.0	0.0	0.0	0.0	0.0	0.0	380.2	26.0	490.9	3.1	1,140.2	14.7%
107 . Townsend Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	406.4	7.9	17,988.7	209.3	2,095.5	14.9	20,722.7	3.7%
TOTAL	**208.1**	**26,335.0**	**49,348.1**	**5,258.6**	**5,167.0**	**275.9**	**162.2**	**11,501.3**	**1,960.0**	**134,499.4**	**54,024.7**	**62,854.1**	**3,447.9**	**355,042.5**	**14.1%**

Table 4-6a. Distribution of Existing Land Use per Hydrologic Unit for the Estero Bay and Tidal Caloosahatchee Basins

Hydrologic Unit	EXISTING LAND USE (Acres)													Total Area (Acres)	Total % Imperviousness
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, communication, and utilities		
3 . Babcock	0.0	43.1	0.0	0.0	0.0	0.0	0.0	4.8	0.0	4,990.0	6,330.8	2,510.7	0.4	13,880	4.5%
5 . Bayshore Creek	18.4	320.4	177.0	0.0	0.0	69.6	0.0	0.0	18.1	423.6	499.7	469.9	74.6	2,071	16.2%
8 . Billy's Creek	199.8	150.5	2,104.4	110.5	392.0	1,108.6	0.0	69.3	764.9	352.8	874.3	418.6	186.2	6,732	38.1%
9 . Blackstone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	482.1	7.9	67.4	103.6	34.3	695	8.2%
13 . Caloosahatchee South Shore	53.1	105.3	2,716.1	464.3	388.1	13.7	0.0	32.5	149.5	420.8	105.0	1,786.9	191.7	6,427	34.1%
17 . Carrol Canal	3.2	0.0	459.6	113.8	75.9	150.3	0.0	69.8	7.1	183.0	0.0	1.3	11.1	1,075	44.4%
18 . Chapel Branch	90.4	174.5	42.9	0.0	0.0	20.7	0.0	0.0	0.0	309.6	435.4	261.1	33.9	1,369	13.6%
22 . Cohn Branch	0.0	24.4	125.3	18.0	0.0	0.0	0.0	0.0	22.7	56.4	113.5	109.1	2.8	472	17.8%
24 . Cow Creek	548.7	64.6	211.5	518.9	254.0	20.3	0.0	0.0	123.4	375.5	218.0	5,598.1	232.0	8,165	27.8%
29 . Cypress Lakes	0.0	0.0	120.0	75.7	33.2	0.0	0.0	0.0	0.0	98.5	2.4	14.9	6.6	351	37.1%
30 . Daughtrey Creek	105.0	1,264.6	406.4	0.0	0.0	12.1	0.0	21.4	61.2	6,833.6	8,197.9	6,115.5	245.7	23,263	8.3%
32 . Deep Lagoon	0.0	0.0	247.1	357.4	97.1	1.5	0.0	78.1	243.6	240.2	275.5	226.8	10.1	1,777	28.0%
35 . Estero River	286.7	1,453.5	462.0	270.5	63.3	45.9	3,536.7	180.8	601.7	9,449.1	9,002.2	13,163.6	652.9	39,169	13.4%
38 . Flint Pen	41.3	40.1	0.0	3.7	0.0	12.0	55.8	0.0	15.4	164.7	1,466.9	7,208.8	0.4	9,009	16.8%
39 . Fort Myers Shores	0.0	33.5	870.2	19.4	47.5	0.0	0.0	0.0	17.2	155.8	80.4	570.0	278.2	2,072	35.2%
43 . Gator Slough	711.5	330.1	98.3	204.0	2.2	0.0	225.9	82.1	1,274.4	7,637.0	15,751.3	12,216.7	799.8	39,333	10.3%
44 . Gordon Swamp	0.0	63.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	201.3	1,021.3	3,520.1	0.0	4,806	15.0%
46 . Green Meadows	0.0	123.6	0.0	0.0	0.0	0.0	42.1	0.0	17.9	7,416.1	4,213.7	5,203.9	114.8	17,132	7.5%
48 . Halfway Creek	4.2	64.8	263.5	158.0	0.0	5.5	0.0	9.9	279.5	2,025.0	553.1	826.2	65.2	4,255	10.9%
49 . Hancock Creek	164.6	492.6	949.9	57.8	422.7	45.1	0.0	86.6	287.0	386.0	667.8	339.1	84.4	3,984	27.7%
51 . Hendry Creek	252.7	542.7	988.9	834.2	565.7	433.4	0.0	9.4	236.6	888.8	2,106.4	4,442.3	216.6	11,518	26.7%
55 . Imperial River	692.1	449.4	3,571.3	613.6	445.4	44.3	538.3	97.9	378.8	2,871.5	3,168.2	3,355.6	452.1	16,679	22.9%
57 . Iona	384.8	186.4	478.8	145.4	302.8	90.7	0.0	67.8	165.0	499.5	342.5	600.9	20.2	3,285	30.3%
60 . Kickapoo Creek	0.0	349.6	0.0	0.0	0.0	0.0	0.0	0.0	89.5	118.9	188.8	164.1	44.7	956	11.7%
68 . Lochmoor County Club	0.0	23.5	59.1	482.6	19.4	12.8	0.0	0.0	18.5	198.8	88.7	102.4	46.9	1,053	41.0%
70 . Manuel's Branch	7.6	0.0	438.0	34.9	41.1	247.5	0.0	76.2	19.0	0.0	0.4	2.4	18.2	885	54.8%
71 . Marsh Point	802.0	235.6	305.9	76.6	29.8	0.0	0.0	2.4	39.7	58.4	113.0	262.0	35.8	1,961	35.5%
76 . Mullock Creek	129.6	93.6	2,568.0	106.2	31.8	169.8	0.0	42.2	196.8	676.3	1,169.4	1,705.0	123.3	7,012	24.4%
80 . Northcentral Cape Coral	320.2	1,647.5	427.0	3.7	63.3	125.3	30.2	126.4	14,280.9	605.6	1,805.3	344.0	1,241.0	21,020	9.8%
81 . Northwest Cape Coral	0.4	252.4	235.9	302.0	0.0	0.0	379.3	0.0	4,239.8	141.8	2,135.6	3,023.2	1,024.2	11,735	17.1%
82 . Olga	3.2	217.1	152.7	0.0	38.6	0.0	0.0	3.6	38.0	1,225.5	206.9	438.0	46.6	2,370	10.8%
83 . Orange River	226.2	13,723.0	3,413.1	373.6	463.6	110.6	0.0	194.2	10,279.4	8,327.6	7,085.3	5,161.2	982.0	50,340	11.3%
84 . Otter Creek	0.0	154.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	684.3	54.8	144.6	13.1	1,051	6.0%
85 . Owl Creek	0.0	456.7	24.6	0.0	0.0	0.0	186.4	0.0	17.9	1,768.1	729.8	675.4	11.2	3,870	7.2%
86 . Palm Creek	0.0	686.7	16.3	0.0	0.0	0.0	0.0	0.0	0.3	327.7	686.7	185.1	66.0	1,969	9.2%
87 . Panther Island W	0.0	58.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,609.6	822.9	896.7	5.7	4,393	5.1%
89 . Piggot Bridge	0.0	45.4	0.0	17.8	5.9	0.0	0.0	0.0	64.1	116.7	44.0	264.8	27.4	586	17.3%
90 . Piney Point	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.6	254.1	0.0	357	16.9%
92 . Popash Creek	0.0	950.9	38.6	0.0	0.0	0.0	0.0	0.0	8.9	2,944.5	4,239.1	3,065.2	109.6	11,357	7.9%
94 . Powell Creek	1,514.2	1,134.1	374.7	2.0	156.0	43.7	24.1	43.8	86.0	1,086.9	2,748.7	1,199.1	136.7	8,550	18.8%
96 . Six Mile Cypress Slough	6.0	1,772.6	1,601.5	426.7	203.7	416.8	30.0	31.6	821.6	8,666.0	10,851.2	7,788.7	2,962.4	35,579	16.9%
97 . Southeast Cape Coral	0.4	145.5	13,452.7	1,004.8	942.1	104.2	0.0	198.0	561.8	303.6	190.7	1,069.4	2,243.4	20,216	42.6%
98 . Southwest Cape Coral	14.4	184.1	7,426.6	79.3	84.0	5.4	0.0	76.5	1,266.0	739.5	761.0	5,439.5	1,418.5	17,495	29.6%
100 . Spring Creek	227.4	409.0	1,106.0	97.1	159.4	286.7	0.0	3.2	449.7	1,309.0	1,043.4	1,932.5	60.7	7,084	20.8%
101 . Stroud Creek	0.0	1,103.4	0.0	0.0	0.0	0.0	351.8	0.0	0.0	1,341.4	1,478.0	1,245.1	71.4	5,591	10.0%
103 . Telegraph Creek	0.0	78.8	23.0	0.0	0.0	0.0	0.0	0.0	37.9	7,910.7	20,189.6	11,042.9	25.9	39,309	6.4%
104 . Ten Mile Canal (North)	0.0	511.0	345.0	282.0	136.0	693.0	0.0	57.0	812.1	1,697.9	1,974.0	1,110.0	311.0	7,929	21.0%
105 . Ten Mile Canal (South)	66.0	22.0	166.0	6.0	29.0	15.0	0.0	0.0	9.0	113.0	131.0	258.0	23.0	838	25.2%
106 Thompson Cutoff	8.7	44.2	17.5	0.0	0.0	0.0	0.0	0.0	21.5	67.3	64.6	333.1	25.9	583	18.3%
108 . Trout Creek	0.0	131.8	0.0	0.0	0.0	0.0	561.2	0.0	0.0	8,521.6	6,322.2	2,836.5	0.1	18,373	4.9%
109 . Whiskey Creek	59.1	74.1	1,639.5	1,359.3	916.7	94.6	0.0	247.0	164.0	239.1	88.8	107.3	827.7	5,817	55.9%
110 . Winkler Canal	0.0	0.0	307.7	91.2	241.3	155.5	0.0	66.6	72.1	0.0	0.0	0.0	42.8	977	59.7%
111 . Yellow Fever Creek	585.7	11.2	140.4	0.2	236.7	8.0	2.8	23.3	106.4	337.1	1,186.8	372.2	105.2	3,116	24.2%
TOTAL	**7,527.7**	**30,443.2**	**48,597.8**	**8,711.0**	**6,888.0**	**4,562.8**	**5,964.5**	**2,002.4**	**38,847.1**	**98,123.5**	**121,972.1**	**120,486.3**	**15,764.5**	**509,890.7**	**16.3%**

Table 4-6b. Distribution of Future Land Use per Hydrologic Unit for the Estero Bay and Tidal Caloosahatchee Basins

Hydrologic Unit	FUTURE LAND USE (Acres)													Total Area (Acres)	Total % Imperviousness
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Upland Forests	Wetlands	Transportation, communication, and utilities		
3 . Babcock	0.00	43.08	0.00	0.00	0.00	0.00	0.00	4.83	0.00	4,990.0	6,330.81	2,510.68	0.40	13,880	4.5%
5 . Bayshore Creek	6.56	475.65	610.35	0.00	93.95	100.05	0.00	32.23	2.97	108.1	96.89	469.87	74.63	2,071	29.6%
8 . Billy's Creek	73.56	3.79	506.46	2,156.44	1,113.23	1,701.82	0.00	135.92	194.85	26.1	214.96	418.63	186.17	6,732	65.9%
9 . Blackstone	0.00	0.00	439.70	0.00	0.00	0.00	0.00	0.00	95.67	1.3	20.77	103.63	34.27	695	29.7%
13 . Caloosahatchee South Shore	40.18	14.07	2,419.43	860.52	614.95	13.74	0.00	32.53	82.60	320.0	50.58	1,786.93	191.66	6,427	39.3%
17 . Carrol Canal	0.00	0.00	160.05	284.43	259.50	150.70	0.00	69.85	0.00	138.1	0.00	1.33	11.11	1,075	59.8%
18 . Chapel Branch	89.63	554.22	235.85	0.00	0.04	33.32	0.00	0.00	0.00	0.0	160.49	261.06	33.92	1,369	21.7%
22 . Cohn Branch	0.00	3.51	317.29	17.98	0.00	0.00	0.00	0.00	2.52	1.0	17.89	109.10	2.79	472	31.3%
24 . Cow Creek	541.65	0.04	391.11	672.94	253.98	37.16	0.00	0.00	13.37	298.7	125.90	5,598.10	231.96	8,165	29.8%
29 . Cypress Lakes	0.00	0.00	0.00	186.37	44.85	0.00	0.00	0.00	0.00	98.5	0.00	14.90	6.61	351	48.5%
30 . Daughtrey Creek	105.02	3,154.15	1,049.42	0.00	0.00	12.15	0.00	22.40	0.00	5,661.5	6,897.59	6,115.49	245.73	23,263	10.0%
32 . Deep Lagoon	0.00	0.00	3.89	1,174.78	97.10	1.49	0.00	79.39	6.86	121.7	55.24	226.82	10.07	1,777	52.8%
35 . Estero River	286.70	5,123.43	5,145.60	1,598.46	244.06	45.88	1,391.58	259.89	150.62	6,207.5	4,527.24	13,163.56	1,024.24	39,169	20.2%
38 . Flint Pen	41.29	42.68	243.53	3.72	0.00	11.97	0.49	6.49	15.44	150.5	1,283.82	7,208.80	0.37	9,009	17.6%
39 . Fort Myers Shores	0.00	0.00	1,047.61	26.59	47.54	0.00	0.00	53.28	12.62	32.7	3.74	569.97	278.17	2,072	39.1%
43 . Gator Slough	712.97	1,734.45	717.64	203.65	92.00	0.00	225.83	534.96	97.80	7,086.9	14,517.77	12,216.66	1,192.62	39,333	12.7%
44 . Gordon Swamp	0.00	80.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	192.6	1,013.06	3,520.15	0.00	4,806	15.1%
46 . Green Meadows	0.00	705.52	53.79	0.00	0.00	0.00	21.16	0.00	10.66	7,128.0	3,894.34	5,203.94	114.84	17,132	7.9%
48 . Halfway Creek	4.22	105.80	1,757.32	699.32	0.00	7.97	0.00	10.15	1.46	631.3	146.17	826.16	65.18	4,255	31.1%
49 . Hancock Creek	0.62	12.34	1,400.57	584.21	914.59	261.29	0.00	123.42	215.37	35.5	12.08	339.12	84.40	3,984	52.8%
51 . Hendry Creek	4.69	15.02	1,624.53	2,619.07	1,008.43	444.43	0.00	17.57	59.40	369.3	696.36	4,442.28	216.63	11,518	40.5%
55 . Imperial River	671.56	410.29	4,600.59	4,086.48	1,164.87	66.06	5.83	100.34	130.34	885.9	748.66	3,355.61	452.07	16,679	41.2%
57 . Iona	210.60	0.00	683.94	1,114.00	302.77	134.63	0.00	115.96	40.53	55.62	5.63	600.94	20.17	3,285	49.9%
60 . Kickapoo Creek	0.00	615.34	3.18	0.00	0.00	0.00	0.00	0.79	88.94	36.1	2.48	164.08	44.71	956	14.4%
68 . Lochmoor County Club	0.00	0.00	174.19	482.64	19.39	0.00	0.00	12.78	18.52	195.8	0.00	102.45	46.93	1,053	43.8%
70 . Manuel's Branch	1.33	0.00	114.06	319.20	86.94	247.92	0.00	76.19	19.01	0.0	0.00	2.35	18.24	885	67.1%
71 . Marsh Point	585.37	52.29	367.96	571.56	29.76	0.00	0.00	2.41	11.87	42.1	0.07	262.05	35.84	1,961	46.4%
76 . Mullock Creek	129.33	54.33	2,116.77	1,530.96	31.75	246.84	0.00	42.16	29.91	384.6	617.04	1,705.01	123.25	7,012	36.1%
80 . Northcentral Cape Coral	289.83	3,672.56	12,327.19	162.47	1,229.97	215.63	0.00	609.62	67.55	398.9	234.26	344.03	1,468.34	21,020	37.3%
81 . Northwest Cape Coral	0.41	3,452.26	2,324.82	268.22	231.18	0.00	3.01	217.52	104.81	100.7	980.08	3,023.22	1,028.34	11,735	26.9%
82 . Olga	3.16	2.78	1,764.07	0.00	38.58	0.00	0.00	24.87	5.94	36.7	9.46	438.03	46.61	2,370	33.4%
83 . Orange River	222.20	7,781.05	20,911.60	10,981.31	602.43	814.63	0.00	638.45	295.79	1,045.6	902.74	5,161.17	982.76	50,340	37.3%
84 . Otter Creek	0.00	779.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.3	37.10	144.64	13.14	1,051	11.4%
85 . Owl Creek	0.00	513.95	92.56	0.00	23.43	0.00	183.52	0.00	17.92	1,663.2	688.90	675.42	11.18	3,870	8.5%
86 . Palm Creek	0.00	1,283.80	17.25	0.00	0.00	0.00	0.00	0.00	0.27	257.8	158.46	185.08	66.00	1,969	11.9%
87 . Panther Island W	0.00	58.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,609.6	822.93	896.69	5.75	4,393	5.1%
89 . Piggot Bridge	0.00	172.16	79.92	17.78	5.95	0.00	0.00	0.00	4.34	13.8	0.00	264.79	27.42	586	23.9%
90 . Piney Point	0.00	0.00	102.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.13	254.14	0.00	357	24.3%
92 . Popash Creek	0.00	764.81	673.68	0.00	53.68	0.00	0.00	3.40	0.00	2,779.2	3,907.24	3,065.15	109.64	11,357	10.0%
94 . Powell Creek	1,022.44	229.36	1,365.37	1,494.55	342.27	43.73	2.64	81.05	0.00	877.7	1,755.07	1,199.05	136.70	8,550	32.1%
96 . Six Mile Cypress Slough	0.29	263.76	7,478.52	4,338.01	3,297.09	2,086.40	8.56	56.16	247.56	2,296.1	1,700.68	7,788.72	6,016.90	35,579	48.6%
97 . Southeast Cape Coral	0.00	1.98	12,794.93	820.78	2,559.45	114.65	0.00	238.73	153.17	209.2	10.77	1,069.37	2,243.39	20,216	48.0%
98 . Southwest Cape Coral	14.38	37.58	9,025.09	438.11	414.91	5.39	0.00	187.89	164.96	272.1	76.14	5,439.54	1,418.45	17,495	35.8%
100 . Spring Creek	213.07	1,049.84	542.64	1,344.72	159.41	371.20	0.00	8.07	80.27	1,148.3	173.27	1,932.51	60.71	7,084	31.2%
101 . Stroud Creek	0.00	948.42	532.73	0.00	0.00	0.00	348.18	0.00	0.00	1,224.4	1,220.76	1,245.14	71.39	5,591	12.9%
103 . Telegraph Creek	0.00	842.37	22.98	0.00	0.00	0.00	0.00	0.00	0.26	7,326.6	20,047.16	11,042.88	25.87	39,308	6.6%
104 . Ten Mile Canal (North)	0.00	18.35	131.37	2,244.47	1,781.65	1,402.57	0.00	96.72	135.29	423.5	273.58	1,109.25	310.63	7,927	61.6%
105 . Ten Mile Canal (South)	59.35	0.21	104.80	339.42	35.14	15.50	0.00	0.00	0.00	1.8	0.66	258.01	22.86	838	48.2%
106 Thompson Cutoff	8.67	1.71	114.79	0.00	0.00	0.00	0.00	0.00	21.50	30.4	46.64	333.12	25.92	583	23.3%
108 . Trout Creek	0.00	634.91	0.00	0.00	1.19	0.00	561.15	0.00	0.00	8,019.7	6,319.89	2,836.51	0.15	18,373	5.1%
109 . Whiskey Creek	36.41	0.01	984.22	1,247.20	2,033.92	103.84	0.00	284.24	56.58	134.1	1.73	107.27	827.73	5,817	67.6%
110 . Winkler Canal	0.00	0.00	217.01	67.75	427.59	155.45	0.00	66.60	0.00	0.0	0.00	0.00	42.79	977	71.6%
111 . Yellow Fever Creek	19.56	1.53	486.22	1,297.96	237.58	218.94	0.32	24.76	0.17	209.1	142.29	372.20	105.22	3,116	51.7%
TOTAL	**5,395.0**	**35,711.6**	**98,279.0**	**44,256.1**	**19,895.1**	**9,065.4**	**2,752.3**	**4,271.6**	**2,657.7**	**66,354.5**	**80,949.5**	**120,485.6**	**19,814.9**	**509,888.2**	**27.6%**

R_L = Total average annual surface runoff from land use L (computed from annual precipitation, land-use imperviousness, and runoff coefficients (in/yr); and

K = 0.2266 (this is a conversion constant)

By multiplying the pollutant loading factor for each land use by the acreage in each land use and then summing for all land uses, the total annual pollution load from a water quality basin can be computed. Land use specific event mean concentrations were applied to the existing and future land use scenarios within the study area.

Event Mean Concentrations

WMM uses land use categories and associated event mean concentrations (EMCs) to simulate pollutant loads carried in stormwater runoff. Runoff volumes computed for each land use (R_L) are multiplied by land use specific mean EMC load factors (mg/L) to obtain nonpoint pollution loads by land use category. The EMCs used for this project are presented in **Table 3-10**.

4.1.4 Delivery Ratio and Travel Time

A delivery ratio of 1.0 was used for the preliminary application of WMM to the Study Area. This delivery ratio is only related to the travel time within the hydrologic unit (i.e., to its outlet). Delivery ratio values are refined during the model calibration task (Task 4).

4.1.5 Baseflow Loading Factors

An average baseflow unit volume of 7 inches per year was used for the preliminary application of WMM to the study area. This value is typical of values seen in other Florida hydrologic modeling studies (Wanielista et al, 2005; Schmidt et al, 1995) and may be refined during the model calibration task (Task 4).

Baseflow concentrations were determined using baseflow separation at the GATOR_S2 flow station (USGS station, DBKEY:06845) located at the Gator Slough at US-41 and the GATRGR60 water quality station (Lee County Monitoring Program) for "dry" weather conditions. Water quality measurements for the parameters COD, TDS, DP and Cd are missing at this station. After a sensitivity analysis, the following relationships were evaluated based upon transferring other local water quality data:

- COD is 6 times the BOD concentration
- TDS is 9 times the TSS concentration
- Dissolved P is 80% of Total
- Cd is approximately to be zero

Table 4-7 provides a summary of the baseflow concentrations used in WMM for all the parameters.

Table 4-7. Baseflow Concentrations to use in WMM Based on Baseflow Separation

Parameter	Concentration (mg/L)
BOD	1.2
COD[a]	7
TSS	15
TDS[a]	135
TP	0.08
DP[a]	0.06
TKN	0.72
NO2 +NO3	0.04
Pb	0.001
Cu	0.001
Zn	0.008
Cd[a]	0

[a] Data are an estimate based on transferring other local water quality data

4.1.6 Septic Tank Loads

WMM requires an estimate of the septic tank coverage by percentage of land area in each hydrologic unit for each residential land use classification (i.e., low density, medium density, and high density). Estimates of septic tank coverages for existing and future land use for each sub-watershed are presented in **Table 4-8** through **Table 4-10** and are based on the criteria and GIS coverage developed in Section 3.4.2. The "total" value for each hydrologic unit as shown in these tables is based on the total residential area served by septic tanks relative to the total residential land area. The "total" value for each residential land use corresponds to the total residential area served by septic tanks in given residential land use to the total residential land area of the same residential land use. The overall "total" septic tank coverage (lower right corner in each table) reflects the percentage of all residential land in the respective sub-area that is served by septic tanks.

Septic tank impacts are estimated by WMM by considering "failing" septic tanks only. For the preliminary application of WMM to the Study Area, a septic tank failure rate of 10 percent was used based on previous applications by CDM (City of Jacksonville Master Stormwater Management Plan Methodologies, 1994), the Jacksonville Health and Rehabilitative Services (HRS) Surface Water Improvement and Management (SWIM) program survey (1988), and US EPA (Forecasting Onsite Soil Adsorption System Failure Rates, 1986). Pollutant loading rates for failing septic tanks were developed from septic tank leachate monitoring studies.

Table 4-8. East Caloosahatchee Sub-watershed Existing and Future Septic Tank Coverages

Hydrologic Unit	EXISTING SEPTIC TANK COVERAGE			Total	FUTURE SEPTIC TANK COVERAGE			Total
	Residential, low density	Residential, medium density	Residential, high density		Residential, low density	Residential, medium density	Residential, high density	
1 . 30-foot Canal	0%	0%	0%	0%	0%	0%	0%	0%
2 . 42-foot Canal	100%	100%	0%	100%	100%	100%	0%	100%
10 . Bronson	0%	0%	0%	0%	0%	0%	0%	0%
11 . C-19	98%	0%	0%	98%	98%	0%	0%	0%
12 . C20 Canal	0%	0%	0%	0%	0%	0%	0%	0%
16 . Canal 3	94%	0%	0%	94%	94%	0%	0%	0%
19 . Citrus Center	100%	0%	0%	100%	100%	0%	0%	100%
21 . Clewiston	5%	44%	0%	40%	5%	44%	0%	28%
33 . Disston Island WCD	100%	100%	0%	100%	100%	100%	0%	79%
37 . Flaghole WCD	100%	0%	0%	100%	100%	0%	0%	100%
45 . Grassy Marsh	0%	0%	0%	0%	0%	0%	0%	0%
52 . Hendry Hilliard WCD	101%	100%	0%	100%	101%	100%	0%	100%
54 . Hilliard	100%	100%	0%	100%	100%	100%	0%	100%
56 . Industrial Canal	0%	0%	0%	0%	0%	0%	0%	0%
58 . Jack Spratt (Myrtle Slough)	100%	100%	0%	100%	100%	100%	0%	100%
61 . L-42	100%	0%	0%	100%	100%	0%	0%	100%
65 . Lake Hicpochee	99%	100%	0%	100%	99%	100%	0%	44%
67 . Linden Pens Marsh	8%	7%	0%	7%	8%	7%	0%	7%
72 . Meander Ditch	100%	0%	0%	100%	100%	0%	0%	46%
75 . Moore Haven	100%	100%	0%	100%	100%	100%	0%	84%
77 . Nicodemus Slough	0%	0%	0%	0%	0%	0%	0%	0%
78 . Ninemile Canal	0%	0%	0%	0%	0%	0%	0%	0%
102 . Sugarland WCD	100%	100%	0%	100%	100%	100%	0%	73%
Total	**86%**	**75%**	**0%**	**79%**	**100%**	**60%**	**0%**	**65%**

Table 4-9. West Caloosahatchee Sub-watershed Existing and Future Septic Tank Coverages

Hydrologic Unit	EXISTING SEPTIC TANK COVERAGE			Total	FUTURE SEPTIC TANK COVERAGE			Total
	Residential, low density	Residential, medium density	Residential, high density		Residential, low density	Residential, medium density	Residential, high density	
4 . Banana Branch	0%	0%	0%	0%	100%	0%	0%	78%
6 . Bedman Creek	100%	100%	0%	100%	100%	100%	0%	97%
7 . Bee Branch	100%	100%	0%	100%	100%	100%	0%	98%
14 . Canal 1	0%	0%	0%	0%	0%	0%	0%	0%
15 . Canal 2	100%	0%	0%	100%	100%	0%	0%	2%
20 . City Ditch	76%	73%	0%	76%	76%	73%	0%	76%
23 . County Line Drainage District	99%	0%	0%	99%	99%	0%	0%	80%
25 . Cow Slough	100%	0%	0%	100%	100%	0%	0%	94%
26 . Crawford Canal	99%	0%	0%	99%	99%	0%	0%	82%
27 . Cypress Branch	100%	0%	0%	100%	100%	0%	0%	1%
28 . Cypress Creek	100%	0%	0%	100%	100%	0%	0%	86%
31 . Deadmans Branch	100%	0%	0%	100%	100%	0%	0%	13%
34 . Dog Canal	100%	100%	100%	100%	100%	100%	100%	100%
36 . Fichter Branch	100%	100%	0%	100%	100%	100%	0%	100%
40 . Franklin Run	99%	0%	0%	99%	99%	0%	0%	99%
41 . Ft. Denaud Branch	100%	0%	0%	100%	100%	0%	0%	100%
42 . Ft. Simmons	100%	0%	0%	100%	100%	0%	0%	1%
47 . Greenbriar Swamp	100%	0%	0%	100%	0%	0%	0%	0%
50 . Hendry Canal	0%	0%	0%	0%	0%	0%	0%	0%
53 . Hickey's Creek	100%	99%	0%	100%	100%	99%	0%	80%
59 . Jacks Branch	100%	0%	0%	100%	100%	0%	0%	85%
62 . LaBelle	64%	52%	0%	59%	64%	52%	0%	52%
63 . LaBelle East	92%	100%	100%	97%	92%	100%	100%	99%
64 . LaBelle Private Drainage District	98%	99%	0%	99%	98%	99%	0%	96%
66 . LeHigh SE	100%	100%	0%	100%	100%	100%	0%	100%
69 . Mackeral Canal	62%	0%	0%	62%	62%	0%	0%	1%
73 . Messer	0%	0%	0%	0%	0%	0%	0%	0%
74 . Miller's Gulley	100%	100%	0%	100%	100%	100%	0%	100%
79 . North LaBelle	100%	0%	0%	100%	100%	0%	0%	65%
88 . Park Branch	100%	0%	0%	100%	100%	0%	0%	100%
91 . Polywog	100%	99%	0%	100%	100%	99%	0%	99%
93 . Port LaBelle	100%	0%	0%	100%	100%	0%	0%	1%
95 . Roberts	100%	100%	0%	100%	100%	100%	0%	100%
99 . Spanish Creek	100%	0%	0%	100%	100%	0%	0%	36%
107 . Townsend Canal	0%	0%	0%	0%	0%	0%	0%	0%
TOTAL	**94%**	**87%**	**100%**	**93%**	**98%**	**64%**	**12%**	**72%**

Table 4-10. Estero Bay and Tidal Caloosahatchee Sub-watershed Existing and Future Septic Tank Coverages

Hydrologic Unit	EXISTING SEPTIC TANK COVERAGE			Total	FUTURE SEPTIC TANK COVERAGE			Total
	Residential, low density	Residential, medium density	Residential, high density		Residential, low density	Residential, medium density	Residential, high density	
3 . Babcock	100%	0%	0%	100%	100%	0%	0%	100%
5 . Bayshore Creek	83%	51%	0%	72%	83%	51%	0%	65%
8 . Billy's Creek	11%	5%	2%	5%	0%	0%	0%	0%
9 . Blackstone	0%	0%	0%	0%	0%	0%	0%	0%
13 . Caloosahatchee South Shore	44%	11%	3%	11%	44%	11%	3%	9%
17 . Carrol Canal	0%	0%	0%	0%	0%	0%	0%	0%
18 . Chapel Branch	98%	0%	0%	79%	98%	0%	0%	69%
22 . Cohn Branch	0%	1%	0%	1%	0%	1%	0%	1%
24 . Cow Creek	51%	1%	3%	6%	51%	1%	3%	2%
29 . Cypress Lakes	0%	36%	15%	28%	0%	36%	15%	15%
30 . Daughtrey Creek	61%	37%	0%	55%	61%	37%	0%	55%
32 . Deep Lagoon	0%	19%	8%	13%	0%	0%	0%	0%
35 . Estero River	70%	41%	2%	55%	70%	41%	2%	48%
38 . Flint Pen	100%	0%	100%	100%	100%	0%	100%	16%
39 . Fort Myers Shores	5%	13%	5%	12%	5%	13%	5%	13%
43 . Gator Slough	67%	99%	100%	83%	67%	99%	100%	78%
44 . Gordon Swamp	100%	0%	0%	100%	30%	0%	0%	30%
46 . Green Meadows	100%	0%	0%	100%	100%	0%	0%	93%
48 . Halfway Creek	42%	42%	100%	61%	42%	42%	100%	58%
49 . Hancock Creek	27%	54%	22%	44%	0%	0%	0%	0%
51 . Hendry Creek	90%	59%	39%	59%	0%	0%	0%	0%
55 . Imperial River	89%	5%	23%	16%	89%	5%	23%	17%
57 . Iona	51%	5%	8%	16%	0%	0%	0%	0%
60 . Kickapoo Creek	100%	0%	0%	100%	100%	0%	0%	99%
68 . Lochmoor County Club	57%	0%	0%	2%	0%	0%	0%	0%
70 . Manuel's Branch	0%	0%	0%	0%	0%	0%	0%	0%
71 . Marsh Point	0%	0%	0%	0%	0%	0%	0%	0%
76 . Mullock Creek	50%	85%	39%	83%	0%	0%	0%	0%
80 . Northcentral Cape Coral	84%	98%	95%	87%	0%	0%	0%	0%
81 . Northwest Cape Coral	98%	97%	88%	94%	0%	0%	0%	0%
82 . Olga	100%	60%	0%	83%	0%	0%	0%	0%
83 . Orange River	99%	96%	68%	98%	10%	0%	0%	2%
84 . Otter Creek	100%	0%	0%	100%	30%	0%	0%	30%
85 . Owl Creek	100%	100%	0%	100%	100%	100%	0%	100%
86 . Palm Creek	100%	100%	0%	100%	100%	100%	0%	100%
87 . Panther Island W	100%	0%	0%	100%	100%	0%	0%	100%
89 . Piggot Bridge	100%	0%	100%	100%	50%	0%	50%	35%
90 . Piney Point	0%	0%	0%	0%	0%	0%	0%	0%
92 . Popash Creek	96%	100%	0%	96%	96%	100%	0%	98%
94 . Powell Creek	0%	0%	0%	0%	0%	0%	0%	0%
96 . Six Mile Cypress Slough	92%	50%	69%	72%	0%	0%	0%	0%
97 . Southeast Cape Coral	1%	17%	6%	16%	1%	0%	1%	0%
98 . Southwest Cape Coral	19%	84%	16%	81%	0%	0%	0%	0%
100 . Spring Creek	57%	0%	0%	14%	0%	0%	0%	0%
101 . Stroud Creek	100%	0%	0%	100%	100%	0%	0%	64%
103 . Telegraph Creek	100%	100%	0%	100%	100%	100%	0%	100%
104 . Ten Mile Canal (North)	90%	85%	13%	70%	0%	0%	0%	0%
105 . Ten Mile Canal (South)	54%	63%	99%	63%	0%	0%	0%	0%
106 Thompson Cutoff	100%	100%	0%	100%	50%	50%	0%	50%
108 . Trout Creek	100%	0%	0%	100%	100%	0%	0%	100%
109 . Whiskey Creek	47%	11%	4%	9%	0%	0%	0%	0%
110 . Winkler Canal	0%	14%	5%	12%	0%	14%	5%	12%
111 . Yellow Fever Creek	0%	7%	0%	6%	0%	0%	0%	0%
TOTAL	**85%**	**39%**	**23%**	**53%**	**44%**	**6%**	**4%**	**13%**

Low, medium, and high estimates of total phosphorus and total nitrogen concentrations due to failing septic tanks were developed from a review of septic tank leachate monitoring studies that are cited in the WMM manual (1998), and are presented in **Table 4-11**. The medium rates were used in the WMM application for the Estero Bay and Caloosahatchee River Watershed. A septic tank failure rate of 10 percent was used as denoted in Section 3.4.2.

Table 4-11. Summary of Septic Loading Rates (WMM User's Manual, 1998)

Concentration Level	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
Low	1.0	7.5
Medium	2.0	15.0
High	4.0	30.0

4.1.7 Point Source Discharges

Table 3-14 presents a list of wastewater treatment plants (WWTPs) that exist in the Study Area, each facility's permitted operating capacity, daily water quality constituent load estimates discharged by each facility via its effluent, and the corresponding hydrologic unit affected by each facility. These data were entered in WMM as input parameters. It should be noted that data were unavailable for COD and dissolved phosphorus (DP) in the Monthly Operating Reports (MORs) submitted to the Florida Department of Environmental Protection (FDEP).

4.1.8 Lake Okeechobee Releases

Average annual Lake Okeechobee flow releases and corresponding average annual water quality constituent concentrations were entered in WMM as point sources. The hydrologic unit affected by these releases was Moore Haven (S-77), which is located within the East Caloosahatchee sub-watershed. It should be noted that at this location BOD5 and COD data were unavailable for these discharges.

4.1.9 BMP Types, Efficiencies, and Spatial Extent

As discussed in Section 3.1.5, wet detention ponds are the predominant structural BMP implemented in southwest Florida. Consequently, for the preliminary application of WMM to the Study Area, wet detention ponds were used as future land use BMPs. Wet detention pond removal efficiencies were also used for agricultural BMPs as a composite value of all the BMPs alternatives used in agricultural lands, since this information was unavailable. Estimates of BMP coverage for existing and future land use are presented in **Table 4-12** through **Table 4-14** for each of the sub-watersheds. The "total" value for each hydrologic unit as shown in these tables is based on the total land area served by the BMPs relative to the total land area. The overall "total" BMP coverage (lower right corner of each table) reflects the percentage of all land in the respective sub-watershed that is served by BMPs.

Table 4-12a. East Caloosahatchee Sub-watershed Existing BMP Coverage

Hydrologic Unit	EXISTING BMP COVERAGE											Total[a]
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Transportation, communication, and utilities	
1 . 30-foot Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 . 42-foot Canal	1%	11%	7%	0%	0%	0%	0%	0%	0%	43%	1%	40%
10 . Bronson	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	55%	95%
11 . C-19	0%	0%	0%	0%	0%	0%	0%	0%	0%	78%	0%	76%
12 . C20 Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16 . Canal 3	0%	29%	0%	0%	0%	0%	0%	0%	0%	42%	1%	38%
19 . Citrus Center	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	0%	20%
21 . Clewiston	11%	2%	0%	0%	5%	1%	0%	0%	36%	90%	0%	34%
33 . Disston Island WCD	0%	0%	0%	0%	0%	0%	0%	0%	18%	100%	0%	97%
37 . Flaghole WCD	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	95%
45 . Grassy Marsh	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
52 . Hendry Hilliard WCD	0%	3%	0%	0%	0%	0%	0%	0%	0%	61%	0%	61%
54 . Hilliard	0%	65%	100%	0%	0%	100%	0%	0%	0%	51%	0%	51%
56 . Industrial Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	99%	0%	94%
58 . Jack Spratt (Myrtle Slough)	16%	4%	0%	0%	0%	4%	0%	0%	0%	19%	4%	18%
61 . L-42	0%	97%	0%	0%	0%	0%	0%	0%	0%	2%	0%	2%
65 . Lake Hicpochee	3%	2%	14%	0%	0%	0%	0%	0%	100%	94%	0%	90%
67 . Linden Pens Marsh	0%	14%	0%	0%	1%	0%	75%	0%	0%	0%	0%	4%
72 . Meander Ditch	0%	24%	0%	0%	0%	0%	0%	0%	0%	12%	1%	12%
75 . Moore Haven	30%	0%	0%	0%	0%	0%	0%	0%	4%	69%	2%	48%
77 . Nicodemus Slough	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
78 . Ninemile Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	99%
102 . Sugarland WCD	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	93%
Total[b]	**11%**	**11%**	**2%**	**0%**	**3%**	**6%**	**75%**	**0%**	**5%**	**59%**	**0%**	**51%**

[a] Weigthed BMP coverage with respect to the total area of land uses with BMPs.

[b] Weigthed BMP coverage with respect to the total area of a given land use.

Table 4-12b. East Caloosahatchee Sub-watershed Future BMP Coverage

Hydrologic Unit	FUTURE BMP COVERAGE											Total[a]
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Transportation, communication, and utilities	
1 . 30-foot Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2 . 42-foot Canal	1%	11%	87%	0%	100%	100%	0%	100%	99%	43%	1%	55%
10 . Bronson	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	55%	95%
11 . C-19	0%	0%	100%	100%	100%	100%	0%	0%	0%	78%	0%	80%
12 . C20 Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
16 . Canal 3	0%	29%	100%	0%	100%	0%	100%	100%	0%	42%	1%	48%
19 . Citrus Center	0%	95%	0%	0%	100%	0%	0%	100%	0%	20%	11%	25%
21 . Clewiston	11%	2%	0%	100%	94%	65%	0%	0%	36%	90%	0%	66%
33 . Disston Island WCD	0%	94%	77%	100%	85%	95%	0%	0%	75%	100%	2%	97%
37 . Flaghole WCD	0%	55%	0%	0%	94%	98%	0%	0%	0%	100%	0%	95%
45 . Grassy Marsh	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
52 . Hendry Hilliard WCD	0%	3%	0%	0%	0%	0%	0%	0%	0%	61%	0%	61%
54 . Hilliard	0%	65%	100%	0%	0%	100%	0%	0%	0%	51%	0%	52%
56 . Industrial Canal	0%	0%	99%	0%	100%	0%	0%	0%	0%	99%	0%	94%
58 . Jack Spratt (Myrtle Slough)	0%	4%	82%	0%	0%	4%	0%	100%	0%	19%	4%	21%
61 . L-42	0%	99%	0%	0%	0%	95%	0%	0%	0%	2%	0%	3%
65 . Lake Hicpochee	3%	2%	14%	100%	100%	100%	0%	0%	100%	94%	0%	92%
67 . Linden Pens Marsh	0%	14%	90%	0%	91%	0%	86%	0%	60%	0%	0%	21%
72 . Meander Ditch	0%	63%	100%	0%	100%	100%	0%	100%	0%	12%	1%	22%
75 . Moore Haven	30%	94%	0%	100%	94%	96%	0%	4%	4%	69%	2%	84%
77 . Nicodemus Slough	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
78 . Ninemile Canal	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	99%
102 . Sugarland WCD	0%	0%	63%	100%	100%	80%	0%	0%	100%	100%	0%	95%
Total[b]	**9%**	**82%**	**85%**	**100%**	**96%**	**91%**	**86%**	**53%**	**51%**	**58%**	**2%**	**50%**

[a] Weigthed BMP coverage with respect to the total area of land uses with BMPs.

[b] Weigthed BMP coverage with respect to the total area of a given land use.

Table 4-13a. West Caloosahatchee Sub-watershed Existing BMP Coverage

Hydrologic Unit	EXISTING BMP COVERAGE											Total[a]
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Transportation, communication, and utilities	
4 . Banana Branch	0%	0%		0%	0%	0%	0%	0%	0%	13%	0%	11%
6 . Bedman Creek	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
7 . Bee Branch	0%	2%	0%	0%	0%	0%	0%	0%	0%	34%	0%	31%
14 . Canal 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	50%
15 . Canal 2	7%	0%	0%	0%	0%	0%	0%	0%	0%	77%	0%	74%
20 . City Ditch	0%	17%	100%	0%	8%	0%	0%	0%	0%	0%	0%	9%
23 . County Line Drainage District	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%	0%	12%
25 . Cow Slough	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%
26 . Crawford Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
27 . Cypress Branch	0%	15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
28 . Cypress Creek	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
31 . Deadmans Branch	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
34 . Dog Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
36 . Fichter Branch	0%	28%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40 . Franklin Run	0%	16%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
41 . Ft. Denaud Branch	0%	0%	0%	0%	0%	0%	0%	0%	0%	69%	0%	54%
42 . Ft. Simmons	0%	15%	0%	0%	0%	0%	0%	0%	0%	3%	0%	4%
47 . Greenbriar Swamp	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50 . Hendry Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
53 . Hickey's Creek	0%	2%	11%	0%	0%	0%	0%	0%	0%	0%	1%	1%
59 . Jacks Branch	0%	5%	0%	0%	0%	0%	0%	0%	0%	100%	0%	97%
62 . LaBelle	0%	72%	38%	0%	71%	0%	0%	77%	0%	0%	6%	43%
63 . LaBelle East	0%	12%	85%	82%	0%	0%	0%	41%	17%	2%	3%	12%
64 . LaBelle Private Drainage District	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	2%
66 . LeHigh SE	0%	0%	10%	0%	0%	0%	0%	0%	0%	97%	0%	96%
69 . Mackeral Canal	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%
73 . Messer	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
74 . Miller's Gulley	14%	21%	3%	0%	0%	0%	0%	0%	0%	3%	5%	5%
79 . North LaBelle	0%	1%	0%	0%	0%	0%	0%	0%	0%	65%	0%	49%
88 . Park Branch	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
91 . Polywog	11%	0%	0%	0%	0%	0%	0%	0%	0%	51%	0%	44%
93 . Port LaBelle	0%	64%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
95 . Roberts	0%	5%	0%	0%	17%	0%	0%	0%	0%	5%	0%	5%
99 . Spanish Creek	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	0%	24%
107 . Townsend Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	2%
Total[b]	**4%**	**8%**	**29%**	**71%**	**39%**	**0%**	**0%**	**29%**	**4%**	**33%**	**1%**	**29%**

[a] Weigthed BMP coverage with respect to the total area of land uses with BMPs.

[b] Weigthed BMP coverage with respect to the total area of a given land use.

Table 4-13b. West Caloosahatchee Sub-watershed Future BMP Coverage

Hydrologic Unit	FUTURE BMP COVERAGE											Total[a]
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Transportation, communication, and utilities	
4 . Banana Branch	0%	87%	100%	0%	100%	0%	0%	0%	0%	13%	0%	87%
6 . Bedman Creek	0%	84%	92%	100%	0%	0%	0%	100%	0%	0%	1%	71%
7 . Bee Branch	0%	68%	96%	100%	100%	0%	0%	100%	0%	34%	0%	55%
14 . Canal 1	0%	0%	100%	0%	0%	0%	0%	100%	21%	52%	0%	52%
15 . Canal 2	0%	0%	100%	0%	100%	0%	100%	0%	0%	77%	0%	76%
20 . City Ditch	0%	17%	100%	0%	88%	0%	0%	0%	0%	0%	0%	46%
23 . County Line Drainage District	0%	91%	100%	0%	0%	0%	0%	1%	0%	74%	0%	75%
25 . Cow Slough	0%	93%	100%	0%	65%	0%	0%	0%	59%	0%	0%	19%
26 . Crawford Canal	0%	95%	100%	0%	100%	0%	0%	100%	100%	0%	0%	92%
27 . Cypress Branch	0%	15%	100%	0%	100%	0%	0%	0%	0%	0%	0%	17%
28 . Cypress Creek	0%	84%	100%	0%	0%	0%	0%	0%	0%	0%	0%	16%
31 . Deadmans Branch	0%	60%	100%	0%	100%	100%	0%	0%	0%	0%	0%	6%
34 . Dog Canal	0%	0%	96%	95%	0%	0%	0%	0%	0%	0%	0%	95%
36 . Fichter Branch	0%	98%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%
40 . Franklin Run	0%	97%	0%	0%	0%	0%	0%	100%	0%	0%	1%	79%
41 . Ft. Denaud Branch	0%	65%	0%	0%	100%	100%	0%	0%	0%	69%	0%	66%
42 . Ft. Simmons	0%	15%	100%	100%	100%	0%	0%	0%	76%	3%	0%	90%
47 . Greenbriar Swamp	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	83%
50 . Hendry Canal	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	100%	80%
53 . Hickey's Creek	0%	0%	99%	100%	0%	0%	0%	100%	0%	0%	1%	77%
59 . Jacks Branch	0%	88%	100%	0%	87%	0%	0%	100%	0%	100%	0%	97%
62 . LaBelle	0%	72%	38%	0%	96%	100%	0%	91%	0%	0%	6%	80%
63 . LaBelle East	0%	43%	99%	88%	100%	0%	0%	41%	17%	2%	3%	46%
64 . LaBelle Private Drainage District	0%	64%	75%	100%	93%	100%	0%	100%	100%	2%	0%	61%
66 . LeHigh SE	0%	0%	100%	100%	100%	2%	0%	100%	0%	97%	0%	99%
69 . Mackeral Canal	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	4%	8%
73 . Messer	0%	9%	100%	0%	0%	0%	0%	0%	0%	0%	0%	99%
74 . Miller's Gulley	0%	21%	88%	0%	100%	18%	0%	0%	0%	3%	5%	24%
79 . North LaBelle	0%	22%	100%	0%	0%	0%	0%	0%	0%	65%	0%	78%
88 . Park Branch	0%	24%	0%	0%	0%	0%	0%	0%	0%	0%	1%	13%
91 . Polywog	11%	87%	76%	100%	100%	0%	0%	0%	0%	51%	0%	75%
93 . Port LaBelle	0%	64%	100%	0%	100%	0%	0%	100%	0%	0%	0%	54%
95 . Roberts	0%	5%	100%	0%	17%	0%	0%	87%	0%	0%	0%	2%
99 . Spanish Creek	0%	69%	100%	0%	0%	0%	0%	0%	0%	25%	0%	49%
107 . Townsend Canal	0%	0%	0%	0%	0%	0%	0%	100%	0%	2%	1%	4%
Total[b]	**2%**	**70%**	**98%**	**99%**	**95%**	**59%**	**100%**	**99%**	**15%**	**29%**	**36%**	**57%**

[a] Weigthed BMP coverage with respect to the total area of land uses with BMPs.

[b] Weigthed BMP coverage with respect to the total area of a given land use.

Table 4-14a. Estero and Tidal Caloosahatchee Sub-watershed Existing BMP Coverage

Hydrologic Unit	EXISTING BMP COVERAGE											Total[a]
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Transportation, communication, and utilities	
3 . Babcock	0%	29%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
5 . Bayshore Creek	0%	5%	3%	0%	0%	17%	0%	0%	0%	0%	2%	3%
8 . Billy's Creek	0%	2%	3%	0%	0%	8%	0%	0%	37%	0%	14%	8%
9 . Blackstone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13 . Caloosahatchee South Shore	18%	15%	8%	3%	6%	0%	0%	11%	17%	3%	32%	9%
17 . Carrol Canal	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
18 . Chapel Branch	11%	0%	13%	0%	0%	81%	0%	0%	0%	0%	1%	5%
22 . Cohn Branch	0%	93%	67%	87%	0%	0%	0%	0%	91%	2%	35%	58%
24 . Cow Creek	6%	8%	34%	48%	26%	59%	0%	0%	63%	48%	37%	33%
29 . Cypress Lakes	0%	0%	0%	0%	0%	0%	0%	0%	2%	2%	22%	1%
30 . Daughtrey Creek	3%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
32 . Deep Lagoon	0%	0%	37%	20%	0%	45%	0%	10%	0%	0%	0%	13%
35 . Estero River	23%	13%	36%	44%	78%	19%	59%	63%	95%	6%	2%	23%
38 . Flint Pen	2%	0%	0%	0%	0%	0%	58%	0%	0%	0%	0%	10%
39 . Fort Myers Shores	0%	5%	2%	0%	9%	0%	0%	0%	16%	2%	23%	6%
43 . Gator Slough	24%	0%	0%	0%	0%	0%	48%	95%	7%	2%	0%	5%
44 . Gordon Swamp	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
46 . Green Meadows	0%	9%	0%	0%	0%	0%	28%	0%	0%	0%	1%	0%
48 . Halfway Creek	39%	32%	94%	81%	0%	42%	0%	71%	94%	29%	10%	44%
49 . Hancock Creek	1%	17%	0%	1%	3%	0%	0%	20%	57%	0%	0%	9%
51 . Hendry Creek	9%	8%	22%	18%	28%	8%	0%	1%	6%	3%	2%	13%
55 . Imperial River	2%	12%	9%	45%	32%	11%	79%	32%	63%	18%	4%	20%
57 . Iona	10%	2%	3%	5%	3%	8%	0%	54%	52%	8%	4%	10%
60 . Kickapoo Creek	0%	5%	0%	0%	0%	0%	0%	0%	2%	0%	0%	3%
68 . Lochmoor County Club	0%	18%	0%	0%	0%	0%	0%	0%	27%	2%	1%	2%
70 . Manuel's Branch	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
71 . Marsh Point	3%	2%	1%	2%	41%	0%	0%	0%	11%	4%	4%	3%
76 . Mullock Creek	2%	28%	3%	2%	2%	17%	0%	35%	75%	1%	2%	8%
80 . Northcentral Cape Coral	16%	4%	0%	0%	17%	15%	0%	0%	4%	4%	12%	5%
81 . Northwest Cape Coral	0%	0%	1%	7%	0%	0%	48%	0%	12%	0%	6%	12%
82 . Olga	0%	4%	3%	0%	3%	0%	0%	0%	0%	0%	7%	1%
83 . Orange River	3%	2%	2%	0%	21%	40%	0%	4%	13%	0%	2%	5%
84 . Otter Creek	0%	84%	0%	0%	0%	0%	0%	0%	0%	0%	17%	16%
85 . Owl Creek	0%	3%	0%	0%	0%	0%	95%	0%	9%	0%	0%	8%
86 . Palm Creek	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%
87 . Panther Island W	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
89 . Piggot Bridge	0%	8%	0%	5%	1%	0%	0%	0%	96%	0%	17%	26%
90 . Piney Point	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	3%
92 . Popash Creek	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
94 . Powell Creek	11%	1%	30%	0%	3%	0%	34%	2%	0%	0%	2%	7%
96 . Six Mile Cypress Slough	6%	5%	29%	13%	13%	19%	9%	33%	76%	6%	5%	12%
97 . Southeast Cape Coral	0%	0%	0%	0%	2%	9%	0%	0%	0%	0%	10%	2%
98 . Southwest Cape Coral	0%	0%	2%	0%	1%	0%	0%	45%	11%	1%	16%	5%
100 . Spring Creek	13%	8%	67%	62%	52%	63%	0%	100%	92%	64%	4%	58%
101 . Stroud Creek	0%	1%	0%	0%	0%	0%	53%	0%	0%	0%	1%	7%
103 . Telegraph Creek	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
104 . Ten Mile Canal (North)	0%	6%	50%	24%	23%	19%	0%	35%	65%	12%	7%	25%
105 . Ten Mile Canal (South)	2%	24%	10%	0%	64%	16%	0%	0%	0%	0%	8%	10%
106 Thompson Cutoff	30%	17%	6%	0%	0%	0%	0%	0%	26%	0%	88%	22%
108 . Trout Creek	0%	2%	0%	0%	0%	0%	32%	0%	0%	0%	0%	2%
109 . Whiskey Creek	0%	2%	0%	4%	0%	0%	0%	10%	0%	0%	5%	2%
110 . Winkler Canal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
111 . Yellow Fever Creek	0%	0%	75%	0%	37%	3%	97%	4%	32%	0%	0%	15%
Total[b]	**9%**	**4%**	**7%**	**15%**	**13%**	**15%**	**57%**	**21%**	**16%**	**4%**	**8%**	**9%**

[a] Weigthed BMP coverage with respect to the total area of land uses with BMPs.

[b] Weigthed BMP coverage with respect to the total area of a given land use.

Table 4-14b. Estero and Tidal Caloosahatchee Sub-watershed Future BMP Coverage

Hydrologic Unit	FUTURE BMP COVERAGE											Total[a]
	Urban and Built-Up	Residential, low density	Residential, medium density	Residential, high density	Commercial and services	Industrial	Extractive	Institutional	Recreational	Agriculture	Transportation, communication, and utilities	
3 . Babcock	0%	29%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
5 . Bayshore Creek	0%	36%	72%	0%	100%	42%	0%	100%	0%	0%	2%	52%
8 . Billy's Creek	0%	2%	3%	95%	65%	40%	0%	49%	37%	0%	14%	60%
9 . Blackstone	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	77%
13 . Caloosahatchee South Shore	18%	15%	8%	48%	41%	0%	0%	11%	17%	3%	32%	21%
17 . Carrol Canal	0%	0%	0%	60%	71%	1%	0%	0%	0%	0%	0%	33%
18 . Chapel Branch	11%	69%	84%	0%	100%	88%	0%	0%	0%	0%	1%	65%
22 . Cohn Branch	0%	93%	87%	87%	0%	0%	0%	0%	91%	2%	35%	86%
24 . Cow Creek	6%	8%	65%	60%	26%	78%	0%	0%	63%	48%	37%	42%
29 . Cypress Lakes	0%	0%	0%	59%	26%	0%	0%	0%	0%	2%	22%	38%
30 . Daughtrey Creek	3%	60%	62%	0%	0%	0%	0%	5%	0%	0%	0%	25%
32 . Deep Lagoon	0%	0%	37%	76%	0%	45%	0%	12%	0%	0%	0%	60%
35 . Estero River	23%	75%	94%	90%	94%	19%	59%	74%	95%	6%	38%	58%
38 . Flint Pen	2%	6%	100%	0%	0%	0%	58%	100%	0%	0%	0%	49%
39 . Fort Myers Shores	0%	5%	18%	27%	9%	0%	0%	100%	16%	2%	23%	22%
43 . Gator Slough	24%	81%	86%	0%	98%	0%	48%	99%	7%	2%	33%	27%
44 . Gordon Swamp	0%	23%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%
46 . Green Meadows	0%	84%	100%	0%	0%	0%	28%	0%	0%	0%	1%	8%
48 . Halfway Creek	39%	58%	99%	96%	0%	60%	0%	72%	94%	29%	10%	81%
49 . Hancock Creek	1%	17%	32%	90%	55%	83%	0%	44%	57%	0%	0%	52%
51 . Hendry Creek	9%	8%	52%	74%	59%	10%	0%	47%	6%	3%	2%	54%
55 . Imperial River	2%	12%	30%	92%	74%	40%	79%	34%	63%	18%	4%	51%
57 . Iona	10%	0%	32%	88%	3%	38%	0%	73%	52%	8%	4%	52%
60 . Kickapoo Creek	0%	46%	100%	0%	0%	0%	0%	100%	2%	0%	0%	37%
68 . Lochmoor County Club	0%	0%	66%	0%	0%	0%	0%	100%	27%	2%	1%	14%
70 . Manuel's Branch	0%	0%	0%	89%	53%	0%	0%	0%	0%	0%	0%	37%
71 . Marsh Point	3%	2%	18%	87%	41%	0%	0%	0%	11%	4%	4%	35%
76 . Mullock Creek	2%	28%	3%	93%	2%	43%	0%	35%	75%	1%	2%	36%
80 . Northcentral Cape Coral	16%	57%	97%	98%	96%	51%	0%	79%	4%	4%	26%	80%
81 . Northwest Cape Coral	0%	93%	90%	7%	100%	0%	48%	100%	12%	0%	7%	76%
82 . Olga	0%	4%	92%	0%	3%	0%	0%	85%	0%	0%	7%	85%
83 . Orange River	3%	2%	84%	97%	39%	92%	0%	71%	13%	0%	2%	67%
84 . Otter Creek	0%	97%	0%	0%	0%	0%	0%	0%	0%	0%	17%	87%
85 . Owl Creek	0%	13%	73%	0%	100%	0%	95%	0%	9%	0%	0%	13%
86 . Palm Creek	0%	47%	6%	0%	0%	0%	0%	0%	0%	0%	2%	37%
87 . Panther Island W	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
89 . Piggot Bridge	0%	76%	100%	5%	1%	0%	0%	100%	96%	0%	17%	68%
90 . Piney Point	0%	0%	76%	0%	0%	0%	0%	0%	0%	0%	0%	76%
92 . Popash Creek	0%	1%	94%	0%	100%	0%	0%	100%	0%	0%	0%	16%
94 . Powell Creek	11%	1%	81%	100%	56%	0%	34%	47%	0%	0%	2%	53%
96 . Six Mile Cypress Slough	6%	5%	85%	91%	95%	84%	9%	62%	76%	6%	53%	72%
97 . Southeast Cape Coral	0%	0%	0%	0%	64%	18%	0%	17%	0%	0%	10%	10%
98 . Southwest Cape Coral	0%	0%	20%	82%	80%	0%	0%	78%	11%	1%	16%	24%
100 . Spring Creek	13%	64%	67%	97%	52%	71%	0%	100%	92%	64%	4%	71%
101 . Stroud Creek	0%	1%	100%	0%	0%	0%	53%	0%	0%	0%	1%	23%
103 . Telegraph Creek	0%	91%	0%	0%	0%	0%	0%	0%	0%	0%	0%	9%
104 . Ten Mile Canal (North)	0%	6%	50%	91%	94%	60%	0%	61%	65%	12%	7%	74%
105 . Ten Mile Canal (South)	2%	24%	10%	98%	70%	19%	0%	0%	0%	0%	8%	65%
106 Thompson Cutoff	30%	17%	86%	0%	0%	0%	0%	0%	26%	0%	88%	64%
108 . Trout Creek	0%	80%	0%	0%	100%	0%	32%	0%	0%	0%	0%	7%
109 . Whiskey Creek	0%	2%	0%	4%	55%	9%	0%	22%	0%	0%	5%	22%
110 . Winkler Canal	0%	0%	0%	0%	44%	0%	0%	0%	0%	0%	0%	19%
111 . Yellow Fever Creek	0%	0%	93%	100%	37%	96%	97%	10%	32%	0%	0%	79%
Total[b]	**10%**	**50%**	**59%**	**84%**	**70%**	**57%**	**54%**	**63%**	**35%**	**3%**	**27%**	**41%**

[a] Weigthed BMP coverage with respect to the total area of land uses with BMPs.

[b] Weigthed BMP coverage with respect to the total area of a given land use.

4.2 Model Results

Applications of the WMM to the Study Area provided preliminary estimates of average annual stormwater runoff rates, baseflow rates, and associated water quality constituent loads under existing (year 2000) and future (year 2050) land use scenarios. These values were tabulated and compared to evaluate the relative changes in magnitude due to future development.

As discussed, the simulations included flows and loads from Lake Okeechobee, WWTPs, septic tanks, baseflows, and stormwater runoff. Estimates of stormwater runoff flows and loads included implementation of existing and future required BMPs for current criteria under Chapter 40E-4 FAC. The estimated BMP efficiencies are presented in Table 3-4.

The preliminary WMM results are presented in **Table 4-15a** through **Table 4-17b f**or each of the three geographic groupings of the 111 hydrologic units in the Study Area (East Caloosahatchee sub-watershed, West Caloosahatchee sub-watershed, and Estero-Tidal Caloosahatchee sub-watershed). The tables list the magnitude of the tributary land area, level of imperviousness, total average flow in acre-feet, and the average annual loads for each of the 12 NPDES water quality parameters considered in the study. As evidenced by the results data presented in the tables, there are expected increases in impervious area, stormwater runoff, and water quality parameter loads to all three geographic areas in varying degrees due to future development. The model results data can be used to compare relative load magnitudes and differences between hydrologic units for consideration of potential retrofit projects to reduce pollutant water quality parameter loads as desired by the SFWMD.

4.2.1 Summary of Results

The goal of this modeling task was to provide a first estimate of the relative contributions of pollutants from the three major sub-watersheds that constitutes the Study Area. The following table and graphics intend to summarize the loads and flows estimated for each sub-watershed and for the Study Area.

Tables 4-18a and **4-18b** provide a summary of loads and flows by source (runoff, baseflow, point source and septic tank) for existing and future conditions, respectively. **Table 4-19** shows the percentage increase in loads and flows.

An important finding from the analysis is that the future loads are expected to increase relative to existing loads, even considering the implementation of BMPs on all new development. For example, the total P load in the Estero Bay and Tidal Caloosahatchee sub-watershed is projected to increase 18 percent when comparing the existing WMM load (472,675 lb/yr) to the future WMM load (555,506 lb/yr). This indicates that the removal efficiency of the BMPs projected for future development is not sufficient to counteract the increase in runoff load that is caused by increased runoff flow (increase in impervious area) and higher runoff concentrations for urban

Table 4-15a: Average Annual Loads for the East Caloosahatchee Sub-watershed (Existing Land Use)

	Existing Land Use (Year 2000)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
1 . 30-foot Canal	210	12.9%	27	284	3,688	1	37,789	7	95	267	10	108,000	1,048	223	35,349	54
2 . 42-foot Canal	22,029	5.7%	1,251	25,294	172,000	14	2,100,000	190	6,151	15,572	216	8,060,000	79,143	13,054	1,110,000	1,149
10 . Bronson	1,848	6.2%	115	2,151	14,895	1	169,000	13	402	1,214	17	661,000	6,636	973	82,869	123
11 . C-19	6,783	3.1%	209	7,288	48,876	2	511,000	50	1,785	4,335	67	2,260,000	25,613	4,255	316,000	404
12 . C20 Canal	911	14.3%	130	1,269	6,125	0	124,000	3	139	625	4	394,000	2,584	250	39,155	23
16 . Canal 3	31,874	5.0%	1,603	36,009	233,000	9	2,830,000	192	9,261	21,812	239	11,300,000	117,000	20,067	1,300,000	1,321
19 . Citrus Center	17,905	5.1%	915	20,270	128,000	11	1,710,000	139	4,988	12,545	189	6,610,000	63,831	10,869	954,000	1,008
21 . Clewiston	4,509	23.9%	1,080	7,506	138,000	17	1,050,000	275	3,094	7,766	262	2,570,000	28,187	5,526	939,000	1,298
33 . Disston Island WCD	19,675	2.7%	530	20,900	139,000	6	1,340,000	139	4,479	11,480	155	6,270,000	71,150	10,747	810,000	973
37 . Flaghole WCD	23,840	4.9%	1,177	26,853	196,000	13	2,040,000	210	5,558	15,723	293	8,330,000	87,455	13,431	1,290,000	1,708
45 . Grassy Marsh	2,186	2.5%	54	2,311	11,774	0	135,000	7	436	1,129	6	675,000	7,507	1,067	57,998	57
52 . Hendry Hilliard WCD	16,882	4.6%	777	18,864	111,000	4	1,400,000	92	4,360	10,796	113	5,840,000	61,093	9,866	667,000	683
54 . Hilliard	26,341	4.6%	1,218	29,443	169,000	6	2,210,000	131	6,797	16,805	156	9,160,000	93,513	15,098	995,000	941
56 . Industrial Canal	9,506	6.7%	640	12,509	129,000	45	947,000	155	2,519	12,770	223	7,390,000	39,163	6,424	743,000	1,227
58 . Jack Spratt (Myrtle Slough)	3,340	4.0%	135	3,679	26,114	1	297,000	27	1,150	2,498	36	1,200,000	13,334	2,531	169,000	192
61 . L-42	4,829	2.6%	128	5,127	32,253	0	381,000	28	1,818	3,502	33	1,650,000	19,855	3,966	185,000	179
65 . Lake Hicpochee	10,345	10.8%	1,113	13,373	83,234	4	1,200,000	70	2,227	7,394	97	4,120,000	36,180	4,946	525,000	579
67 . Linden Pens Marsh	20,869	6.5%	1,356	24,448	146,000	14	2,100,000	131	5,093	13,728	141	7,800,000	68,089	10,303	923,000	799
72 . Meander Ditch	6,549	4.0%	261	7,203	53,344	3	595,000	60	2,415	5,097	79	2,370,000	27,052	5,317	355,000	422
75 . Moore Haven	3,934	13.0%	510	5,327	73,136	8	598,000	135	1,959	4,775	133	1,770,000	20,106	3,816	497,000	670
77 . Nicodemus Slough	17,298	4.9%	851	19,488	113,000	5	1,580,000	97	5,366	12,126	119	6,270,000	64,012	11,468	722,000	635
78 . Ninemile Canal	914	2.8%	26	974	5,824	0	61,758	5	195	513	6	291,000	3,244	481	34,287	42
102 . Sugarland WCD	11,202	3.9%	435	12,288	90,674	5	854,000	110	2,916	7,358	113	3,710,000	42,677	6,703	542,000	674
Lake Okeechobee	0	0.0%	-	720,000	0	254	0	4,324	31,073	174,000	590	557,000,000	3,120,000	98,267	10,800,000	23,584
Total	**263,776**	**5.5%[a]**	**14,539**	**1,022,858**	**2,123,937**	**423**	**24,270,547**	**6,590**	**104,276**	**363,830**	**3,297**	**655,809,000**	**4,098,472**	**259,648**	**24,091,658**	**38,745**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to 100% for this simulation (pre-calibration).

5. The total impervious area percentage is an area-weighted value.

Table 4-15b: Average Annual Loads for the East Caloosahatchee Sub-watershed (Future Land Use)

	Future Land Use (Year 2050)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
1 . 30-foot Canal	210	12.9%	27	284	3,647	0	37,420	6	94	264	10	107,000	1,044	221	34,054	53
2 . 42-foot Canal	22,029	11.6%	2,565	29,011	269,000	15	2,640,000	317	7,254	20,243	260	8,740,000	95,536	15,382	1,170,000	1,774
10 . Bronson	1,848	19.1%	354	2,829	38,821	2	304,000	36	538	1,763	35	823,000	8,624	1,226	118,000	313
11 . C-19	6,783	12.3%	838	9,074	104,000	4	819,000	91	2,032	5,645	72	2,610,000	30,424	4,684	276,000	747
12 . C20 Canal	911	18.8%	171	1,386	6,866	0	142,000	2	147	686	2	420,000	2,754	258	32,014	17
16 . Canal 3	31,874	8.3%	2,659	39,014	284,000	7	3,200,000	252	9,527	24,367	220	11,800,000	127,000	20,976	1,210,000	1,631
19 . Citrus Center	17,905	6.5%	1,161	20,971	149,000	10	1,800,000	133	4,896	12,838	155	6,680,000	64,797	10,695	805,000	1,043
21 . Clewiston	4,509	61.2%	2,759	12,257	331,000	35	2,120,000	512	4,468	12,005	455	3,830,000	43,506	7,624	1,480,000	2,913
33 . Disston Island WCD	19,674	11.2%	2,205	25,252	329,000	14	2,160,000	308	5,238	17,967	261	7,400,000	85,579	12,783	943,000	1,932
37 . Flaghole WCD	23,840	13.1%	3,127	31,498	469,000	20	3,040,000	368	6,138	23,327	380	9,900,000	103,000	15,349	1,200,000	2,802
45 . Grassy Marsh	2,186	2.5%	54	2,311	11,774	0	135,000	7	436	1,129	6	675,000	7,507	1,067	57,998	57
52 . Hendry Hilliard WCD	16,882	4.6%	777	18,864	107,000	2	1,370,000	74	4,243	10,549	80	5,780,000	60,659	9,638	554,000	583
54 . Hilliard	26,341	5.4%	1,412	29,996	180,000	5	2,260,000	136	6,914	17,364	137	9,200,000	96,020	15,386	912,000	953
56 . Industrial Canal	9,505	6.8%	643	14,467	139,000	91	886,000	139	2,296	19,665	203	12,600,000	40,800	6,635	540,000	1,498
58 . Jack Spratt (Myrtle Slough)	3,340	5.0%	166	3,766	23,440	1	258,000	17	678	1,986	15	1,110,000	11,755	1,645	101,000	142
61 . L-42	4,829	2.7%	129	5,132	32,516	0	382,000	28	1,818	3,509	33	1,650,000	19,850	3,965	185,000	179
65 . Lake Hicpochee	10,345	19.5%	2,015	15,939	167,000	6	1,660,000	123	2,538	9,071	102	4,630,000	42,785	5,463	450,000	1,103
67 . Linden Pens Marsh	20,869	9.8%	2,039	26,392	204,000	15	2,410,000	179	5,201	15,090	156	8,150,000	73,042	10,552	908,000	1,190
72 . Meander Ditch	6,549	10.4%	684	8,403	89,171	3	781,000	79	2,397	5,772	72	2,560,000	29,553	5,272	290,000	617
75 . Moore Haven	3,934	40.2%	1,583	8,231	206,000	17	1,200,000	259	2,366	8,207	228	2,480,000	27,355	4,613	698,000	1,478
77 . Nicodemus Slough	17,298	4.9%	851	19,487	111,000	4	1,570,000	87	5,307	11,997	101	6,230,000	63,784	11,347	660,000	579
78 . Ninemile Canal	913	23.8%	217	1,427	33,726	1	169,000	26	282	1,330	24	464,000	4,905	736	57,916	178
102 . Sugarland WCD	11,202	11.7%	1,314	14,776	162,000	9	1,260,000	213	3,348	10,051	152	4,150,000	51,090	7,709	645,000	1,166
Lake Okeechobee	0	0.0%	-	720,000	0	254	0	4,324	31,073	174,000	590	557,000,000	3,120,000	98,267	10,800,000	23,584
Total	**263,775**	**10.5%**	**27,751**	**1,060,767**	**3,450,961**	**515**	**30,603,420**	**7,716**	**109,229**	**408,825**	**3,749**	**668,989,000**	**4,211,369**	**271,493**	**24,126,982**	**46,532**
Percent Increase Over Existing	**0.0%**	**97.3%**	**90.9%**	**3.7%**	**62.5%**	**21.8%**	**26.1%**	**17.1%**	**4.7%**	**12.4%**	**13.7%**	**2.0%**	**2.8%**	**4.6%**	**0.1%**	**20.1%**

Notes: 1. Existing BMPs are included along with BMPs for new development as per current SFWMD criteria in Chapter 40E-4 FAC.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to 100% for this simulation (pre-calibration).

5. The total impervious area percentage is an area-weighted value.

Table 4-16a: Average Annual Loads for the West Caloosahatchee Sub-watershed (Existing Land Use)

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
	Existing Land Use (Year 2000)															
4 . Banana Branch	2,707	5.9%	160	3,309	33,895	4	337,000	44	1,095	2,686	65	1,130,000	11,872	2,371	235,000	321
6 . Bedman Creek	3,735	8.7%	326	4,904	48,502	5	529,000	69	1,562	3,965	94	1,670,000	17,056	3,340	356,000	475
7 . Bee Branch	22,663	6.3%	1,426	27,985	165,000	14	2,410,000	133	5,820	16,445	154	8,770,000	79,647	12,103	981,000	795
14 . Canal 1	12,190	4.5%	553	14,360	82,412	3	1,110,000	63	3,432	8,535	75	4,420,000	46,999	7,736	470,000	448
15 . Canal 2	16,664	6.6%	1,105	20,757	115,000	3	1,660,000	70	3,913	11,359	79	6,240,000	60,652	8,733	591,000	514
20 . City Ditch	1,521	13.1%	200	2,215	41,046	5	292,000	54	899	2,191	68	768,000	7,925	1,690	211,000	334
23 . County Line Drainage District	6,155	14.2%	877	9,180	57,918	4	961,000	49	1,489	5,389	67	2,890,000	22,149	2,959	372,000	353
25 . Cow Slough	9,192	4.2%	382	10,714	73,551	2	889,000	67	3,631	7,504	76	3,420,000	39,969	7,816	402,000	403
26 . Crawford Canal	837	7.3%	61	1,061	10,165	1	113,000	16	328	840	22	367,000	3,707	718	83,320	111
27 . Cypress Branch	27,329	5.1%	1,392	32,687	169,000	16	2,760,000	134	6,990	18,958	161	10,400,000	94,125	14,707	1,150,000	829
28 . Cypress Creek	13,057	6.2%	805	16,069	94,901	7	1,420,000	81	3,855	9,962	100	5,120,000	48,645	8,128	600,000	514
31 . Deadmans Branch	10,437	4.6%	485	12,331	69,603	7	1,060,000	67	2,877	7,531	88	3,990,000	37,392	6,178	510,000	452
34 . Dog Canal	7,855	5.9%	462	9,594	105,000	14	924,000	117	3,098	7,539	126	3,110,000	30,240	5,660	476,000	508
36 . Fichter Branch	5,508	8.1%	448	7,129	42,891	2	654,000	36	1,639	4,398	42	2,250,000	20,845	3,389	258,000	217
40 . Franklin Run	325	15.2%	49	494	7,785	1	70,054	11	140	452	18	184,000	1,399	279	55,652	85
41 . Ft. Denaud Branch	7,156	5.3%	380	8,609	64,508	8	739,000	57	1,903	5,412	74	2,710,000	25,156	3,933	348,000	359
42 . Ft. Simmons	1,244	10.3%	129	1,699	20,005	2	200,000	28	562	1,482	42	596,000	5,965	1,222	145,000	212
47 . Greenbriar Swamp	2,490	4.4%	108	2,918	40,221	5	289,000	34	873	2,140	44	968,000	7,433	1,379	134,000	158
50 . Hendry Canal	17,127	3.7%	635	19,719	214,000	21	1,790,000	182	6,418	14,319	231	6,450,000	61,393	11,917	825,000	919
53 . Hickey's Creek	16,963	6.3%	1,075	20,970	209,000	28	2,090,000	227	6,091	15,868	307	6,970,000	64,867	11,969	1,160,000	1,378
59 . Jacks Branch	46,734	5.4%	2,500	56,284	319,000	25	4,780,000	261	12,863	33,797	319	17,800,000	169,000	27,377	2,030,000	1,660
62 . LaBelle (With WWTP)	2,267	26.0%	589	4,543	87,784	17	601,000	127	1,409	4,315	135	2,200,000	14,514	3,099	424,000	820
63 . LaBelle East	17,085	7.0%	1,197	21,771	212,000	27	2,040,000	213	6,002	15,993	251	7,640,000	67,887	12,221	993,000	1,225
64 . LaBelle Private Drainage District	7,895	7.0%	551	9,924	98,727	11	999,000	127	3,172	7,666	153	3,290,000	33,618	6,376	605,000	740
66 . LeHigh SE	17,761	2.3%	410	19,645	126,000	4	1,260,000	107	4,183	11,022	128	5,790,000	68,362	10,417	675,000	818
69 . Mackeral Canal	6,055	6.9%	418	7,597	58,320	4	714,000	57	2,165	5,277	76	2,460,000	24,700	4,546	341,000	378
73 . Messer	1,369	1.2%	16	1,463	16,275	2	126,000	15	464	1,045	19	488,000	4,420	841	67,100	72
74 . Miller's Gulley	7,576	9.5%	720	10,138	78,662	5	994,000	80	2,735	7,036	98	3,240,000	31,876	5,662	452,000	496
79 . North LaBelle	708	7.9%	56	911	7,535	1	82,699	6	218	600	7	282,000	2,676	436	32,715	35
88 . Park Branch	877	14.8%	129	1,323	15,917	2	170,000	22	330	1,098	34	466,000	3,745	681	118,000	168
91 . Polywog	11,725	5.5%	640	14,161	81,133	10	1,190,000	68	2,661	7,995	72	4,430,000	38,447	5,415	492,000	362
93 . Port LaBelle (With WWTP)	3,475	4.0%	140	4,038	44,432	5	382,000	45	1,303	3,057	61	1,350,000	12,996	2,542	217,000	271
95 . Roberts	24,499	6.0%	1,462	29,995	190,000	5	2,570,000	147	8,531	19,653	174	9,450,000	101,000	18,234	1,020,000	885
99 . Spanish Creek	1,140	9.7%	110	1,533	9,172	0	141,000	6	329	918	7	473,000	4,364	683	46,813	38
107 . Townsend Canal	20,723	3.1%	633	23,421	152,000	1	1,850,000	133	8,452	16,742	160	7,500,000	92,054	18,562	851,000	845
Total	**355,044**	**5.8%**	**20,629**	**433,451**	**3,161,360**	**271**	**38,196,753**	**2,953**	**111,432**	**283,189**	**3,627**	**139,282,000**	**1,357,095**	**233,319**	**17,727,600**	**18,198**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to 100% for this simulation (pre-calibration)

5. The total impervious area percentage is an area-weighted value.

Table 4-16b: Average Annual Loads for the West Caloosahatchee Sub-watershed (Future Land Use)

Future Land Use (Year 2050)

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
4 . Banana Branch	2,707	20.2%	546	4,557	82,073	7	541,000	86	1,184	4,052	92	1,360,000	13,774	2,395	279,000	560
6 . Bedman Creek	3,734	22.0%	822	6,504	90,421	5	715,000	108	1,593	5,607	79	1,850,000	20,939	3,378	273,000	600
7 . Bee Branch	22,663	11.1%	2,525	31,530	256,000	15	2,890,000	227	6,354	20,486	172	9,330,000	91,215	13,343	955,000	1,268
14 . Canal 1	12,190	5.2%	631	14,613	88,684	2	1,140,000	66	3,588	8,864	67	4,440,000	48,661	8,092	432,000	460
15 . Canal 2	16,664	7.5%	1,245	21,211	125,000	2	1,710,000	76	3,942	11,645	70	6,300,000	62,103	8,843	555,000	562
20 . City Ditch	1,521	43.7%	664	3,713	81,770	5	520,000	73	888	2,864	58	1,020,000	11,772	1,819	135,000	606
23 . County Line Drainage District	6,155	6.1%	374	7,559	68,826	5	697,000	77	2,334	5,673	94	2,440,000	26,679	5,082	391,000	513
25 . Cow Slough	9,192	6.4%	586	11,373	99,712	3	983,000	75	3,423	7,998	78	3,500,000	39,357	7,340	377,000	488
26 . Crawford Canal	837	48.4%	405	2,170	47,666	2	302,000	41	416	1,595	31	578,000	6,314	869	72,010	348
27 . Cypress Branch	27,329	7.8%	2,143	35,110	226,000	18	3,100,000	194	7,036	20,784	168	10,800,000	100,000	14,808	1,120,000	1,176
28 . Cypress Creek	13,057	7.0%	920	16,442	110,000	7	1,440,000	78	3,666	10,170	82	5,110,000	48,171	7,738	518,000	507
31 . Deadmans Branch	10,437	6.4%	671	12,931	88,042	7	1,150,000	80	2,955	7,941	79	4,090,000	38,958	6,257	466,000	530
34 . Dog Canal	7,855	35.1%	2,755	16,996	272,000	19	2,010,000	503	5,824	17,820	299	4,560,000	66,483	11,137	1,110,000	1,897
36 . Fichter Branch	5,508	9.2%	507	7,320	51,208	2	671,000	33	1,536	4,523	34	2,250,000	20,374	3,165	220,000	211
40 . Franklin Run	325	20.4%	66	548	7,867	0	64,304	5	97	428	6	168,000	1,413	220	16,997	56
41 . Ft. Denaud Branch	7,156	7.7%	548	9,151	93,730	8	820,000	68	1,779	6,041	77	2,790,000	24,907	3,678	330,000	420
42 . Ft. Simmons	1,244	51.7%	643	3,360	65,482	4	452,000	82	716	2,831	58	864,000	10,644	1,524	167,000	522
47 . Greenbriar Swamp	2,490	26.1%	651	4,670	59,715	2	477,000	68	913	3,469	36	1,220,000	14,140	1,934	124,000	348
50 . Hendry Canal	17,127	26.9%	4,605	32,531	522,000	46	4,330,000	1,112	12,883	34,283	805	10,300,000	125,000	24,401	3,040,000	4,638
53 . Hickey's Creek	16,963	33.1%	5,617	35,630	533,000	34	3,980,000	942	9,526	35,204	526	9,010,000	128,000	20,357	1,990,000	3,623
59 . Jacks Branch	46,734	6.8%	3,184	58,492	399,000	25	5,040,000	280	12,555	35,746	286	18,000,000	170,000	26,652	1,810,000	1,815
62 . LaBelle (With WWTP)	2,267	75.1%	1,703	10,076	244,000	72	1,280,000	254	1,982	8,329	245	8,290,000	25,716	6,836	581,000	2,226
63 . LaBelle East	17,084	16.9%	2,879	27,478	346,000	39	2,960,000	542	9,014	24,688	409	9,710,000	98,927	17,815	1,620,000	2,390
64 . LaBelle Private Drainage District	7,895	25.8%	2,037	14,718	244,000	16	1,730,000	279	3,380	11,831	195	4,050,000	45,737	7,035	660,000	1,617
66 . LeHigh SE	17,761	37.2%	6,611	39,660	593,000	24	4,270,000	759	8,956	34,381	400	9,830,000	138,000	19,751	1,140,000	3,838
69 . Mackeral Canal	6,055	8.7%	529	7,953	62,833	3	753,000	71	2,284	5,608	66	2,510,000	26,320	4,736	328,000	388
73 . Messer	1,369	34.7%	475	2,945	51,668	4	371,000	101	1,123	3,012	65	841,000	11,241	2,003	235,000	377
74 . Miller's Gulley	7,576	15.8%	1,200	11,687	121,000	5	1,220,000	116	2,859	8,196	96	3,500,000	36,199	5,882	413,000	745
79 . North LaBelle	708	25.8%	183	1,320	16,768	1	138,000	17	261	991	10	354,000	3,876	542	35,274	92
88 . Park Branch	877	15.2%	134	1,336	13,502	1	147,000	10	220	913	12	421,000	3,385	488	43,304	102
91 . Polywog	11,725	9.4%	1,105	15,663	152,000	11	1,430,000	107	3,117	10,308	96	4,680,000	42,121	6,278	485,000	622
93 . Port LaBelle (With WWTP)	3,475	20.5%	713	5,885	82,634	6	662,000	133	1,963	5,166	95	1,740,000	21,338	3,801	352,000	597
95 . Roberts	24,499	6.4%	1,566	30,330	196,000	4	2,610,000	161	8,604	20,019	177	9,510,000	102,000	18,403	1,040,000	939
99 . Spanish Creek	1,140	14.7%	168	1,717	13,918	0	167,000	11	356	1,111	9	506,000	4,885	738	47,546	64
107 . Townsend Canal	20,723	3.7%	769	23,861	162,000	1	1,910,000	145	8,463	17,127	161	7,560,000	93,282	18,601	842,000	902
Total	**355,043**	**14.1%**	**50,180**	**531,040**	**5,667,519**	**405**	**52,680,304**	**6,980**	**135,790**	**399,704**	**5,233**	**163,482,000**	**1,721,931**	**285,941**	**22,203,131**	**36,047**
Percent Increase Over Existing	**0.0%**	**143.1%**	**143.2%**	**22.5%**	**79.3%**	**49.9%**	**37.9%**	**136.4%**	**21.9%**	**41.1%**	**44.3%**	**17.4%**	**26.9%**	**22.6%**	**25.2%**	**98.1%**

Notes: 1. Existing BMPs are included along with BMPs for new development as per current SFWMD criteria in Chapter 40E-4 FAC.
2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.
3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).
4. Delivery ratios are set to 100% for this simulation (pre-calibration)
5. The total impervious area percentage is an area-weighted value.

Table 4-17a: Average Annual Loads for the Estero Bay and Tidal Caloosahatchee Sub-watershed (Existing Land Use)

	Existing Land Use (Year 2000)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
3 . Babcock	13,880	4.5%	622	16,326	77,904	9	1,340,000	57	3,283	9,105	64	5,180,000	45,769	6,864	537,000	326
5 . Bayshore Creek	2,071	16.2%	336	3,189	44,640	6	403,000	68	1,018	2,758	77	1,080,000	10,121	1,879	275,000	382
8 . Billy's Creek	6,732	38.1%	2,564	15,242	359,000	48	2,430,000	686	6,761	15,665	609	5,210,000	56,072	10,887	2,150,000	3,257
9 . Blackstone	695	8.2%	57	902	14,297	2	111,000	17	281	777	26	324,000	2,511	506	78,995	116
13 . Caloosahatchee South Shore	6,427	34.1%	2,192	13,700	254,000	28	1,990,000	556	5,600	14,677	427	4,310,000	50,897	9,715	1,640,000	2,176
17 . Carrol Canal	1,075	44.4%	477	2,576	64,204	8	427,000	144	1,349	3,112	111	830,000	10,990	2,234	416,000	570
18 . Chapel Branch	1,368	13.6%	187	2,004	24,609	3	234,000	36	593	1,626	39	661,000	6,234	1,115	147,000	195
22 . Cohn Branch	472	17.8%	84	759	8,203	1	78,159	12	172	568	8	218,000	2,266	340	34,667	51
24 . Cow Creek	8,165	27.8%	2,269	15,738	185,000	15	1,980,000	298	3,457	12,062	246	4,740,000	43,298	6,448	1,040,000	1,408
29 . Cypress Lakes	351	37.1%	130	783	16,603	2	116,000	43	382	991	30	234,000	3,423	696	118,000	146
30 . Daughtrey Creek (With WWTP)	23,263	8.3%	1,935	30,308	222,000	27	2,930,000	244	6,852	19,855	288	9,920,000	86,004	13,638	1,410,000	1,401
32 . Deep Lagoon (With WWTP)	1,777	28.0%	497	3,640	60,975	12	441,000	143	1,262	4,112	94	1,520,000	14,125	2,649	383,000	512
35 . Estero River	39,169	13.4%	5,264	57,376	581,000	55	6,280,000	694	12,769	38,334	738	18,200,000	161,000	24,895	3,140,000	4,326
38 . Flint Pen	9,009	16.8%	1,513	14,172	73,194	3	1,460,000	29	1,637	7,230	27	4,280,000	29,038	2,847	361,000	169
39 . Fort Myers Shores	2,072	35.2%	729	4,491	84,211	10	724,000	176	1,769	5,012	181	1,600,000	16,427	3,338	624,000	948
43 . Gator Slough (With WWTP)	39,333	10.3%	4,066	54,510	412,000	62	5,520,000	522	10,581	41,754	625	18,700,000	146,000	21,533	2,910,000	3,265
44 . Gordon Swamp	4,806	15.0%	723	7,290	35,206	2	729,000	11	848	3,692	11	2,210,000	15,084	1,513	177,000	65
46 . Green Meadows	17,132	7.5%	1,286	21,824	129,000	9	1,990,000	106	4,882	13,287	136	6,930,000	63,456	10,247	816,000	713
48 . Halfway Creek	4,255	10.9%	465	5,887	52,769	3	555,000	66	1,427	4,274	61	1,760,000	19,042	3,151	268,000	371
49 . Hancock Creek	3,984	27.7%	1,104	7,652	164,000	21	1,160,000	309	3,398	8,038	274	2,560,000	28,590	5,609	978,000	1,405
51 . Hendry Creek (With WWTP)	11,518	26.7%	3,076	21,881	334,000	45	2,870,000	612	6,429	19,624	509	7,410,000	70,113	11,901	1,990,000	2,763
55 . Imperial River (With WWTP)	16,679	22.9%	3,813	29,602	457,000	52	3,840,000	879	10,111	27,621	744	9,680,000	102,000	18,551	2,840,000	3,940
57 . Iona	3,285	30.3%	995	6,558	132,000	15	963,000	256	2,708	6,572	207	2,090,000	24,011	4,523	777,000	1,088
60 . Kickapoo Creek	956	11.7%	112	1,347	20,370	3	168,000	24	440	1,244	35	469,000	4,045	819	108,000	157
68 . Lochmoor County Club (With WWTP)	1,053	41.0%	431	3,636	55,633	35	346,000	160	1,013	4,208	120	3,830,000	13,029	2,783	405,000	704
70 . Manuel's Branch	885	54.8%	485	2,358	65,737	9	428,000	137	1,269	2,807	115	799,000	9,819	1,986	410,000	602
71 . Marsh Point	1,961	35.5%	695	4,267	89,182	10	650,000	192	2,023	4,917	150	1,380,000	16,766	3,387	559,000	736
76 . Mullock Creek (With WWTP)	7,012	24.4%	1,711	13,089	201,000	32	1,690,000	421	5,091	13,659	341	5,220,000	48,847	9,277	1,310,000	1,732
80 . Northcentral Cape Coral	21,020	9.8%	2,055	28,258	542,000	78	3,730,000	735	10,692	27,854	975	10,300,000	88,699	19,121	2,900,000	4,546
81 . Northwest Cape Coral	11,735	17.1%	2,010	18,592	285,000	40	2,560,000	461	5,190	17,028	598	6,570,000	54,733	10,367	2,010,000	3,005
82 . Olga	2,370	10.8%	256	3,273	38,392	4	362,000	55	1,149	2,733	60	1,080,000	11,517	2,250	226,000	298
83 . Orange River (With WWTP)	50,340	11.3%	5,677	71,592	1,140,000	181	8,370,000	1,539	26,710	68,984	1,713	27,300,000	234,000	48,959	5,450,000	7,749
84 . Otter Creek	1,051	6.0%	64	1,289	11,340	1	117,000	10	404	954	13	412,000	4,523	874	55,436	71
85 . Owl Creek	3,870	7.2%	281	4,898	45,649	4	463,000	41	1,407	3,442	47	1,560,000	15,573	2,800	199,000	247
86 . Palm Creek	1,969	9.2%	181	2,615	35,718	5	303,000	42	841	2,317	59	899,000	7,967	1,566	191,000	260
87 . Panther Island W	4,393	5.1%	225	5,257	31,039	1	443,000	24	1,428	3,356	29	1,670,000	17,153	3,047	181,000	151
89 . Piggot Bridge	586	17.3%	101	931	10,406	1	112,000	15	223	734	17	301,000	2,665	454	65,752	89
90 . Piney Point	357	16.9%	60	563	3,420	0	58,982	3	82	316	2	171,000	1,244	139	19,318	12
92 . Popash Creek	11,357	7.9%	892	14,596	104,000	12	1,390,000	96	3,127	9,252	125	4,690,000	39,638	6,176	620,000	585
94 . Powell Creek (With WWTP)	8,550	18.8%	1,606	14,777	225,000	47	1,810,000	390	4,913	14,172	365	6,750,000	50,965	9,582	1,300,000	1,929
96 . Six Mile Cypress Slough (With WWTP)	35,579	16.9%	6,021	56,899	743,000	127	7,450,000	1,267	15,461	51,076	1,677	22,300,000	183,000	34,152	5,840,000	8,862
97 . Southeast Cape Coral	20,217	42.6%	8,618	51,925	1,110,000	174	8,290,000	2,596	24,779	64,573	2,361	20,700,000	204,000	43,822	8,230,000	11,936
98 . Southwest Cape Coral	17,495	29.6%	5,176	34,753	591,000	69	5,170,000	1,235	14,123	38,098	1,185	12,000,000	128,000	25,396	4,240,000	5,947
100 . Spring Creek (With WWTP)	7,084	20.8%	1,473	17,090	205,000	145	1,380,000	273	3,012	19,539	302	17,600,000	67,513	12,625	726,000	2,340
101 . Stroud Creek	5,591	10.0%	557	7,567	85,309	10	812,000	89	2,043	5,558	109	2,460,000	21,906	3,805	407,000	540
103 . Telegraph Creek	39,308	6.4%	2,529	48,717	218,000	28	4,210,000	139	7,547	25,315	154	15,300,000	120,000	15,133	1,530,000	783
104 . Ten Mile Canal (North)	7,928	21.0%	1,667	13,225	224,000	28	1,780,000	367	4,185	11,638	371	4,330,000	43,574	7,833	1,330,000	2,045
105 . Ten Mile Canal (South) (With WWTP)	838	25.2%	211	1,538	23,812	2	207,000	43	530	1,410	38	497,000	5,190	936	144,000	202
106 Thompson Cutoff	583	18.3%	106	945	8,575	1	107,000	8	180	641	9	297,000	2,398	351	37,369	58
108 . Trout Creek	18,373	4.9%	897	21,851	140,000	13	1,870,000	131	5,371	13,239	140	6,960,000	67,151	11,110	845,000	771
109 . Whiskey Creek (With WWTP)	5,817	55.9%	3,251	16,449	423,000	58	2,990,000	1,006	7,862	22,100	894	5,540,000	69,679	14,686	3,200,000	4,576
110 . Winkler Canal	977	59.7%	584	2,817	83,809	11	537,000	171	1,478	3,399	150	959,000	11,660	2,355	527,000	798
111 . Yellow Fever Creek	3,116	24.2%	754	5,644	99,362	12	800,000	179	1,943	5,111	167	1,880,000	19,067	3,416	615,000	917
Estuary	0	NA	NA	16,232	113,000	384	0	163	0	28,081	397	39,500,000	119,000	8,389	224,000	3,797
Total	**509,889**	**16.3%**	**83,072**	**823,400**	**10,757,568**	**1,962**	**97,175,141**	**17,976**	**242,085**	**728,501**	**18,250**	**333,371,000**	**2,689,792**	**472,675**	**67,015,537**	**96,038**
Total to the River	**335,971**	**16.8%**	**53,226**	**541,749**	**7,465,945**	**1,441**	**64,405,141**	**12,843**	**170,436**	**500,708**	**12,990**	**226,310,000**	**1,818,061**	**324,556**	**46,734,537**	**66,805**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to 100% for this simulation (pre-calibration)

5. "Total to the River" denotes the loads and flows from hydrologic units that discharge to the tidal river.

6. "Estuary" corresponds to the loads and flows from Wastewater Treatment Plants that discharge directly to the Caloosahatchee River.

7. The total impervious area percentage is an area-weighted value.

Table 4-17b: Average Annual Loads for the Estero Bay and Tidal Caloosahatchee Sub-watershed (Future Land Use)

Future Land Use (Year 2050)

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
3 . Babcock	13,880	4.5%	622	16,326	77,906	9	1,340,000	57	3,284	9,105	64	5,180,000	45,770	6,864	538,000	326
5 . Bayshore Creek	2,071	29.6%	613	4,066	70,442	6	537,000	93	1,173	3,616	89	1,240,000	13,038	2,222	286,000	551
8 . Billy's Creek	6,732	65.9%	4,435	20,994	481,000	48	3,080,000	762	6,121	19,862	590	5,600,000	72,239	11,532	1,890,000	4,072
9 . Blackstone	695	29.7%	207	1,384	20,695	2	166,000	28	321	1,184	26	399,000	4,415	695	79,705	173
13 . Caloosahatchee South Shore	6,427	39.3%	2,528	14,783	276,000	28	2,110,000	573	5,453	15,415	424	4,390,000	53,746	9,780	1,600,000	2,330
17 . Carrol Canal	1,075	59.8%	643	3,111	76,422	8	486,000	140	1,174	3,300	103	857,000	11,940	2,112	360,000	643
18 . Chapel Branch	1,368	21.7%	297	2,355	37,114	3	284,000	46	638	2,025	44	716,000	7,073	1,201	147,000	253
22 . Cohn Branch	472	31.3%	148	964	12,834	1	106,000	18	218	787	11	255,000	3,066	446	38,688	84
24 . Cow Creek	8,165	29.8%	2,435	16,264	194,000	15	2,030,000	314	3,507	12,623	249	4,790,000	45,310	6,668	1,050,000	1,476
29 . Cypress Lakes	351	48.5%	170	913	17,416	2	118,000	40	296	1,055	24	213,000	3,652	639	94,059	143
30 . Daughtrey Creek (With WWTP)	23,263	10.0%	2,324	31,608	271,000	29	3,110,000	278	7,039	21,571	308	10,200,000	89,466	14,119	1,400,000	1,612
32 . Deep Lagoon (With WWTP)	1,777	52.8%	938	5,197	82,060	15	564,000	188	1,263	6,053	98	1,550,000	20,223	3,217	379,000	679
35 . Estero River	39,169	20.2%	7,931	65,986	770,000	54	7,300,000	914	13,988	49,464	803	19,300,000	192,000	29,113	3,060,000	5,403
38 . Flint Pen	9,009	17.6%	1,583	14,396	77,681	3	1,480,000	35	1,697	7,503	29	4,320,000	30,038	3,005	358,000	193
39 . Fort Myers Shores	2,072	39.1%	811	4,755	89,781	10	758,000	184	1,802	5,271	184	1,640,000	17,333	3,425	629,000	988
43 . Gator Slough (With WWTP)	39,333	12.7%	4,999	57,520	489,000	63	6,020,000	597	10,986	45,126	675	19,400,000	156,000	23,449	2,970,000	4,003
44 . Gordon Swamp	4,806	15.1%	724	7,295	35,495	2	730,000	11	846	3,693	11	2,210,000	15,070	1,508	177,000	66
46 . Green Meadows	17,132	7.9%	1,350	22,032	139,000	9	2,020,000	110	4,902	13,588	138	6,950,000	63,737	10,283	806,000	739
48 . Halfway Creek	4,255	31.1%	1,325	8,663	111,000	6	908,000	162	1,848	7,652	96	2,150,000	29,433	4,310	331,000	760
49 . Hancock Creek	3,984	52.8%	2,105	10,776	242,000	22	1,600,000	393	3,570	10,463	302	3,010,000	38,330	6,455	999,000	1,997
51 . Hendry Creek (With WWTP)	11,518	40.5%	4,664	27,279	440,000	53	3,460,000	776	6,733	25,267	555	8,640,000	89,659	14,105	2,030,000	3,570
55 . Imperial River (With WWTP)	16,679	41.2%	6,863	39,438	669,000	58	5,030,000	1,230	11,507	39,463	863	10,700,000	140,000	23,177	3,050,000	5,363
57 . Iona	3,285	49.9%	1,640	8,616	165,000	15	1,150,000	318	2,712	8,840	213	2,190,000	31,269	5,156	768,000	1,302
60 . Kickapoo Creek	956	14.4%	137	1,429	25,212	3	180,000	26	466	1,384	37	479,000	4,230	867	106,000	172
68 . Lochmoor County Club (With WWTP)	1,053	43.8%	461	4,256	60,142	48	350,000	160	992	4,624	127	5,240,000	14,429	3,078	381,000	823
70 . Manuel's Branch	885	67.1%	594	2,709	68,349	8	433,000	128	1,041	2,966	100	746,000	10,429	1,831	342,000	598
71 . Marsh Point	1,961	46.4%	911	4,962	92,861	8	672,000	200	1,834	5,566	134	1,330,000	19,101	3,442	498,000	746
76 . Mullock Creek (With WWTP)	7,012	36.1%	2,534	15,709	245,000	32	1,930,000	496	4,800	16,058	347	5,290,000	56,331	9,707	1,280,000	2,001
80 . Northcentral Cape Coral	21,020	37.3%	7,838	51,919	910,000	115	6,120,000	1,158	14,714	46,839	1,139	18,900,000	187,000	32,551	3,020,000	8,457
81 . Northwest Cape Coral	11,735	26.9%	3,162	22,313	351,000	34	2,970,000	502	5,209	19,825	574	7,080,000	66,609	11,432	1,890,000	3,367
82 . Olga	2,370	33.4%	793	5,004	73,875	4	586,000	104	1,201	4,184	74	1,370,000	16,308	2,460	245,000	546
83 . Orange River (With WWTP)	50,340	37.3%	18,791	120,000	1,860,000	219	13,000,000	2,863	33,102	112,000	1,986	36,200,000	393,000	67,258	6,040,000	13,495
84 . Otter Creek	1,051	11.4%	120	1,471	20,826	1	144,000	13	309	1,077	15	433,000	3,819	629	49,020	91
85 . Owl Creek	3,870	8.5%	328	5,052	50,461	4	488,000	46	1,426	3,594	49	1,580,000	16,000	2,836	201,000	276
86 . Palm Creek	1,969	11.9%	235	2,790	46,781	5	329,000	47	933	2,658	63	919,000	8,608	1,755	185,000	295
87 . Panther Island W	4,393	5.1%	225	5,257	31,038	1	443,000	24	1,428	3,356	29	1,670,000	17,153	3,047	181,000	151
89 . Piggot Bridge	586	23.9%	140	1,056	14,039	1	129,000	18	231	859	19	322,000	2,945	473	66,715	107
90 . Piney Point	357	24.3%	87	648	5,638	0	70,588	6	111	418	4	186,000	1,631	205	20,984	27
92 . Popash Creek	11,357	10.0%	1,139	15,394	121,000	12	1,500,000	118	3,259	10,047	132	4,830,000	42,934	6,546	630,000	720
94 . Powell Creek (With WWTP)	8,550	32.1%	2,745	19,787	284,000	77	2,130,000	489	4,777	20,442	381	10,500,000	72,435	12,474	1,200,000	2,608
96 . Six Mile Cypress Slough (With WWTP)	35,579	48.6%	17,282	92,829	1,690,000	172	13,400,000	2,396	20,374	87,841	2,381	31,000,000	302,000	49,933	6,960,000	17,758
97 . Southeast Cape Coral	20,217	48.0%	9,695	56,326	1,220,000	186	8,910,000	2,615	24,421	65,486	2,380	22,400,000	210,000	43,481	8,090,000	12,869
98 . Southwest Cape Coral	17,495	35.8%	6,266	38,268	664,000	70	5,630,000	1,334	13,741	39,662	1,214	12,500,000	135,000	25,459	4,290,000	6,509
100 . Spring Creek (With WWTP)	7,084	31.2%	2,208	22,377	287,000	220	1,620,000	380	3,224	28,518	390	25,800,000	94,443	17,772	763,000	3,310
101 . Stroud Creek	5,591	12.9%	723	8,103	95,546	10	876,000	104	2,107	6,033	113	2,540,000	23,928	4,016	409,000	618
103 . Telegraph Creek	39,308	6.6%	2,598	48,938	230,000	28	4,240,000	142	7,489	25,568	156	15,300,000	119,000	14,975	1,520,000	811
104 . Ten Mile Canal (North)	7,928	61.6%	4,884	23,261	496,000	38	3,300,000	681	5,420	20,622	513	5,900,000	76,463	11,410	1,560,000	4,079
105 . Ten Mile Canal (South) (With WWTP)	838	48.2%	404	2,161	34,452	3	266,000	64	533	2,122	41	520,000	7,360	1,139	146,000	269
106 Thompson Cutoff	583	23.3%	136	1,039	10,088	1	118,000	11	183	717	9	311,000	2,732	372	37,782	71
108 . Trout Creek	18,373	5.1%	944	22,001	148,000	13	1,900,000	133	5,300	13,377	141	6,980,000	66,669	10,925	840,000	788
109 . Whiskey Creek (With WWTP)	5,817	67.6%	3,933	18,645	495,000	59	3,370,000	996	7,542	22,388	889	5,960,000	73,307	14,380	3,050,000	5,103
110 . Winkler Canal	977	71.6%	700	3,192	95,700	12	602,000	169	1,434	3,457	149	1,030,000	12,342	2,319	504,000	887
111 . Yellow Fever Creek	3,116	51.7%	1,612	8,312	144,000	11	1,020,000	231	1,836	7,895	156	1,930,000	28,460	4,240	494,000	1,161
Estuary	0	NA	NA	29,127	205,000	737	177	293	0	48,329	634	72,500,000	181,000	11,013	413,000	6,386
Total	**509,889**	**27.6%**	**140,979**	**1,039,056**	**14,919,854**	**2,592**	**121,113,765**	**23,214**	**260,515**	**940,838**	**20,275**	**417,646,000**	**3,438,473**	**555,506**	**68,452,953**	**131,825**
Total to the River	**335,971**	**27.1%**	**86,396**	**675,196**	**9,682,772**	**1,924**	**77,078,765**	**15,581**	**179,412**	**622,013**	**13,806**	**288,193,000**	**2,275,824**	**369,690**	**46,606,894**	**86,544**
Percent Increase Over Existing	**0.0%**	**69.3%**	**69.7%**	**26.2%**	**38.7%**	**32.1%**	**24.6%**	**29.1%**	**7.6%**	**29.1%**	**11.1%**	**25.3%**	**27.8%**	**17.5%**	**2.1%**	**37.3%**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to 100% for this simulation (pre-calibration)

5. "Total to the River" denotes the loads and flows from hydrologic units that discharge to the tidal river.

6. "Estuary" corresponds to the loads and flows from Wastewater Treatment Plants that discharge directly to the Caloosahatchee River.

7. The total impervious area percentage is an area-weighted value.

Table 4-18a. Loads and Flows Summary by Source for the Study Area's sub-watersheds (Existing Land Use, Year 2000).

Parameter	East Caloosahatchee						West Caloosahatchee					Estero Bay and Tidal Caloosahatchee				
	Runoff	Baseflow	WWTPs	L. Okeechobee	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total
Flow (ac-ft/yr)	156,023	145,422	1,411	720,000	0	1,022,858	237,795	195,075	582	0	433,451	542,568	249,376	31,455	0	823,400
BOD (lb/yr)	1,636,338	474,685	13,553	0	0	2,123,937	2,510,835	636,757	12,472	0	3,161,360	9,733,727	814,001	188,614	0	10,744,354
Cd (lb/yr)	133	0	36	254	0	423	256	0	15	0	271	1,264	0	724	0	1,989
COD (lb/yr)	21,511,658	2,771,240	0	0	0	24,270,547	34,478,452	3,713,436	0	0	38,196,753	92,416,541	4,748,981	0	0	97,175,141
Cu (lb/yr)	1,855	393	14	4,324	0	6,590	2,417	531	6	0	2,953	17,011	678	289	0	17,976
DP (lb/yr)	49,468	23,734	0	31,073	255	104,276	79,596	31,839	0	801	111,432	201,118	40,704	0	4,092	241,815
NO23 (lb/yr)	168,669	15,822	5,337	174,000	544	363,830	261,156	21,224	810	1,961	283,189	644,835	27,132	48,830	9,497	720,800
Pb (lb/yr)	2,282	393	33	590	0	3,297	3,083	531	13	0	3,627	16,891	678	584	0	18,152
TDS (lb/yr)	41,581,928	53,411,091	3,840,000	557,000,000	0	655,809,000	66,109,000	71,606,929	1,585,000	0	139,282,000	168,265,000	91,566,938	73,322,000	0	333,371,000
TKN (lb/yr)	692,078	284,812	1,766	3,120,000	1,498	4,098,472	972,364	382,052	1,763	4,667	1,357,095	2,024,412	488,403	160,579	28,521	2,673,792
TP (lb/yr)	129,274	31,648	461	98,267	393	259,648	190,077	42,448	792	1,335	233,319	396,141	54,268	22,764	6,851	473,174
TSS (lb/yr)	7,352,029	5,932,608	14,667	10,800,000	0	24,091,658	9,752,108	7,955,799	16,158	0	17,727,600	56,565,730	3,392,047	234,837	0	60,157,336
Zn (lb/yr)	11,665	3,165	330	23,584	0	38,745	13,818	4,244	137	0	18,198	83,905	5,428	6,784	0	96,113
Total Load	73,137,377	62,949,592	3,876,197	571,252,092	2,690	711,170,423	114,373,162	84,395,791	1,617,166	8,764	200,377,797	330,366,575	101,139,259	73,986,005	48,961	505,691,642

Table 4-18b. Loads and Flows Summary by Source for the Study Area's sub-watersheds (Future Land Use, Year 2050).

Parameter	East Caloosahatchee						West Caloosahatchee					Estero Bay and Tidal Caloosahatchee				
	Runoff	Baseflow	WWTPs	L. Okeechobee	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total
Flow (ac-ft/yr)	199,359	138,050	3,361	720,000	0	1,060,767	350,404	177,835	2,800	0	531,040	760,661	215,988	59,606	0	1,039,056
BOD (lb/yr)	2,967,797	450,620	32,269	0	0	3,450,961	5,036,180	580,488	51,192	0	5,667,519	13,784,514	705,028	390,491	0	14,870,768
Cd (lb/yr)	176	0	85	254	0	515	334	0	71	0	405	1,289	0	1,373	0	2,660
COD (lb/yr)	27,968,393	2,628,962	0	0	0	30,603,420	49,275,434	3,387,075	0	0	52,680,304	117,076,757	4,113,123	0	0	121,113,765
Cu (lb/yr)	2,980	374	34	4,324	0	7,716	6,468	482	29	0	6,980	22,108	589	546	0	23,240
DP (lb/yr)	55,625	22,530	0	31,073	439	109,229	106,766	29,024	0	2,719	135,790	217,530	35,252	0	1,017	252,784
NO23 (lb/yr)	207,099	15,019	12,707	174,000	1,496	408,825	377,447	19,350	2,910	9,026	399,704	822,085	23,503	90,503	3,431	935,887
Pb (lb/yr)	2,707	374	78	590	0	3,749	4,687	482	65	0	5,233	18,467	589	1,138	0	20,193
TDS (lb/yr)	52,116,223	50,693,098	9,140,000	557,000,000	0	668,989,000	90,627,000	65,285,821	7,610,000	0	163,482,000	206,072,329	79,305,165	140,858,000	0	426,316,000
TKN (lb/yr)	817,050	270,370	4,205	3,120,000	4,985	4,211,369	1,369,638	348,291	3,794	30,887	1,721,931	2,703,718	423,020	313,481	10,295	3,440,473
TP (lb/yr)	142,088	30,042	1,097	98,267	921	271,493	243,438	38,698	3,809	5,605	285,941	464,087	47,001	45,063	2,068	556,152
TSS (lb/yr)	7,666,321	5,631,388	34,920	10,800,000	0	24,126,982	14,863,438	7,258,464	78,495	0	22,203,131	59,043,903	2,936,519	501,231	0	62,472,951
Zn (lb/yr)	19,159	3,003	786	23,584	0	46,532	31,525	3,868	655	0	36,047	114,859	4,703	12,794	0	132,355
Total Load	91,965,618	59,745,781	9,226,181	571,252,092	7,841	732,229,791	161,942,355	76,952,043	7,751,020	48,237	246,624,985	400,341,647	87,594,492	142,214,620	16,811	630,137,229

Table 4-19. Percentage Increase in Loads and Flows Summary for the Study Area's sub-watersheds.

Parameter	East Caloosahatchee						West Caloosahatchee					Estero Bay and Tidal Caloosahatchee				
	Runoff	Baseflow	Point Source	L. Okeechobee	Septic Tank	Total	Runoff	Baseflow	Point Source	Septic Tank	Total	Runoff	Baseflow	Point Source	Septic Tank	Total
Flow (ac-ft/yr)	27.8%	-5.1%	138.2%	0.0%	ND	3.7%	47.4%	-8.8%	381.1%	ND	22.5%	40.2%	-13.4%	89.5%	ND	26.2%
BOD (lb/yr)	81.4%	-5.1%	138.1%	ND	ND	62.5%	100.6%	-8.8%	310.5%	ND	79.3%	41.6%	-13.4%	107.0%	ND	38.4%
Cd (lb/yr)	32.6%	ND	136.1%	0.0%	ND	21.8%	30.9%	ND	373.3%	ND	49.9%	2.0%	ND	89.6%	ND	33.8%
COD (lb/yr)	30.0%	-5.1%	ND	ND	ND	26.1%	42.9%	-8.8%	ND	ND	37.9%	26.7%	-13.4%	ND	ND	24.6%
Cu (lb/yr)	60.6%	-4.8%	142.9%	0.0%	ND	17.1%	167.6%	-9.3%	383.3%	ND	136.4%	30.0%	-13.2%	89.2%	ND	29.3%
DP (lb/yr)	12.4%	-5.1%	ND	0.0%	72.2%	4.7%	34.1%	-8.8%	ND	239.5%	21.9%	8.2%	-13.4%	ND	-75.1%	4.5%
NO23 (lb/yr)	22.8%	-5.1%	138.1%	0.0%	175.0%	12.4%	44.5%	-8.8%	259.3%	360.3%	41.1%	27.5%	-13.4%	85.3%	-63.9%	29.8%
Pb (lb/yr)	18.6%	-4.8%	136.4%	0.0%	ND	13.7%	52.0%	-9.3%	400.0%	ND	44.3%	9.3%	-13.2%	94.9%	ND	11.2%
TDS (lb/yr)	25.3%	-5.1%	138.0%	0.0%	ND	2.0%	37.1%	-8.8%	380.1%	ND	17.4%	22.5%	-13.4%	92.1%	ND	27.9%
TKN (lb/yr)	18.1%	-5.1%	138.1%	0.0%	232.8%	2.8%	40.9%	-8.8%	115.2%	561.8%	26.9%	33.6%	-13.4%	95.2%	-63.9%	28.7%
TP (lb/yr)	9.9%	-5.1%	138.0%	0.0%	134.4%	4.6%	28.1%	-8.8%	380.9%	319.9%	22.6%	17.2%	-13.4%	98.0%	-69.8%	17.5%
TSS (lb/yr)	4.3%	-5.1%	138.1%	0.0%	ND	0.1%	52.4%	-8.8%	385.8%	ND	25.2%	4.4%	-13.4%	113.4%	ND	3.8%
Zn (lb/yr)	64.2%	-5.1%	138.2%	0.0%	ND	20.1%	128.1%	-8.9%	378.1%	ND	98.1%	36.9%	-13.4%	88.6%	ND	37.7%
Total Load	25.7%	-5.1%	138.0%	0.0%	191.5%	3.0%	41.6%	-8.8%	379.3%	450.4%	23.1%	21.2%	-13.4%	92.2%	-65.7%	24.6%

areas. The SFWMD is currently developing supplemental water quality criteria to be implemented in future environmental resource permits (ERPs) in the Southwest Florida basin. Among these criteria are enhanced efficiency BMPs, low impact development practices, and stormwater recycling that once implemented are expected to reduce the projected increase (e.g., 24% for total P) for the year 2050.

Tables 4-20a and **4-20b** provide normalized values (unit area loads) by sub-watershed area of the load and flows shown in Table 4-18a and 4-18b, respectively.

Tables 4-21 and **4-22** show a ranking of hydrologic units with the highest unit area loads estimated by WMM in each sub-watershed for existing and future conditions, respectively. The hydrologic units were selected based on loads of TKN and total P relative to average sub-watershed and Study Area loads, but the same hydrologic units often have above-average loads of other constituents as well. These tables also provide average unit area load values of each sub-watershed and for the entire Study Area. This information is provided because it may be desirable to focus alternative load reduction analysis on controlling the hydrologic units with the highest unit loads.

As requested during IMC review, CDM compared limited available agricultural loading data (lb/ac/yr) from SFWMD with the loading factors used in the WMM for this Estero Bay-Caloosahatchee River Nutrient Assessment Study. This comparison is presented, for calibrated results, in **Table 4-23**. It should be noted that agricultural loading data can be highly variable, and the agricultural practices for the monitored area may be different. Therefore, these values may not necessarily compare. It should also be noted that the WMM results are based on calibration to measured data for the Caloosahatchee River for the variety of land uses in the watershed.

Table 4-20a. Unit Area Loads (lb/acre/yr) for the Study Area's sub-watersheds (Existing Land Use, Year 2000).

Parameter	East Caloosahatchee					West Caloosahatchee					Estero Bay and Tidal Caloosahatchee				
	Runoff	Baseflow	WWTPs	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total
FLOW (in/yr)	7.10	6.62	1.8E+00	0.0E+00	46.53	8.04	6.59	2.0E-02	0.0E+00	14.65	12.77	5.87	0.74	0.0E+00	19.38
BOD	6.20	1.80	1.4E+00	0.0E+00	8.05	7.07	1.79	3.5E-02	0.0E+00	8.90	19.09	1.60	0.37	0.0E+00	21.07
Cd	5.0E-04	0.0E+00	3.8E-03	0.0E+00	1.6E-03	7.2E-04	0.0E+00	4.2E-05	0.0E+00	7.6E-04	2.5E-03	0.0E+00	1.4E-03	0.0E+00	3.9E-03
COD	81.55	10.51	0.0E+00	0.0E+00	92.01	97.11	10.46	0.0E+00	0.0E+00	107.58	181.25	9.31	0.00	0.0E+00	190.58
Cu	7.0E-03	1.5E-03	1.5E-03	0.0E+00	2.5E-02	6.8E-03	1.5E-03	1.7E-05	0.0E+00	8.3E-03	3.3E-02	1.3E-03	5.7E-04	0.0E+00	0.04
DP	0.19	0.09	0.0E+00	9.7E-04	0.28	0.22	0.09	0.0E+00	2.3E-03	0.31	0.39	0.08	0.00	8.0E-03	0.47
NO23	0.64	0.06	5.6E-01	2.1E-03	0.76	0.74	0.06	2.3E-03	5.5E-03	0.80	1.26	0.05	0.10	1.9E-02	1.41
Pb	0.01	0.00	3.5E-03	0.0E+00	0.01	0.01	0.00	3.7E-05	0.0E+00	0.01	0.03	0.00	0.00	0.0E+00	0.04
TDS	157.64	202.49	4.0E+02	0.0E+00	2486.23	186.20	201.68	4.5E+00	0.0E+00	392.29	330.00	179.58	143.80	0.0E+00	653.81
TKN	2.62	1.08	1.9E-01	5.7E-03	15.54	2.74	1.08	5.0E-03	1.3E-02	3.82	3.97	0.96	0.31	5.6E-02	5.24
TP	0.49	0.12	4.8E-02	1.5E-03	0.98	0.54	0.12	2.2E-03	3.8E-03	0.66	0.78	0.11	0.04	1.3E-02	0.93
TSS	27.87	22.49	1.5E+00	0.0E+00	91.33	27.47	22.41	4.6E-02	0.0E+00	49.93	110.94	6.65	0.46	0.0E+00	117.98
Zn	0.04	0.01	3.5E-02	0.0E+00	0.15	0.04	0.01	3.9E-04	0.0E+00	0.05	0.16	0.01	0.01	0.0E+00	0.19
Total	277.27	238.65	407.78	0.01	2695.37	322.14	237.70	4.55	0.02	564.37	647.92	198.36	145.10	0.10	991.77

Table 4-20b. Unit Area Loads (lb/acre/yr) for the Study Area's sub-watersheds (Future Land Use, Year 2050).

Parameter	East Caloosahatchee					West Caloosahatchee					Estero Bay and Tidal Caloosahatchee				
	Runoff	Baseflow	WWTPs	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total	Runoff	Baseflow	WWTPs	Septic Tank	Total
FLOW (in/yr)	9.07	6.28	4.2E+00	0.0E+00	48.26	11.84	6.01	9.5E-02	0.0E+00	17.95	17.90	5.08	1.40	0.0E+00	24.45
BOD	11.25	1.71	3.4E+00	0.0E+00	13.08	14.18	1.63	1.4E-01	0.0E+00	15.96	27.03	1.38	0.77	0.0E+00	29.16
Cd	0.00	0.00	8.9E-03	0.0E+00	0.00	0.00	0.00	2.0E-04	0.0E+00	0.00	0.00	0.00	0.00	0.0E+00	5.2E-03
COD	106.03	9.97	0.0E+00	0.0E+00	116.02	138.79	9.54	0.0E+00	0.0E+00	148.38	229.61	8.07	0.00	0.0E+00	237.53
Cu	0.01	0.00	3.6E-03	0.0E+00	0.03	0.02	0.00	8.2E-05	0.0E+00	0.02	0.04	0.00	0.00	0.0E+00	0.05
DP	0.21	0.09	0.0E+00	1.7E-03	0.30	0.30	0.08	0.0E+00	7.7E-03	0.38	0.43	0.07	0.00	2.0E-03	0.50
NO23	0.79	0.06	1.3E+00	5.7E-03	0.93	1.06	0.05	8.2E-03	2.5E-02	1.13	1.61	0.05	0.18	6.7E-03	1.84
Pb	0.01	0.00	8.2E-03	0.0E+00	0.01	0.01	0.00	1.8E-04	0.0E+00	0.01	0.04	0.00	0.00	0.0E+00	0.04
TDS	197.58	192.18	9.6E+02	0.0E+00	2536.20	255.26	183.88	2.1E+01	0.0E+00	460.46	404.15	155.53	276.25	0.0E+00	836.10
TKN	3.10	1.02	4.4E-01	1.9E-02	15.97	3.86	0.98	1.1E-02	8.7E-02	4.85	5.30	0.83	0.61	2.0E-02	6.75
TP	0.54	0.11	1.2E-01	3.5E-03	1.03	0.69	0.11	1.1E-02	1.6E-02	0.81	0.91	0.09	0.09	4.1E-03	1.09
TSS	29.06	21.35	3.7E+00	0.0E+00	91.47	41.86	20.44	2.2E-01	0.0E+00	62.54	115.80	5.76	0.98	0.0E+00	122.52
Zn	0.07	0.01	8.3E-02	0.0E+00	0.18	0.09	0.01	1.8E-03	0.0E+00	0.10	0.23	0.01	0.03	0.0E+00	0.26
Total	348.65	226.50	970.62	0.03	2775.21	456.12	216.74	21.83	0.14	694.63	785.15	171.79	278.91	0.03	1235.83

Table 4-21. Ranking of Hydrologic Units with Higher Unit Area Loads (lb/acre/yr) within each Sub-watershed (Existing Land Use - Year 2000)

Hydrologic Units	Area (acres)	Flow (ft/yr)	BOD (lbs/ac/yr)	Cd (lbs/ac/yr)	COD (lbs/ac/yr)	Cu (lbs/ac/yr)	DP (lbs/ac/yr)	NO23 (lbs/ac/yr)	Pb (lbs/ac/yr)	TDS (lbs/ac/yr)	TKN (lbs/ac/yr)	TP (lbs/ac/yr)	TSS (lbs/ac/yr)	Zn (lbs/ac/yr)
East Caloosahatchee Sub-watershed														
Clewiston	4,509	1.7	30.6	0.00	232.9	0.06	0.69	1.72	0.06	570	6.25	1.23	208	0.29
30-Foot Canal	210	1.4	17.6	0.00	180.4	0.03	0.45	1.27	0.05	516	5.00	1.06	169	0.26
Moore Haven	3,934	1.4	18.6	0.00	152.0	0.03	0.50	1.21	0.03	450	5.11	0.97	126	0.17
L-42	4,829	1.1	6.7	0.00	78.9	0.01	0.38	0.73	0.01	342	4.11	0.82	38	0.04
Meander Ditch	6,549	1.1	8.1	0.00	90.8	0.01	0.37	0.78	0.01	362	4.13	0.81	54	0.06
Industrial Canal	9,506	1.3	13.6	0.00	99.6	0.02	0.27	1.34	0.02	777	4.12	0.68	78	0.13
MEAN		**1.2**	**9.4**	**0.00**	**101.7**	**0.01**	**0.30**	**0.79**	**0.01**	**393**	**3.89**	**0.66**	**62**	**0.08**
West Caloosahatchee Sub-watershed														
LaBelle	2,267	2.0	38.7	0.01	265.1	0.06	0.62	1.90	0.06	970	6.40	1.37	187	0.36
City Ditch	1,521	1.5	27.0	0.00	191.9	0.04	0.59	1.44	0.04	505	5.21	1.11	139	0.22
Ft. Simmons	1,244	1.4	16.1	0.00	160.7	0.02	0.45	1.19	0.03	479	4.79	0.98	117	0.17
Townsend Canal	20,723	1.1	7.3	0.00	89.3	0.01	0.41	0.81	0.01	362	4.44	0.90	41	0.04
Bedman Creek	3,735	1.3	13.0	0.00	141.7	0.02	0.42	1.06	0.03	447	4.57	0.89	95	0.13
Banana Branch	2,707	1.2	12.5	0.00	124.5	0.02	0.40	0.99	0.02	417	4.39	0.88	87	0.12
Crawford Canal	837	1.3	12.2	0.00	135.1	0.02	0.39	1.00	0.03	439	4.43	0.86	100	0.13
MEAN		**1.3**	**11.9**	**0.00**	**125.1**	**0.01**	**0.35**	**0.91**	**0.02**	**426**	**4.00**	**0.72**	**68**	**0.08**
Estero Bay - Tidal Caloosahatchee Sub-watershed														
Lochmoor County Club	1,053	3.5	52.9	0.0	329	0.2	1.0	4.0	0.1	3,639	12.4	2.6	375	0.7
Whiskey Creek	5,817	2.8	72.7	0.0	514	0.2	1.4	3.8	0.2	952	12.0	2.5	542	0.8
Winkler Canal	977	2.9	85.8	0.0	549	0.2	1.5	3.5	0.2	981	11.9	2.4	533	0.8
Manuel's Branch	885	2.7	74.3	0.0	483	0.2	1.4	3.2	0.1	903	11.1	2.2	455	0.7
Southeast Cape Coral	20,217	2.6	54.9	0.0	410	0.1	1.2	3.1	0.1	1,024	10.2	2.2	398	0.6
Carrol Canal	1,075	2.4	59.7	0.0	397	0.1	1.3	2.9	0.1	772	10.2	2.1	378	0.5
Cypress Lakes	351	2.2	47.3	0.0	330	0.1	1.1	2.8	0.1	666	9.7	2.0	325	0.4
Spring Creek	7,084	2.4	28.9	0.0	195	0.0	0.4	2.8	0.0	2,484	9.5	1.8	90	0.3
Marsh Point	1,961	2.2	45.5	0.0	331	0.1	1.0	2.5	0.1	704	8.5	1.7	275	0.4
Billy's Creek	6,732	2.3	53.3	0.0	361	0.1	1.0	2.3	0.1	774	8.3	1.6	309	0.5
MEAN		**1.8**	**27.2**	**0.00**	**226**	**0.05**	**0.59**	**1.65**	**0.05**	**671**	**5.95**	**1.11**	**156**	**0.24**
MEAN OF STUDY AREA		**1.5**	**18.3**	**0.00**	**161**	**0.03**	**0.48**	**1.39**	**0.03**	**583**	**5.07**	**0.96**	**107**	**0.15**

Table 4-22. Ranking of Hydrologic Units with Higher Unit Area Loads (lb/acre/yr) within each Sub-watershed (Future Land Use - Year 2050)

Hydrologic Units	Area (acres)	Flow (ft/yr)	BOD (lbs/ac/yr)	Cd (lbs/ac/yr)	COD (lbs/ac/yr)	Cu (lbs/ac/yr)	DP (lbs/ac/yr)	NO23 (lbs/ac/yr)	Pb (lbs/ac/yr)	TDS (lbs/ac/yr)	TKN (lbs/ac/yr)	TP (lbs/ac/yr)	TSS (lbs/ac/yr)	Zn (lbs/ac/yr)
East Caloosahatchee Sub-watershed														
Clewiston	4,509	2.72	73.41	0.01	470.19	0.11	0.99	2.66	0.10	849.45	9.65	1.69	328.25	0.65
Moore Haven	3,934	2.09	52.37	0.00	305.05	0.07	0.60	2.09	0.06	630.43	6.95	1.17	177.44	0.38
30-foot Canal	210	1.36	17.41	0.00	178.62	0.03	0.45	1.26	0.05	510.74	4.98	1.05	162.55	0.25
L-42	4,829	1.06	6.73	0.00	79.11	0.01	0.38	0.73	0.01	341.71	4.11	0.82	38.31	0.04
Ninemile Canal	914	1.56	36.92	0.00	185.00	0.03	0.31	1.46	0.03	507.94	5.37	0.81	63.40	0.19
Meander Ditch	6,549	1.28	13.62	0.00	119.25	0.01	0.37	0.88	0.01	390.88	4.51	0.80	44.28	0.09
MEAN		**1.4**	**17.3**	**0.00**	**139.8**	**0.02**	**0.33**	**1.02**	**0.02**	**464**	**4.47**	**0.72**	**67**	**0.13**
West Caloosahatchee Sub-watershed														
LaBelle	2,267	4.44	107.62	0.03	564.55	0.11	0.87	3.67	0.11	3,656.33	11.34	3.02	256.25	0.98
Mackeral Canal	1,369	2.15	37.74	0.00	271.01	0.07	0.82	2.20	0.05	614.34	8.21	1.46	171.67	0.28
Hendry Canal	17,127	1.90	30.48	0.00	252.82	0.06	0.75	2.00	0.05	601.39	7.30	1.42	177.50	0.27
Dog Canal	7,855	2.16	34.63	0.00	255.88	0.06	0.74	2.27	0.04	580.51	8.46	1.42	141.31	0.24
Ft. Simmons	1,244	2.70	52.63	0.00	363.31	0.07	0.58	2.28	0.05	694.48	8.56	1.22	134.23	0.42
Hickey's Creek	16,963	2.10	31.42	0.00	234.63	0.06	0.56	2.08	0.03	531.17	7.55	1.20	117.32	0.21
LaBelle Private Drainage District	17,761	2.23	33.39	0.00	240.41	0.04	0.50	1.94	0.02	553.46	7.77	1.11	64.19	0.22
MEAN		**1.7**	**23.6**	**0.00**	**188.2**	**0.03**	**0.42**	**1.35**	**0.02**	**569**	**5.43**	**0.91**	**75**	**0.16**
Estero Bay - Tidal Caloosahatchee Sub-watershed														
Lochmoor County Club	1,053	4.0	57.1	0.0	332.5	0.2	0.9	4.4	0.1	4,978.1	13.7	2.9	353.4	0.8
Spring Creek	7,084	3.2	39.2	0.0	228.7	0.1	0.5	4.0	0.1	3,642.0	13.3	2.5	95.4	0.5
Whiskey Creek	5,817	3.2	85.1	0.0	579.3	0.2	1.3	3.8	0.2	1,024.6	12.6	2.5	519.2	0.9
Winkler Canal	977	3.3	97.9	0.0	616.0	0.2	1.5	3.5	0.2	1,053.9	12.6	2.4	510.6	0.9
Southeast Cape Coral	20,217	2.8	60.3	0.0	440.7	0.1	1.2	3.2	0.1	1,108.0	10.5	2.2	391.8	0.6
Manuel's Branch	885	3.1	77.2	0.0	489.1	0.1	1.2	3.4	0.1	842.7	11.8	2.1	380.7	0.7
Carrol Canal	1,075	2.9	71.1	0.0	452.1	0.1	1.1	3.1	0.1	797.3	11.1	2.0	327.5	0.6
Deep Lagoon	1,777	2.9	46.7	0.0	317.3	0.1	0.7	3.4	0.1	1,080.2	11.4	1.9	207.0	0.4
Cypress Lakes	351	2.6	49.6	0.0	336.0	0.1	0.8	3.0	0.1	606.5	10.4	1.8	259.7	0.4
Billy's Creek	6,732	3.1	71.5	0.0	457.5	0.1	0.9	3.0	0.1	831.9	10.7	1.7	274.8	0.6
MEAN		**2.1**	**35.0**	**0.00**	**268.1**	**0.06**	**0.59**	**2.01**	**0.05**	**784**	**7.21**	**1.22**	**153**	**0.30**
MEAN OF STUDY AREA		**1.9**	**27.7**	**0.00**	**216.3**	**0.04**	**0.48**	**1.60**	**0.03**	**650**	**6.08**	**1.02**	**111**	**0.22**

Table 4-23. Comparison between WMM-Estimated Unit Area Loads and Published Values

Statistic	East - West Caloosahatchee Area-Weighted TP Unit Area Loads (lb/ac/yr)	WY06 Unit Area Load (lbs/ac)*
Mean	0.76	1.44
Maximum	1.38	6.13
Minimum	0.21	0.00
Standard Deviation	0.20	1.12

* 2007 South Florida Environmental Report, Draft, Appendix 4-2.

Section 5
Task 4. Model Calibration

For the water quality model calibration task, average annual water quality constituent loads calculated using WMM were compared to observed loads at stations S-78, and S-79 for the calibration period 1991-1995. Based on the comparison, several reasonable refinements to WMM input parameters were made to improve agreement between calculated WMM loads and observed loads. Sensitivity analysis were conducted and the presented results illustrate how changes in WMM input parameter values affect the average annual WMM load results. WMM calculated average annual and average seasonal (wet and dry) loads that reflect the incorporation of the refined WMM input parameters are presented, and the calculated average annual loads are compared to the observed loads. Conclusions and recommendations from these analyses are also provided.

5.1 Calculation of Observed Loads

The observed loads at a particular location where flow and water quality data are available were calculated by multiplying the daily average discharge rate by the respective daily concentrations of the various water quality constituents. The flow and water quality stations listed in Tables 3-6, 3-10, and 3-11 were initially considered for model calibration purposes. However, a proper comparison of observed and modeled long-term annual average flows and loads requires a long-term record of flows and concentrations at the same location, and the gage location must be at or near the outlet of a hydrologic unit or sub-watershed so that the tributary area to the gage and the tributary area in WMM are roughly equivalent. Only two stations within the study area satisfied these criteria; these were S-78 and S-79 along the C-43 canal. It should also be noted that for relatively small tributary areas, WMM results can be significantly different than measured data because (1) the rainfall data used in WMM may not be representative of that small tributary area for certain periods, and (2) EMC values may be variable across the study area, but it is important that the WMM EMCs are representative of the overall average EMC values. Again, this is best established using gages such as the ones at S-78 and S-79 and, consequently, these two stations were used exclusively for the model calibration effort.

The stations located in the hydrologic units at Gator Slough, Estero River, Imperial River, and Southeast Cape Coral were not included because the flows recorded at these gages did not represent the runoff from either the hydrologic unit areas they are in or their site specific drainage areas developed using GIS techniques. The inconsistencies between the expected and the observed runoff can be explained with the high level of diversion present in these hydrologic units.

Station S-235 was initially included in the calibration process, but was not included in the final results for several reasons. One reason is that the measured data at S-235

indicate that water flows in two directions (forwards and backwards). Another reason is that water leaves the basin at several locations. The pump stations at S-4 and S-169 pump water back to Lake Okeechobee year-round. Disston Main Canal and Ninemile Canal divert water back and forth from the S-235 basin to the Lake Hicpochee's canal network. Consequently, the area tributary to the S-235 station is somewhat indeterminate, and the referenced flow reversals can have a major effect on the flows and concentrations measured at the gages.

For the selected calibration points (S-78 and S-79), an observed load was calculated for each day, based on the measured daily flow, and either a measured concentration or an interpolated concentration based on measured concentrations before and after that day. The interpolation procedure was necessary due to the fact that the only available measured concentrations were associated with a range of 10 to 80 water quality grab samples taken over a five-year period. Consequently, at most 4 percent (80 samples/ 1826 days) of the daily loads were based on field measured concentrations.

5.2 Evaluation of WMM Results and Estimation of Delivery Ratios

Results from the initial WMM model runs as presented in Section 4 were compared to the observed loads at S-78 and S-79 to assess the need for model input value refinements. The findings of this comparison and the refinements that were incorporated as a result of the analysis are presented below.

5.2.1 Comparisons of Observed Versus Modeled Flows and Loads

As discussed above, the average annual flows and loads calculated by WMM were compared to observed flows and loads at stations S-78 and S-79 on the C-43 canal. The flows and loads at station S-78 include flows and loads from the East Caloosahatchee sub-watershed, plus the flows and loads released to the C-43 canal from Lake Okeechobee. The flows and loads from Lake Okeechobee are entered in WMM as a point source load that is equal to the observed flow and loads at Station S-77. The flow and load values at station S-79 reflect the WMM flow and loads from the East Caloosahatchee and West Caloosahatchee sub-watersheds, again including the Lake Okeechobee discharge to the C-43 canal.

In comparing the WMM results to observed values, one must consider that the observed values are based on measurements and are thus subject to measurement error. Flow measurements are usually fairly reliable, and we would anticipate that the measured flows should be within 10 percent of the actual flows. In contrast, the observed loads are based on daily flows and a limited number of water quality grab samples, such that the error in the observed loads could be on the order of 50 percent or more. This is particularly true of constituents such as lead and cadmium, which are frequently below the sampling detection limit.

A comparison of the initial WMM results (as presented in Section 4) and the observed flows and loads yields the following observations:

Flows

The WMM calculated average annual flow volumes at S-78 and S-79 were both within 10 percent of the measured results. Overall, the WMM flow at S-79 was 10 percent lower than the measured average flow, and the WMM flow was 6 percent higher than the measured average flow at S-78. Both of these results are reasonable, given that measured flows may have an error of 10 percent relative to the true value. Excluding the flow from Lake Okeechobee (which in WMM was equal to the observed value), the WMM flow from the East Caloosahatchee and West Caloosahatchee subwatersheds was 18 percent lower than the difference between the measured flows at S-79 and S-77, and the WMM flow from the East Caloosahatchee sub-watershed was 25 percent higher than the difference between the measured average flows at S-77 and S-78. Consequently, there was some question whether WMM was overestimating flow in the East Caloosahatchee sub-watershed and underestimating flow in the West Caloosahatchee sub-watershed. Further consideration was given to determine whether there are characteristics of the subwatersheds that would justify changing model input parameters to produce less WMM flow in the East Caloosahatchee and more WMM flow in the West Caloosahatchee. Review of the soil type distribution in the two subwatersheds showed that the distributions were similar, which would not justify varying the pervious runoff coefficient by subwatershed. Another consideration was the potential for greater baseflow quantity in the West Caloosahatchee sub-watershed, which receives about 5.4 inches more precipitation per year than the East Caloosahatchee sub-watershed does. Based on these considerations, several adjustments were made to the WMM flow input parameters. These include the following:

- The pervious runoff coefficient for all subwatersheds was increased from 0.10 to 0.15.

- Annual baseflow quantities were set at 4.6 inches per year for the East Caloosahatchee subwatershed, and 6.5 inches per year for the West Caloosahatchee subwatershed. The rationale was that the additional rainfall for the West Caloosahatchee subwatershed (5.4 inches) resulted in additional runoff of 0.8 inches for pervious areas (based on the runoff coefficient of 0.15), and the remaining 4.6 inches is estimated to be split between additional baseflow and additional evapotranspiration.

Using the revised pervious runoff coefficient and baseflow quantity values, the WMM calculated average annual flow delivered to S-79 was 7 percent lower than the measured flow (it was 10 percent lower before the refinement), and the flow difference at S-79 excluding the Lake Okeechobee discharge was 12 percent (it was 18 percent before the refinement).

TSS

Review of the observed TSS load and the WMM estimated TSS load results suggest that a substantial amount of settling is likely occurring, particularly in the East

Caloosahatchee sub-watershed (above S-78). Calculated WMM TSS loads at S-78 and S-79 were more than double the measured loads at these two stations. Furthermore, the observed TSS load at S-78 is less than the observed TSS load at S-77 (from Lake Okeechobee).

The initial WMM results (as presented in Section 4) were based on a delivery ratio of 1 for all hydrologic units in the study area. This means that 100 percent of the suspended solids and other suspended constituents were delivered from the hydrologic units to the C-43 canal. Clearly, the assignment of delivery ratios that would limit the amount of suspended material that is delivered to the canal was required.

The WMM input parameter refinements for the simulation of TSS and other suspended constituents are presented in Section 5.2.2.

Total P

The initial WMM total P loads at S-78 and S-79, as presented in Section 4, were both within 10 percent of the observed results. Consequently, no refinements were identified. It should be noted, however, that the changes outlined above for flow and TSS would have an impact on the WMM total P loads at S-78 and S-79. Increasing the pervious runoff coefficient would tend to increase the total P load, whereas the reduction in baseflow quantity and the refinement of delivery ratios would reduce the total P load in the canal.

Total N

The initial WMM total N load at S-79 (as presented in Section 4) was within 10 percent of the measured load, while the WMM load at S-78 was about 30 percent higher than the measured load. However, the measured total N load at S-78 is suspect, given that it is only slightly higher than the observed load at S-77, and we do not expect significant loss of nitrogen in the canal due to settling of particulate nitrogen. Therefore, no refinements specific to total N were made.

Other Constituents

Discussion of other constituents will be limited based on absence of sampling data (BOD, COD, and TDS) and limited amount of metals data that were typically below the detection limit (copper, lead, cadmium).

5.2.2 Estimation of Delivery Ratios and Suspended Fractions, and Comparisons of Measured and Refined Modeled Loads of All Constituents

Calculations were performed outside of the WMM model to estimate delivery ratios that would provide better estimates in WMM of the watershed load that is lost by settling of suspended material. The methodology for the refinement and the results are presented below.

For a given hydrologic unit, the delivery ratio to a given point of interest in the study area (e.g., S-79) was estimated by defining the percentage of the hydrologic unit that was more than 24 hours from the point of interest. The value of 24 hours was selected based on typical storm characteristics in the southeastern United States. The premise is that flow conditions in the receiving waters during a storm, and for a limited time after a storm, are turbulent and do not allow any significant settling, but within a day the receiving waters will typically have quiescent conditions in which settling of suspended material can occur.

The calculation of travel time for a hydrologic unit could include travel time to the hydrologic unit outlet, travel time from the outlet to a major receiving water (e.g., C-43 Canal), and travel time within the canal. Canal travel times by hydrologic unit were estimated for three instream flow conditions:

- Brim-full conditions in the canals and stream channels, which corresponded to an average instream velocity of 2.8 ft/s;
- An average instream flow velocity of 1.4 ft/s (50% of the brim-full velocity) which approximated a mid-range depth for wet weather flows in the canals and stream channels; and
- An average velocity of 0.7 ft/s (25% of the brim-full velocity) which approximated a low-range depth for wet weather flows in the canals and stream channels.

The mid-range condition (average instream velocity of 1.4 ft/s) was used.

Table 5-1 lists the estimated delivery ratios for the study area hydrologic units. As shown in the table, the East Caloosahatchee subwatershed has separate delivery ratios to S-78 and S-79 (i.e., the two calibration points along the C-43 canal that receive flow and loads from the East Caloosahatchee subwatershed). The other subwatersheds show a single delivery ratio for loads delivered to the tidal Caloosahatchee River or Estero Bay. The table also lists the area-weighted delivery ratio for each sub-watershed. As shown, the delivery of suspended material to the tidal Caloosahatchee River or Estero Bay is estimated as 20 percent for the East Caloosahatchee sub-watershed, 66 percent for the West Caloosahatchee sub-watershed, and 94 percent for the tidal Caloosahatchee River-Estero Bay subwatershed.

WMM applies the delivery ratio to the suspended fraction of each water quality constituent in the surface runoff to determine the overall delivery of the constituent (suspended plus dissolved). Consider a case in which the delivery ratio equals 0.40 and the suspended fraction of the constituent is 60 percent. The overall delivery of the constituent in this case would be 64 percent, which includes the entire dissolved fraction (40%) + 0.4 times the suspended fraction (0.4 * 60% = 24%).

The delivery of suspended fraction loads from Lake Okeechobee were addressed by calculating the overall delivery (based on suspended fraction and assigned delivery

Table 5-1. Estimated Hydrologic Unit Delivery Ratios Based on a Mid-Range Travel Time to Downstream Points of Interest (1.4 ft/s flow velocity).

East Caloosahatchee Subwaterhsed			West Caloosahatche Subwatershed		Estero Bay-Tidal Caloosahatchee Subwatershed	
Hydrologic Units	Delivery to S-78	Delivery to S-79	Hydrologic Units	Delivery to S-79	Hydrologic Units	Delivery to Estuary or Bay
1 . 30-foot Canal	*1.00* [b]	*0.32*	4 . Banana Branch	*1.00*	3 . Babcock	*1.00*
2 . 42-foot Canal	0.46	0.23	6 . Bedman Creek	1.00	5 . Bayshore Creek	*1.00*
10 . Bronson	*0.41*	*0.22*	7 . Bee Branch	0.64	8 . Billy's Creek	*1.00*
11 . C-19	0.22	0.15	14 . Canal 1	0.39	9 . Blackstone	*0.74*
12 . C20 Canal	*0.20*	*0.14*	15 . Canal 2	0.35	13 . Caloosahatchee South Shore	*1.00*
16 . Canal 3	0.92	0.31	20 . City Ditch	*0.55*	17 . Carrol Canal	*1.00*
19 . Citrus Center	0.77	0.29	23 . County Line Drainage District	1.00	18 . Chapel Branch	*1.00*
21 . Clewiston	0.16	0.12	25 . Cow Slough	*0.78*	22 . Cohn Branch	*1.00*
33 . Disston Island WCD	0.17	0.13	26 . Crawford Canal	0.78	24 . Cow Creek	*1.00*
37 . Flaghole WCD	0.15	0.11	27 . Cypress Branch	0.37	29 . Cypress Lakes	*1.00*
45 . Grassy Marsh	*0.39*	*0.21*	28 . Cypress Creek	1.00	30 . Daughtrey Creek	*1.00*
52 . Hendry Hilliard WCD	0.19	0.13	31 . Deadmans Branch	0.52	32 . Deep Lagoon	*1.00*
54 . Hilliard	0.26	0.17	34 . Dog Canal	1.00	35 . Estero River	*1.00*
56 . Industrial Canal	0.14	0.11	36 . Fichter Branch	*1.00*	38 . Flint Pen	*1.00*
58 . Jack Spratt (Myrtle Slough)	0.34	0.19	40 . Franklin Run	*1.00*	39 . Fort Myers Shores	*1.00*
61 . L-42	*0.18*	*0.13*	41 . Ft. Denaud Branch	0.80	43 . Gator Slough	*1.00*
65 . Lake Hicpochee	0.25	0.16	42 . Ft. Simmons	*1.00*	44 . Gordon Swamp	*1.00*
67 . Linden Pens Marsh	1.00	0.34	47 . Greenbriar Swamp	*1.00*	46 . Green Meadows	*1.00*
72 . Meander Ditch	0.52	0.24	50 . Hendry Canal	0.67	48 . Halfway Creek	*1.00*
75 . Moore Haven	*0.19*	*0.13*	53 . Hickey's Creek	1.00	49 . Hancock Creek	*1.00*
77 . Nicodemus Slough	0.22	0.15	59 . Jacks Branch	0.73	51 . Hendry Creek	*1.00*
78 . Ninemile Canal	0.18	0.13	62 . LaBelle	*0.71*	55 . Imperial River	*1.00*
102 . Sugarland WCD	0.15	0.12	63 . LaBelle East	*0.45*	57 . Iona	*1.00*
Area Weighted Average [a]	**0.45**	**0.20**	64 . LaBelle Private Drainage District	*0.79*	60 . Kickapoo Creek	*1.00*
			66 . LeHigh SE	*0.65*	68 . Lochmoor County Club	*1.00*
			69 . Mackeral Canal	*1.00*	70 . Manuel's Branch	*1.00*
			73 . Messer	0.56	71 . Marsh Point	*1.00*
			74 . Miller's Gulley	*1.00*	76 . Mullock Creek	*1.00*
			79 . North LaBelle	*0.70*	80 . Northcentral Cape Coral	*1.00*
			88 . Park Branch	*1.00*	81 . Northwest Cape Coral	*1.00*
			91 . Polywog	0.62	82 . Olga	*1.00*
			93 . Port LaBelle	*0.51*	83 . Orange River	*0.74*
			95 . Roberts	0.64	84 . Otter Creek	*1.00*
			99 . Spanish Creek	*1.00*	85 . Owl Creek	*1.00*
			107 . Townsend Canal	0.78	86 . Palm Creek	*1.00*
			Area Weigthed Average [a]	**0.66**	87 . Panther Island W	*1.00*
					89 . Piggot Bridge	*1.00*
					90 . Piney Point	*1.00*
					92 . Popash Creek	*1.00*
					94 . Powell Creek	*1.00*
					96 . Six Mile Cypress Slough	*1.00*
					97 . Southeast Cape Coral	*1.00*
					98 . Southwest Cape Coral	*0.08*
					100 . Spring Creek	*1.00*
					101 . Stroud Creek	*1.00*
					103 . Telegraph Creek	*1.00*
					104 . Ten Mile Canal (North)	*1.00*
					105 . Ten Mile Canal (South)	*1.00*
					106 Thompson Cutoff	*1.00*
					108 . Trout Creek	*1.00*
					109 . Whiskey Creek	*1.00*
					110 . Winkler Canal	*1.00*
					111 . Yellow Fever Creek	*1.00*
					Area Weigthed Average [a]	**0.94**

[a] Area weigthed average estimated based on available travel time/distance information. Extrapolated delivery ratios from surrounding tributaries were not included in its calculation.

[b] Delivery ratios in italic font were extrapolated from surrounding tributaries due to lack of travel time/velocity information.

ratio) and then reducing the assigned point source concentration for the Lake Okeechobee discharge accordingly. The assigned delivery ratios for suspended materials released from Lake Okeechobee was set, as shown in **Table 5-2**, at 0.38 and 0.34 at S-78 and S-79, respectively. This is based on most of the settling of suspended material would occur between S-77 and S-78.

Typical suspended fraction values for each WMM water quality constituent are presented in **Table 5-3**. These values were established based on typical removal efficiency values for Best Management Practices (BMPs) that have settling as the primary removal mechanism (e.g., extended-dry detention basins). As shown, the constituents with the highest suspended fraction are the metals, and the nitrogen species tend to have the lowest suspended fraction.

Table 5-3. Suspended Fraction Values

Parameter	Suspended Fraction(1)
BOD	30%
COD	30%
TSS	100%
TDS	0%
TP	30%
DP	0%
TKN	15%
NO23	0%
Pb	90%
Cu	65%
Zn	50%
Cd	90%

Notes: (1) Suspended fraction estimated based on comparison of typical TSS removal and typical removal of other constituents in extended dry detention ponds.

5.2.3 Baseflow Concentrations

Based on comments from the SFWMD, a new water quality station was used as the basis for determining baseflow constituent concentrations for WMM input. Flow and water quality data for the Gator Slough station were evaluated to determine which grab sample data reflected dry weather conditions, and these data were analyzed to determine typical dry weather (baseflow) concentrations. **Table 5-4** presents the revised baseflow constituent concentrations used in WMM; however, they are not substantially different from the values used in WMM for the initial analysis.

Table 5-2. Summary of Delivery Ratios Based on Adjusting Lake Okeechobee Loads and Mid-Range Travel Times in Tributary Areas.

CALIBRATION POINT/AREA	WMM TSS LOAD WITH NO DELIVERY RATIO (Ton/yr)	ESTIMATED TSS LOAD (Ton/yr)	DELIVERY RATIO TO S-78	WMM TSS LOAD AT S-78 WITH DELIVERY RATIO (Ton/yr)	DELIVERY RATIO TO S-79	WMM TSS LOAD AT S-78 WITH DELIVERY RATIO (Ton/yr)
S-77	5,400	5,400	38%		34%	1,836
Between S-77 and S-78	6,646		45%		20%	1,329
S-78	12,046	5,020		5,020		
Between S-78 and S-79	8,864				66%	5,837
S-79	20,910	9,002				9,002

Note: 1. Delivery ratios highlighted in yellow were determined based on matching estimated loads at S-235, S-78, and S79 to WMM-calculated loads.
2. Delivery ratios highlighted in light green were based on a mid-range instream velocity of 1.4 ft/s.

Table 5-4. Baseflow Concentrations Based on Gator Slough Water Quality Station Data.

Parameter	Concentration (mg/L)
BOD	1.2
COD	7.0
TSS	15
TDS	135
TP	0.08
DP	0.06
TKN	0.72
NO23	0.04
Pb	0.001
Cu	0.001
Zn	0.008
Cd	0

5.3 Evaluation of WMM Results with Calibration Refinements

After incorporating the changes documented above for pervious runoff coefficient, baseflow, percent suspended fraction, and delivery ratios, the WMM model was run again. This model run will be referred to as the "base calibration run" and will serve as a reference point for further analysis. **Table 5-5** shows the base calibration run results for average annual flows and loads, compared to observed flows and loads at the calibration points.

As shown in Table 5-5, the observed loads and WMM loads at S-79 are very close for flow, total N, total P, and copper. The model seems to perform well in projecting the zinc and copper loads, which are heavy metals that exhibit high concentrations in urban runoff.

WMM loads of total suspended solids (TSS) still tend to be high relative to the measured loads, particularly at S-79. However, the average concentrations for observed and modeled are both very low at these gages:

- S-78 : 4.1 mg/L (modeled) vs. 3.5 mg/L (observed);
- S-79 : 7.8 mg/L (modeled) vs. 3.6 mg/L (observed).

It should also be noted that the results show a marked improvement over the initial results. Cadmium and lead show relatively high differences, but still match better than the previous run. On these constituents, factors such as below detection limit

Table 5-5. Comparison of WMM Average Annual Loads and Loads Estimated from Available Flow and Water Quality Data.

Constituent	S-77 [1]			S-78 [3]			S-79 [5]		
	Observed [2]	Modeled	% Difference	Observed [4]	Modeled	% Difference	Observed [6]	Modeled	% Difference
Flow (cfs)	999	--	--	1,332	1,413	6%	2,240	2,096	-6%
Total Suspended Solids (Tons/yr)	5,419	--	--	4,626	5,668	23%	7,955	16,043	102%
Total Phosphorus (Tons/yr)	49	--	--	123	124	1%	263	279	6%
Total Nitrogen (Tons/yr)	1,648	--	--	1,716	2,160	26%	3,050	3,184	4%
Zinc (Tons/yr)	11	--	--	15	14	-5%	19	25	31%
Lead (Tons/yr)	0.1	--	--	0.3	0.8	240%	0.6	3.3	415%
Copper (Tons/yr)	2.2	--	--	1.7	2.1	22%	4.0	4.0	-1%
Cadmium (Tons/yr)	0.1	--	--	0.5	0.1	-76%	0.5	0.3	-47%

[1] Structure S-77 (Lake Okeechobee outlet to C-43 Canal) is entered in WMM as an upstream point source load.

[2] Observed load at S-77 is based on daily flows and grab sample data (84-96 samples for TSS and nutrients, and 20 samples for metals) during the period 1991-1995.

[3] Structure S-78 is located downstream of structures S-77 and S-235, with an estimated tributary area of 412 square miles (all of East Caloosahatchee subwatershed in WMM).

[4] Observed load at S-78 is based on daily flows and grab sample data (28-41 samples for TSS and nutrients, and 10 samples for metals) during the period 1991-1995

[5] Structure S-79 is located downstream of structure S-78, with an estimated tributary area of 967 square miles (all of East Caloosahatchee and West Caloosahatchee subwatersheds in WMM).

[6] Observed load at S-79 is based on daily flows and grab sample data (27-41 samples for TSS and nutrients, and 10 samples for metals) during the period 1991-1995

samples and the sampling frequency of these constituents could be significant sources of error in the determination of the observed loads for the calibration period (1991-1995). Comparing the modeled (1.6 ug Pb/L, 0.1 ug Cd/L) and the observed (0.3 ug Pb/L, 0.2 ug Cd/L) lead and cadmium (respectively) mean concentrations at S-79 with the detection limits for these constituents indicates that the model does a reasonably good job at predicting the relatively low loadings for these metals (i.e., both simulated and observed mean concentrations are fairly close to the detection limits of 0.6 ug/L for lead and 0.1 ug/L for cadmium).

5.4 Sensitivity Runs

A sensitivity analysis was conducted to assess the effect that changes in selected WMM input parameter values (i.e., modifying one input parameter value while holding all others unchanged) would have on the loads calculated by WMM. The analysis included varying the following inputs:

1. Point source loads varied by +/- 50% due to limited amount of measured data.

2. EMCs varied by +/- 25%. EMCs are based on a good amount of measured data in Florida.

3. Delivery ratio varied based on varying the travel time to hydrologic unit outlet by +/- 50%.

4. BMP efficiencies varied by +/- 10 percentage points (e.g., if base efficiency is 50%, evaluate for 40% and 60%). BMP efficiencies are based on good amount of measured data.

5. Lake Okeechobee loads varied by +/- 50% due to limited amount of measured data.

6. Baseflow concentrations varied by +/- 50% due to limited amount of measured data.

7. Agricultural BMP efficiency set at 1/3 the base efficiency, considering that little is known about the BMP practices in the study area.

Other input parameters such as septic tank failure rate, pervious runoff coefficients, and baseflow quantities were not considered because either initial results indicated that they were not significant (septic tanks) or because the values were established through calibration (runoff coefficient, baseflow quantity).

Table 5-6 provides a summary of the variability in the average annual loads for all parameters delivered to S-79 from the East and West Caloosahatchee sub-watershed (including Lake Okeechobee discharges) for the input parameters covered by the sensitivity analysis. Highlighted cells show the parameter exhibiting maximum

Table 5-6. Variability in Average Annual Load Based on Sensitivity Analysis for the East and West Caloosahatchee Subwatershed Loads to S-79

Constituent	Increase or Decrease in Total Load	Percent Change in Total Load based on Sensitivity Analysis of Selected Model Parameters						
		Point Source	EMCs	Delivery Ratios	BMP Efficiencies	Baseflow Concentrations	Lake Okeechobee Discharge	Agricultural BMPs
BOD	Increase	0%	21%	2%	2%	8%	0%	3%
	Decrease	0%	-21%	-2%	-2%	-8%	0%	---
Cadmium	Increase	6%	16%	5%	0%	0%	12%	0%
	Decrease	-6%	-16%	-6%	0%	0%	-12%	---
COD	Increase	0%	23%	2%	2%	4%	0%	3%
	Decrease	0%	-23%	-3%	-2%	-4%	0%	---
Copper	Increase	0%	13%	3%	1%	6%	18%	4%
	Decrease	0%	-13%	-3%	-1%	-6%	-18%	---
Dissolved P	Increase	0%	20%	0%	3%	10%	0%	13%
	Decrease	0%	-20%	0%	-3%	-10%	0%	---
NO23N	Increase	0%	18%	0%	2%	2%	12%	4%
	Decrease	0%	-18%	0%	-2%	-2%	-12%	---
Lead	Increase	0%	19%	6%	1%	8%	3%	5%
	Decrease	0%	-19%	-9%	-1%	-8%	-3%	---
TDS	Increase	0%	4%	0%	0%	6%	35%	1%
	Decrease	0%	-4%	0%	0%	-6%	-35%	---
TKN	Increase	0%	10%	0%	1%	5%	26%	2%
	Decrease	0%	-10%	-1%	-1%	-5%	-26%	---
Total P	Increase	0%	18%	2%	3%	6%	8%	8%
	Decrease	0%	-18%	-2%	-3%	-6%	-8%	---
TSS	Increase	0%	10%	4%	1%	22%	7%	2%
	Decrease	0%	-10%	-5%	-1%	-22%	-7%	---
Zinc	Increase	1%	13%	2%	1%	7%	17%	3%
	Decrease	-1%	-13%	-2%	-1%	-7%	-17%	---

Notes:

1. Results reflect following changes to base WMM input parameters for existing conditions:

2. Sensitivity Parameters:

Point Source: + / - 50% of assigned value
EMCs: + / - 25% of assigned value
Delivery ratios: Based on + / - 50% of the estimated travel time
BMP efficiencies: + / - 10 percentage points (e.g., if base efficiency is 50%, used 40% and 60% in sensitivity)
Baseflow concentrations: + / - 50% of assigned value
Agricultural BMPs efficiency = 1/3 of assigned value

3. Shaded cells show the parameter exhibiting maximum variability for each constituent.

variability for each constituent. From this table it can be observed that the baseflow concentrations and EMCs are the most sensitive input parameters for TSS, the constituent with major differences between observed and modeled values.

Table 5-7 provides a summary of the variability for loads from the tidal Caloosahatchee River - Estero Bay subwatershed. For most of the constituents, the surface runoff EMC is the input parameter that has the greatest effect on the calculated loads.

5.5 Additional Refinement Based on Sensitivity Analysis and Additional Information

Based on the sensitivity analysis results, a final base run was conducted with one change: reducing the baseflow TSS concentration from 15 mg/l to 5 mg/l. This modification appears justified based on the fact that the observed TSS average concentration at S-78 and S-79 are less than 5 mg/L. The previous value of 15 mg/l seems high relative to the TSS concentrations measured elsewhere in the system, whereas the refined value seems more representative of concentrations in the system. **Table 5-8** presents the average annual results with the change in baseflow TSS concentration. With the change, the percent difference between WMM loads and observed loads of TSS is reduced to about 10 percent at both S-78 and S-79.

5.6 Calculated Seasonal Loads

The limited availability of a long-term record of measured flows and water quality constituent concentrations associated with a specific location precluded the ability to perform meaningful model calibration based on observed seasonal data. However, seasonal water quality constituent loads were calculated based upon the following observations and/or assumptions:

- The 80-year daily precipitation record applicable to the study area clearly indicates that two distinct seasons exist (wet and dry).
- The difference between seasonal and annual pervious and impervious runoff coefficients is negligible.
- Seasonal baseflow values were derived from the referenced long-term precipitation record.
- Mean monthly point source flows (WWTP and Lake Okeechobee) are applicable for the duration of the specific season being analyzed (wet or dry).

Table 5-9 presents the mean monthly and seasonal precipitation values for each of the three study area sub-watersheds as calculated from the 80-year precipitation record. Based on the record, it is clear that two distinct seasons exist (wet and dry); the wet season runs from the months of May through October, and the dry season November through April.

Table 5-7. Variability in Average Annual Load Based on Sensitivity Analysis for the Tidal Caloosahatchee/Estero Bay Subwatershed

Constituent	Increase or Decrease in Total Load	Percent Change in Total Load based on Sensitivity Analysis of Selected Model Parameters					
		Point Source	EMCs	Delivery Ratios	BMP Efficiencies	Baseflow Concentrations	Agricultural BMPs
BOD	Increase	1%	21%	1%	1%	3%	0%
	Decrease	-1%	-24%	-3%	-1%	-3%	---
Cadmium	Increase	18%	15%	2%	1%	0%	0%
	Decrease	-18%	-17%	-6%	-1%	0%	---
COD	Increase	0%	21%	1%	1%	2%	0%
	Decrease	0%	-26%	-3%	-1%	-2%	---
Copper	Increase	1%	23%	2%	1%	2%	1%
	Decrease	-1%	-24%	-5%	-1%	-2%	---
Dissolved P	Increase	0%	19%	0%	1%	7%	0%
	Decrease	0%	-23%	0%	-1%	-7%	---
NO23N	Increase	3%	20%	0%	1%	2%	0%
	Decrease	-3%	-24%	0%	-1%	-2%	---
Lead	Increase	2%	22%	3%	1%	2%	1%
	Decrease	-2%	-24%	-8%	-1%	-2%	---
TDS	Increase	10%	12%	0%	0%	12%	0%
	Decrease	-10%	-15%	0%	0%	-12%	---
TKN	Increase	3%	17%	0%	1%	8%	0%
	Decrease	-3%	-22%	-1%	-1%	-8%	---
Total P	Increase	2%	19%	1%	1%	5%	1%
	Decrease	-2%	-23%	-2%	-1%	-5%	---
TSS	Increase	0%	20%	3%	1%	7%	1%
	Decrease	0%	-22%	-7%	-1%	-7%	---
Zinc	Increase	3%	21%	1%	1%	3%	0%
	Decrease	-3%	-23%	-4%	-1%	-3%	---

Notes:

1. Results reflect following changes to base WMM input parameters for existing conditions:

2. Sensitivity Parameters:

Point Source: + / - 50% of assigned value

EMCs: + / - 25% of assigned value

Delivery ratios: Based on + / - 50% of the estimated travel time

BMP efficiencies: + / - 10 percentage points (e.g., if base efficiency is 50%, used 40% and 60% in sensitivity)

Baseflow concentrations: + / - 50% of assigned value

Agricultural BMPs efficiency = 1/3 of assigned value

3. Shaded cells show the parameter exhibiting maximum variability for each constituent.

Table 5-8. Comparison of WMM Average Annual Loads and Loads Estimated from Available Flow and Water Quality Data.

Constituent	S-77 [1]			S-78 [3]			S-79 [5]		
	Observed [2]	Modeled	% Difference	Observed [4]	Modeled	% Difference	Observed [6]	Modeled	% Difference
Flow (cfs)	999	--	--	1,332	1,413	6%	2,240	2,096	-6%
Total Suspended Solids (Tons/yr)	5,419	--	--	4,626	4,445	-4%	7,955	8,854	11%
Total Phosphorus (Tons/yr)	49	--	--	123	109	-11%	263	257	-2%
Total Nitrogen (Tons/yr)	1,648	--	--	1,716	2,067	20%	3,050	3,086	1%
Zinc (Tons/yr)	11	--	--	15	14	-6%	19	22	17%
Lead (Tons/yr)	0.1	--	--	0.3	0.8	229%	0.6	2.3	263%
Copper (Tons/yr)	2.2	--	--	1.7	2.0	20%	4.0	3.4	-15%
Cadmium (Tons/yr)	0.1	--	--	0.5	0.1	-78%	0.5	0.2	-58%

[1] Structure S-77 (Lake Okeechobee outlet to C-43 Canal) is entered in WMM as an upstream point source load.

[2] Observed load at S-77 is based on daily flows and grab sample data (84-96 samples for TSS and nutrients, and 20 samples for metals) during the period 1991-1995.

[3] Structure S-78 is located downstream of structures S-77 and S-235, with an estimated tributary area of 395 square miles (all of East Caloosahatchee subwatershed in WMM).

[4] Observed load at S-78 is based on daily flows and grab sample data (28-41 samples for TSS and nutrients, and 10 samples for metals) during the period 1991-1995.

[5] Structure S-79 is located downstream of structure S-78, with an estimated tributary area of 950 square miles (all of East Caloosahatchee and West Caloosahatchee subwatersheds in WMM).

[6] Observed load at S-79 is based on daily flows and grab sample data (27-41 samples for TSS and nutrients, and 10 samples for metals) during the period 1991-1995.

Changes :

1. Baseflow TSS = 5 mg/l

2. WMM flow and loads at S-78 and S-79 modified to exclude the S-236 hydrologic unit. Tributary area at S-78 and S-79 reduced by 17 square miles.

Table 5-9 Mean Monthly and Seasonal Precipitation (1) (2)

Month / Season	East Caloosahatchee River Sub-watershed (inches)	West Caloosahatchee River Sub-watershed (inches)	Tidal Caloosahatchee River – Estero Bay Sub-watershed (inches)
January	1.77	1.84	1.84
February	1.95	2.01	2.01
March	2.72	2.56	2.56
April	2.54	2.08	2.08
May	4.07	3.69	3.69
June	7.65	9.26	9.26
July	7.14	8.79	8.79
August	6.86	8.68	8.68
September	6.98	8.38	8.38
October	3.69	3.65	3.65
November	1.59	1.53	1.53
December	1.42	1.51	1.51
Wet Season Total	36.4	42.4	42.4
Dry Season Total	12.0	11.5	11.5

Notes: (1) – Mean values based on 80-year record of measured values.
(2) – Wet season runs from May through October; Dry season runs from November through April.

Table 5-10 presents the WMM calculated wet and dry season loads delivered to S-77, S-78, and S-79, respectively. **Table 5-11** presents the WMM calculated wet and dry season loads delivered to the Tidal Caloosahatchee River and to Estero Bay, respectively. Note that both tables also provide the combined loads from both seasons (total) and this value is compared against the annual total presented in Table 5-8.

5.7 Conclusions and Recommendations

The comparisons of the WMM simulations with the available water quality monitoring data in the C-43 canal result in the following conclusions and recommendations:

- The use of a higher value of pervious runoff coefficient across the watershed resulted in a better match between observed and modeled flows at all stations (and in incremental areas between stations).
- The delivery ratios and the suspended fraction recommended for the base calibration run appear to provide a reasonable representation of instream transport of TSS and suspended loadings through the watershed.

Table 5-10. WMM Seasonal Loads for the East and West Caloosahatchee River Sub-watersheds.

Constituent	S-77 [1]				S-78 [5]				S-79 [6]			
	Wet Season [2]	Dry Season [3]	Total [4]	Annual	Wet Season	Dry Season	Total	Annual	Wet Season	Dry Season	Total	Annual
Flow (cfs)	795	1,224	1,009	999	1,471	1,378	1,425	1,412	2,576	1,612	2,094	2,096
Total Suspended Solids (tons/yr)	2,158	3,289	5,447	5,419	2,654	1,716	4,370	4,363	6,450	2,413	8,863	8,854
Total Phosphorus (tons/yr)	19	30	49	49	80	43	124	124	188	69	258	257
Total Nitrogen (tons/yr)	653	995	1,648	1,648	1,101	1,058	2,159	2,158	1,859	1,230	3,089	3,086
Zinc (tons/yr)	4.5	6.9	11.4	11.4	7.7	6.1	13.8	13.7	14.7	7.6	22	22
Lead (tons/yr)	0.11	0.17	0.27	0.27	0.61	0.24	0.85	0.84	1.8	0.5	2.3	2.3
Copper (tons/yr)	0.86	1.31	2.18	2.20	1.1	1.0	2.1	2.1	2.2	1.2	3.4	3.4
Cadmium (tons/yr)	0.05	0.08	0.13	0.13	0.06	0.05	0.11	0.10	0.15	0.08	0.22	0.23

[1] Structure S-77 (Lake Okeechobee outlet to C-43 Canal) is entered in WMM as an upstream point source load.

[2] Wet Season comprises the months of May through October.

[3] Dry Season comprises the months of November through May.

[4] 'Total' corresponds to the sum of wet and dry seasons.

[5] Structure S-78 is located downstream of structures S-77 and S-235, with an estimated tributary area of 395 square miles (all of East Caloosahatchee subwatershed in WMM).

[6] Structure S-79 is located downstream of structure S-78, with an estimated tributary area of 950 square miles (all of East Caloosahatchee and West Caloosahatchee subwatersheds in WMM).

Table 5-11. WMM Seasonal Loads for the Tidal Caloosahatchee River and Estero Bay Sub-watershed.

Constituent	Tidal Caloosahatchee [1]				Estero Bay [5]			
	Wet Season [2]	Dry Season [3]	Total [4]	Annual	Wet Season	Dry Season	Total	Annual
Flow (cfs)	1,312	318	815	820	685	161	423	425
Total Suspended Solids (tons/yr)	15,907	4,160	20,067	20,066	7,590	1,964	9,553	9,558
Total Phosphorus (tons/yr)	142	38	180	180	66	18	84	84
Total Nitrogen (tons/yr)	1,008	275	1,283	1,283	490	130	620	620
Zinc (tons/yr)	25.8	7.6	33.5	33.5	11.9	3.4	15.3	15.3
Lead (tons/yr)	4.88	1.36	6.24	6.24	2.18	0.60	2.78	2.78
Copper (tons/yr)	5.04	1.36	6.40	6.40	2.15	0.57	2.72	2.72
Cadmium (tons/yr)	0.51	0.24	0.75	0.75	0.20	0.09	0.28	0.28

[1] Estimated Loads for all Caloosahatchee River's hydrologic units downstream from structure S-79.

[2] Wet Season comprises the months of May through October.

[3] Dry Season comprises the months of November through May.

[4] 'Total' corresponds to the average load between wet and dry seasons.

[5] Structure S-78 is located downstream of structures S-77 and S-235, with an estimated tributary area of 395 square miles (all of East Caloosahatchee subwatershed in WMM).

- The model provides a reasonably good representation of loadings of the heavy metals Zinc and Copper. Model simulations of these metals can be used to evaluate the relative impacts of impervious area runoff and potential toxicant loadings from urban land uses.

- Resetting the TSS baseflow concentration from 15 mg/L to 5 mg/L based on the sensitivity studies improved the calibration results for TSS loadings. A TSS concentration of 5 mg/L in baseflow is consistent with average annual TSS concentrations observed at S-78 and S-79.

5.8 Final Calibrated Loads for Existing Scenario

Tables 5-12 through **5-14** provide the final loading estimates for the existing conditions after incorporating all the changes in parameters recommended during the calibration process.

Figures 5-1 through **5-3** depict in a pie chart format the annual loads by source for the entire Study Area for existing conditions and for all the NPDES parameters. For each constituent, the labels indicate whether or not the point source flow or load includes the Lake Okeechobee discharge. As discussed earlier, concentrations of BOD and COD were not readily available, and therefore the current WMM simulation does not include loads of these constituents from Lake Okeechobee.

5.8.1 Agricultural BMP Efficiency

In order to incorporate comments from the SFWMD and the IMC evaluation committee, a sensitivity analysis was conducted on the agricultural BMP efficiency. A final calibration set of loading estimates for the existing conditions using one-third of the original agricultural BMP efficiency is presented in **Appendix A**. **Figures 7-1** and **7-2** in Section 7 show the distribution of relative loads in the Study Area with the reduced BMP efficiency estimate.

Table 5-12: Average Calibrated Annual Loads for the East Caloosahatchee Sub-watershed (Existing Land Use)

	Existing Land Use (Year 2000)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
1 . 30-foot Canal	210	12.9%	27	284	3,157	0	33,913	4	109	312	4	105,000	1,083	213	11,306	37
2 . 42-foot Canal	22,029	5.7%	1,251	25,329	154,000	5	2,010,000	115	6,907	19,778	88	7,590,000	82,287	12,680	276,000	813
10 . Bronson	1,848	6.2%	115	2,154	13,157	0	156,000	8	425	1,512	7	606,000	6,878	924	18,941	83
11 . C-19	6,783	3.1%	209	7,299	43,537	1	481,000	28	2,021	5,644	22	2,060,000	27,186	4,112	60,799	270
12 . C20 Canal	911	14.3%	130	1,270	4,936	0	108,000	2	122	721	2	380,000	2,349	195	7,394	14
16 . Canal 3	31,874	5.0%	1,603	36,060	226,000	4	2,820,000	137	10,909	28,479	126	10,600,000	126,000	20,772	385,000	1,049
19 . Citrus Center	17,905	5.1%	915	20,298	117,000	5	1,690,000	90	5,715	16,115	86	6,270,000	67,419	10,913	276,000	729
21 . Clewiston	4,509	23.9%	1,080	7,512	109,000	4	845,000	126	3,244	8,515	60	2,500,000	26,259	4,445	126,000	767
33 . Disston Island WCD	19,675	2.7%	530	20,932	122,000	2	1,260,000	76	4,798	14,889	52	5,620,000	74,819	10,189	154,000	653
37 . Flaghole WCD	23,840	4.9%	1,177	26,891	166,000	3	1,830,000	105	5,902	19,693	78	7,580,000	90,123	12,321	205,000	1,063
45 . Grassy Marsh	2,186	2.5%	54	2,315	11,003	0	133,000	5	468	1,499	3	603,000	8,012	1,056	13,170	44
52 . Hendry Hilliard WCD	16,882	4.6%	777	18,891	98,981	1	1,310,000	53	4,973	14,013	40	5,410,000	63,970	9,505	128,000	472
54 . Hilliard	26,341	4.6%	1,218	29,485	153,000	2	2,100,000	82	7,783	21,889	64	8,540,000	98,207	14,776	216,000	679
56 . Industrial Canal	9,506	6.7%	640	12,524	107,000	38	822,000	80	2,663	14,333	79	7,100,000	39,934	5,830	120,000	875
58 . Jack Spratt (Myrtle Slough)	3,340	4.0%	135	3,684	23,861	0	287,000	17	1,389	3,282	14	1,130,000	14,331	2,536	37,900	136
61 . L-42	4,829	2.6%	128	5,135	30,377	0	374,000	18	2,278	4,768	13	1,560,000	21,629	4,000	38,075	137
65 . Lake Hicpochee	10,345	10.8%	1,113	13,388	70,227	1	1,050,000	37	2,293	8,834	31	3,870,000	35,930	4,454	100,000	369
67 . Linden Pens Marsh	20,869	6.5%	1,356	24,481	134,000	7	2,090,000	91	5,623	17,465	76	7,440,000	70,436	10,298	298,000	609
72 . Meander Ditch	6,549	4.0%	261	7,214	49,673	1	584,000	38	2,948	6,707	33	2,240,000	29,421	5,439	91,739	307
75 . Moore Haven	3,934	13.0%	510	5,333	59,553	2	504,000	64	2,126	5,532	33	1,680,000	19,796	3,303	75,490	409
77 . Nicodemus Slough	17,298	4.9%	851	19,515	103,000	1	1,510,000	60	6,432	15,942	46	5,960,000	67,573	11,334	151,000	462
78 . Ninemile Canal	914	2.8%	26	975	5,173	0	57,998	3	209	669	2	261,000	3,412	457	6,488	28
102 . Sugarland WCD	11,202	3.9%	435	12,306	78,505	1	782,000	56	3,134	9,320	33	3,350,000	44,345	6,210	93,244	439
Lake Okeechobee	0	0.0%	-	720,000	0	104	0	2,465	33,411	187,000	236	557,000,000	2,810,000	78,614	3,690,000	15,314
Total	**263,776**	**5.5%**	**14,539**	**1,023,275**	**1,883,140**	**182**	**22,837,911**	**3,760**	**115,882**	**426,911**	**1,228**	**649,455,000**	**3,831,399**	**234,576**	**6,579,546**	**25,758**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to deliver to S-79.

5. The total percent impervious is an area-weighted composite.

Table 5-13: Average Calibrated Annual Loads for the West Caloosahatchee Sub-watershed (Existing Land Use)

	Existing Land Use (Year 2000)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
4 . Banana Branch	2,707	5.9%	160	3,774	40,019	5	416,000	50	1,364	3,436	72	1,250,000	14,789	3,042	213,000	350
6 . Bedman Creek	3,735	8.7%	326	5,526	55,865	6	636,000	76	1,916	4,939	103	1,830,000	20,861	4,217	328,000	511
7 . Bee Branch	22,663	6.3%	1,426	31,861	180,000	13	2,730,000	129	7,043	21,344	135	9,690,000	93,686	14,092	541,000	792
14 . Canal 1	12,190	4.5%	553	16,484	87,056	2	1,190,000	53	4,321	11,415	50	4,870,000	55,290	8,651	182,000	413
15 . Canal 2	16,664	6.6%	1,105	23,597	118,000	2	1,690,000	58	4,740	14,744	53	6,810,000	69,449	9,457	211,000	468
20 . City Ditch	1,521	13.1%	200	2,456	40,685	4	294,000	42	1,063	2,632	45	833,000	8,799	1,790	116,000	281
23 . County Line Drainage District	6,155	14.2%	877	10,144	64,742	5	1,120,000	53	1,684	6,400	71	3,130,000	25,413	3,481	312,000	367
25 . Cow Slough	9,192	4.2%	382	12,322	87,250	2	1,090,000	74	4,754	10,207	82	3,820,000	50,195	10,004	266,000	457
26 . Crawford Canal	837	7.3%	61	1,202	10,874	1	128,000	15	400	1,054	19	403,000	4,424	851	61,122	106
27 . Cypress Branch	27,329	5.1%	1,392	37,421	175,000	10	2,930,000	113	8,643	25,156	108	11,600,000	108,000	16,137	452,000	755
28 . Cypress Creek	13,057	6.2%	805	18,305	115,000	9	1,790,000	98	4,824	13,067	122	5,680,000	60,501	10,649	482,000	595
31 . Deadmans Branch	10,437	4.6%	485	14,148	74,172	5	1,180,000	60	3,580	9,997	65	4,440,000	44,074	7,079	251,000	415
34 . Dog Canal	7,855	5.9%	462	10,943	129,000	18	1,170,000	140	3,772	9,693	155	3,480,000	36,787	7,135	430,000	605
36 . Fichter Branch	5,508	8.1%	448	8,053	51,336	3	809,000	43	2,030	5,648	51	2,480,000	25,571	4,390	209,000	250
40 . Franklin Run	325	15.2%	49	544	9,157	1	80,433	13	164	532	19	198,000	1,570	321	54,493	90
41 . Ft. Denaud Branch	7,156	5.3%	380	9,846	73,517	8	882,000	60	2,264	6,997	73	2,990,000	30,149	4,700	231,000	373
42 . Ft. Simmons	1,244	10.3%	129	1,902	22,951	3	236,000	31	688	1,816	46	649,000	7,242	1,526	136,000	226
47 . Greenbriar Swamp	2,490	4.4%	108	3,353	55,273	8	383,000	48	1,138	2,929	62	1,100,000	9,067	1,822	128,000	214
50 . Hendry Canal	17,127	3.7%	635	22,729	264,000	22	2,160,000	203	8,443	19,705	234	7,280,000	74,699	14,699	535,000	1,057
53 . Hickey's Creek	16,963	6.3%	1,075	23,869	250,000	35	2,600,000	266	7,421	20,267	357	7,730,000	79,082	15,072	1,040,000	1,545
59 . Jacks Branch	46,734	5.4%	2,500	64,357	362,000	26	5,640,000	273	16,014	44,678	310	19,800,000	204,000	33,375	1,250,000	1,738
62 . LaBelle (With WWTP)	2,267	26.0%	589	4,849	86,631	15	600,000	110	1,532	4,771	107	2,280,000	15,209	3,126	301,000	740
63 . LaBelle East	17,085	7.0%	1,197	24,670	226,000	20	2,180,000	176	7,546	20,566	172	8,410,000	77,457	13,463	464,000	1,111
64 . LaBelle Private Drainage District	7,895	7.0%	551	11,264	106,000	10	1,130,000	118	3,874	9,743	129	3,640,000	39,746	7,444	399,000	707
66 . LeHigh SE	17,761	2.3%	410	22,812	147,000	4	1,540,000	109	5,069	14,844	120	6,290,000	85,355	12,935	357,000	864
69 . Mackeral Canal	6,055	6.9%	418	8,626	64,832	3	803,000	54	2,749	6,869	65	2,720,000	29,538	5,419	204,000	370
73 . Messer	1,369	1.2%	16	1,710	22,255	3	175,000	21	606	1,472	26	556,000	5,609	1,131	60,600	96
74 . Miller's Gulley	7,576	9.5%	720	11,389	82,361	3	1,060,000	68	3,392	8,874	72	3,550,000	36,938	6,431	239,000	454
79 . North LaBelle	708	7.9%	56	1,030	9,097	1	102,000	7	262	761	9	309,000	3,263	551	25,705	40
88 . Park Branch	877	14.8%	129	1,459	17,650	3	194,000	24	371	1,276	36	502,000	4,244	774	111,000	174
91 . Polywog	11,725	5.5%	640	16,184	87,832	9	1,350,000	64	3,122	10,400	62	4,900,000	44,799	6,164	264,000	358
93 . Port LaBelle (With WWTP)	3,475	4.0%	140	4,647	50,127	4	430,000	41	1,679	4,107	45	1,510,000	15,365	2,921	112,000	255
95 . Roberts	24,499	6.0%	1,462	34,199	214,000	4	2,940,000	151	11,001	26,127	162	10,500,000	122,000	22,147	571,000	948
99 . Spanish Creek	1,140	9.7%	110	1,721	10,982	0	171,000	7	406	1,163	9	517,000	5,331	884	35,366	45
107 . Townsend Canal	20,723	3.1%	633	27,087	185,000	1	2,310,000	154	11,222	23,136	177	8,420,000	117,000	23,996	556,000	989
Total	**355,044**	**5.8%**	**20,629**	**494,483**	**3,575,664**	**268**	**44,139,433**	**3,002**	**139,097**	**370,765**	**3,423**	**154,167,000**	**1,625,502**	**279,876**	**11,128,286**	**18,759**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. The total percent impervious is an area-weighted composite.

Table 5-14: Average Calibrated Annual Loads for the Estero Bay and Tidal Caloosahatchee Sub-watershed (Existing Land Use)

	Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
	Existing Land Use (Year 2000)																
3	Babcock	13,880	4.5%	622	18,746	94,707	12	1,740,000	72	4,033	12,187	82	5,780,000	56,780	8,945	407,000	385
5	Bayshore Creek	2,071	16.2%	336	3,507	49,451	6	461,000	74	1,149	3,213	83	1,160,000	11,511	2,168	264,000	403
8	Billy's Creek	6,732	38.1%	2,564	16,033	377,000	51	2,590,000	719	7,161	16,878	636	5,430,000	59,562	11,623	2,170,000	3,378
9	Blackstone	695	8.2%	57	1,018	16,846	2	126,000	18	350	986	24	358,000	2,862	580	58,482	115
13	Caloosahatchee South Shore	6,427	34.1%	2,192	14,473	269,000	30	2,140,000	586	5,972	15,792	449	4,520,000	54,289	10,412	1,650,000	2,275
17	Carrol Canal	1,075	44.4%	477	2,690	67,104	8	449,000	151	1,434	3,316	116	862,000	11,697	2,400	424,000	593
18	Chapel Branch	1,368	13.6%	187	2,220	27,426	3	272,000	39	674	1,926	42	717,000	7,173	1,303	138,000	207
22	Cohn Branch	472	17.8%	84	830	9,096	1	89,917	13	189	653	9	235,000	2,529	385	31,246	55
24	Cow Creek	8,165	27.8%	2,269	16,815	195,000	16	2,160,000	307	3,629	13,094	253	5,000,000	46,205	6,837	986,000	1,441
29	Cypress Lakes	351	37.1%	130	823	17,420	2	124,000	44	411	1,064	31	245,000	3,689	758	119,000	152
30	Daughtrey Creek (With WWTP)	23,263	8.3%	1,935	34,201	258,000	33	3,600,000	277	8,126	24,876	327	10,900,000	103,000	16,959	1,210,000	1,532
32	Deep Lagoon (With WWTP)	1,777	28.0%	497	3,873	65,401	13	484,000	150	1,368	4,468	103	1,580,000	15,185	2,873	382,000	536
35	Estero River	39,169	13.4%	5,264	63,565	652,000	64	7,340,000	758	14,665	45,845	806	19,700,000	186,000	29,618	2,850,000	4,652
38	Flint Pen	9,009	16.8%	1,513	15,541	81,326	4	1,690,000	31	1,735	8,397	29	4,630,000	32,081	3,122	269,000	169
39	Fort Myers Shores	2,072	35.2%	729	4,737	88,713	11	771,000	185	1,886	5,361	188	1,670,000	17,503	3,559	628,000	980
43	Gator Slough (With WWTP)	39,333	10.3%	4,066	60,946	464,000	74	6,610,000	566	12,049	49,264	675	20,300,000	170,000	25,925	2,570,000	3,429
44	Gordon Swamp	4,806	15.0%	723	8,035	39,634	2	853,000	12	915	4,363	13	2,400,000	16,887	1,702	128,000	66
46	Green Meadows	17,132	7.5%	1,286	24,716	153,000	12	2,470,000	126	6,047	17,156	161	7,660,000	78,053	13,287	658,000	809
48	Halfway Creek	4,255	10.9%	465	6,579	60,819	4	664,000	73	1,710	5,222	68	1,920,000	22,724	3,908	227,000	405
49	Hancock Creek	3,984	27.7%	1,104	8,179	175,000	22	1,260,000	326	3,655	8,855	289	2,700,000	30,945	6,112	979,000	1,467
51	Hendry Creek (With WWTP)	11,518	26.7%	3,076	23,433	353,000	48	3,140,000	636	6,838	21,480	530	7,810,000	75,436	12,801	1,940,000	2,849
55	Imperial River (With WWTP)	16,679	22.9%	3,813	31,951	492,000	57	4,260,000	933	10,994	30,764	788	10,300,000	112,000	20,514	2,790,000	4,141
57	Iona	3,285	30.3%	995	6,978	140,000	16	1,040,000	268	2,904	7,185	218	2,200,000	25,941	4,929	774,000	1,133
60	Kickapoo Creek	956	11.7%	112	1,501	23,997	4	198,000	27	518	1,500	39	512,000	4,688	971	104,000	171
68	Lochmoor County Club (With WWTP)	1,053	41.0%	431	3,750	57,584	36	366,000	164	1,070	4,395	123	3,860,000	13,644	2,917	407,000	717
70	Manuel's Branch	885	54.8%	485	2,438	68,316	9	445,000	143	1,327	2,946	119	824,000	10,241	2,081	419,000	623
71	Marsh Point	1,961	35.5%	695	4,498	95,146	10	698,000	203	2,151	5,282	158	1,450,000	17,790	3,611	567,000	775
76	Mullock Creek (With WWTP)	7,012	24.4%	1,711	14,061	216,000	34	1,870,000	450	5,496	15,018	363	5,480,000	53,037	10,087	1,310,000	1,827
80	Northcentral Cape Coral	21,020	9.8%	2,055	31,722	669,000	98	4,490,000	856	12,999	34,526	1,132	11,300,000	103,000	23,071	2,880,000	5,056
81	Northwest Cape Coral	11,735	17.1%	2,010	20,367	326,000	47	2,910,000	500	5,867	19,604	646	7,060,000	60,608	11,609	1,960,000	3,169
82	Olga	2,370	10.8%	256	3,658	44,072	4	430,000	61	1,387	3,361	67	1,180,000	13,882	2,810	211,000	325
83	Orange River (With WWTP)	50,340	11.3%	5,677	79,746	1,250,000	172	9,250,000	1,471	31,559	83,374	1,534	29,600,000	264,000	54,319	4,000,000	7,622
84	Otter Creek	1,051	6.0%	64	1,469	13,861	1	147,000	12	517	1,250	16	456,000	5,707	1,157	46,023	82
85	Owl Creek	3,870	7.2%	281	5,553	54,789	5	578,000	50	1,748	4,441	57	1,720,000	19,196	3,620	169,000	288
86	Palm Creek	1,969	9.2%	181	2,941	41,858	7	365,000	48	987	2,833	67	988,000	9,356	1,870	180,000	284
87	Panther Island W	4,393	5.1%	225	6,018	38,546	2	570,000	31	1,832	4,494	38	1,860,000	21,728	4,081	142,000	185
89	Piggot Bridge	586	17.3%	101	1,020	11,633	1	127,000	16	252	847	18	323,000	3,015	525	60,918	93
90	Piney Point	357	16.9%	60	617	3,762	0	68,093	4	86	364	3	185,000	1,367	150	16,151	13
92	Popash Creek	11,357	7.9%	892	16,506	122,000	16	1,720,000	111	3,717	11,702	144	5,180,000	47,557	7,672	523,000	646
94	Powell Creek (With WWTP)	8,550	18.8%	1,606	16,045	244,000	50	2,050,000	416	5,360	15,813	390	7,090,000	56,006	10,547	1,270,000	2,025
96	Six Mile Cypress Slough (With WWTP)	35,579	16.9%	6,021	62,305	800,000	137	8,370,000	1,325	17,203	58,105	1,742	23,700,000	206,000	38,562	5,600,000	9,112
97	Southeast Cape Coral	20,217	42.6%	8,618	54,045	1,170,000	181	8,740,000	2,737	25,986	67,148	2,464	21,300,000	217,000	46,333	8,410,000	12,397
98	Southwest Cape Coral	17,495	29.6%	5,176	37,002	466,000	13	4,090,000	540	15,212	41,412	230	12,600,000	120,000	20,210	425,000	3,426
100	Spring Creek (With WWTP)	7,084	20.8%	1,473	18,121	219,000	146	1,550,000	287	3,289	20,783	314	17,900,000	71,501	13,307	675,000	2,402
101	Stroud Creek	5,591	10.0%	557	8,486	99,637	13	980,000	102	2,422	6,872	126	2,700,000	25,942	4,652	370,000	600
103	Telegraph Creek	39,308	6.4%	2,529	55,429	256,000	40	5,320,000	167	8,767	32,819	187	17,000,000	144,000	18,818	1,150,000	864
104	Ten Mile Canal (North)	7,928	21.0%	1,667	14,386	242,000	31	1,980,000	385	4,606	13,239	390	4,620,000	48,620	8,835	1,280,000	2,124
105	Ten Mile Canal (South) (With WWTP)	838	25.2%	211	1,653	25,400	3	228,000	46	573	1,560	40	527,000	5,667	1,027	142,000	211
106	Thompson Cutoff	583	18.3%	106	1,031	9,589	1	123,000	9	203	742	10	319,000	2,688	402	32,700	61
108	Trout Creek	18,373	4.9%	897	25,041	169,000	17	2,410,000	159	6,703	17,651	172	7,760,000	83,909	14,604	689,000	904
109	Whiskey Creek (With WWTP)	5,817	55.9%	3,251	16,920	436,000	60	3,090,000	1,037	8,173	22,950	917	5,670,000	72,216	15,262	3,240,000	4,679
110	Winkler Canal	977	59.7%	584	2,893	86,405	12	554,000	176	1,534	3,536	154	983,000	12,053	2,446	535,000	818
111	Yellow Fever Creek	3,116	24.2%	754	6,075	104,000	13	877,000	186	2,056	5,644	173	1,990,000	20,686	3,685	604,000	944
	Estuary	0	NA	NA	16,232	99,786	411	0	163	0	21,635	296	39,500,000	101,000	8,389	178,000	3,872
	Total	**509,889**	**16.3%**	**83,072**	**901,418**	**11,609,324**	**2,064**	**108,928,010**	**18,246**	**271,494**	**828,191**	**18,049**	**353,714,000**	**2,978,156**	**528,350**	**59,248,520**	**97,487**
	Total to the River	**335,971**	**16.8%**	**53,226**	**593,416**	**8,024,179**	**1,502**	**71,659,010**	**12,802**	**191,551**	**567,607**	**12,483**	**239,962,000**	**1,998,528**	**359,904**	**40,132,520**	**66,942**

Notes: 1. Existing BMPs are included.
2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.
3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).
4. "Total to the River" denotes the loads and flows from hydrologic units that discharge to the tidal river.
5. "Estuary" corresponds to the loads and flows from Wastewater Treatment Plants that discharge directly to the Caloosahatchee River.
6. The total percent impervious is an area-weighted composite.

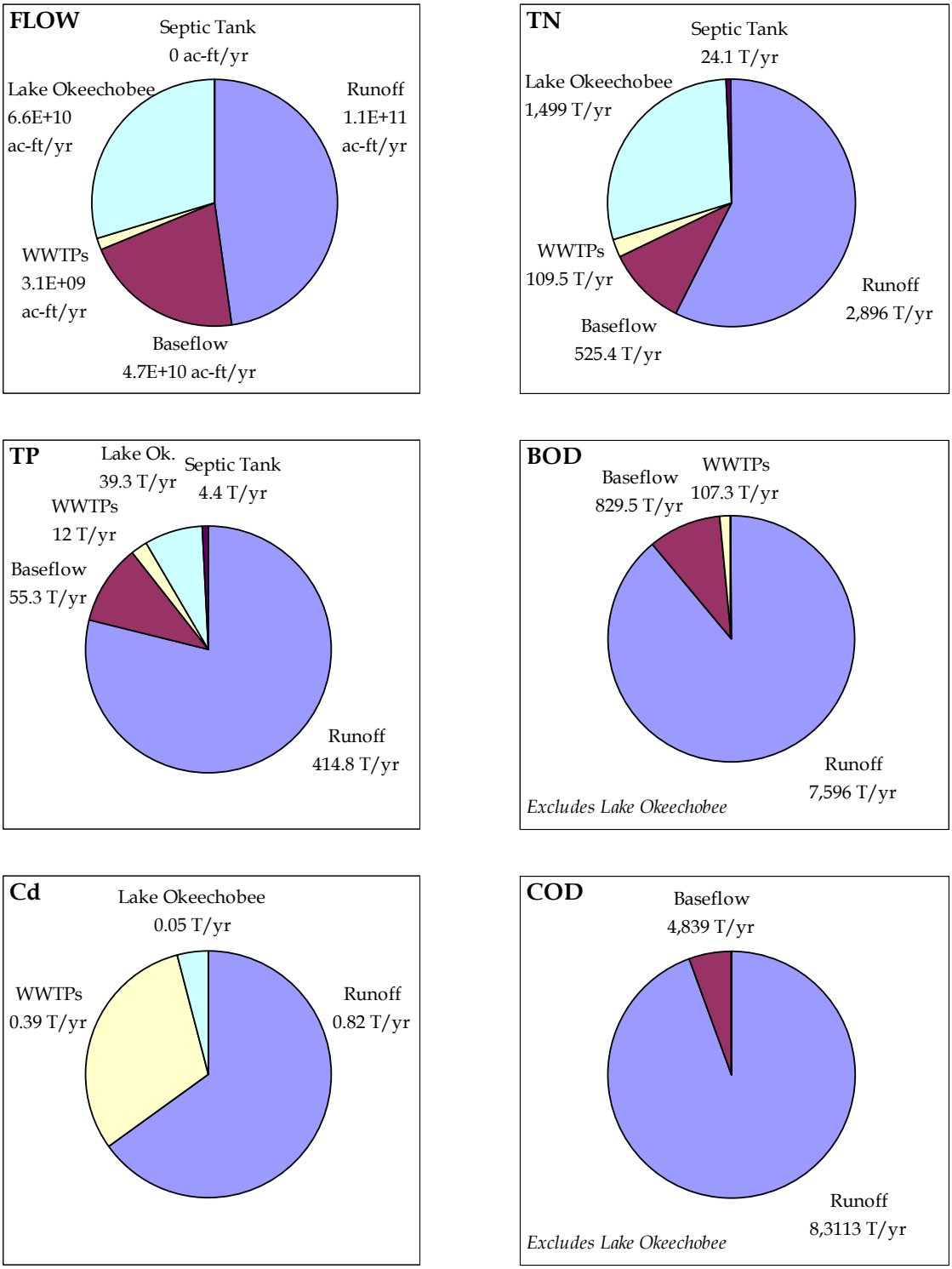


Figure 5-1. Gallery of WMM-Estimated Loads (TN, TP, BOD, Cd and COD) and Flows of the Estero Bay – Caloosahatchee River Watershed for Existing Conditions (Year 2000).

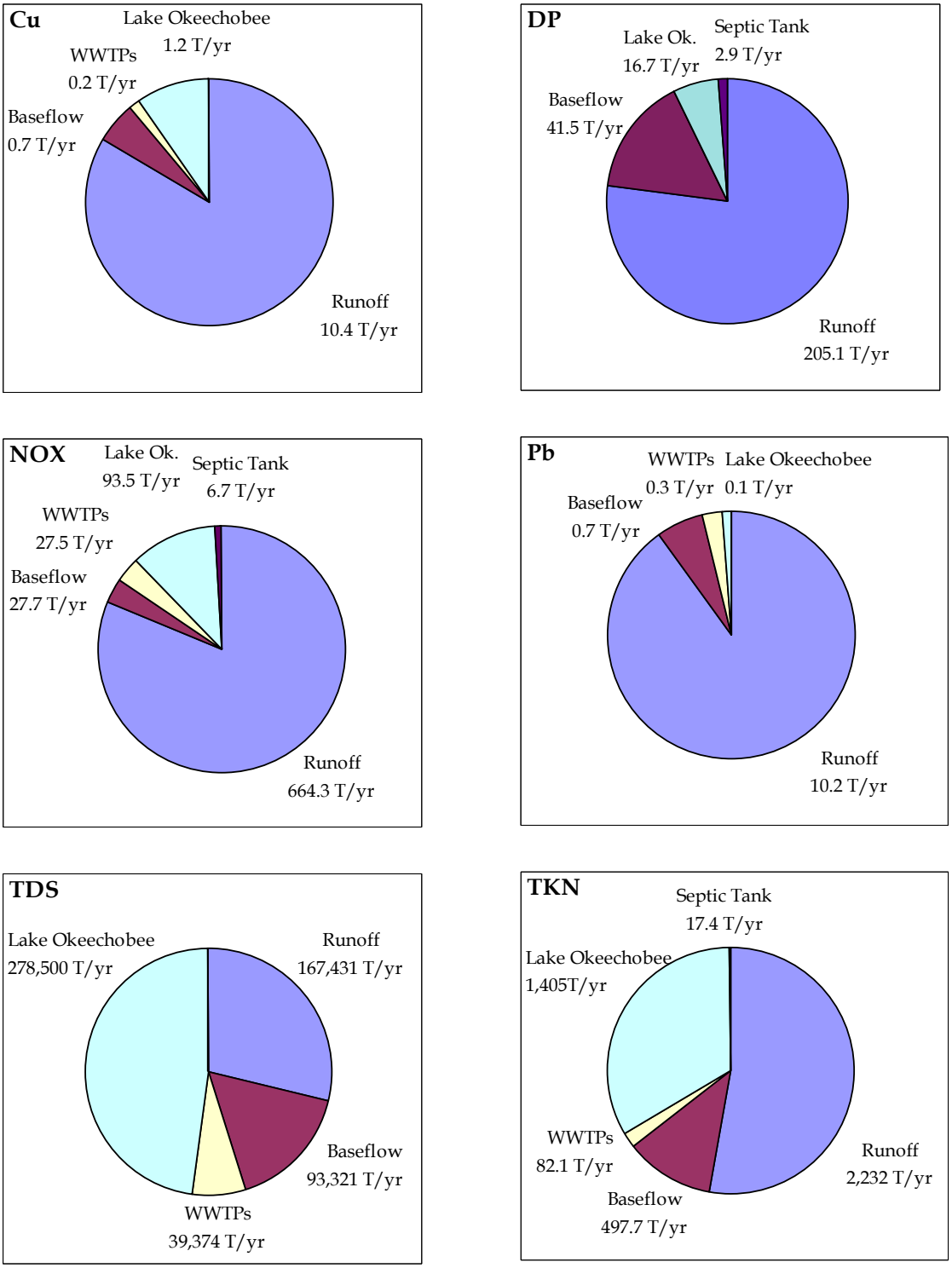


Figure 5-2. Gallery of WMM-Estimated Loads (Cu, DP, NOX, Pb, TDS, and TKN) of the Estero Bay – Caloosahatchee River Watershed for Existing Conditions (Year 2000).

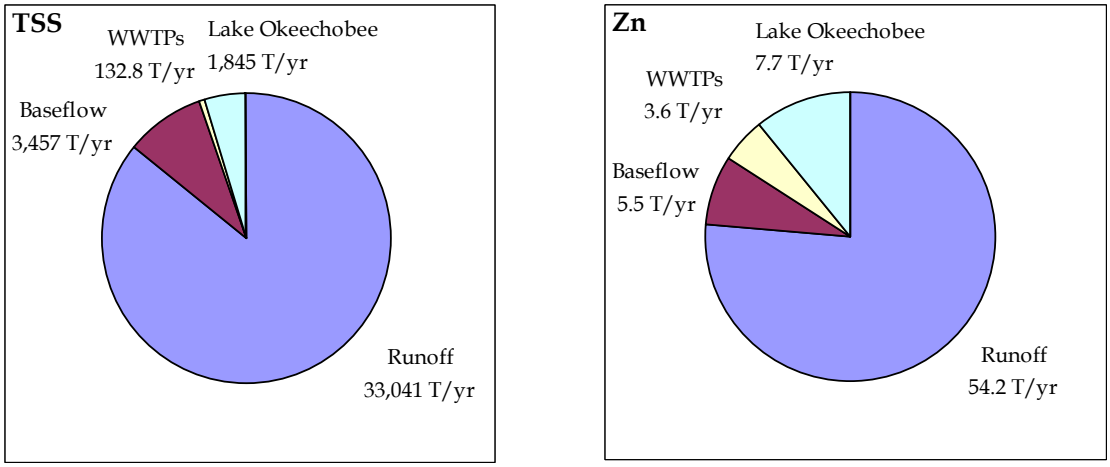


Figure 5-3. Gallery of WMM-Estimated Loads (TSS and Zn) of the Estero Bay – Caloosahatchee River Watershed for Existing Conditions (Year 2000).

Section 6
Tasks 5 and 6 – Evaluation of Future Conditions and BMP Evaluations

The calibrated WMM was applied to future land use conditions to evaluate changes in sub-watershed loads, and to evaluate alternative BMP implementation strategies to reduce existing pollutant loads and to control loads from future development. The future conditions (year 2050) are based on a build-out GIS coverage provided by the SFWMD (SWFFS, Figure 3-3).

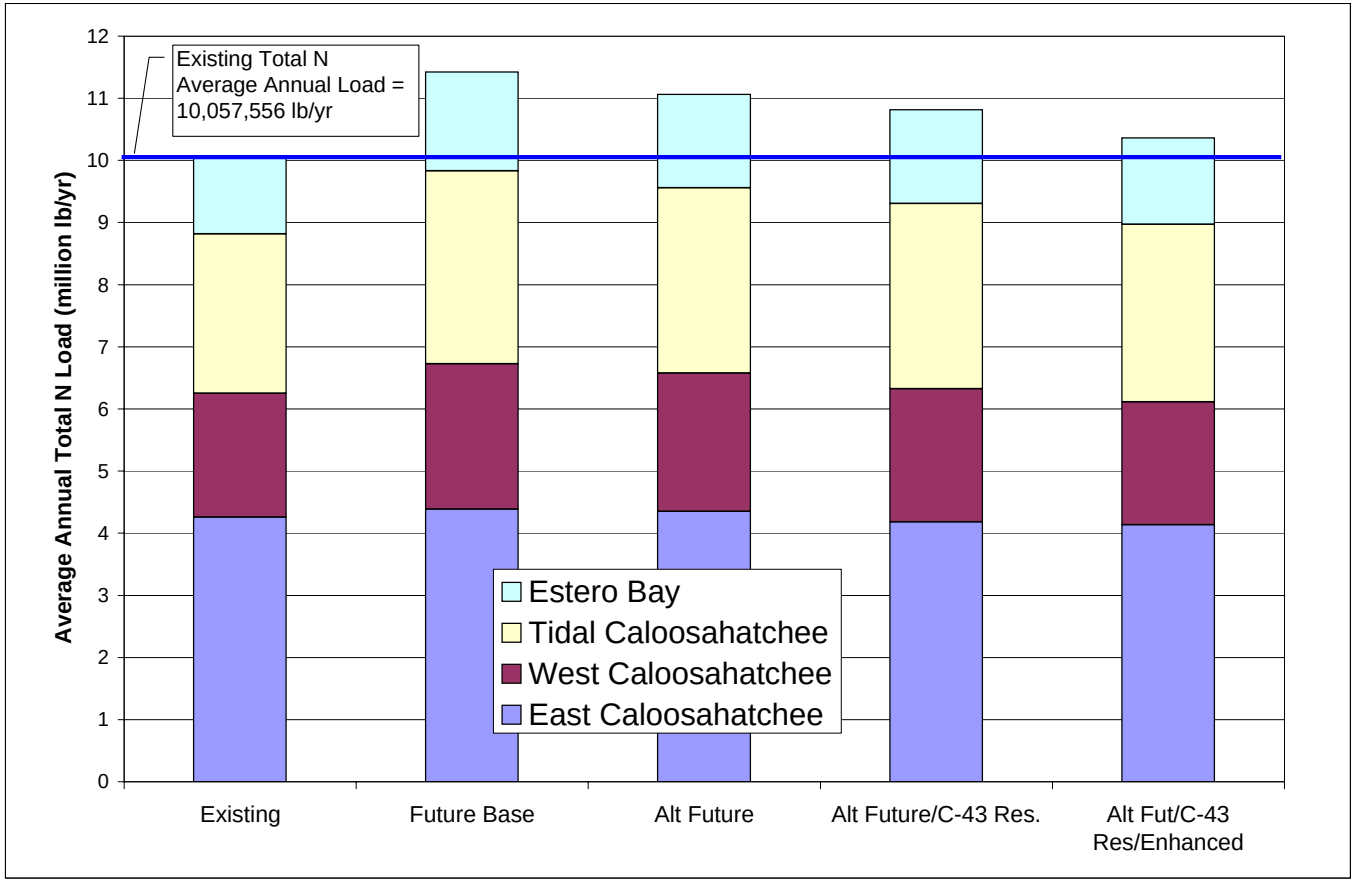
WMM was run for two future land use scenarios, which included a base condition of current projected development with BMPs (as per current SFWMD regulations in Chapter 40E-4 FAC) and an alternative future condition reflecting lower net imperviousness due to cluster development or other site design practices to reduce directly-connected impervious area. The projected loads under these two alternative future land uses are compared to existing loads to demonstrate potential changes in pollutant loading reductions.

WMM was then applied to evaluate several alternative BMP strategies in the study area. These strategies included the following:

- Higher efficiency (enhanced) onsite BMPs (as per the draft SFWMD Southwest Florida Supplemental Water Quality Criteria, April 2005);
- Retrofit BMPs for existing urban and agricultural areas;
- Potential water quality benefits from the proposed C-43 reservoir; and
- Combination of the above.

WMM results were used to show what levels of BMP implementation and effectiveness are required to reduce existing pollutant loads and control future loads from new development. In the analysis, total N (TN) was used as the "indicator pollutant" by which the alternatives were evaluated, based on its impacts on eutrophication potential in tidal receiving waters, and the fact that BMP efficiencies for total N are typically lower than for other water quality constituents such as total phosphorus (TP). Results demonstrate that BMPs that effectively control TN also control total P and other water quality constituents.

Figure 6-1 is a graphical representation of some of the results generated in this analysis. Each bar represents a different land use and BMP scenario, showing the average annual total N load from various areas of the study area, as well as the total TN load. The figure shows how the total load of TN increases from the existing condition to the base future condition even with current SFWMD BMP requirements, and how alternative future land use and BMP scenarios will reduce the total load of TN and move toward limiting the future TN load to existing levels in the Study Area.



Scenarios:

Existing	Year 2000 land use, existing BMPs/septic tank/point sources
Future Base	Year 2050 land use, projected septic tanks/point sources, with typical current SFWMD BMPs on all new development (30% efficiency for TN)
Alt Future	Like Future Base, except reduced imperviousness on new development
Alt Future/C-43 Res.	Like Alt Future, except proposed C-43 Reservoir captures and treats pumped water from C-43 Canal
Alt Future/C-43 Res./Enhanced	Like Alt Future/C-43 Res., except new development BMPs have higher efficiency (50%) to account for supplemental water quality criteria

Figure 6-1
Summary Results for Average Annual Total N Loads Under Various Scenarios

For the future scenarios, the amount of load above the horizontal line (existing TN load) shows the additional amount of load reduction required to limit the future TN load to existing levels. The alternatives shown in the figure will be discussed later in this section.

6.1 Future Land Use Load Calculations with Calibrated WMM – Base Condition

As discussed previously in Section 4, the base future land use conditions are based on year 2050 projections provided by the SFWMD. Under this scenario, all new development is treated with onsite wet detention BMPs that meet current SFWMD design standards. Available planning documents (Master Plans) were used and local officials (Public Works and Planning) were consulted to estimate the wastewater treatment plant (WWTP) flows, loads and services areas for the year 2050 in the study area. Potential WWTP expansion was considered for the year 2050 conditions in all the existing plants. For those plants, for which this information was unavailable, it was considered that the plant will work at design capacity in the future scenario. The residential land uses excluded from the future WWTPs service areas were expected to use septic tanks as onsite wastewater disposal systems.

Lake Okeechobee discharge flows and loads to the C-43 canal were evaluated to be the same for both year 2000 and year 2050 conditions for comparison, although it is expected that these should be less in the future based on the implementation of upstream projects in the Lake Okeechobee Watershed and eventual re-direction of treated flows back to the Everglades.

Tables 6-1 through **6-3** present average annual flows and loads of 12 water quality constituents for each hydrologic unit in the East Caloosahatchee, West Caloosahatchee, and Estero Bay and Tidal Caloosahatchee sub-watersheds, respectively. The results presented in these tables reflect the base future (year 2050) conditions with the calibrated WMM, and therefore the loads in these tables will differ somewhat from the values in the Section 4 tables that were based on the preliminary (pre-calibration) WMM. For many of the water quality constituents, the future sub-watershed loads are lower than in the preliminary WMM results in Section 4 because of the adjustments to delivery ratios in the calibration of WMM. The loads of TSS and metals show the greatest change in comparison to the preliminary WMM results because those constituents have the highest fraction of particulates than can settle out before delivery to the sub-watershed outlet. The delivery ratio adjustments make the biggest difference in the East Caloosahatchee sub-watershed (which has the longer travel distances and times), and the least difference in the Estero Bay and Tidal Caloosahatchee sub-watershed.

Table 6-1. Average Annual Loads for the East Caloosahatchee Subwatershed (Future Land Use)

	Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
		Future Land Use (Year 2050)															
1 .	30-foot Canal	210	12.9%	27	284	3,157	0	33,918	4	109	312	4	105,000	1,083	213	11,306	37
2 .	42-foot Canal	22,029	11.6%	2,565	29,044	230,000	5	2,390,000	177	7,792	24,044	102	8,280,000	95,588	14,121	289,000	1,232
10 .	Bronson	1,848	19.1%	354	2,831	30,975	1	253,000	18	541	1,984	10	768,000	8,423	1,066	23,483	191
11 .	C-19	6,783	12.3%	838	9,084	84,052	1	699,000	45	2,185	6,754	22	2,420,000	30,626	4,243	52,943	464
12 .	C20 Canal	911	18.8%	171	1,387	5,703	0	121,000	2	140	784	1	410,000	2,499	210	7,121	14
16 .	Canal 3	31,874	8.3%	2,659	39,063	263,000	4	3,100,000	178	10,900	30,593	127	11,100,000	134,000	21,043	389,000	1,311
19 .	Citrus Center	17,905	6.5%	1,161	20,999	139,000	6	1,790,000	101	5,801	16,745	91	6,430,000	68,628	11,013	280,000	850
21 .	Clewiston	4,509	61.2%	2,759	12,260	219,000	4	1,420,000	155	3,245	10,843	63	3,430,000	35,121	4,671	107,000	1,344
33 .	Disston Island WCD	19,674	11.2%	2,205	25,281	269,000	4	1,890,000	156	5,679	21,364	81	6,870,000	86,135	11,601	181,000	1,256
37 .	Flaghole WCD	23,840	13.1%	3,127	31,533	370,000	4	2,550,000	174	6,490	27,172	97	9,250,000	102,000	13,540	195,000	1,683
45 .	Grassy Marsh	2,186	2.5%	54	2,315	11,003	0	133,000	5	468	1,499	3	603,000	8,012	1,056	13,170	44
52 .	Hendry Hilliard WCD	16,882	4.6%	777	18,891	99,029	1	1,310,000	53	4,981	14,023	40	5,410,000	63,997	9,516	129,000	472
54 .	Hilliard	26,341	5.4%	1,412	30,037	164,000	2	2,160,000	91	8,009	22,630	66	8,640,000	101,000	15,149	218,000	740
56 .	Industrial Canal	9,505	6.8%	643	14,481	122,000	86	785,000	89	2,487	21,331	113	12,300,000	41,800	6,202	120,000	1,243
58 .	Jack Spratt (Myrtle Slough)	3,340	5.0%	166	3,772	25,413	0	295,000	18	1,389	3,355	14	1,140,000	14,497	2,533	38,110	144
61 .	L-42	4,829	2.7%	129	5,192	32,204	0	384,000	20	2,328	4,873	14	1,580,000	21,893	4,056	39,731	148
65 .	Lake Hicpochee	10,345	19.5%	2,015	15,953	136,000	2	1,420,000	72	2,731	10,665	43	4,490,000	41,521	4,948	113,000	755
67 .	Linden Pens Marsh	20,869	9.8%	2,039	26,424	182,000	8	2,340,000	123	5,683	18,636	85	7,810,000	74,169	10,304	303,000	894
72 .	Meander Ditch	6,549	10.4%	684	8,413	79,676	2	741,000	55	2,978	7,463	39	2,500,000	31,428	5,424	97,072	478
75 .	Moore Haven	3,934	40.2%	1,583	8,235	151,000	3	881,000	93	2,039	8,313	43	2,320,000	23,540	3,297	71,368	769
77 .	Nicodemus Slough	17,298	4.9%	851	19,515	103,000	1	1,510,000	60	6,432	15,943	46	5,960,000	67,573	11,334	151,000	462
78 .	Ninemile Canal	913	23.8%	217	1,428	26,158	0	137,000	12	302	1,481	7	446,000	4,762	638	10,407	110
102 .	Sugarland WCD	11,202	11.7%	1,314	14,793	129,000	2	1,070,000	91	3,512	11,746	41	3,830,000	50,652	6,779	99,338	714
	Lake Okeechobee	NA	NA	NA	720,000	0	104	0	2,465	33,411	187,000	236	557,000,000	2,810,000	78,614	3,690,000	15,314
	Total	**263,775**	**10.4%**	**27,751**	**1,061,215**	**2,874,370**	**241**	**27,412,918**	**4,257**	**119,632**	**469,553**	**1,388**	**663,092,000**	**3,918,947**	**241,571**	**6,629,049**	**30,669**

Notes: 1. Existing BMPs are included along with BMPs for new development as per current SFWMD criteria in Chapter 40E-4 FAC.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to deliver to S-79.

5. The total percent impervious is an area-weighted composite.

Table 6-2. Average Annual Loads for the West Caloosahatchee Subwatershed (Future Land Use)

		Future Land Use (Year 2050)															
	Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
4 .	Banana Branch	2,707	20.2%	546	4,951	90,884	7	593,000	83	1,246	4,575	88	1,420,000	14,974	2,611	211,000	562
6 .	Bedman Creek	3,734	22.0%	822	7,036	104,000	8	834,000	125	1,844	6,517	121	2,040,000	23,399	3,975	340,000	752
7 .	Bee Branch	22,663	11.1%	2,525	35,206	273,000	16	3,150,000	217	7,463	25,276	168	10,200,000	102,000	14,671	579,000	1,268
14 .	Canal 1	12,190	5.2%	631	16,723	93,542	1	1,210,000	59	4,452	11,738	52	4,890,000	56,768	8,911	182,000	450
15 .	Canal 2	16,664	7.5%	1,245	24,025	127,000	2	1,740,000	66	4,789	15,063	54	6,880,000	70,696	9,556	213,000	529
20 .	City Ditch	1,521	43.7%	664	3,870	78,812	4	509,000	69	1,166	3,403	56	1,130,000	12,428	2,007	135,000	565
23 .	County Line Drainage District	6,155	6.1%	374	8,614	76,051	6	793,000	75	2,048	6,321	88	2,540,000	29,856	4,931	276,000	520
25 .	Cow Slough	9,192	6.4%	586	12,943	116,000	4	1,180,000	86	4,460	10,631	87	3,900,000	48,435	9,271	258,000	551
26 .	Crawford Canal	837	48.4%	405	2,248	47,864	3	305,000	42	487	1,789	35	617,000	6,538	941	82,831	348
27 .	Cypress Branch	27,329	7.8%	2,143	39,707	222,000	11	3,200,000	155	8,544	26,760	119	12,000,000	112,000	15,881	465,000	1,039
28 .	Cypress Creek	13,057	7.0%	920	18,656	135,000	11	1,840,000	109	4,671	13,423	127	5,710,000	59,609	10,242	474,000	663
31 .	Deadmans Branch	10,437	6.4%	671	14,714	91,013	6	1,260,000	72	3,624	10,419	71	4,560,000	45,301	7,132	260,000	522
34 .	Dog Canal	7,855	35.1%	2,755	17,927	261,000	11	1,950,000	354	4,330	16,665	184	4,400,000	65,147	9,440	491,000	1,662
36 .	Fichter Branch	5,508	9.2%	507	8,232	62,311	4	833,000	45	1,915	5,802	51	2,490,000	24,768	4,107	198,000	273
40 .	Franklin Run	325	20.4%	66	595	10,087	1	82,114	11	141	562	17	197,000	1,682	314	47,882	90
41 .	Ft. Denaud Branch	7,156	7.7%	548	10,357	108,000	9	985,000	75	2,319	7,900	85	3,110,000	29,716	4,642	236,000	477
42 .	Ft. Simmons	1,244	51.7%	643	3,469	66,441	4	470,000	82	701	2,995	66	894,000	10,970	1,607	178,000	548
47 .	Greenbriar Swamp	2,490	26.1%	651	5,006	68,361	4	542,000	78	1,076	3,982	47	1,310,000	15,485	2,221	116,000	392
50 .	Hendry Canal	17,127	26.9%	4,605	34,816	411,000	13	3,590,000	429	8,223	29,908	271	9,550,000	115,000	17,782	645,000	3,023
53 .	Hickey's Creek	16,963	33.1%	5,617	37,700	564,000	37	4,230,000	777	9,264	36,407	514	9,350,000	132,000	20,400	1,340,000	3,705
59 .	Jacks Branch	46,734	6.8%	3,184	66,440	423,000	30	5,490,000	256	10,490	40,843	246	19,200,000	183,000	23,289	979,000	1,778
62 .	LaBelle	2,267	75.1%	1,703	10,179	226,000	67	1,180,000	208	1,967	8,497	196	8,320,000	24,970	6,609	424,000	1,986
63 .	LaBelle East	17,084	16.9%	2,879	30,070	298,000	24	2,660,000	255	7,811	25,636	174	9,900,000	98,528	15,238	470,000	1,687
79 .	North LaBelle	7,895	25.8%	2,037	15,787	245,000	15	1,780,000	233	3,965	13,574	180	4,380,000	48,516	7,516	466,000	1,530
64 .	LaBelle Private Drainage District	17,761	37.2%	6,611	41,695	598,000	21	4,300,000	709	9,462	36,923	364	10,200,000	142,000	19,815	868,000	3,721
66 .	LeHigh SE	6,055	8.7%	529	8,961	67,175	3	831,000	59	2,731	7,076	62	2,770,000	30,734	5,479	201,000	399
69 .	Mackeral Canal	1,369	34.7%	475	3,109	46,689	2	335,000	59	683	2,611	30	764,000	10,517	1,501	70,260	297
73 .	Messer	7,576	15.8%	1,200	12,851	121,000	5	1,260,000	102	3,497	10,039	86	3,840,000	40,370	6,547	261,000	707
74 .	Miller's Gulley	708	25.8%	183	1,416	19,532	1	159,000	21	323	1,163	15	384,000	4,291	646	37,053	108
88 .	Park Branch	877	15.2%	134	1,472	18,547	3	196,000	24	367	1,292	36	503,000	4,201	760	111,000	176
91 .	Polywog	11,725	9.4%	1,105	17,601	163,000	10	1,560,000	98	3,467	12,659	83	5,110,000	46,491	6,543	258,000	602
93 .	Port LaBelle	3,475	20.5%	713	6,390	71,680	2	596,000	69	1,754	5,392	44	1,770,000	21,423	3,359	114,000	439
95 .	Roberts	24,499	6.4%	1,566	34,515	219,000	4	2,970,000	157	11,003	26,390	161	10,500,000	123,000	22,197	569,000	985
99 .	Spanish Creek	1,140	14.7%	168	1,894	16,137	1	195,000	13	410	1,328	11	547,000	5,650	878	38,470	74
107 .	Townsend Canal	20,723	3.7%	769	27,502	194,000	1	2,350,000	166	11,105	23,369	179	8,460,000	118,000	23,784	557,000	1,048
	Total	**355,043**	**14.1%**	**50,180**	**586,677**	**5,733,126**	**351**	**55,158,114**	**5,438**	**141,798**	**456,928**	**4,168**	**173,836,000**	**1,878,463**	**294,803**	**12,151,496**	**33,476**

Notes: 1. Existing BMPs are included along with BMPs for new development as per current SFWMD criteria in Chapter 40E-4 FAC.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. The total percent impervious is an area-weighted composite.

Table 6-3. Average Annual Loads for the Estero Bay and Tidal Caloosahatchee Subwatershed (Future Land Use)

Future Land Use (Year 2050)

	Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
3	Babcock	13,880	4.5%	622	18,746	94,710	12	1,740,000	72	4,034	12,187	82	5,780,000	56,781	8,945	407,000	385
5	Bayshore Creek	2,071	28.9%	598	4,334	76,170	7	585,000	99	1,277	3,994	95	1,300,000	14,091	2,431	276,000	578
8	Billy's Creek	6,732	62.1%	4,179	21,460	492,000	49	3,170,000	781	6,276	20,472	602	5,710,000	74,056	11,843	1,900,000	4,150
9	Blackstone	695	29.7%	207	1,474	20,920	1	167,000	25	348	1,298	21	420,000	4,577	697	56,753	160
13	Caloosahatchee South Shore	6,427	39.3%	2,526	15,495	290,000	29	2,250,000	601	5,769	16,403	443	4,580,000	56,763	10,376	1,610,000	2,420
17	Carrol Canal	1,075	57.7%	620	3,194	78,438	8	501,000	144	1,227	3,440	106	877,000	12,434	2,222	363,000	659
18	Chapel Branch	1,369	21.3%	292	2,551	41,421	4	319,000	50	697	2,292	47	763,000	7,731	1,322	138,000	270
22	Cohn Branch	472	31.3%	148	1,023	13,803	1	115,000	20	231	853	11	267,000	3,274	476	35,788	89
24	Cow Creek	8,165	29.8%	2,429	17,311	203,000	16	2,210,000	324	3,662	13,601	255	5,050,000	48,086	7,021	992,000	1,508
29	Cypress Lakes	351	48.5%	170	946	17,951	2	123,000	41	315	1,111	25	220,000	3,865	687	93,549	147
30	Daughtrey Creek (With WWTP)	23,263	10.0%	2,323	35,430	314,000	35	3,760,000	313	8,235	26,484	347	11,200,000	105,000	17,145	1,200,000	1,765
32	Deep Lagoon (With WWTP)	1,777	52.8%	938	5,350	85,392	15	588,000	193	1,311	6,265	107	1,950,000	20,897	3,466	378,000	694
35	Estero River	39,169	20.2%	7,925	71,688	850,000	61	8,260,000	981	15,630	56,413	863	20,700,000	214,000	33,138	2,740,000	5,737
38	Flint Pen	9,009	17.5%	1,581	15,752	86,043	4	1,710,000	37	1,799	8,661	30	4,650,000	33,074	3,284	266,000	195
39	Fort Myers Shores	2,072	39.1%	811	4,985	94,264	11	802,000	193	1,903	5,587	191	1,700,000	18,278	3,608	633,000	1,020
43	Gator Slough (With WWTP)	39,333	12.7%	4,999	63,786	540,000	73	7,070,000	638	12,317	52,301	718	21,000,000	179,000	27,146	2,620,000	4,166
44	Gordon Swamp	4,806	15.1%	724	8,040	39,982	2	854,000	12	912	4,361	13	2,400,000	16,862	1,695	128,000	67
46	Green Meadows	17,132	7.9%	1,350	24,913	166,000	12	2,500,000	130	6,051	17,448	163	7,670,000	78,095	13,271	646,000	839
48	Halfway Creek	4,255	31.1%	1,324	9,198	119,000	6	990,000	171	2,005	8,318	101	2,260,000	31,777	4,716	300,000	802
49	Hancock Creek	3,984	51.9%	2,066	11,126	250,000	23	1,670,000	408	3,724	10,961	313	3,100,000	39,822	6,744	1,000,000	2,054
51	Hendry Creek (With WWTP)	11,518	39.9%	4,597	28,542	456,000	54	3,670,000	799	6,996	26,644	569	8,940,000	93,709	14,707	1,980,000	3,650
55	Imperial River (With WWTP)	16,679	41.1%	6,853	41,232	701,000	61	5,340,000	1,286	12,163	41,866	901	11,100,000	147,000	24,533	3,030,000	5,561
57	Iona	3,285	49.3%	1,620	8,920	171,000	16	1,210,000	329	2,817	9,238	220	2,260,000	32,480	5,369	767,000	1,341
60	Kickapoo Creek	956	14.4%	137	1,578	29,865	4	209,000	30	545	1,644	41	517,000	4,817	1,013	101,000	189
68	Lochmoor County Club (With WWTP)	1,053	43.8%	461	4,363	62,149	48	368,000	165	1,049	4,801	130	5,260,000	15,039	3,212	383,000	836
70	Manuel's Branch	885	62.9%	556	2,769	70,142	8	445,000	132	1,073	3,060	103	761,000	10,714	1,888	346,000	613
71	Marsh Point	1,961	46.4%	911	5,154	97,324	9	708,000	209	1,926	5,852	141	1,380,000	19,960	3,614	504,000	778
76	Mullock Creek (With WWTP)	7,012	35.6%	2,498	16,533	258,000	34	2,070,000	522	5,102	17,145	365	5,500,000	59,652	10,315	1,280,000	2,087
80	Northcentral Cape Coral	21,020	37.1%	7,805	54,330	947,000	196	6,520,000	1,253	12,765	56,215	1,187	27,700,000	197,000	34,300	2,890,000	8,775
81	Northwest Cape Coral	11,735	26.9%	3,162	23,877	380,000	36	3,230,000	525	5,525	21,648	592	7,430,000	71,349	12,190	1,800,000	3,481
82	Olga	2,370	33.4%	793	5,292	78,945	5	631,000	111	1,274	4,513	78	1,430,000	17,390	2,627	230,000	576
83	Orange River (With WWTP)	50,340	37.1%	18,669	123,000	1,850,000	190	12,900,000	2,532	30,659	120,000	1,646	37,500,000	402,000	64,224	4,410,000	12,504
84	Otter Creek	1,051	11.4%	120	1,641	24,997	2	172,000	15	356	1,306	17	468,000	4,399	745	37,028	104
85	Owl Creek	3,870	8.5%	328	5,699	59,793	5	601,000	54	1,757	4,575	59	1,750,000	19,517	3,627	172,000	318
86	Palm Creek	1,969	11.9%	235	3,106	55,415	6	389,000	53	1,098	3,202	72	999,000	9,992	2,087	173,000	327
87	Panther Island W	4,393	5.1%	225	6,018	38,544	2	570,000	31	1,832	4,494	38	1,860,000	21,728	4,081	142,000	185
89	Piggot Bridge	586	23.8%	140	1,137	15,495	1	143,000	19	250	955	19	341,000	3,190	515	61,797	112
90	Piney Point	357	24.3%	87	697	6,132	0	78,734	7	118	463	4	198,000	1,757	219	18,015	29
92	Popash Creek	11,357	10.0%	1,139	17,258	139,000	15	1,820,000	134	3,819	12,409	150	5,300,000	50,654	7,979	532,000	783
94	Powell Creek (With WWTP)	8,550	32.0%	2,738	20,848	299,000	79	2,310,000	510	5,085	21,664	396	10,800,000	76,691	13,210	1,170,000	2,690
96	Six Mile Cypress Slough (With WWTP)	35,579	47.7%	16,969	96,226	1,740,000	176	14,000,000	2,457	21,233	91,784	2,425	31,700,000	315,000	52,048	6,810,000	18,057
97	Southeast Cape Coral	20,217	47.9%	9,678	58,249	1,280,000	192	9,310,000	2,745	25,730	68,785	2,474	23,000,000	220,000	45,700	8,260,000	13,302
98	Southwest Cape Coral	17,495	35.8%	6,265	40,318	514,000	13	4,390,000	577	14,592	42,385	232	13,000,000	125,000	19,912	421,000	3,718
100	Spring Creek (With WWTP)	7,084	30.4%	2,152	23,277	292,000	221	1,770,000	394	3,479	29,623	401	26,000,000	97,976	18,401	706,000	3,373
101	Stroud Creek	5,591	12.9%	723	8,991	110,000	12	1,040,000	117	2,462	7,277	128	2,770,000	27,810	4,815	373,000	681
103	Telegraph Creek	39,309	6.6%	2,598	55,637	270,000	41	5,350,000	170	8,652	33,024	188	17,000,000	143,000	18,514	1,140,000	894
104	Ten Mile Canal (North)	7,929	58.9%	4,673	23,855	506,000	39	3,400,000	695	5,574	21,326	522	6,020,000	78,733	11,788	1,540,000	4,142
105	Ten Mile Canal (South) (With WWTP)	838	47.9%	402	2,241	35,676	3	279,000	66	553	2,214	42	537,000	7,630	1,181	144,000	276
106	Thompson Cutoff	583	23.3%	136	1,120	10,961	1	132,000	11	198	801	10	331,000	2,977	407	32,983	74
108	Trout Creek	18,373	5.1%	944	25,182	178,000	18	2,430,000	161	6,579	17,743	173	7,770,000	82,952	14,285	682,000	921
109	Whiskey Creek (With WWTP)	5,817	67.3%	3,917	18,991	505,000	60	3,440,000	1,020	7,752	22,984	906	6,050,000	75,115	14,775	3,080,000	5,185
110	Winkler Canal	977	69.3%	677	3,247	97,516	12	614,000	174	1,470	3,547	152	1,050,000	12,623	2,380	510,000	902
111	Yellow Fever Creek	3,116	50.7%	1,579	8,592	149,000	11	1,060,000	238	1,909	8,241	159	1,980,000	29,611	4,431	480,000	1,187
	Estuary	0	NA	NA	29,128	185,000	737	201	293	0	38,822	555	72,500,000	181,000	14,261	345,000	6,916
	Total	**509,891**	**27.3%**	**139,619**	**1,103,850**	**15,486,048**	**2,678**	**129,983,935**	**23,067**	**274,115**	**1,022,700**	**19,628**	**442,799,000**	**3,676,928**	**593,586**	**60,333,913**	**132,272**
	Total to the River	**335,973**	**25.5%**	**85,746**	**718,078**	**9,976,852**	**1,985**	**82,237,935**	**15,121**	**186,809**	**677,691**	**12,915**	**308,192,000**	**2,429,741**	**392,720**	**39,536,364**	**85,646**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. "Total to the River" denotes the loads and flows from hydrologic units that discharge to the tidal river.

5. "Estuary" corresponds to the loads and flows from Wastewater Treatment Plants that discharge directly to the Caloosahatchee River.

6. The total percent impervious is an area-weighted composite.

A summary comparison of existing and future flows and loads of TN and TP is presented in **Table 6-4**. Flow and load totals are summarized by sub-watersheds within the Study Area (see **Figure 6-2**), as well as by loads to specific locations (e.g., structure S-79). TN and TP are summarized because these are the most important for managing eutrophication in the tidal Caloosahatchee River and Estero Bay, which is already a concern in the Study Area. The flows and loads for each sub-watershed are compared in the table, which also shows the percent increase from the existing condition to the future condition. In the case of the Estero Bay and Tidal Caloosahatchee sub-watershed, the flow and load totals are split between the hydrologic units that discharge to the tidal river and those that discharge to the bay. As well as the three sub-watersheds, the table shows the total flow and load at S-79 (total of East Caloosahatchee and West Caloosahatchee), and the total flow and load delivered to the tidal Caloosahatchee River (flows and loads at S-79 plus flows and loads from tributary area to the tidal river).

The table shows that the flows and loads in all cases are higher for the future condition compared to the existing condition, even with BMPs on all new development in accordance with current SFWMD regulations in Chapter 40E-4 FAC. The smallest increases occur in the East Caloosahatchee sub-watershed, whereas the greatest increases occur in the Estero Bay and Tidal Caloosahatchee sub-watershed. Limited increases in the East Caloosahatchee sub-watershed are due to the relatively small amount of urban development anticipated in the sub-watershed, and because much of the future urban development will occur on existing agricultural land which already produces a moderate load of TN and TP in the existing condition. In contrast, there is greater urban development in the Estero Bay and Tidal Caloosahatchee sub-watershed, and a greater percentage of that urban development will occur on land that is currently open/forest land cover that produces low TN and TP loads in the existing condition.

Figures 6-3 through **6-5** depict in a pie chart format the annual loads by source for the entire Study Area for future buildout conditions and for all the NPDES parameters. For each constituent, the labels indicate whether or not the point source flow or load includes the Lake Okeechobee discharge. As discussed earlier, concentrations of BOD and COD were not readily available, and therefore the current WMM simulation does not include loads of these constituents from Lake Okeechobee.

6.2 Future Land Use Load Calculation with Calibrated WMM – Alternative Future Land Use (Reduced Impervious Cover)

An alternative future land use condition was evaluated as part of this study. Rather than changing the projected future land use, the alternative scenario considered that either cluster development would yield a lower effective impervious area or that development design practices could effectively reduce the percentage of directly

Table 6-4. Average Annual Flow, Total N and Total P Loads for Base Future Conditions (Wet Detention BMPs for Future Development).

Parameter	Scenario	East Caloosahatchee [1]	West Caloosahatchee [2]	At S-79 [3]	Tidal Caloosahatchee [4]	Total to Tidal River [5]	Estero Bay [6]
Flow (ac- ft/yr)	Existing	1,023,275	494,483	1,517,758	593,416	2,111,174	308,002
	Future	1,061,215	586,677	1,647,892	718,078	2,365,970	382,772
	Increase	37,940	92,194	130,134	124,662	254,796	74,770
	%	4%	19%	9%	21%	12%	24%
Total N Load (pounds/year)	Existing	4,258,310	1,996,267	6,254,577	2,562,767	8,817,344	1,240,212
	Future	4,388,500	2,335,391	6,723,891	3,107,432	9,831,323	1,592,196
	Increase	130,190	339,124	469,314	544,665	1,013,979	351,984
	%	3%	17%	8%	21%	11%	28%
Total P Load (pounds/year)	Existing	234,576	279,876	514,452	359,328	873,780	168,446
	Future	241,571	294,803	536,374	392,720	929,094	200,866
	Increase	6,995	14,927	21,922	33,392	55,314	32,420
	%	3%	5%	4%	9%	6%	19%

[1] Load delivered from subwatershed to structure S-79 on C-43 Canal (including Lake Okeechobee releases)

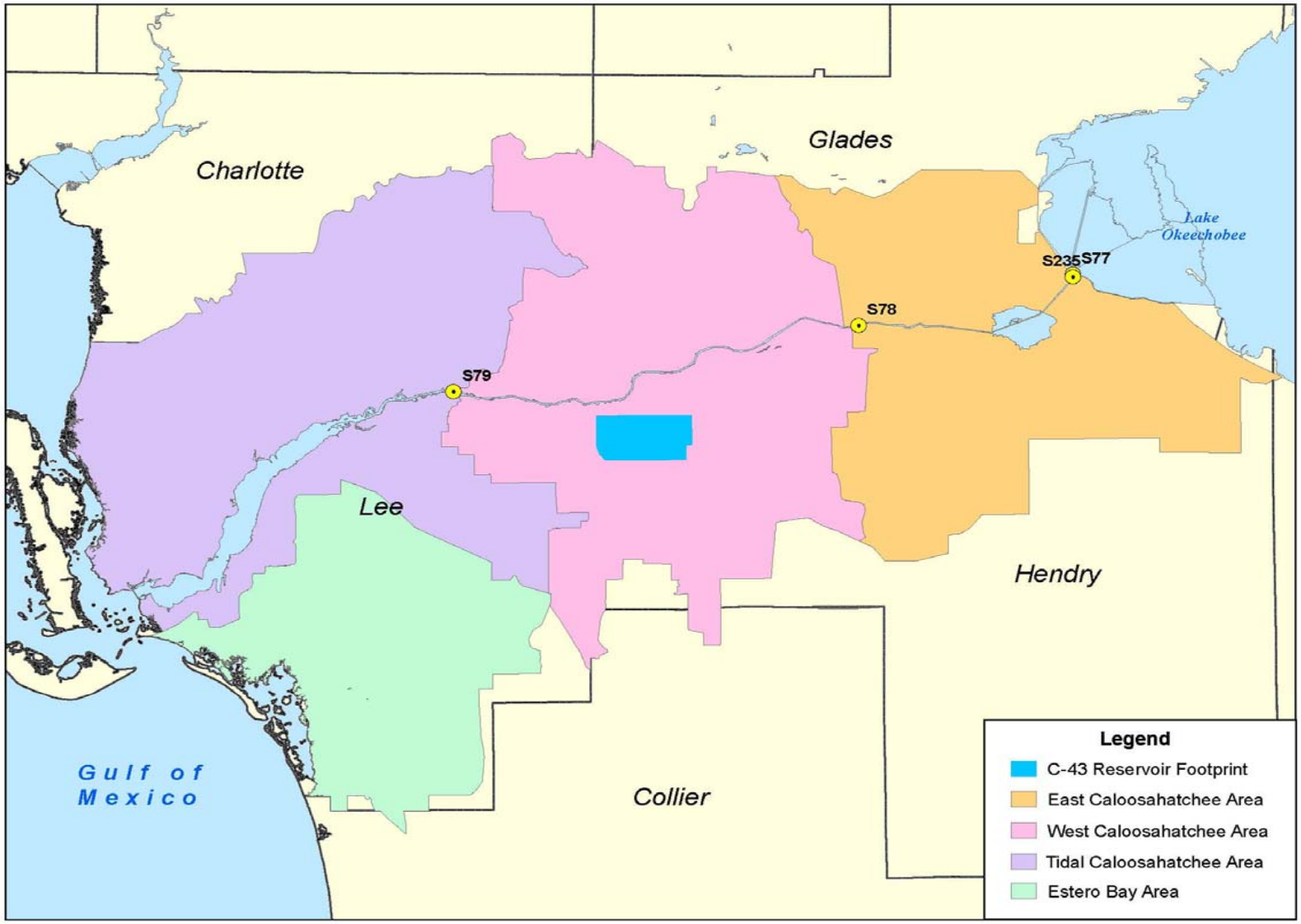
[2] Load delivered from subwatershed to structure S-79

[3] Load delivered from East Caloosahatchee and West Caloosahatchee subwatersheds to structure S-79 on C-43 Canal (including Lake Okeechobee releases)

[4] Load delivered from portion of Estero Bay and Tidal Caloosahatchee subwatershed that discharges to the tidal Caloosahatchee River

[5] Load delivered to structure S-79 plus load from portion of Estero Bay and Tidal Caloosahatchee subwatershed that discharges to the tidal Caloosahatchee River

[6] Load delivered from portion of Estero Bay and Tidal Caloosahatchee subwatershed that discharges to Estero Bay



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Section 6_Figures.xls

Figure 6-2
Study Area Map with Subwatersheds and Proposed C-43 Basin Reservoir Site

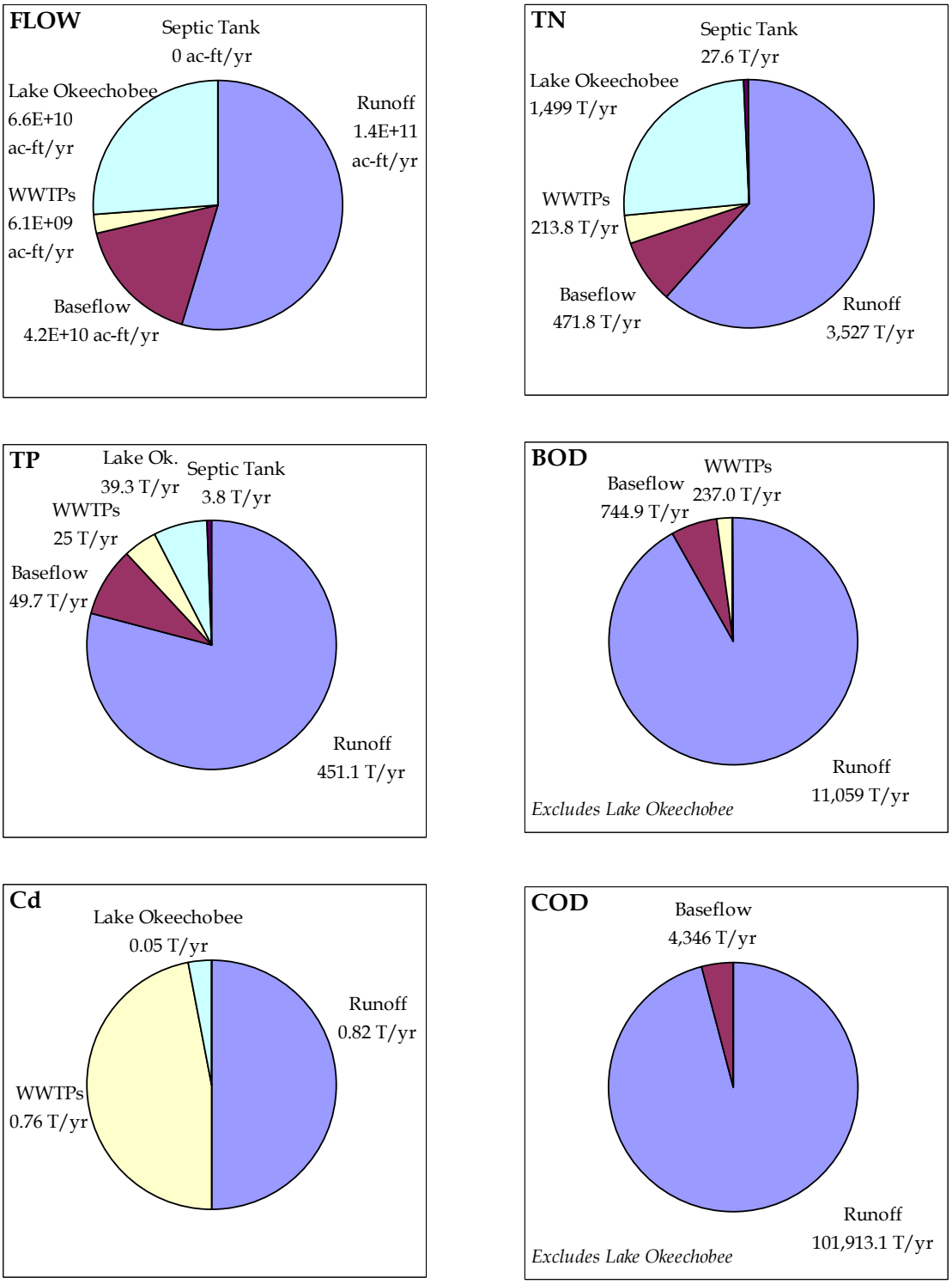

Figure 6-3. WMM-Estimated Loads (TN, TP, BOD, Cd and COD) and Flows of the Estero Bay – Caloosahatchee River Watershed for Future Conditions (Year 2050).

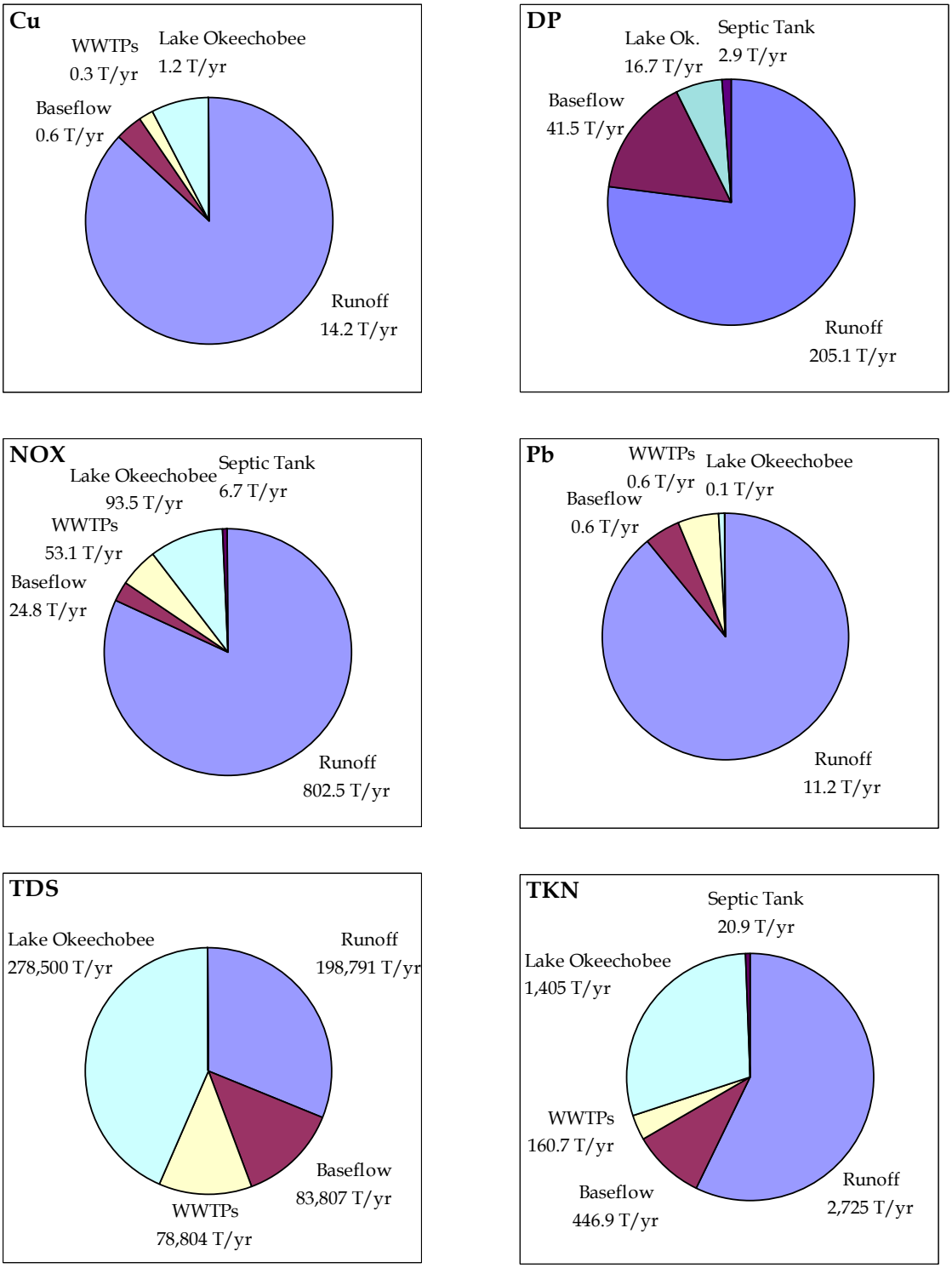

Figure 6-4. WMM-Estimated Loads (Cu, DP, NOX, Pb, TDS, and TKN) of the Estero Bay – Caloosahatchee River Watershed for Future Conditions (Year 2050).

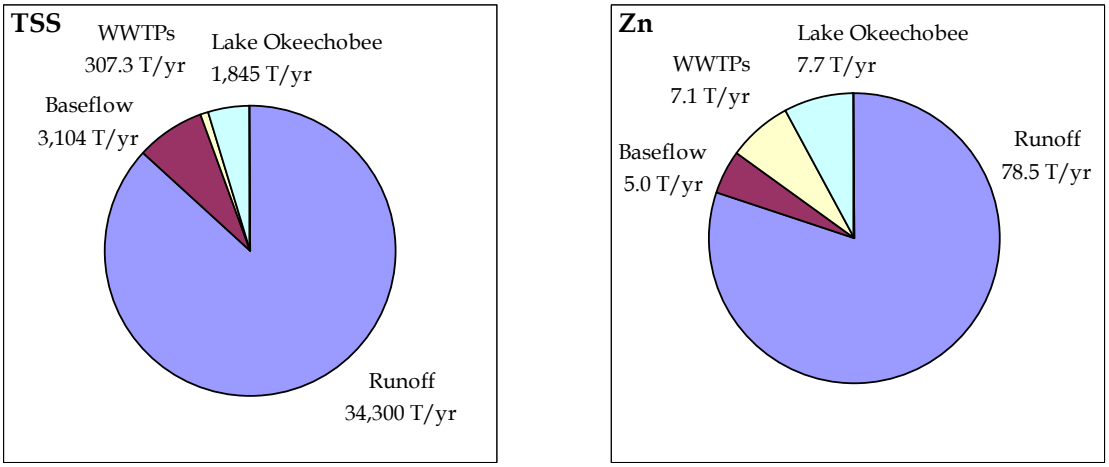

Figure 6-5. WMM-Estimated Loads (TSS and Zn) of the Estero Bay – Caloosahatchee River Watershed for Future Conditions (Year 2050).

connected impervious cover without changing the actual land use (e.g., maintaining the same number of dwelling units per acre). Examples of practices for reducing imperviousness include the following:

- Clustering of residential development;
- Using grassed and/or landscape swales instead of curb and gutter for roadway and parking lot runoff;
- Use of decked parking instead of surface parking (commercial areas);
- Multistory buildings with smaller footprints; and
- Commercial structures with "green roof" systems (vegetated roof cover BMP).

Some of these are BMPs being considered in the draft SW FL Basin Supplemental Water Quality Criteria.

For modeling purposes, this alternative was analyzed by reducing the impervious cover of future urban development by 20 percent compared to existing development. For example, existing medium density residential development has an assigned imperviousness of 35 percent. In the alternative future run, an imperviousness of 28 percent was assigned to all new medium density development. In the model, this was done by representing all future development at 80 percent of the projected future urban land use acreage (at the original percent imperviousness) plus 20 percent open/forest land use.

The results for the alternative future land use condition are presented in **Tables 6-5** through **6-8**. Average annual loads for each of the hydrologic units are presented in Tables 6-5 through 6-7, and the summary of flow, TN load and TP load by sub-watershed are presented in Table 6-8. The overall percent change from the existing to the future condition is also presented in Table 6-8.

A review of the values in Table 6-8 shows that the example reduction in future development impervious cover is not sufficient to limit future loads of TN and TP to existing levels. However, a comparison to Table 6-4 shows that limiting the impervious cover does provide noticeable benefit. Considering the total load to the tidal Caloosahatchee River, the percent increase of TN load has been reduced from 21 percent (base future condition) to 16 percent (alternative future condition) for TN, and is reduced from 9 percent to 5 percent for TP. For loads to Estero Bay, the percent increase of TN load has been reduced from 28 percent (base future condition) to 21 percent (alternative future condition) for TN, and is reduced from 19 percent to 13 percent for TP.

In summary, a reduction of impervious cover for future development is not expected to limit the year 2050 loads of TN and TP to the existing levels, but this approach can be one part of an overall solution to limiting future loads.

6.3 Evaluation of Alternative BMP Strategies

A number of alternative BMP strategies were considered in this study in addition to the current SFWMD design standards. Specific BMPs that were considered are listed below:

- Enhanced higher efficiency onsite BMPs for new development (draft Southwest Florida Basin Supplemental Water Quality Criteria in Chapter 40E-41 FAC, Part V);
- Retrofit BMPs for existing urban and agricultural areas that do not currently have BMPs;
- Potential treatment benefits within the proposed C-43 reservoir; and
- Combination of the above BMPs.

All of these BMPs were evaluated for both the base future condition and the alternative (reduced imperviousness) future condition.

For the analysis of alternatives, a spreadsheet was developed which tabulated the WMM results for existing and future conditions, and allowed the user to evaluate combinations of the higher efficiency onsite BMPs and retrofit BMPs. By altering specific input values, the user can determine various BMP combinations that will limit future loads to existing levels (non-degradation performance standard).

Table 6-5. Average Annual Loads for the East Caloosahatchee Subwatershed (Alternative Future Land Use)

	Future Land Use (Year 2050)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
1 . 30-foot Canal	210	12.9%	27	284	3,157	0	33,918	4	109	312	4	105,000	1,083	213	11,306	37
2 . 42-foot Canal	22,029	10.4%	2288	28,278	211,000	5	2,310,000	160	7,419	22,963	97	8,120,000	91,983	13,546	282,000	1,129
10 . Bronson	1,848	16.6%	306	2,696	27,256	1	234,000	16	508	1,881	10	737,000	8,031	1,019	22,657	168
11 . C-19	6,783	10.5%	711	8,726	74,855	1	653,000	40	2,089	6,449	21	2,340,000	29,512	4,102	51,787	411
12 . C20 Canal	911	18.8%	171	1,387	5,703	0	121,000	2	140	784	1	410,000	2,499	210	7,121	14
16 . Canal 3	31,874	7.7%	2448	38,462	249,000	4	3,030,000	166	10,676	29,893	123	11,000,000	132,000	20,661	385,000	1,233
19 . Citrus Center	17,905	6.2%	1112	20,858	134,000	5	1,770,000	98	5,745	16,574	89	6,390,000	68,149	10,923	278,000	820
21 . Clewiston	4,509	52.3%	2359	11,162	189,000	4	1,280,000	138	2,948	9,889	58	3,180,000	31,817	4,256	102,000	1,175
33 . Disston Island WCD	19,674	8.9%	1748	24,414	237,000	3	1,770,000	137	5,359	19,932	74	6,640,000	82,691	11,052	174,000	1,119
37 . Flaghole WCD	23,840	10.4%	2477	30,604	326,000	4	2,400,000	154	6,193	25,413	88	8,890,000	98,524	12,982	188,000	1,510
45 . Grassy Marsh	2,186	2.5%	54	2,315	11,003	0	133,000	5	468	1,499	3	603,000	8,012	1,056	13,170	44
52 . Hendry Hilliard WCD	16,882	4.6%	776	18,891	99,029	1	1,310,000	53	4,981	14,023	40	5,410,000	63,997	9,516	129,000	472
54 . Hilliard	26,341	5.2%	1369	29,925	162,000	2	2,150,000	89	7,962	22,477	66	8,620,000	100,000	15,071	217,000	727
56 . Industrial Canal	9,505	6.4%	606	14,480	122,000	86	785,000	89	2,487	21,329	113	12,300,000	41,794	6,202	120,000	1,242
58 . Jack Spratt (Myrtle Slough)	3,340	4.8%	159	3,754	25,038	0	294,000	18	1,382	3,333	14	1,140,000	14,422	2,522	38,038	142
61 . L-42	4,829	2.7%	129	5,139	30,552	0	375,000	18	2,277	4,774	13	1,560,000	21,613	3,997	38,078	137
65 . Lake Hicpochee	10,345	17.7%	1834	15,439	127,000	3	1,390,000	72	2,608	10,269	51	4,380,000	40,565	4,918	148,000	722
67 . Linden Pens Marsh	20,869	9.1%	1901	26,030	171,000	8	2,280,000	113	5,538	18,248	80	7,730,000	72,735	10,088	296,000	820
72 . Meander Ditch	6,549	9.1%	598	8,173	73,045	1	709,000	51	2,910	7,247	37	2,450,000	30,660	5,320	95,523	439
75 . Moore Haven	3,934	32.8%	1289	7,554	127,000	3	792,000	81	1,796	7,389	38	2,170,000	21,151	2,911	68,390	665
77 . Nicodemus Slough	17,298	4.9%	851	19,515	103,000	1	1,510,000	60	6,432	15,943	46	5,960,000	67,573	11,334	151,000	462
78 . Ninemile Canal	913	16.7%	153	1,338	21,858	0	122,000	10	277	1,314	6	411,000	4,422	587	9,707	93
102 . Sugarland WCD	11,202	10.1%	1129	14,281	117,000	2	1,010,000	82	3,328	11,132	38	3,740,000	48,722	6,502	96,741	648
Lake Okeechobee	NA	NA	NA	720,000	0	104	0	2,465	0	187,000	236	557,000,000	2,810,000	78,614	3,690,000	15,314
Total	**263,775**	**9.3%**	**24,495**	**1,053,705**	**2,646,496**	**238**	**26,461,918**	**4,121**	**83,632**	**460,067**	**1,346**	**661,286,000**	**3,891,955**	**237,602**	**6,612,518**	**29,543**

Notes: 1. Existing BMPs are included along with BMPs for new development as per current SFWMD criteria in Chapter 40E-4 FAC.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to deliver to S-79.

5. The total percent impervious is an area-weighted composite.

Table 6-6. Average Annual Loads for the West Caloosahatchee Subwatershed (Alternative Future Land Use)

	Future Land Use (Year 2050)															
Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
4 . Banana Branch	2,707	17.3%	469	4,717	78,205	7	556,000	74	1,094	4,163	81	1,380,000	13,804	2,313	208,000	502
6 . Bedman Creek	3,734	19.3%	722	6,732	92,635	8	794,000	113	1,694	6,032	115	1,990,000	21,764	3,646	336,000	689
7 . Bee Branch	22,663	10.2%	2,305	34,537	252,000	16	3,070,000	198	7,150	24,267	159	10,100,000	98,830	14,062	572,000	1,155
14 . Canal 1	12,190	5.0%	615	16,675	92,395	1	1,200,000	58	4,433	11,679	52	4,890,000	56,558	8,878	182,000	443
15 . Canal 2	16,664	7.3%	1,217	23,939	125,000	2	1,730,000	64	4,757	14,972	54	6,870,000	70,354	9,504	212,000	514
20 . City Ditch	1,521	37.2%	566	3,570	69,303	4	461,000	63	1,090	3,159	53	1,060,000	11,468	1,879	130,000	501
23 . County Line Drainage District	6,155	5.7%	352	8,545	72,151	6	783,000	72	2,004	6,195	86	2,530,000	29,509	4,840	277,000	503
25 . Cow Slough	9,192	5.9%	545	12,819	109,000	4	1,160,000	82	4,381	10,407	84	3,890,000	47,872	9,122	258,000	521
26 . Crawford Canal	837	40.2%	336	2,039	40,215	2	270,000	36	426	1,599	31	574,000	5,817	829	78,016	296
27 . Cypress Branch	27,329	7.3%	1,991	39,244	211,000	11	3,140,000	145	8,380	26,241	115	11,900,000	110,000	15,599	462,000	969
28 . Cypress Creek	13,057	6.8%	892	18,570	130,000	11	1,820,000	106	4,612	13,255	124	5,700,000	59,166	10,120	475,000	642
31 . Deadmans Branch	10,437	6.1%	633	14,600	87,419	6	1,250,000	69	3,593	10,312	70	4,540,000	44,909	7,076	258,000	499
34 . Dog Canal	7,855	28.9%	2,269	16,446	219,000	12	1,760,000	297	3,713	14,548	158	4,180,000	57,026	8,040	457,000	1,375
36 . Fichter Branch	5,508	9.0%	495	8,196	59,235	4	827,000	44	1,883	5,713	50	2,490,000	24,576	4,041	199,000	262
40 . Franklin Run	325	19.3%	63	585	9,217	1	80,610	11	131	537	16	196,000	1,627	295	48,266	87
41 . Ft. Denaud Branch	7,156	7.2%	514	10,254	99,794	10	969,000	71	2,242	7,660	82	3,100,000	29,208	4,490	237,000	449
42 . Ft. Simmons	1,244	43.3%	538	3,149	56,357	4	421,000	70	616	2,662	60	842,000	9,698	1,412	168,000	475
47 . Greenbriar Swamp	2,490	21.8%	543	4,675	58,557	4	498,000	65	947	3,574	41	1,260,000	13,882	1,937	108,000	326
50 . Hendry Canal	17,127	22.2%	3,805	32,380	349,000	13	3,250,000	358	7,473	26,794	232	9,040,000	105,000	16,050	592,000	2,499
53 . Hickey's Creek	16,963	27.7%	4,701	34,911	490,000	38	3,890,000	663	8,274	32,476	468	9,020,000	117,000	17,996	1,270,000	3,204
59 . Jacks Branch	46,734	6.5%	3,048	66,024	400,000	30	5,430,000	243	10,221	40,069	238	19,100,000	181,000	22,777	982,000	1,690
62 . LaBelle	2,267	64.5%	1,462	9,446	200,000	66	1,050,000	188	1,787	7,888	184	8,150,000	22,589	6,284	406,000	1,809
63 . LaBelle East	17,084	14.9%	2,543	29,046	271,000	24	2,540,000	231	7,388	24,246	165	9,730,000	93,609	14,465	461,000	1,533
79 . North LaBelle	7,895	22.0%	1,737	14,874	214,000	15	1,650,000	207	3,673	12,521	167	4,230,000	44,977	6,936	450,000	1,342
64 . LaBelle Private Drainage District	17,761	30.1%	5,354	37,866	494,000	23	3,820,000	583	7,952	31,961	310	9,620,000	124,000	16,678	802,000	3,056
66 . LeHigh SE	6,055	8.4%	507	8,894	65,407	3	823,000	57	2,705	6,993	62	2,760,000	30,426	5,428	200,000	388
69 . Mackeral Canal	1,369	28.0%	383	2,829	38,448	2	298,000	48	574	2,266	25	718,000	9,161	1,262	64,135	241
73 . Messer	7,576	14.6%	1,103	12,558	113,000	4	1,220,000	94	3,395	9,722	82	3,780,000	39,184	6,367	255,000	650
74 . Miller's Gulley	708	22.2%	157	1,339	17,160	1	149,000	18	292	1,066	14	371,000	3,915	578	35,450	92
88 . Park Branch	877	15.1%	133	1,469	18,327	3	196,000	24	365	1,285	36	503,000	4,187	756	111,000	175
91 . Polywog	11,725	8.6%	1,012	17,318	146,000	10	1,520,000	90	3,271	12,088	78	5,080,000	45,144	6,184	261,000	542
93 . Port LaBelle	3,475	17.2%	596	6,034	62,611	2	555,000	60	1,619	4,966	41	1,710,000	19,872	3,110	110,000	384
95 . Roberts	24,499	6.3%	1,543	34,446	217,000	4	2,960,000	155	10,973	26,293	160	10,500,000	123,000	22,138	569,000	974
99 . Spanish Creek	1,140	13.7%	156	1,860	14,926	1	191,000	12	395	1,281	10	541,000	5,479	845	37,903	67
107 . Townsend Canal	20,723	3.6%	739	27,411	192,000	1	2,340,000	163	11,071	23,257	178	8,450,000	117,000	23,713	556,000	1,032
Total	**355,043**	**12.4%**	**44,045**	**567,997**	**5,164,362**	**353**	**52,671,610**	**4,832**	**134,574**	**432,147**	**3,881**	**170,795,000**	**1,791,611**	**279,650**	**11,827,770**	**29,886**

Notes: 1. Existing BMPs are included along with BMPs for new development as per current SFWMD criteria in Chapter 40E-4 FAC.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. The total percent impervious is an area-weighted composite.

Table 6-7. Average Annual Loads for the Estero Bay and Tidal Caloosahatchee Subwatershed (Alternative Future Land Use)

Future Land Use (Year 2050)

	Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
3	Babcock	13,880	4.5%	622	18,746	94,710	12	1,740,000	72	4,034	12,187	82	5,780,000	56,781	8,945	407,000	385
5	Bayshore Creek	2,071	26.2%	542	4,166	70,402	7	560,000	94	1,223	3,807	92	1,280,000	13,358	2,309	275,000	540
8	Billy's Creek	6,732	55.0%	3,699	19,998	449,000	48	2,960,000	722	5,924	18,811	575	5,520,000	68,145	10,954	1,840,000	3,839
9	Blackstone	695	25.4%	177	1,383	18,453	1	156,000	22	313	1,186	20	405,000	4,154	626	55,333	144
13	Caloosahatchee South Shore	6,427	37.9%	2,436	15,221	282,000	29	2,210,000	591	5,714	16,105	439	4,540,000	55,689	10,224	1,600,000	2,366
17	Carrol Canal	1,075	52.7%	567	3,031	73,365	8	476,000	138	1,188	3,270	103	853,000	11,805	2,130	357,000	622
18	Chapel Branch	1,369	19.7%	270	2,485	38,251	4	310,000	47	661	2,187	46	754,000	7,408	1,247	138,000	255
22	Cohn Branch	472	28.5%	135	983	12,640	1	110,000	18	216	804	11	261,000	3,082	443	35,070	81
24	Cow Creek	8,165	29.3%	2,395	17,206	201,000	16	2,200,000	319	3,633	13,461	254	5,040,000	47,595	6,943	990,000	1,490
29	Cypress Lakes	351	43.9%	154	896	16,759	2	117,000	39	303	1,043	24	217,000	3,642	652	91,505	138
30	Daughtrey Creek (With WWTP)	23,263	9.6%	2,245	35,193	302,000	35	3,730,000	304	8,097	26,078	341	11,100,000	104,000	16,851	1,210,000	1,709
32	Deep Lagoon (With WWTP)	1,777	46.9%	833	5,031	78,435	15	555,000	179	1,244	5,821	102	1,930,000	19,460	3,249	369,000	647
35	Estero River	39,169	18.6%	7,267	69,684	782,000	61	7,980,000	901	14,855	53,541	820	20,400,000	204,000	31,314	2,690,000	5,287
38	Flint Pen	9,009	17.4%	1,564	15,700	84,502	4	1,700,000	35	1,778	8,597	29	4,650,000	32,821	3,239	265,000	185
39	Fort Myers Shores	2,072	38.3%	794	4,934	92,794	11	795,000	191	1,884	5,523	190	1,700,000	18,030	3,565	632,000	1,010
43	Gator Slough (With WWTP)	39,334	12.8%	4,813	63,219	519,000	73	6,970,000	619	12,113	51,508	703	20,800,000	177,000	26,639	2,610,000	3,995
44	Gordon Swamp	4,806	15.1%	724	8,039	39,907	2	854,000	12	911	4,359	13	2,400,000	16,859	1,693	128,000	67
46	Green Meadows	17,132	7.8%	1,336	24,870	163,000	12	2,490,000	128	6,017	17,354	161	7,660,000	77,870	13,203	647,000	828
48	Halfway Creek	4,255	27.1%	1,152	8,674	105,000	6	927,000	149	1,824	7,576	93	2,200,000	29,099	4,269	286,000	709
49	Hancock Creek	3,984	46.4%	1,847	10,462	229,000	22	1,570,000	382	3,541	10,253	299	2,990,000	37,162	6,331	977,000	1,899
51	Hendry Creek (With WWTP)	11,518	36.9%	4,246	27,473	427,000	54	3,540,000	755	6,731	25,310	551	8,830,000	89,095	13,995	1,950,000	3,453
55	Imperial River (With WWTP)	16,679	37.2%	6,210	39,273	650,000	61	5,110,000	1,210	11,711	39,389	872	10,900,000	138,000	23,248	2,970,000	5,215
57	Iona	3,285	44.8%	1,472	8,469	160,000	16	1,160,000	310	2,711	8,633	213	2,220,000	30,456	5,058	754,000	1,270
60	Kickapoo Creek	956	13.8%	132	1,563	28,590	4	207,000	29	531	1,607	41	516,000	4,734	986	101,000	184
68	Lochmoor County Club (With WWTP)	1,053	43.0%	453	4,337	62,111	48	369,000	170	1,073	4,837	133	5,260,000	15,052	3,246	401,000	840
70	Manuel's Branch	885	57.8%	512	2,634	66,801	8	429,000	126	1,042	2,885	101	750,000	10,128	1,799	341,000	590
71	Marsh Point	1,961	43.0%	843	4,948	92,752	9	687,000	200	1,881	5,568	138	1,360,000	19,031	3,472	498,000	747
76	Mullock Creek (With WWTP)	7,012	32.9%	2,304	15,943	245,000	34	2,010,000	495	4,967	16,328	356	5,460,000	56,996	9,906	1,250,000	1,994
80	Northcentral Cape Coral	21,020	31.6%	6,647	50,803	833,000	197	6,010,000	1,127	11,526	52,116	1,123	27,100,000	181,000	31,543	2,830,000	7,998
81	Northwest Cape Coral	11,734	24.8%	2,906	23,095	346,000	37	3,120,000	496	5,169	20,596	575	7,310,000	67,847	11,439	1,790,000	3,299
82	Olga	2,370	28.8%	682	4,953	69,018	5	586,000	98	1,145	4,099	72	1,380,000	15,756	2,340	224,000	509
83	Orange River (With WWTP)	50,340	31.7%	15,960	115,000	1,650,000	191	12,000,000	2,254	28,216	109,000	1,544	36,600,000	365,000	58,522	4,250,000	11,240
84	Otter Creek	1,051	10.3%	109	1,606	22,096	2	167,000	14	329	1,233	16	466,000	4,244	689	38,521	94
85	Owl Creek	3,870	8.2%	319	5,669	58,636	5	596,000	53	1,744	4,537	59	1,740,000	19,378	3,601	171,000	311
86	Palm Creek	1,969	11.4%	224	3,073	52,686	7	384,000	52	1,071	3,125	71	997,000	9,823	2,031	174,000	318
87	Panther Island W	4,393	5.1%	225	6,018	38,544	2	570,000	31	1,832	4,494	38	1,860,000	21,728	4,081	142,000	185
89	Piggot Bridge	586	22.5%	132	1,114	14,425	1	140,000	18	239	919	19	338,000	3,077	490	61,777	107
90	Piney Point	357	22.8%	81	681	5,655	0	76,589	6	111	443	4	196,000	1,679	205	17,601	26
92	Popash Creek	11,357	9.6%	1,087	17,098	134,000	15	1,800,000	128	3,753	12,197	147	5,270,000	49,822	7,836	528,000	748
94	Powell Creek (With WWTP)	8,550	28.6%	2,445	19,953	276,000	79	2,200,000	473	4,848	20,503	382	10,700,000	72,681	12,576	1,140,000	2,533
96	Six Mile Cypress Slough (With WWTP)	35,579	41.4%	14,738	89,431	1,530,000	171	12,800,000	2,210	19,543	84,030	2,263	30,300,000	288,000	47,592	6,530,000	16,170
97	Southeast Cape Coral	20,217	46.5%	9,392	57,378	1,240,000	191	9,140,000	2,717	25,511	68,092	2,454	22,800,000	217,000	45,277	8,230,000	13,055
98	Southwest Cape Coral	17,495	34.5%	6,044	39,646	500,000	13	4,320,000	567	14,392	41,629	230	12,900,000	122,000	19,579	421,000	3,645
100	Spring Creek (With WWTP)	7,084	27.8%	1,968	22,716	277,000	221	1,700,000	369	3,327	28,823	391	25,900,000	95,460	17,978	686,000	3,278
101	Stroud Creek	5,591	12.3%	687	8,881	106,000	12	1,020,000	113	2,420	7,141	126	2,750,000	27,275	4,721	370,000	659
103	Telegraph Creek	39,308	6.6%	2,584	55,595	266,000	41	5,350,000	168	8,611	32,915	187	17,000,000	142,000	18,433	1,140,000	882
104	Ten Mile Canal (North)	7,927	50.8%	4,028	21,889	445,000	37	3,100,000	626	5,141	19,347	487	5,730,000	71,300	10,721	1,480,000	3,697
105	Ten Mile Canal (South) (With WWTP)	838	42.7%	358	2,432	32,665	3	265,000	60	522	2,027	40	530,000	7,025	1,087	139,000	256
106	Thompson Cutoff	583	22.1%	129	1,100	10,368	1	129,000	11	190	774	9	328,000	2,872	389	32,575	70
108	Trout Creek	18,373	5.1%	934	25,154	175,000	18	2,430,000	160	6,555	17,675	172	7,770,000	82,804	14,235	683,000	914
109	Whiskey Creek (With WWTP)	5,817	63.9%	3,719	18,387	483,000	60	3,330,000	1,002	7,614	22,517	895	5,920,000	73,102	14,496	3,060,000	5,020
110	Winkler Canal	977	65.9%	644	3,148	93,943	12	596,000	171	1,450	3,473	151	1,030,000	12,299	2,336	508,000	876
111	Yellow Fever Creek	3,116	43.6%	1,358	7,919	132,000	11	985,000	210	1,750	7,372	149	1,930,000	26,657	3,979	460,000	1,072
	Estuary	NA	NA	NA	29,126	185,000	737	0	293	0	38,821	555	72,500,000	181,000	14,261	345,000	6,916
	Total	**509,889**	**24.9%**	**127,141**	**1,066,426**	**14,360,508**	**2,672**	**124,736,589**	**21,684**	**263,129**	**975,926**	**18,961**	**437,121,000**	**3,512,281**	**566,973**	**59,319,382**	**124,367**
	Total to the River	**335,972**	**23.4%**	**78,473**	**696,182**	**9,323,131**	**1,986**	**79,373,589**	**14,345**	**180,034**	**650,247**	**12,569**	**305,044,000**	**2,332,791**	**377,052**	**39,074,877**	**81,415**

Notes: 1. Existing BMPs are included.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. "Total to the River" denotes the loads and flows from hydrologic units that discharge to the tidal river.

5. "Estuary" corresponds to the loads and flows from Wastewater Treatment Plants that discharge directly to the Caloosahatchee River.

6. The total percent impervious is an area-weighted composite.

Table 6-8. Average Annual Flow, Total N and Total P Loads for Strategy Involving Reduced Impervious Cover for Future Urban Development.

Parameter	Scenario	East Caloosahatchee [1]	West Caloosahatchee [2]	At S-79 [3]	Tidal Caloosahatchee [4]	Total to Tidal River [5]	Estero Bay [6]
Flow (ac- ft/yr)	Existing	1,023,275	494,483	1,517,758	593,416	2,111,174	308,002
	Future	1,053,705	567,997	1,621,702	696,182	2,317,884	370,244
	Increase	30,430	73,514	103,944	102,766	206,710	62,242
	%	3%	15%	7%	17%	10%	20%
Total N Load (pounds/year)	Existing	4,258,310	1,996,267	6,254,577	2,562,767	8,817,344	1,240,212
	Future	4,352,022	2,223,758	6,575,780	2,983,038	9,558,818	1,505,169
	Increase	93,712	227,491	321,203	420,271	741,474	264,957
	%	2%	11%	5%	16%	8%	21%
Total P Load (pounds/year)	Existing	234,576	279,876	514,452	359,328	873,780	168,446
	Future	237,602	279,650	517,252	377,052	894,304	189,921
	Increase	3,026	-226	2,800	17,724	20,524	21,475
	%	1%	0%	1%	5%	2%	13%

[1] Load delivered from subwatershed to structure S-79 on C-43 Canal (including Lake Okeechobee releases)

[2] Load delivered from subwatershed to structure S-79

[3] Load delivered from East Caloosahatchee and West Caloosahatchee subwatersheds to structure S-79 on C-43 Canal (including Lake Okeechobee releases)

[4] Load delivered from portion of Estero Bay and Tidal Caloosahatchee subwatershed that discharges to the tidal Caloosahatchee River

[5] Load delivered to structure S-79 plus load from portion of Estero Bay and Tidal Caloosahatchee subwatershed that discharges to the tidal Caloosahatchee River

[6] Load delivered from portion of Estero Bay and Tidal Caloosahatchee subwatershed that discharges to Estero Bay

Example spreadsheets (for the East Caloosahatchee sub-watershed) are displayed in **Figures 6-6** and **6-7**. Figure 6-6 shows the load evaluation spreadsheet for the base future condition (e.g., existing SFWMD BMP requirements with no enhanced onsite BMPs or existing land use retrofits), whereas Figure 6-7 shows how enhanced BMPs and existing land use retrofits can be assigned to limit the future TN load to existing levels. Most of the values shown in the figures represent WMM results (e.g., existing and future loads) or values calculated from the WMM results (e.g., increase in loads without new development BMPs). The values that are shaded represent the values that can be modified by the user (and are modified in going from Figure 6-6 to Figure 6-7) to evaluate BMP alternatives. These values include the following:

- Onsite BMP efficiency for new development;
- Percent of existing urban and agricultural land that will be served by retrofit BMPs; and
- Efficiency of the retrofit BMPs.

The overall percent increase (or decrease) in surface runoff load, as well as the overall percent increase (or decrease) in total load (runoff, point sources, baseflow) with respect to existing TN levles is presented at the bottom of the page.

It should be noted that the spreadsheet focuses on TN loads. Reasons for this are as follow:

1. In the tidal Caloosahatchee River, there are existing concerns about managing eutrophication, which is stimulated by nitrogen and phosphorus.
2. In tidal areas, nitrogen is often the nutrient that "limits" eutrophication (i.e., greater loads of TN will likely increase algae growth).
3. Nitrogen tends to have a high dissolved fraction and low particulate fraction relative to phosphorus or other water quality constituents, making it more difficult to remove within traditional BMPs which rely on sedimentation and filtration.

For these reasons, TN is being used as an "indicator" parameter. Since TN loads typically have lower BMP removal efficiencies than TP and TSS, the BMPs should effectively control other water quality constituents as well (e.g., TP).

6.3.1 Enhanced-Efficiency BMPs – Draft Southwest Florida Basin Supplemental Criteria

For the base future and alternative future evaluations with WMM, the new urban development was expected to have wet detention pond BMPs, with a typical TN removal efficiency of 30 percent (this can range from 20 to 45 percent). This value was

Land Use / BMP Condition	Surface Runoff Total N (lb/yr) by Land Use Categories				Total N Loads from Other Sources (lb/yr)	Total N Load from All Sources (lb/yr)
	Urban	Agricultural	Other	Total		
EXISTING LAND USE						
East Caloosahatchee	121,049	766,849	168,475	1,056,373	3,201,937	4,258,310
Existing BMP Coverage (%)	4%	58%				
Load without BMPs	122,631	929,739				
FUTURE LAND USE - TRADITIONAL BMPs - TRADITIONAL IMPERVIOUSNESS						
East Caloosahatchee	329,609	695,011	162,205	1,186,825	3,201,675	4,388,500
INCREASE IN LOAD WITHOUT NEW DEVELOPMENT BMPs	30%	0%	0%			
East Caloosahatchee	297,943	-71,838	-6,270	219,835	0	219,835
DECREASE IN LOAD BASED ON EXISTING LAND USE RETROFIT						
Percent retrofit area	0%	0%				
Percent Total N removal efficiency	30%	30%				
Overall total N reduction	0.0%	0.0%				
East Caloosahatchee	0	0	0	0	0	0
NET CHANGE IN FUTURE LOAD DUE TO ENHANCED BMPs AND RETROFITTING						
East Caloosahatchee	208,560	-71,838	-6,270	130,452	-262	130,190
Percent Increase/Decrease from Existing Total N Load		Surface Runoff Only ====>		12.3%	All Sources ===>	3.1%

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Section 6_Figures.xls

Figure 6-6
Example Calculation of Future Total N Loads with Current BMP Requirements

Land Use / BMP Condition	Surface Runoff Total N (lb/yr) by Land Use Categories				Total N Loads from Other Sources (lb/yr)	Total N Load from All Sources (lb/yr)
	Urban	Agricultural	Other	Total		
EXISTING LAND USE						
East Caloosahatchee	121,049	766,849	168,475	1,056,373	3,201,937	4,258,310
Existing BMP Coverage (%)	4%	58%				
Load without BMPs	122,631	929,739				
FUTURE LAND USE - TRADITIONAL BMPs - TRADITIONAL IMPERVIOUSNESS						
East Caloosahatchee	329,609	695,011	162,205	1,186,825	3,201,675	4,388,500
INCREASE IN LOAD WITH NEW DEVELOPMENT BMPs						
East Caloosahatchee	208,560	-71,838	-6,270	130,452	-262	130,190
INCREASE IN LOAD WITHOUT NEW DEVELOPMENT BMPs	30%	0%	0%			
East Caloosahatchee	297,943	-71,838	-6,270	219,835	0	219,835
INCREASE IN LOAD WITH ENHANCED NEW DEVELOPMENT BMPs	50%	0%	0%			
East Caloosahatchee	148,971	-71,838	-6,270	70,863	0	70,863
DECREASE IN LOAD BASED ON EXISTING LAND USE RETROFIT						
Percent retrofit area	30%	30%				
Percent Total N removal efficiency	50%	50%				
Overall total N reduction	14.4%	6.2%				
East Caloosahatchee	-17,604	-52,581	0	-70,185	0	-70,185
NET CHANGE IN FUTURE LOAD DUE TO ENHANCED BMPs AND RETROFITTING						
East Caloosahatchee	131,368	-124,419	-6,270	679	-262	417
Percent Increase/Decrease from Existing Total N Load		Surface Runoff Only ====>		0.1%	All Sources ===>	0.0%

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Section 6_Figures.xls

Figure 6-7
Example Calculation of Future Total N Loads with Enhanced BMP and Retrofit BMP Benefits

selected based on BMP removal efficiency data in the literature, and empirical estimates of TN removal from models using southeastern United States reservoir data as the basis (Reckhow, 1988; Walker, 1985). Potential enhancements to achieve a higher onsite BMP efficiency for TN loadings would include the following: using specific BMPs with a greater removal efficiency (e.g., wet detention with a longer residence time, retention or exfiltration), using source controls (e.g., reduced coverage of fertilized turf; onsite stormwater recycling/reuse), using a "treatment" train (several BMPs in series), and combinations of methods.

The draft Southwest Florida Basin criteria (SFWMD, April 2005) includes a menu of BMPs in Tables A, B, and C that can be used to achieve an appropriate level of stormwater runoff treatment. The rule has been evaluated by Wanielista (draft, 2006) with respect to the potential removal efficiencies that can be expected from the BMPs included in the basin draft supplemental criteria menu of BMPs.

Based on research by Harper (2006), the draft Wanielista report suggests several methods by which wet detention pond removal of TN can be enhanced. One method is oversizing the pond to achieve longer average residence times (say 50 days or more) in contrast to the 14 to 21 day residence time that is typical for wet detention pond design. In this case, Harper suggests that it may be possible to achieve a TN removal efficiency of 40 to 45 percent rather than the 30 percent average removal assumed for the base condition in this study. Harper also suggests that chemical treatment (e.g., alum injection) can enhance the removal of TN (and especially enhance TP removal) in wet detention ponds, to the point that the expected TN removal could be in the range of 65 to 73 percent. However, enhanced removal of TN is typically not associated with alum injection. Generally, anaerobic processes are required to achieve these higher levels of TN removal.

Other BMPs that are considered in the Wanielista report include the following:

- **Retention devices** (e.g., infiltration basins) direct stormwater runoff into the ground through infiltration, or lose water through evaporation. It is fairly straightforward to estimate how much water can be captured by such a facility based on its size relative to the size and imperviousness of its tributary area, and the minimum infiltration rate, but it is difficult to say how much of the mass of TN or other constituents that infiltrates into the soil may still reach a receiving water. These type of devices are most suitable for sandy soils with high infiltration rates (such as hydrologic group A and B soil types or dual class soils where some water table drainage is allowed per permits), and may not be suitable in areas with a high water table.

- **Stormwater recycling and reuse** involves the capture of stormwater for use as irrigation water. TN removal would occur mainly as uptake for the vegetation that is being irrigated. This would be expected to have a relatively high removal efficiency, though it would be hard to measure just how much TN mass delivered to the surface may actually infiltrate and ultimately still reach a receiving water.

- **Vegetated swales and filter strips** are "conveyance/pretreatment" BMPs that encourage infiltration and filtration of relatively shallow stormwater flows being routed to a major stormwater BMP (e.g., wet detention pond). These can include retention landscape swales which can reduce flow volumes, pollutant loads, and temperature impacts to waters.

As discussed in the draft report by Wanielista, these types of BMPs can be used in a "treatment train" of multiple BMPs in series to enhance stormwater pollutant removal.

For the purposes of this study, WMM results were used to determine the TN removal efficiency that would be required for new development so that the future TN load would be less than or equal to the existing load. Other BMPs (e.g., existing land use BMP retrofits, C-43 reservoir) were not considered in this particular analysis.

The results of the analysis are summarized in **Table 6-9**. For each sub-watershed, the table shows the required TN removal efficiency needed to limit the future TN load in each sub-watershed to the existing load value. In the case of the Caloosahatchee River, the table also shows an overall TN removal efficiency which, applied equally to the three sub-watersheds that ultimately discharge to the tidal Caloosahatchee River, would limit the total future load from the three sub-watersheds to the existing total load.

As shown in the table, the overall TN reduction required to limit future TN loads to existing levels is 80 percent for the base future land use, and 76 percent for the reduced imperviousness alternative. Based on the discussion above, it is unlikely that enhancing wet detention pond BMPs with greater residence times and chemical addition would achieve the required efficiency. It is likely that a treatment train of BMPs would be required to meet the overall requirement. This is consistent with the draft supplemental criteria. For individual sub-watersheds, the Tidal Caloosahatchee sub-watershed would require 99 to 100 percent TN efficiency, which could be extremely difficult to achieve.

6.3.2 Retrofit BMPs for Existing Urban and Agricultural Lands

Another strategy that was evaluated was the retrofit of BMPs on land that is already developed (either urban or agricultural land use) and does not have a BMP. In the case of agricultural land, some of the existing land will be converted to urban land use in the future. Therefore, the implementation of BMPs on agricultural land was limited to existing agricultural land that remains agricultural land in the future condition. For this study, the urban and agricultural lands that will remain as the same land use in the future are referred to as "legacy" urban and agricultural areas.

One restriction that was used in evaluating the load reduction potential for retrofit BMPs was the limitation of the extent to which retrofitting would be feasible.

Table 6-9. Onsite BMPs Required to Limit Future (year 2050) Total N Loads to Existing (year 2000) Levels.

Receiving Water	Subwatershed	Future Land Use Scenario	Required Total N Efficiency for BMPs Serving Future Urban Development
Caloosahatchee River	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Base Future	74 64 99 79
	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Alternative Future (Lower Imperviousness)	69 57 100 75
Estero Bay	Estero Bay (272 sq mi)	Base Future	80
	Estero Bay (272 sq mi)	Alternative Future (Lower Imperviousness)	76

NOTES:

1. Base future land use conditions include the current projected year 2050 land use with current SFWMD criteria.
2. "Alternative future" land use was represented in WMM by representing projected development as a combination of 80% development and 20% open space, thereby reducing the imperviousness of the projected development by 20%
3. See Figure 6-1 for map of the study area subwatersheds.

Particularly in urban areas, it is often difficult to locate open land areas that would be suitable for a BMP to treat runoff from existing development. Based on previous experience, the fraction of legacy urban and agricultural areas to be controlled with retrofit BMPs was limited to no more than 30 percent of the potential retrofit area. In some areas this will be higher than actual. The evaluation of specific onsite BMPs to this degree is beyond the scope of this study and can be evaluated in WMM for subsequent scenarios.

Another consideration for the BMP retrofit analysis was the TN removal efficiency for onsite BMPs serving new development. For this analysis, a value of 50 percent was used, which is significantly higher than the value of 30 percent used in the base future analysis. Reasons for selecting this value are as follows:

- It is expected that a reasonable "treatment train" of BMPs (e.g., swales followed by an oversized wet detention pond) could achieve this level of efficiency; and
- The 50 percent value is close to the minimum efficiency value (57 percent) that would be required if onsite BMPs alone were designed to limit future loads.

The results of the analysis are presented in **Table 6-10**. For the Estero Bay sub-watershed, the results show that even with a relatively high onsite TN BMP efficiency (50 percent), and a high level of retrofitting (30 percent), the future TN load would still exceed the existing load for the base future case, and would require an extremely high efficiency (96 percent) from retrofit BMPs for the alternative future (reduced imperviousness) condition. For the Caloosahatchee River, the overall required TN retrofit BMP efficiency is 67 percent (base future) or 44 percent (alternative future), with 50 percent onsite BMP efficiency and 30 percent retrofit area.

6.3.3 Proposed C-43 Reservoir

Based on the Comprehensive Everglades Restoration Plan (CERP), there is a planned C-43 reservoir on a site located in the West Caloosahatchee sub-watershed (USACE/SFWMD, 2005). It is likely that the reservoir will provide water quality as well as flow attenuation benefits. The footprint of the proposed site is shown in Figure 6-2 earlier in this section. The most recent preliminary design criteria (Peter deGolian, DHI, personal communication, 2006) for the proposed reservoir include the following:

- Total storage volume of 170,000 acre-feet;
- Inflow pump from C-43 canal to reservoir, with maximum pumping capacity of 1,500 cubic feet per second (cfs);
- Outflow from reservoir to C-43 canal, with maximum rate of up to 1,000 cfs; and
- Minimum flow in the C-43 canal from all sources is 450 cfs (i.e., pumping from canal will occur only to the extent that the flow continuing down the canal will not be less than 450 cfs).

Table 6-10. Combinations of Retrofit and Onsite BMPs Required to Limit Future (year 2050) Total N Loads to Existing (year 2000) Levels.

Receiving Water	Subwatershed	Future Land Use Scenario	Assumed Total N Efficiency for BMPs Serving Future Urban Development	Required Percent of Uncontrolled Legacy Urban and Agricultural Areas with Retrofit BMPs	Required Total N Efficiency for Retrofit BMPs
Caloosahatchee River	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Base Future	50	30 30 30 30	50 62 85 67
	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Alternative Future (Lower Imperviousness)	50	30 25 30 30	30 33 66 44
Estero Bay	Estero Bay (272 sq mi)	Base Future	50	30	>100
	Estero Bay (272 sq mi)	Alternative Future (Lower Imperviousness)	50	30	96

NOTES:

1. "Uncontrolled legacy" urban and agricultural areas are those areas that are currently urban or agricultural land use, are expected to remain the same land use in the future (as opposed to agricultural land that is expected to be converted to urban development in the future), and are not currently served by BMPs.
2. "Alternative future" land use was represented in WMM by representing projected development as a combination of 80% development and 20% open space, thereby reducing the imperviousness of the projected development by 20%.
3. Assumed onsite total N BMP efficiency for future development was set at 50% because model results suggest that this is the minimum efficiency that, in conjunction with other BMPs, can reduce future loads of total N to existing levels.
4. Percent of area with retrofit BMPs was limited to 30% based on previous experience.
5. Required efficiency of greater than 100% means that the existing total N load cannot be maintained with the assumed oniste efficiency and retrofit coverage.
6. Values shown in the TOTAL row represent values that, if applied uniformly over the East Caloosahatchee, West Caloosahatchee and Tidal Caloosahatchee subwatersheds, would limit the future total N load to existing levels.
7. See Figure 6-1 for map of the study area subwatersheds.

The values shown above were used to estimate how much flow and TN load would be conveyed to the reservoir in order to estimate the annual TN load reduction potential from the proposed facility.

A relatively simple analysis was conducted to estimate the flow capture for the proposed pump and reservoir system. Flow records at structure S-79 for the year 1990-2000 were used as the basis for the analysis, considering that this period reflects recent Lake Okeechobee release patterns, and considering that the proposed intake pump would be located near the structure. A reservoir operations model (spreadsheet) was developed for daily simulations of reservoir inflows and outflows based on the following operating rules:

- If the C-43 canal flow was less than 450 cfs, there was no pumped flow from the canal to the reservoir (operational ranges will likely be developed);
- If the flow in the canal exceeded 450 cfs, the pumped flow from the canal to the reservoir was the minimum of: (a) the difference between the measured canal flow and the minimum flow of 450 cfs, (b) the available storage volume in the reservoir, or (c) the pump capacity of 1,500 cfs;
- If the flow in the canal exceeded 450 cfs, there was no discharge from the reservoir back to the canal; and
- If the flow in the canal was less than 450 cfs, the discharge from the reservoir back to the canal was the minimum of: (a) the volume in the reservoir, or (b) the discharge capacity of up to 1,000 cfs.

Based on the reservoir operations model for the period 1990 through 2000, an average of 10 percent of the flow in the canal would be pumped from the canal to the proposed reservoir. Sensitivity analysis suggested that relatively large changes to the reservoir volume and pump capacity had little effect on the percent capture value.

The TN load pumped from the canal to the reservoir was estimated based on the flow capture and the average annual TN load at S-79 under existing conditions. As shown in Table 6-4, the sum of the existing TN loads from the East Caloosahatchee and West Caloosahatchee sub-watersheds at S-79 is about 6.2 million pounds per year. If the 10 percent of flow captured will correspond to 10 percent of TN load captured, the amount of TN load pumped to the reservoir is approximately 620,000 pounds per year.

The results of the reservoir operations model analysis also indicated that the average residence time in the reservoir under the design conditions would be over 300 days. Given the extended residence time, it may be reasonable to estimate that at least 40 percent of the incoming TN will be removed in the reservoir (Harper 2006). For the base future conditions, the estimated TN load reduction is on the order of 250,000 pounds per year.

A review of Tables 6-4 and 6-8 shows that the proposed C-43 reservoir alone would not limit the combined future TN load from the East and West Caloosahatchee sub-watersheds to the existing levels. As shown in Table 6-4, the base future conditions results in a 469,000 pound per year increase in TN at S-79, and the alternative future (reduced imperviousness) condition results in a 321,000 pound per year increase in TN load at S-79. Therefore, additional controls (e.g., enhanced efficiency BMPs, retrofit BMPs) would still be necessary to limit the future annual TN loads to existing levels.

Note that the reservoir affects only the loads from the East and West Caloosahatchee sub-watersheds. It does not affect loads from the Estero Bay and Tidal Caloosahatchee sub-watershed. However, the reservoir could be a key factor in limiting the overall load to the tidal Caloosahatchee River. It is recommended that a permanent pool of 3 to 5 feet be considered for the reservoir to provide a minimum hydraulic residence time consistent with nutrient removal.

6.3.4 Combination of BMPs

Combinations of BMPs were evaluated using the spreadsheet format illustrated previously as Figure 6-4. For each sub-watershed, multiple analyses were evaluated, using the following process:

- Various onsite TN removal efficiencies were estimated (40 percent, 50 percent, 60 percent, 70 percent, and 80 percent);
- If the onsite BMP efficiency alone was not sufficient to reduce the future TN load to existing levels, retrofit BMPs (up to 30 percent of the uncontrolled legacy urban and agricultural areas) at the base TN BMP efficiency of 30 percent was added; and
- If the above was insufficient, the efficiency of the retrofit BMPs was increased up to the specified onsite efficiency, to see if that combination would reduce the future annual TN load to existing levels.

Results of these individual analyses were then analyzed to assign ranges of efficiencies and coverages that would be necessary to achieve a non-degradation condition for future loads of TN.

Load reduction beyond these levels will be required since a number of water bodies in the Study Area are on the verified impaired waters list by FDEP and will have total Maximum Daily Loads (TMDLs) established along with associated Pollutant load Reduction Goals (PLRGs). These TMDLs and PLRGs not yet fully established, so the needed level of reduction has not yet been determined, but the WMM developed for this study can be applied to further determine management plan actions to improve water quality. TMDLs and PLRGs are presented in further detail in Section 7

Table 6-11 summarizes the results of the analysis. As shown in the table, loads to the Caloosahatchee River were evaluated under various conditions:

Table 6-11. Combinations of BMPs Required to Limit Future (year 2050) Total N Loads to Existing (year 2000) Levels.

Receiving Water	Subwatershed	Future Land Use Scenario	Including C-43 Reservoir?	Required Total N Efficiency for BMPs Serving Future Urban Development	Required Percent of Uncontrolled Legacy Urban and Agricultural Areas with Retrofit BMPs	Required Total N Efficiency for Retrofit BMPs
Caloosahatchee River	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Base Future	No	60 - 70 60 - 70 60 - 70 65	10 - 30 0 - 20 30 25	30 30 50 - 65 40
	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Alternative Future (Lower Imperviousness)	No	50 - 60 50 - 60 60 - 70 60	15 - 30 0 - 30 30 25	30 - 50 30 40 - 55 35
	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Base Future	Yes	60 60 60 60	0 0 30 15	--- --- 35 35
	East Caloosahatchee (412 sq mi) West Caloosahatchee (555 sq mi) Tidal Caloosahatchee (525 sq mi) Total (1,492 sq mi)	Alternative Future (Lower Imperviousness)	Yes	50 50 50 50	0 0 30 15	--- --- 40 40
Estero Bay	Estero Bay (272 sq mi)	Base Future	---	70	30	50
	Estero Bay (272 sq mi)	Alternative Future (Lower Imperviousness)	---	60 - 70	25 - 30	30 - 60

NOTES:

1. "Uncontrolled legacy" urban and agricultural areas are those areas that are currently urban or agricultural land use, are expected to remain the same land use in the future (as opposed to agricultural land that is expected to be converted to urban development in the future), and are not currently served by BMPs.
2. For the tidal Caloosahatchee River subwatershed alternatives that do not include the projected benefit of the proposed C-43 reservoir, the BMP and retrofit values listed for each subwatershed reflect what is required to limit future total N loads to existing levels within each subwatershed.
3. For the tidal Caloosahatchee River subwatershed alternatives that do not include the projected benefit of the proposed C-43 reservoir, the BMP and retrofit values listed under "Total" reflect values that would limit the total future load of total N to existing levels if applied uniformly across all three subwatersheds.
4. Based on the most recent information about the proposed C-43 reservoir (e.g., storage volume, surface area, inflow and outflow pump capacity, minimum flowby in the C-43 Canal), it is estimated that the reservoir would treat approxiamtely 10% of the flow in the canal at a 40% removal efficiency, resulting in a total N load reduction of 250,000 pounds per year.
5. The treatment requirements for the tidal Caloosahatchee River subwatersheds alternatives with the C-43 reservoir were established based on the following rules:
   (a) All three subwatersheds were assigned the same total N removal efficiency requirement for new urban development.
   (b) Retrofits for East Caloosahatchee and West Caloosahatchee subwatersheds were set to zero (reservoir acts as retrofit BMP for these subwatersheds).
   (c) Values for percent of legacy urban and agricultural area with retrofit BMPs, and retrofit BMP efficiency, in the Tidal Caloosahatchee subwatershed were set to values that are likely to be achievable in the subwatershed.
6. "Alternative future" land use was represented in WMM by representing projected development as a combination of 80% development and 20% open space, thereby reducing the imperviousness of the projected development by 20%.

- Base future and alternative future land use conditions (lower impervious area); and
- With and without consideration of potential water quality benefits from the proposed C-43 reservoir.

The Estero Bay tributary area was evaluated for the two future land use conditions as well.

For Estero Bay, the limitation of future TN loads to the existing level for the base future condition would require a very high onsite BMP efficiency (70 percent), coupled with a moderate to high level of retrofitting (30 percent) of existing urban and agricultural development. With the alternative (reduced imperviousness) future condition, the required onsite efficiency and retrofitting requirements are somewhat lower. Alternatively, if a higher TN efficiency can not be achieved, a greater level of retrofit would be required as discussed below and presented in the example plots in **Appendix B**.

For the tidal Caloosahatchee River, the proposed C-43 reservoir could provide water quality benefits if it is operated with a permanent pool hydraulic residence time of at least 14 to 28 days. Without consideration of the potential water quality benefits of the reservoir, an onsite BMP efficiency of 60 to 65 percent for TN and retrofitting of 25 percent of the uncontrolled legacy urban and agricultural area is required to maintain loads at current levels. As discussed previously and in Section 7, additional BMP retrofit and/or higher efficiency BMPs will be necessary to reduce loads below existing levels for impaired waters to meet TMDLs.

The best case for load control is the alternative future condition (lower impervious area using low impact development practices) with the SFWMD draft supplemental criteria, retrofits, and consideration of potential benefits from the C-43 reservoir.

Appendix B shows a set of Figures that demonstrate example relationships between retrofit and onsite BMPs to maintain current loads. As discussed, additional analyses will need to be performed to identify the load reduction necessary to meet TMDLs and PLRGs. The plots include different levels of retrofit area (coverage) and BMP efficiencies for retrofit and for new development. These examples demonstrate the trade-off between retrofit BMP efficiency and coverage area for different onsite BMP efficiency curves. The low impact development conditions as discussed previously are included for all cases.

Summaries and conclusions are presented in Section 7

Section 7
Summary and Conclusions

7.1 Summary

The Watershed Management Model (WMM) was used in this nutrient load assessment study to:

- Develop a ***relative pollutant load assessment model*** of the Caloosahatchee River and Estero Bay Watershed study area,
- Evaluate various watershed ***management plan alternatives for protecting and improving water quality*** in the study area,
- Provide a ***"big picture" tool*** for future land use and BMP implementation program assessments.

WMM was calibrated for existing watershed conditions based on comparison of average annual measured flows and loads to the average annual flows and loads calculated by WMM at the study area locations with the most complete flow and water quality data (structures S-78 and S-79 on the Caloosahatchee River).

The calibrated model was then applied to a future build-out watershed condition to estimate the changes in flows and pollution loads that are expected to occur as a result of future development in the study area.

Total Nitrogen (TN) was selected as the "indicator" pollutant to demonstrate relative load reduction benefits for the scenarios because:

1. In tidal areas, nitrogen is often the nutrient that "limits" eutrophication (i.e., greater loads of TN will likely increase algal growth), and
2. Nitrogen tends to have a high dissolved fraction and low particulate fraction relative to phosphorus or other water quality constituents, making it more difficult to remove within traditional BMPs which rely on sedimentation and filtration.

For these reasons, TN is being used as an "indicator" parameter. Since TN loads typically have lower BMP removal efficiencies than TP and TSS, the BMPs should effectively control other water quality constituents as well (e.g., TP, TSS, BOD, and metals).

Results of the analyses are summarized below by major subwatersheds within the study area. These areas include the following:

- **East Caloosahatchee** (land tributary to the Caloosahatchee River between Lake Okeechobee and structure S-78)
- **West Caloosahatchee** (land tributary to the Caloosahatchee River between structures S-78 and S-79)
- **Tidal Caloosahatchee** (land tributary to the tidal Caloosahatchee River downstream of structure S-79)
- **Estero Bay** (land tributary to Estero Bay)

This summary focuses on the achievement of the anti-degradation condition for new development and identifies the tables in Section 6 where the data were previously presented.

7.1.1 East Caloosahatchee Subwatershed

For the future build-out condition in the subwatershed, including BMPs for new development (typical wet detention ponds in accordance with existing SFWMD regulations), the model estimates a load increase of 3% for TN (Table 6-4).

To achieve anti-degradation conditions by using onsite BMPs for new development, the TN removal efficiency of the onsite BMPs would have to be 74% (typical for new development imperviousness).

In order to reduce pollutants loads for impaired waters, retrofits of existing urban and agricultural lands will be required. The retrofit evaluation focused on existing urban and agricultural areas that are expected to remain urban and agricultural areas in the future. For the purposes of discussion, these lands will be referred to as "legacy" urban and agricultural areas. Retrofits were not considered for existing agricultural or forest land that is expected to be converted to urban development in the future because development and redevelopment would need to meet current SFWMD water quality criteria for ERPs.

7.1.2 West Caloosahatchee Subwatershed

For the future build-out condition in the subwatershed, including BMPs for new development (typical wet detention ponds in accordance with existing SFWMD regulations), the model estimates a load increase of 17% for TN (Table 6-4).

To achieve the anti-degradation conditions by using onsite BMPs for new development, the TN removal efficiency of the onsite BMPs would have to be 64% (typical of new development imperviousness) as shown in Table 6-9.

In order to reduce pollutant loads for impaired waters, retrofits of existing urban and agricultural lands will be required. The retrofit evaluation focused on existing urban and agricultural areas that are expected to remain urban and agricultural areas in the future. These lands will be referred to as "legacy" urban and agricultural areas. Retrofits were not considered for existing agricultural or forest land that is expected

to be converted to urban development in the future because the development and redevelopment will need to meet current SFWMD water quality criteria for ERPs.

7.1.3 Tidal Caloosahatchee Subwatershed

For the future build out condition in the subwatershed, including BMPs for new development (typical wet detention ponds in accordance with existing SFWMD regulations), the model estimates a load increase of 21% for TN (Table 6-4).

To achieve the anti-degradation conditions by using onsite BMPs for new development, the TN removal efficiency of the onsite BMPs would essentially have to be 100% typical of new development imperviousness (Table 6-9).

In order to reduce pollutants loads for impaired waters, retrofits of existing urban and agricultural lands will be required. The retrofit evaluation focused on existing urban and agricultural areas that are expected to remain urban and agricultural areas in the future. These lands will be referred to as "legacy" urban and agricultural areas. Retrofits were not considered for existing agricultural or forest land that is expected to be converted to urban development in the future because the development and redevelopment will need to meet the current SFWMD water quality criteria for ERPs.

7.1.4 Estero Bay Subwatershed

For the future build-out condition in the subwatershed, including BMPs for new development (typical wet detention ponds in accordance with existing SFWMD regulations), the model estimates a load increase of 28% for TN (Table 6-4).

To achieve the anti-degradation conditions by using onsite BMPs for new development, the TN removal efficiency of the onsite BMPs would have to be 80% (typical of new development imperviousness) (Table 6-9).

In order to reduce pollutants loads for impaired waters, retrofits of existing urban and agricultural lands will be required. The retrofit evaluation focused on existing urban and agricultural areas that are expected to remain urban and agricultural areas in the future. These lands will be referred to as "legacy" urban and agricultural areas. Retrofits were not considered for existing agricultural or forest land that is expected to be converted to urban development in the future because the development and redevelopment will need to meet the current SFWMD water quality criteria for ERPs.

7.2 Conclusions

This section presents the conclusions of these water quality evaluations for the Caloosahatchee River - Estero Bay Watershed with focus on nutrient loads.

7.2.1 BMP Efficiencies and Stormwater Regulations

As discussed, the SFWMD is working on rulemaking including the Southwest Florida Basin Supplemental Water Quality Criteria in Chapter 40E-41 FAC (SW FL Basin Criteria) and the Lake Okeechobee and Estuaries Watershed (LOER) rule. These draft

rule requirements have built upon the efforts of the Water Enhancement and Restoration Coalition (WERC). The State of Florida (FDEP) is working on a statewide "unified stormwater rule" for new development which will incorporate some of the criteria from these two draft rules, namely:

- No net increase in pollutant loads (e.g., TP and TN) through higher efficiency BMPs (e.g., longer wet detention pond residence times)and BMPs in series,
- Reduced average annual flow discharge volumes through retention and recycling,
- Encouragement of stormwater recycling for landscape irrigation, and
- Low Impact Development (LID) practices such as:
  - Buffers along streams and wetlands;
  - Xeriscape (use of native plants); and
  - Reduced directly connected (effective) impervious area by:
    - Clustering of development;
    - Crowned driveways to grassed areas;
    - Roof gutters and drains to pervious areas, landscape areas, and/or cisterns (for recycling);
    - Courtyard driveways with drains to landscaped areas;
    - Decked parking instead of surface parking (commercial areas) and pervious parking or grassed areas;
    - Multistory buildings with smaller footprints; and
    - Green roofs.

The Florida TMDL Protocol (CDM, 2005) presents further information on LID practices and it is available for download from FDEP's web site for free (www.dep.state.fl.us/water/tmdl/docs/TMDL_Protocol.pdf).

The data and WMM evaluations in this study indicate that ***enhanced BMPs with higher efficiencies and LID practices will be necessary components of the plan to control increases in pollutant loads from new development to pre-development levels*** in order to achieve no further water quality degradation. This is consistent with the draft SW FL Basin supplemental water quality criteria, although details on actual BMP performance and demonstration in calculations are to be refined through the rulemaking process. Water quality load reduction and impaired waters are discussed later in the Section.

7.2.2 Data

It is recommended that:

- ***Water quality monitoring data continue to be collected for the watershed.*** In particular, it may be desirable to increase the frequency of samples (to weekly or daily in some cases), reduce the detection limit for metals, and include parameters that are not currently monitored (e.g., BOD and COD for Lake Okeechobee);

- A ***database of urban and agricultural BMPs for the watershed be developed***; and,

- ***Pollutant removal efficiencies of the various BMPs*** that are expected to be included in the SW FL Basin criteria, LOER criteria, and statewide unified stormwater rule ***be quantified with further monitoring data***.

7.2.3 Retrofit Projects

Based on the evaluations conducted over the course of this watershed study, ***retrofit BMPs for existing urban and agricultural areas (that do not currently have BMPs) will be necessary to manage and improve water quality in the watershed***. This includes the entire watershed for consideration, since evaluations show that load reduction goals will be significant throughout. A relative unit loading comparison shows areas with higher unit TN loads in Figures 7-1 and 7-2. Relative load estimates shown in these Figures correspond to a reduced agricultural BMP efficiency (one-third of the original value) suggested by the SFWMD and the IMC evaluation committee. Total annual load estimates for existing conditions with reduced agricultural BMP efficiency are tabulated in Appendix A.

As can be seen from the figures, it may be appropriate to seek retrofit projects in the higher unit load areas that do not currently have existing BMPs (e.g., tidal Caloosahatchee River and Estero Bay subwaterhseds). This will likely provide the greatest water quality benefit for the implementation funding. WMM can be used to evaluate these retrofit projects collectively or individually and compare with costs for the project implementation to identify the greater benefit projects for the costs.

7.2.4 TMDLs and PLRGs

The State of Florida Total Maximum Daily Load (TMDL) Program has identified impaired waterbodies in the Study Area; therefore, for these systems, ***load reductions will be required for these waterbodies to meet TMDL targets and comply with water quality standards.*** The "verified" impaired list for the Estero Bay-Caloosahatchee River Watershed is shown in **Tables 7-1 and 7-2 (FDEP, 2006)**. The tables include the listed waterbody, its identification number, impairment parameters, the likely sources of impairment and the schedule for TMDL evaluations. Some specific levels of parameter concentrations are identified in the FDEP table and draft TMDLs have been published for Daughtrey Creek, Nine Mile Canal, Billy Creek, and Lake Hicpochee as

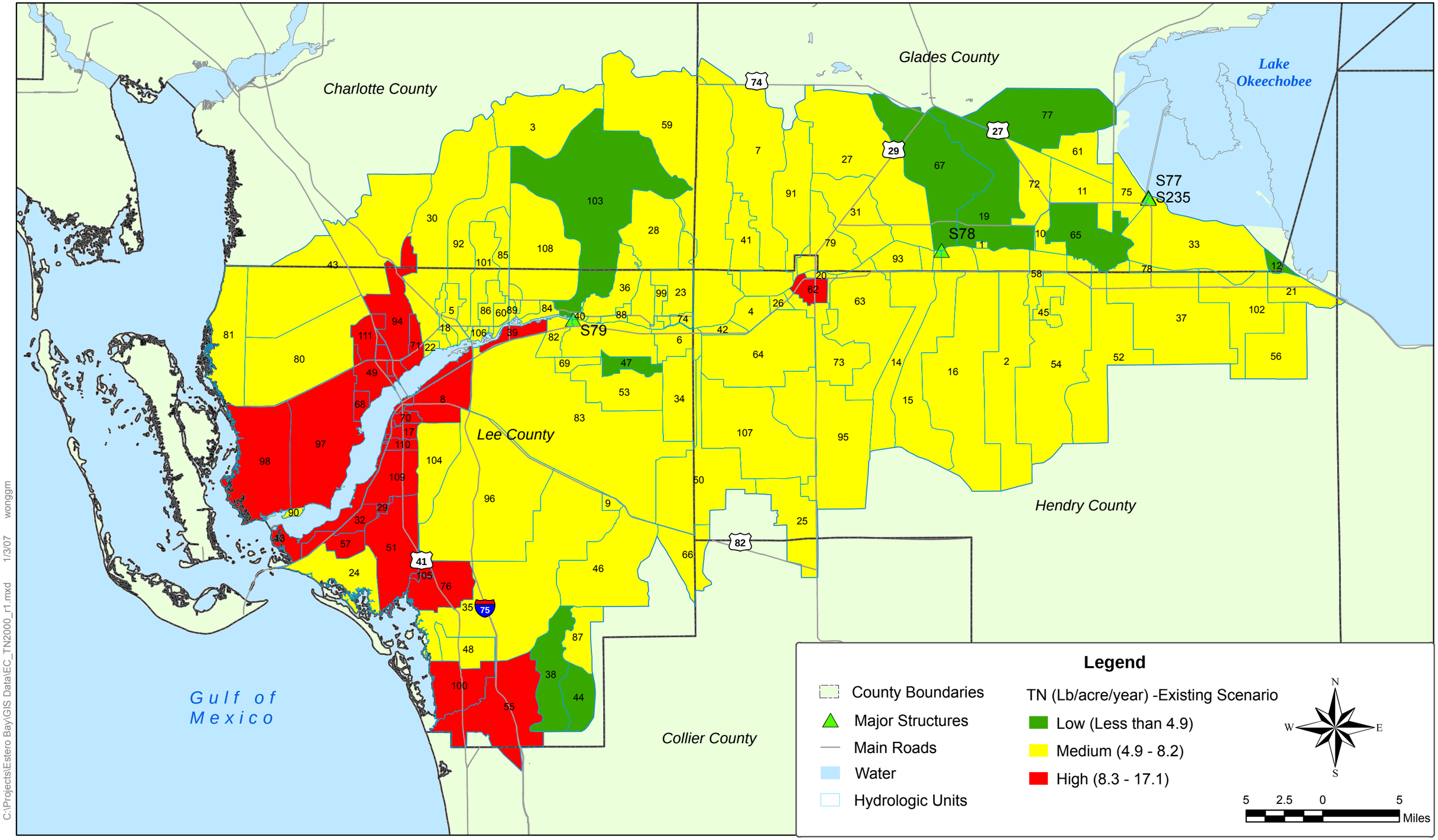

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Figure 7-1
WMM-Estimated Unit Area Total Nitrogen Load
Existing Scenario (year 2000)

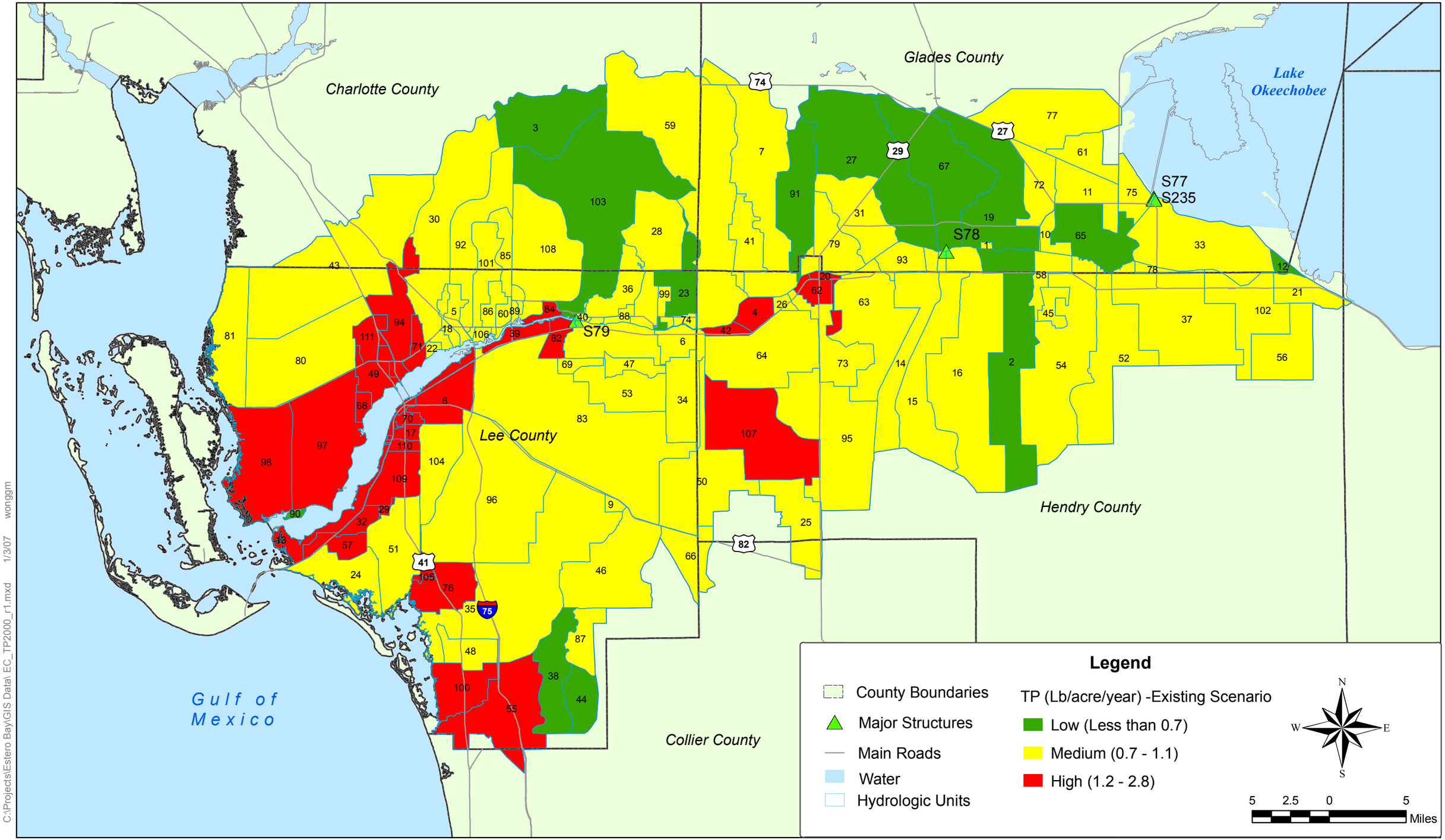

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Figure 7-2
WMM-Estimated Unit Area Total Phosphorus Load
Existing Scenario (year 2000)

Table 7-1. Caloosahatchee River – FDEP Verified Impaired Waters List

Planning Unit	WBID	Waterbody Segment Name	Waterbody Type	Waterbody Class[1]	Parameters Identified Under the Impaired Surface Waters Rule	Concentration Causing Impairment[2]	Priority for TMDL Development[3]	Projected Year for TMDL Development[3]
CALOOSAHATCHEE ESTUARY	3240A	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Copper	> 3.7 ug/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240A	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Dissolved Oxygen	< 4.0 mg/l	Medium	2009
CALOOSAHATCHEE ESTUARY	3240A	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240A	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Nutrients (Chl a)	Median TN = 0.83 mg/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240B	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Dissolved Oxygen	< 4.0 mg/l	Medium	2009
CALOOSAHATCHEE ESTUARY	3240B	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240B	TIDAL CALOOSAHATCHEE	ESTUARY	3M	Nutrients (Chl a)	Median TN = 0.85 mg/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240C	TIDAL CALOOSAHATCHEE	STREAM	3F	Dissolved Oxygen	< 5.0 mg/l	Medium	2009
CALOOSAHATCHEE ESTUARY	3240C	TIDAL CALOOSAHATCHEE	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240C	TIDAL CALOOSAHATCHEE	STREAM	3F	Nutrients (Chl a)	Median TN = 1.105 mg/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240E	YELLOW FEVER CREEK	ESTUARY	3M	Fecal Coliform	> 400 colonies/100 ml	Medium	2009

Table 7-1. Caloosahatchee River – FDEP Verified Impaired Waters List (Continued)

Planning Unit	WBID	Waterbody Segment Name	Waterbody Type	Waterbody Class[1]	Parameters Identified Under the Impaired Surface Waters Rule	Concentration Causing Impairment[2]	Priority for TMDL Development[3]	Projected Year for TMDL Development[3]
CALOOSAHATCHEE ESTUARY	3240E 1	HANCOCK CREEK	ESTUARY	3M	Dissolved Oxygen	< 4.0 mg/l	Medium	2009
CALOOSAHATCHEE ESTUARY	3240E 1	HANCOCK CREEK	ESTUARY	3M	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240E 1	HANCOCK CREEK	ESTUARY	3M	Nutrients (Chl a)	Median TN = 0.83 mg/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240F	DAUGHTREY CREEK	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240G	TROUT CREEK	STREAM	3F	Conductance	> 1275 umhos/cm	Medium	2009
CALOOSAHATCHEE ESTUARY	3240G	TROUT CREEK	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240H	WHISKY CREEK (WYOUA CREEK)	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240I	MANUEL BRANCH	ESTUARY	3M	Copper	> 3.7 ug/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240I	MANUEL BRANCH	ESTUARY	3M	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240I	MANUEL BRANCH	ESTUARY	3M	Lead	> 8.5 ug/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240I	MANUEL BRANCH	ESTUARY	3M	Total Coliform	> 2400 colonies/100 ml	Medium	2009

Table 7-1. Caloosahatchee River – FDEP Verified Impaired Waters List (Continued)

Planning Unit	WBID	Waterbody Segment Name	Waterbody Type	Waterbody Class[1]	Parameters Identified Under the Impaired Surface Waters Rule	Concentration Causing Impairment[2]	Priority for TMDL Development[3]	Projected Year for TMDL Development[3]
CALOOSAHATCHEE ESTUARY	3240L	GILCHREST DRAIN--POWEL	STREAM	3F	Dissolved Oxygen	< 5.0 mg/l	Medium	2009
CALOOSAHATCHEE ESTUARY	3240L	GILCHREST DRAIN--POWEL	STREAM	3F	Fecal Coliform	> 400 colonies /100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240L	GILCHREST DRAIN--POWEL	STREAM	3F	Nutrients (Chl a)	Median TN = 0.65 mg/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240M	STROUD CREEK	STREAM	3F	Fecal Coliform	> 400 colonies /100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240M	STROUD CREEK	STREAM	3F	Nutrients (Chl a)	Median TN = 0.80 mg/L Median = 0.05 mg/L	Medium	2009
CALOOSAHATCHEE ESTUARY	3240N	OWL CREEK	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240Q	POPASH CREEK	STREAM	3F	Dissolved Oxygen	< 5.0 mg/l	Medium	2009
CALOOSAHATCHEE ESTUARY	3240Q	POPASH CREEK	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
CALOOSAHATCHEE ESTUARY	3240Q	POPASH CREEK	STREAM	3F	Nutrients (Chl a)	Median TN = 0.75 mg/L Median TP = 0.05 mg/L	Medium	2009
EAST CALOOSAHATCHEE	3237A	EAST CALOOSAHATCHEE	STREAM	3F	Iron	> 1.0 mg/L	Medium	2009
EAST CALOOSAHATCHEE	3237B	LONG HAMMOCK CREEK	STREAM	3F	Dissolved Oxygen	< 5.0 mg/l	Medium	2009

Table 7-1. Caloosahatchee River – FDEP Verified Impaired Waters List (Continued)

Planning Unit	WBID	Waterbody Segment Name	Waterbody Type	Waterbody Class[1]	Parameters Identified Under the Impaired Surface Waters Rule	Concentration Causing Impairment[2]	Priority for TMDL Development[3]	Projected Year for TMDL Development[3]
EAST CALOOSAHATCHEE	3237B	LONG HAMMOCK CREEK	STREAM	3F	Nutrients (Chl a)	TN = 1.5 mg/L TP = 0.071 mg/L	Medium	2009
EAST CALOOSAHATCHEE	3237C	LAKE HICPOCHEE	LAKE	3F	Lead	> e^(1.273[lnH]-4.705)	Medium	2009
EAST CALOOSAHATCHEE	3237C	LAKE HICPOCHEE	LAKE	3F	Total Coliform	> 2400 colonies/100 ml	Medium	2009
EAST CALOOSAHATCHEE	3237D	NINEMILE CANAL	STREAM	3F	Fecal Coliform	> 400 colonies/100 ml	High	2004
EAST CALOOSAHATCHEE	3237D	NINEMILE CANAL	STREAM	3F	Lead	> e^(1.273[lnH]-4.705)	Medium	2009
EAST CALOOSAHATCHEE	3246	C-21	STREAM	3F	Iron	> 1.0 mg/L	Medium	2009
ORANGE RIVER	3240J	BILLY CREEK	ESTUARY	3M	Fecal Coliform	> 400 colonies/100 ml	Medium	2009
WEST CALOOSAHATCHEE	3235A	WEST CALOOSAHATCHEE	STREAM	1 - Potable	Iron	> 0.3 mg/L	Medium	2009
WEST CALOOSAHATCHEE	3235A	WEST CALOOSAHATCHEE	STREAM	1 - Potable	Lead	> e^(1.273[lnH]-4.705)	Medium	2009
WEST CALOOSAHATCHEE	3235D	JACKS BRANCH	STREAM	3F	Nutrients (Chl a)	TN = 1.32 mg/L TP = 0.051 mg/L	Medium	2009
WEST CALOOSAHATCHEE	3235K	TOWNSEND CANAL	STREAM	3F	Copper	> e^(0.8545[lnH] – 1.702) ug/L	Medium	2009

Table 7-1. Caloosahatchee River – FDEP Verified Impaired Waters List (Continued)

Planning Unit	WBID	Waterbody Segment Name	Waterbody Type	Waterbody Class[1]	Parameters Identified Under the Impaired Surface Waters Rule	Concentration Causing Impairment[2]	Priority for TMDL Development[3]	Projected Year for TMDL Development[3]
WEST CALOOSAHATCHEE	3235K	TOWNSEND CANAL	STREAM	3F	Lead	> e^(1.273[lnH]-4.705)	Medium	2009

Table 7-2. Estero Bay and Everglades West Coast – FDEP Verified Impaired Waters List

Basin	WBID[1]	Water Segment Name	Parameters Identified Using the Impaired Waters Rule	Concentrations Causing Impairement[2]	Priority for TMDL Develop-ment[3]	Projected Year for TMDL Develop-ment	Comments
EVERGLADES WEST COAST	3258B	HENDRY CREEK	DO	< 4.0 MG/L MINIMUM, AND 5.0 AS DAILY AVERAGE	LOW	2007	DO MET VERIFICATION THRESHOLD PER IWR. BOD IS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3258B	HENDRY CREEK (FRESH)	NUTRIENTS (CHL A)	TN = 0.825 MG/L TP = 0.06 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RESPONSIBLE GROWTH MANAGEMENT COALITION (RGMC), WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL TRIBUTARY WAS DIVIDED INTO A FRESHWATER SECTION (THIS WBID) AND A MARINE SECTION (WBID 3258B1), AND THE RE-ASSESSMENT INDICATES THAT CHOLORPHYLL MET THE VERIFICATION THRESHOLD PER THE IWR INDICATING A NUTRIENT IMPAIRMENT. BOTH NITROGEN AND PHOSPHORUS ARE IDENTIFIED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258B1	HENDRY CREEK MARINE	NUTRIENTS (CHL A)	TN = 0.82 MG/L TP = 0.07 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL TRIBUTARY WAS DIVIDED INTO A FRESHWATER SECTION (WBID 3258B) AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT CHOLORPHYLL MET THE VERIFICATION THRESHOLD PER THE IWR INDICATING A NUTRIENT IMPAIRMENT. BOTH NITROGEN AND PHOSPHORUS ARE IDENTIFIED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258B1	HENDRY CREEK MARINE	DO	< 5.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL TRIBUTARY WAS DIVIDED INTO A FRESHWATER SECTION (WBID 3258B) AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. NUTRIENTS ARE INDICATED AS CAUSATIVE POLLUTANTS.

Table 7-2. Estero Bay and Everglades West Coast – FDEP Verified Impaired Waters List (Continued)

Basin	WBID[1]	Water Segment Name	Parameters Identified Using the Impaired Waters Rule	Concentrations Causing Impairement[2]	Priority for TMDL Develop-ment[3]	Projected Year for TMDL Develop-ment	Comments
EVERGLADES WEST COAST	3258B1	HENDRY CREEK MARINE	FECAL COLIFORMS	> 800 PER 100 ML	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL TRIBUTARY WAS DIVIDED INTO A FRESHWATER SECTION (WBID 3258B) AND THISAND THE RE-ASSESSMENT INDICATES THAT FECAL COLIFORM SAMPLES ARE ABOVE THE LISTING THRESHOLD. 11 OF 69 SAMPLES EXCEED THE CRITERION.
EVERGLADES WEST COAST	3258C	ESTERO BAY DRAINAGE (MULLOCK CREEK)	DO	< 5.0 MG/L	MEDIUM	2007	DO MET VERIFICATION THRESHOLD PER IWR. BOD IS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3258C	ESTERO BAY DRAINAGE (MULLOCK CREEK)	NUTRIENTS (CHL A)	TN = 0.88 MG/L TP = 0.05 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL TRIBUTARY WAS DIVIDED INTO A FRESHWATER SECTION (THIS WBID) AND A MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT CHOLORPHYLL MET THE VERIFICATION THRESHOLD PER THE IWR INDICATING A NUTRIENT IMPAIRMENT. BOTH NITROGEN AND PHOSPHORUS ARE IDENTIFIED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258D1	ESTERO RIVER MARINE	NUTRIENTS (CHL A)	TN = 0.65 MG/L TP = 0.05 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO A FRESHWATER SECTION AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT CHOLORPHYLL MET THE VERIFICATION THRESHOLD PER THE IWR INDICATING A NUTRIENT IMPAIRMENT. BOTH NITROGEN AND PHOSPHORUS ARE IDENTIFIED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258D1	ESTERO RIVER MARINE	COPPER	> 2.9 UG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO A FRESHWATER SECTION AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES COPPER SAMPLES ARE ABOVE THE LISTING THRESHOLD. 8 OF 23 SAMPLES EXCEED THE CRITERION.

Table 7-2. Estero Bay and Everglades West Coast – FDEP Verified Impaired Waters List (Continued)

Basin	WBID[1]	Water Segment Name	Parameters Identified Using the Impaired Waters Rule	Concentrations Causing Impairement[2]	Priority for TMDL Develop-ment[3]	Projected Year for TMDL Develop-ment	Comments
EVERGLADES WEST COAST	3258D1	ESTERO RIVER MARINE	DO	< 4.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO A FRESHWATER SECTION AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. NUTRIENTS ARE INDICATED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258E	IMPERIAL RIVER (FRESH)	DO	< 5.0 MG/L	LOW	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO THIS FRESHWATER SECTION AND A MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. NUTRIENTS ARE INDICATED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258E	IMPERIAL RIVER (FRESH)	NUTRIENTS (CHL A)	TN = 0.77 MG/L TP = 0.07 MG/L	LOW	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO THIS FRESHWATER SECTION AND A MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT CHOLORPHYLL MET THE VERIFICATION THRESHOLD PER THE IWR INDICATING A NUTRIENT IMPAIRMENT. BOTH NITROGEN AND PHOSPHORUS ARE IDENTIFIED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3258E1	IMPERIAL RIVER (MARINE)	COPPER	>2.9 UG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO THIS FRESHWATER SECTION AND A MARINE SECTION, AND THE RE-ASSESSMENT INDICATES COPPER SAMPLES ARE ABOVE THE LISTING THRESHOLD. 10 OF 25 SAMPLES EXCEED THE CRITERION.
EVERGLADES WEST COAST	3258H1	SPRING CREEK MARINE	NUTRIENTS (CHL A)	TN = 0.675 MG/L TP = 0.05 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL CREEK WAS DIVIDED INTO A FRESHWATER SECTION AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT CHOLORPHYLL MET THE VERIFICATION THRESHOLD PER THE IWR INDICATING A NUTRIENT IMPAIRMENT. BOTH NITROGEN AND PHOSPHORUS ARE IDENTIFIED AS CAUSATIVE POLLUTANTS.

Table 7-2. Estero Bay and Everglades West Coast – FDEP Verified Impaired Waters List (Continued)

Basin	WBID[1]	Water Segment Name	Parameters Identified Using the Impaired Waters Rule	Concentrations Causing Impairement[2]	Priority for TMDL Develop-ment[3]	Projected Year for TMDL Develop-ment	Comments
EVERGLADES WEST COAST	3258H1	SPRING CREEK MARINE	COPPER	> 2.9 UG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL RIVER WAS DIVIDED INTO A FRESHWATER SECTION AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES COPPER SAMPLES ARE ABOVE THE LISTING THRESHOLD. 29 OF 60 SAMPLES EXCEED THE CRITERION.
EVERGLADES WEST COAST	3258H1	SPRING CREEK MARINE	DO	< 4.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE RGMC, WHO FILED A PETITION CHALLENGING THE AUGUST 28, 2002, SECRETARIAL ORDER ADOPTING THE INITIAL GROUP 1 LIST. THIS TIDAL CREEK WAS DIVIDED INTO A FRESHWATER SECTION AND THIS MARINE SECTION, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. NUTRIENTS ARE INDICATED AS CAUSATIVE POLLUTANTS.
EVERGLADES WEST COAST	3259A	COCOHATCHEE RIVER	DO	DO	LOW	2007	DO MET VERIFICATION THRESHOLD PER IWR AND NITROGEN IS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3259B	COCOHATCHEE RIVER CANAL	DO	< 5.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE CONSERVANCY OF SOUTHWEST FLORIDA, WHO REQUESTED AND RECEIVED AN EXTENSION FOR THE FILING OF A PETITION CHALLENGING THE AUGUST 28, 2002 ADOPTED LIST. THE DEPARTMENT RE-ASSESSED THIS WBID USING ADDITIONAL HISTORICAL DATA COLLECTED BY COLLIER COUNTY, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. BOD IS INDICATED AS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3259B	COCOHATCHEE RIVER CANAL	IRON	> 1.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE CONSERVANCY OF SOUTHWEST FLORIDA, WHO REQUESTED AND RECEIVED AN EXTENSION FOR THE FILING OF A PETITION CHALLENGING THE AUGUST 28, 2002 ADOPTED LIST. THE DEPARTMENT RE-ASSESSED THIS WBID USING ADDITIONAL HISTORICAL DATA COLLECTED BY COLLIER COUNTY, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR.

Table 7-2. Estero Bay and Everglades West Coast – FDEP Verified Impaired Waters List (Continued)

Basin	WBID[1]	Water Segment Name	Parameters Identified Using the Impaired Waters Rule	Concentrations Causing Impairement[2]	Priority for TMDL Develop-ment[3]	Projected Year for TMDL Develop-ment	Comments
EVERGLADES WEST COAST	3259D	GORDON RIVER CANAL	DO	< 5.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE CONSERVANCY OF SOUTHWEST FLORIDA, WHO REQUESTED AND RECEIVED AN EXTENSION FOR THE FILING OF A PETITION CHALLENGING THE AUGUST 28, 2002 ADOPTED LIST. THE DEPARTMENT RE-ASSESSED THIS WBID USING ADDITIONAL HISTORICAL DATA COLLECTED BY COLLIER COUNTY, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. BOD IS INDICATED AS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3259E	HENDERSO N CREEK CANAL	DO	< 5.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE CONSERVANCY OF SOUTHWEST FLORIDA, WHO REQUESTED AND RECEIVED AN EXTENSION FOR THE FILING OF A PETITION CHALLENGING THE AUGUST 28, 2002 ADOPTED LIST. THE DEPARTMENT RE-ASSESSED THIS WBID USING ADDITIONAL HISTORICAL DATA COLLECTED BY COLLIER COUNTY, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. BOD IS INDICATED AS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3259L	BLACKWATE R RIVER	DO	< 5.0 MG/L	MEDIUM	2007	THIS WBID IS BEING ADDED AS A RESULT OF DISCUSSIONS WITH THE CONSERVANCY OF SOUTHWEST FLORIDA, WHO REQUESTED AND RECEIVED AN EXTENSION FOR THE FILING OF A PETITION CHALLENGING THE AUGUST 28, 2002 ADOPTED LIST. THE DEPARTMENT RE-ASSESSED THIS WBID USING ADDITIONAL HISTORICAL DATA COLLECTED BY COLLIER COUNTY, AND THE RE-ASSESSMENT INDICATES THAT DO MET THE VERIFICATION THRESHOLD PER THE IWR. PHOSPHORUS IS INDICATED AS THE CAUSATIVE POLLUTANT.
EVERGLADES WEST COAST	3259W	LAKE TRAFFORD	NUTRIENTS (TSI)	TN = 2.65 MG/L TP = 0.18 MG/L	LOW	2007	TSI MET VERIFICATION THRESHOLD PER IWR. NITROGEN AND PHOSPHORUS ARE BOTH CAUSATIVE AND LIMITING POLLUTANTS.
EVERGLADES WEST COAST	8065	SOUTHWES T COAST GULF 5	BACTERIA (SHELLFISH)	EXCEEDS SEAS THRESHOLDS	MEDIUM	2007	LISTED BASED ON CHANGE IN SHELLFISH HARVESTING CLASSIFICATION (DOWNGRADED FROM APPROVED TO CONDITIONAL).

Table 7-2. Estero Bay and Everglades West Coast – FDEP Verified Impaired Waters List (Continued)

Basin	WBID[1]	Water Segment Name	Parameters Identified Using the Impaired Waters Rule	Concentrations Causing Impairement[2]	Priority for TMDL Develop-ment[3]	Projected Year for TMDL Develop-ment	Comments
EVERGLADES WEST COAST	8999	FLORIDA GULF COAST	MERCURY (IN FISH TISSUE)	LESS THAN CURRENT CRITERION (0.025 MG/L)	MEDIUM	2011	AGE OF DATA VERIFIED TO BE WITHIN LAST 7.5 YEARS. NUMERIC CRITERION IS INADEQUATE BECAUSE MERCURY IS ACCUMULATING IN THE FOOD CHAIN SUCH THAT FISH TISSUE MERCURY LEVELS EXCEED RECOMMENDED LEVELS FOR CONSUMPTION. CONFIRMED RECENT DATA FOR COASTAL FISH ADVISORY FOR MACKEREL. INCLUDES NEARSHORE AREAS IN WBIDS 8060, 8061, 8062, 8063, 8064, AND 8065.

1 WBID = **W**ater**B**ody **ID**entification Number

2 FOR NUTRIENTS, THESE ARE MEDIAN CONCENTRATIONS CALCULATED FROM DATA GENERATED FROM 1995 THROUGH JUNE, 2002. THE SPECIFIC CONCENTRATION OF NUTRIENTS CAUSING THE IMPAIRMENT IS UNKNOWN.

3 PRIORITIES WERE RETAINED FROM THE 1998 303(D) LIST (I.E., HIGH OR LOW), BUT HIGH, MEDIUM AND LOW ARE USED FOR NEWLY LISTED WATERS IDENTIFIED UNDER THE IWR.

shown in **Tables 7-3, 7-4, and 7-5** (FDEP, 2006). In most cases, TMDLs have not been established for the impaired waters in the study area.

Based on the analyses in this report, a combination of enhanced BMP criteria, LID practices, and retrofit BMPs will be necessary to meet these TMDLs. Further evaluations as part of the TMDL-PLRG process will identify these specific reductions based on further data and more complex models that consider instream processes.

Pollutant load reduction goals (PLRGs) are published for Daughtrey Creek, Nine Mile Canal, Billy Creek, and Lake Hicpochee, and additional PLRGs will be identified as part of implementation in the Basin Management Action Plan (BMAP) process. Draft PLRGs for areas evaluated under the TMDL process are listed in Tables 7-3 through 7-5.

WMM can be used in further evaluations by the various stakeholders to identify potential load reductions for specific hydrologic units from the implementation of retrofit BMPs in these impaired waters as well as the amount of implementation that may be required to achieve the TMDLs and associated PLRGs. Tables 6-9 through 6-11 provide examples for WMM application.

As shown in Table 7-1, the Caloosahatchee Estuary is on the impaired waters list for several parameters, including nutrients. This means that the "anti-degradation" condition evaluated in this study is <u>not sufficient</u> to meet the State water quality standards. Future TMDL studies will determine the nutrient load reductions required to meet the water quality standards for nutrients in the tidal river.

In this report, the future flows and loads from Lake Okeechobee to the Caloosahatchee River (C-43 Canal) were set equal to the existing flows and loads for the analysis of future conditions. However, ***it is anticipated that water quality treatment practices and projects proposed under the Comprehensive Everglades Restoration Plan (CERP) will improve the water quality in Lake Okeechobee; therefore in the future, treated water may be re-directed from Lake Okeechobee south to the Everglades, reducing the quantity of flow discharged from Lake Okeechobee to the Caloosahatchee River***. Thus, the nutrient load from Lake Okeechobee to the Caloosahatchee River (and ultimately to the tidal river) may be lower in the future, and this may be an important component for improving water quality in the tidal river.

7.2.5 Implementation

Based on the evaluations, ***a combination of the following BMPs and actions will be necessary to manage and improve water quality in the Estero Bay-Caloosahatchee River Watershed***

- ***Enhanced stormwater criteria and LID practices***, including:
  - higher efficiency BMPs,

Table 7-3. FDEP - Components for DO TMDLs in WBIDs 3240J, 3240F, 3237D.

WBID	WaterBody	Parameter	TMDL (lb/day)	LA (lb/day)	WLA[1]		MOS (lb/day)	Percent Reduction[3]
					Continuous (lb/day)	MS4		
3240F	Daughtrey Creek	BOD	176	176	N/A[2]	N/A[2]	implicit	16%
3240J	Billy Creek	BOD	305	305	N/A[2]	29%	implicit	29%
3237D	Ninemile Canal	BOD	731	731	N/A[2]	N/A[2]	implicit	10%

Notes:

1. WLA component is separated into a load from continuous NPDES facilities (e.g., WWTPs) and a load from MS4s. Currently, there are no continuous discharge facilities or MS4 areas in WBIDs 3240F or 3237D. WBID 3240J is affected by Phase I MS4 permit #FL000035, which covers Lee County, the City of Cape Coral, and the City of Fort Myers. There are no continuous discharge facilities currently discharging to the surface waters of WBID 3240J.
2. N/A = not applicable.
3. Percent reduction in total BOD loading from current conditions to achieve the D.O. standard.

Table 7-4. FDEP - Components for Nutrient TMDL in WBID 3237D.

WBID	WaterBody	Parameter	TMDL (lb/day)	LA (lb/day)	WLA[1]		MOS (lb/day)	Percent Reduction[3]
					Continuous (lb/day)	MS4		
3237D	Ninemile Canal	TBN	188	188	N/A[2]	N/A[2]	implicit	57%
		TBP	39	39	N/A[2]	N/A[2]	implicit	59%

Notes:

1. Represents natural background sources.
2. WLA component is separated into a load from continuous NPDES facilities (e.g., WWTPs) and a load from MS4s. Currently, there are no continuous facilities or MS4 areas in WBID 3237D.
3. N/A = not applicable.
4. Percent reduction in TBN or TBP loading from current conditions to meet the natural conditions standard.

Table 7-5. FDEP - Components for Nutrient TMDL in WBID 3237C.

WBID	WaterBody	Parameter	TMDL (mg/L)	LA (mg/L)	WLA[1]		MOS (lb/day)	Percent Reduction[3]
					Continuous (mg/L)	MS4		
3237C	Lake Hicpochee	Total Phosphorus	0.035	0.035	N/A[2]	N/A[2]	implicit	91%

Notes:

1. WLA component is separated into a load from continuous NPDES facilities (e.g., WWTPs) and a load from MS4s. Currently, there are no continuous discharge facilities or MS4 areas in WBID 3237C.
2. N/A = not applicable
3. Percent reduction from current conditions to achieve the target concentration for phosphorus.

  - retention where practicable,
  - increased stormwater recycling, and
  - LID practices such as reduced directly connected (also called "effective") imperviousness.

- ***Retrofit BMP projects and strategies;***
- Consideration of ***potential water quality benefits from the C-43 Reservoir***; and
- Eventual re-direction of treated flows from Lake Okeechobee to the Everglades as CERP projects are implemented with associated water quality improvements and hydrologic timing restoration.

Section 8
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APPENDIX A

AVERAGE CALIBRATED ANNUAL LOADS FOR THE EAST CALOOSAHATCHEE SUB-WATERSHED (EXISTING LAND USE) WITH REDUCED AGRICULTURAL BMP EFFICIENCY.

Table A-1: Average Calibrated Annual Loads for the East Caloosahatchee Sub-watershed (Existing Land Use) with Reduced Agricultural BMP Efficiency.

Existing Land Use (Year 2000)

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
1 . 30-foot Canal	210	12.9%	27	284	3,157	0	33,913	4	109	312	4	105,000	1,083	213	11,306	37
2 . 42-foot Canal	22,029	5.7%	1,251	25,329	160,000	5	2,083,333	123	7,966	21,005	95	7,776,667	85,915	14,221	292,000	853
10 . Bronson	1,848	6.2%	115	2,154	14,645	0	174,667	10	698	1,829	8	654,667	7,814	1,321	22,876	93
11 . C-19	6,783	3.1%	209	7,299	48,618	1	545,667	35	2,981	6,758	27	2,226,667	30,434	5,467	70,218	303
12 . C20 Canal	911	14.3%	130	1,270	4,936	0	108,000	2	122	721	2	380,000	2,349	195	7,394	14
16 . Canal 3	31,874	5.0%	1,603	36,060	236,000	4	2,953,333	153	12,740	30,602	141	10,933,333	132,667	23,520	421,667	1,122
19 . Citrus Center	17,905	5.1%	915	20,298	119,000	5	1,716,667	93	6,118	16,582	89	6,336,667	68,814	11,513	283,333	745
21 . Clewiston	4,509	23.9%	1,080	7,512	109,667	4	859,000	127	3,455	8,760	61	2,540,000	26,968	4,739	128,000	774
33 . Disston Island WCD	19,675	2.7%	530	20,932	141,333	2	1,500,000	100	8,369	19,029	69	6,253,333	86,871	15,205	186,667	778
37 . Flaghole WCD	23,840	4.9%	1,177	26,891	186,667	3	2,090,000	130	9,828	24,246	95	8,280,000	103,374	17,770	233,667	1,197
45 . Grassy Marsh	2,186	2.5%	54	2,315	13,130	0	160,333	8	861	1,954	6	672,333	9,353	1,623	18,563	59
52 . Hendry Hilliard WCD	16,882	4.6%	777	18,891	106,994	1	1,410,000	64	6,516	15,802	47	5,683,333	69,169	11,663	141,333	525
54 . Hilliard	26,341	4.6%	1,218	29,485	162,333	2	2,226,667	95	9,613	24,012	74	8,866,667	104,736	17,379	236,667	744
56 . Industrial Canal	9,506	6.7%	640	12,524	115,000	38	926,000	91	4,230	16,151	86	7,380,000	45,199	8,005	131,333	928
58 . Jack Spratt (Myrtle Slough)	3,340	4.0%	135	3,684	24,384	0	293,667	18	1,486	3,395	14	1,150,000	14,662	2,675	39,107	139
61 . L-42	4,829	2.6%	128	5,135	30,480	0	375,333	18	2,297	4,791	13	1,566,667	21,695	4,027	38,242	138
65 . Lake Hicpochee	10,345	10.8%	1,113	13,388	75,607	1	1,116,667	44	3,306	10,009	36	4,050,000	39,361	5,889	110,667	405
67 . Linden Pens Marsh	20,869	6.5%	1,356	24,481	134,000	7	2,090,000	91	5,623	17,465	76	7,440,000	70,436	10,298	298,000	609
72 . Meander Ditch	6,549	4.0%	261	7,214	50,364	1	592,667	39	3,074	6,854	34	2,260,000	29,854	5,624	93,718	312
75 . Moore Haven	3,934	13.0%	510	5,333	61,226	2	525,333	66	2,445	5,901	35	1,740,000	20,870	3,749	78,199	420
77 . Nicodemus Slough	17,298	4.9%	851	19,515	103,000	1	1,510,000	60	6,432	15,942	46	5,960,000	67,573	11,334	151,000	462
78 . Ninemile Canal	914	2.8%	26	975	6,046	0	69,124	4	376	862	3	290,333	3,973	690	7,902	34
102 . Sugarland WCD	11,202	3.9%	435	12,306	88,882	1	914,000	69	5,119	11,623	42	3,703,333	51,026	8,977	109,081	507
Lake Okeechobee	0	0.0%	-	720,000	0	104	0	2,465	0	187,000	236	557,000,000	2,810,000	78,614	3,690,000	15,314
Total	**263,776**	**5.5%**	**14,539**	**1,023,275**	**1,995,468**	**182**	**24,274,370**	**3,908**	**103,762**	**451,606**	**1,340**	**653,249,000**	**3,904,195**	**264,712**	**6,800,940**	**26,513**

Notes: 1. Existing BMPs are included and for Agricultural Land Use Their Efficiency was Reduced to One-Third That of Wet Detention Ponds.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. Delivery ratios are set to deliver to S-79.

5. The total percent impervious is an area-weighted composite.

Table A-2: Average Calibrated Annual Loads for the West Caloosahatchee Sub-watershed (Existing Land Use) with Reduced Agricultural BMP Efficiency.

Existing Land Use (Year 2000)

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
4 . Banana Branch	2,707	5.9%	160	3,774	40,368	5	420,000	51	1,413	3,493	73	1,256,667	14,980	3,135	216,333	353
6 . Bedman Creek	3,735	8.7%	326	5,526	55,875	6	636,000	76	1,917	4,940	103	1,830,000	20,866	4,220	328,000	511
7 . Bee Branch	22,663	6.3%	1,426	31,861	184,667	13	2,783,333	137	7,738	22,149	146	9,810,000	96,231	15,264	570,333	827
14 . Canal 1	12,190	4.5%	553	16,484	87,056	2	1,190,000	53	4,321	11,415	50	4,870,000	55,290	8,651	182,000	413
15 . Canal 2	16,664	6.6%	1,105	23,597	128,000	2	1,816,667	73	6,472	16,753	69	7,116,667	75,508	12,098	250,333	539
20 . City Ditch	1,521	13.1%	200	2,456	40,685	4	294,000	42	1,063	2,632	45	833,000	8,799	1,790	116,000	281
23 . County Line Drainage District	6,155	14.2%	877	10,144	64,997	5	1,126,667	54	1,720	6,441	72	3,136,667	25,552	3,549	314,000	370
25 . Cow Slough	9,192	4.2%	382	12,322	87,250	2	1,090,000	74	4,754	10,207	82	3,820,000	50,195	10,004	266,000	457
26 . Crawford Canal	837	7.3%	61	1,202	10,874	1	128,000	15	400	1,054	19	403,000	4,424	851	61,122	106
27 . Cypress Branch	27,329	5.1%	1,392	37,421	175,000	10	2,930,000	113	8,643	25,156	108	11,600,000	108,000	16,137	452,000	755
28 . Cypress Creek	13,057	6.2%	805	18,305	115,000	9	1,790,000	98	4,824	13,067	122	5,680,000	60,501	10,649	482,000	595
31 . Deadmans Branch	10,437	4.6%	485	14,148	74,172	5	1,180,000	60	3,580	9,997	65	4,440,000	44,074	7,079	251,000	415
34 . Dog Canal	7,855	5.9%	462	10,943	129,000	18	1,170,000	140	3,772	9,693	155	3,480,000	36,787	7,135	430,000	605
36 . Fichter Branch	5,508	8.1%	448	8,053	51,336	3	809,000	43	2,030	5,648	51	2,480,000	25,571	4,390	209,000	250
40 . Franklin Run	325	15.2%	49	544	9,157	1	80,433	13	164	532	19	198,000	1,570	321	54,493	90
41 . Ft. Denaud Branch	7,156	5.3%	380	9,846	76,642	8	921,333	66	2,732	7,540	81	3,070,000	31,910	5,534	255,000	399
42 . Ft. Simmons	1,244	10.3%	129	1,902	22,981	3	236,000	31	692	1,821	46	649,667	7,259	1,535	136,667	227
47 . Greenbriar Swamp	2,490	4.4%	108	3,353	55,273	8	383,000	48	1,138	2,929	62	1,100,000	9,067	1,822	128,000	214
50 . Hendry Canal	17,127	3.7%	635	22,729	264,000	22	2,160,000	203	8,446	19,708	234	7,280,000	74,709	14,704	535,667	1,057
53 . Hickey's Creek	16,963	6.3%	1,075	23,869	250,000	35	2,600,000	266	7,421	20,267	357	7,730,000	79,082	15,072	1,040,000	1,545
59 . Jacks Branch	46,734	5.4%	2,500	64,357	365,333	26	5,686,667	280	16,597	45,353	320	19,933,333	206,000	34,389	1,276,667	1,769
62 . LaBelle (With WWTP)	2,267	26.0%	589	4,849	86,631	15	600,000	110	1,532	4,771	107	2,280,000	15,209	3,126	301,000	740
63 . LaBelle East	17,085	7.0%	1,197	24,670	226,000	20	2,180,000	176	7,549	20,569	172	8,410,000	77,467	13,468	464,000	1,111
64 . LaBelle Private Drainage District	7,895	7.0%	551	11,264	171,000	4	1,846,667	156	8,647	18,993	184	6,923,333	98,452	19,282	541,667	1,060
66 . LeHigh SE	17,761	2.3%	410	22,812	64,832	3	803,000	54	2,749	6,869	65	2,720,000	29,538	5,419	204,000	370
69 . Mackeral Canal	6,055	6.9%	418	8,626	22,255	3	175,000	21	606	1,472	26	556,000	5,609	1,131	60,600	96
73 . Messer	1,369	1.2%	16	1,710	82,523	3	1,060,000	69	3,419	8,905	73	3,556,667	37,033	6,474	240,333	455
74 . Miller's Gulley	7,576	9.5%	720	11,389	9,435	1	106,000	8	310	816	10	317,667	3,448	641	28,815	43
79 . North LaBelle	708	7.9%	56	1,030	106,000	10	1,130,000	118	3,874	9,743	129	3,640,000	39,746	7,444	399,000	707
88 . Park Branch	877	14.8%	129	1,459	17,654	3	194,000	24	372	1,277	36	502,000	4,246	775	111,000	174
91 . Polywog	11,725	5.5%	640	16,184	90,559	9	1,383,333	69	3,555	10,903	69	4,980,000	46,383	6,891	281,333	379
93 . Port LaBelle (With WWTP)	3,475	4.0%	140	4,647	50,129	4	430,000	41	1,680	4,108	45	1,510,000	15,366	2,922	112,000	256
95 . Roberts	24,499	6.0%	1,462	34,199	215,333	4	2,953,333	153	11,179	26,333	165	10,500,000	122,667	22,448	578,333	957
99 . Spanish Creek	1,140	9.7%	110	1,721	11,194	0	173,667	8	436	1,198	10	522,333	5,446	941	37,316	47
107 . Townsend Canal	20,723	3.1%	633	27,087	185,000	1	2,310,000	154	11,222	23,136	177	8,420,000	117,000	23,996	556,000	989
Total	**355,044**	**5.8%**	**20,629**	**494,483**	**3,626,211**	**268**	**44,776,100**	**3,097**	**146,966**	**379,887**	**3,545**	**155,555,000**	**1,653,985**	**293,286**	**11,470,013**	**19,162**

Notes: 1. Existing BMPs are included and for Agricultural Land Use Their Efficiency was Reduced to One-Third That of Wet Detention Ponds.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. The total percent impervious is an area-weighted composite.

Table A-3: Average Calibrated Annual Loads for the Estero Bay and Tidal Caloosahatchee Sub-watershed (Existing Land Use) with Reduced Agricultural BMP Efficiency.

Existing Land Use (Year 2000)

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
3 . Babcock	13,880	4.5%	622	18,746	94,707	12	1,740,000	72	4,033	12,187	82	5,780,000	56,780	8,945	407,000	385
5 . Bayshore Creek	2,071	16.2%	336	3,507	49,453	6	461,000	74	1,150	3,214	83	1,160,000	11,512	2,168	264,000	403
8 . Billy's Creek	6,732	38.1%	2,564	16,033	377,000	51	2,590,000	719	7,161	16,879	636	5,430,000	59,563	11,623	2,170,000	3,378
9 . Blackstone	695	8.2%	57	1,018	16,846	2	126,000	18	350	986	24	358,000	2,862	580	58,482	115
13 . Caloosahatchee South Shore	6,427	34.1%	2,192	14,473	270,333	30	2,146,667	592	6,019	15,858	455	4,533,333	54,440	10,476	1,670,000	2,294
17 . Carrol Canal	1,075	44.4%	477	2,690	67,104	8	449,000	151	1,434	3,316	116	862,000	11,697	2,400	424,000	593
18 . Chapel Branch	1,368	13.6%	187	2,220	27,427	3	272,667	39	674	1,926	42	717,000	7,173	1,304	138,000	207
22 . Cohn Branch	472	17.8%	84	830	10,389	1	98,639	20	256	745	14	249,667	2,727	473	53,547	69
24 . Cow Creek	8,165	27.8%	2,269	16,815	204,333	19	2,226,667	359	4,022	13,738	302	5,113,333	47,604	7,452	1,188,667	1,586
29 . Cypress Lakes	351	37.1%	130	823	17,423	2	124,000	44	412	1,065	31	245,000	3,691	759	119,000	152
30 . Daughtrey Creek (With WWTP)	23,263	8.3%	1,935	34,201	258,000	33	3,600,000	277	8,126	24,876	327	10,900,000	103,000	16,939	1,210,000	1,532
32 . Deep Lagoon (With WWTP)	1,777	28.0%	497	3,873	65,402	13	484,000	150	1,368	4,468	103	1,580,000	15,186	2,873	382,000	536
35 . Estero River	39,169	13.4%	5,264	63,565	652,667	64	7,353,333	760	14,780	45,978	809	19,700,000	186,667	29,835	2,856,667	4,659
38 . Flint Pen	9,009	16.8%	1,513	15,541	81,327	4	1,690,000	31	1,735	8,397	29	4,630,000	32,082	3,122	269,000	169
39 . Fort Myers Shores	2,072	35.2%	729	4,737	90,501	12	786,333	193	1,943	5,474	203	1,696,667	17,712	3,666	679,333	1,026
43 . Gator Slough (With WWTP)	39,333	10.3%	4,066	60,946	464,000	74	6,616,667	567	12,079	49,299	676	20,300,000	169,667	25,835	2,576,667	3,431
44 . Gordon Swamp	4,806	15.0%	723	8,035	39,635	2	853,000	12	915	4,363	13	2,400,000	16,888	1,702	128,000	66
46 . Green Meadows	17,132	7.5%	1,286	24,716	153,000	12	2,470,000	126	6,047	17,156	161	7,660,000	78,053	13,287	658,000	809
48 . Halfway Creek	4,255	10.9%	465	6,579	61,724	4	676,000	75	1,837	5,370	71	1,946,667	23,218	4,149	235,667	413
49 . Hancock Creek	3,984	27.7%	1,104	8,179	175,000	22	1,260,000	326	3,656	8,855	289	2,700,000	30,946	6,113	979,000	1,467
51 . Hendry Creek (With WWTP)	11,518	26.7%	3,076	23,433	353,000	48	3,140,000	637	6,844	21,487	531	7,810,000	75,459	12,812	1,940,000	2,849
55 . Imperial River (With WWTP)	16,679	22.9%	3,813	31,951	492,667	57	4,266,667	935	11,107	30,895	790	10,300,000	112,667	20,726	2,796,667	4,148
57 . Iona	3,285	30.3%	995	6,978	140,000	16	1,040,000	268	2,913	7,195	218	2,200,000	25,975	4,946	774,667	1,134
60 . Kickapoo Creek	956	11.7%	112	1,501	23,998	4	198,000	27	518	1,500	40	512,000	4,688	971	104,000	171
68 . Lochmoor County Club (With WWTP)	1,053	41.0%	431	3,750	57,590	36	366,000	164	1,071	4,396	123	3,860,000	13,647	2,919	407,000	717
70 . Manuel's Branch	885	54.8%	485	2,438	68,316	9	445,000	143	1,327	2,946	119	824,000	10,241	2,081	419,000	623
71 . Marsh Point	1,961	35.5%	695	4,498	95,149	10	698,000	203	2,152	5,283	158	1,450,000	17,792	3,612	567,000	775
76 . Mullock Creek (With WWTP)	7,012	24.4%	1,711	14,061	216,000	34	1,870,000	450	5,497	15,020	363	5,480,000	53,042	10,089	1,310,000	1,827
80 . Northcentral Cape Coral	21,020	9.8%	2,055	31,722	669,000	98	4,490,000	856	13,005	34,533	1,132	11,300,000	103,000	23,082	2,880,000	5,057
81 . Northwest Cape Coral	11,735	17.1%	2,010	20,367	326,000	47	2,910,000	500	5,867	19,604	646	7,060,000	60,608	11,609	1,960,000	3,169
82 . Olga	2,370	10.8%	256	3,658	44,072	4	430,000	61	1,387	3,361	67	1,180,000	13,882	2,810	211,000	325
83 . Orange River (With WWTP)	50,340	11.3%	5,677	79,746	1,250,000	172	9,256,667	1,471	31,566	83,383	1,534	29,600,000	264,000	54,332	4,000,000	7,623
84 . Otter Creek	1,051	6.0%	64	1,469	14,860	1	152,333	14	561	1,312	19	465,333	5,806	1,213	53,190	89
85 . Owl Creek	3,870	7.2%	281	5,553	54,792	5	578,000	50	1,749	4,441	57	1,720,000	19,197	3,621	169,000	288
86 . Palm Creek	1,969	9.2%	181	2,941	41,858	7	365,000	48	987	2,833	67	988,000	9,356	1,870	180,000	284
87 . Panther Island W	4,393	5.1%	225	6,018	38,546	2	570,000	31	1,832	4,494	38	1,860,000	21,728	4,081	142,000	185
89 . Piggot Bridge	586	17.3%	101	1,020	12,093	1	129,667	17	270	875	20	327,667	3,060	550	66,682	98
90 . Piney Point	357	16.9%	60	617	3,770	0	68,148	4	87	365	3	185,000	1,368	151	16,291	13
92 . Popash Creek	11,357	7.9%	892	16,506	122,000	16	1,720,000	111	3,717	11,702	144	5,180,000	47,557	7,672	523,000	646
94 . Powell Creek (With WWTP)	8,550	18.8%	1,606	16,045	244,000	50	2,050,000	416	5,360	15,813	390	7,090,000	56,006	10,547	1,270,000	2,025
96 . Six Mile Cypress Slough (With WWTP)	35,579	16.9%	6,021	62,305	800,667	137	8,383,333	1,327	17,322	58,242	1,745	23,700,000	206,000	38,787	5,606,667	9,119
97 . Southeast Cape Coral	20,217	42.6%	8,618	54,045	1,170,000	181	8,740,000	2,737	26,076	67,538	2,464	21,300,000	216,333	46,333	8,410,000	12,397
98 . Southwest Cape Coral	17,495	29.6%	5,176	37,002	466,000	13	4,090,000	540	15,213	41,413	230	12,600,000	120,000	20,212	425,000	3,427
100 . Spring Creek (With WWTP)	7,084	20.8%	1,473	18,121	220,333	146	1,570,000	290	3,471	20,994	319	17,900,000	72,208	13,652	687,000	2,413
101 . Stroud Creek	5,591	10.0%	557	8,486	99,639	13	980,000	102	2,422	6,872	126	2,700,000	25,943	4,653	370,000	600
103 . Telegraph Creek	39,308	6.4%	2,529	55,429	256,000	40	5,320,000	167	8,770	32,822	187	17,000,000	144,000	18,821	1,150,000	865
104 . Ten Mile Canal (North)	7,928	21.0%	1,667	14,386	242,000	31	1,986,667	386	4,652	13,292	391	4,626,667	48,797	8,922	1,286,667	2,127
105 . Ten Mile Canal (South) (With WWTP)	838	25.2%	211	1,653	25,400	3	228,000	46	573	1,560	40	527,000	5,667	1,027	142,000	211
106 Thompson Cutoff	583	18.3%	106	1,031	10,252	1	128,333	12	225	785	15	329,667	2,764	442	50,667	78
108 . Trout Creek	18,373	4.9%	897	25,041	169,000	17	2,410,000	159	6,703	17,651	172	7,760,000	83,909	14,604	689,000	904
109 . Whiskey Creek (With WWTP)	5,817	55.9%	3,251	16,920	436,000	60	3,090,000	1,037	8,173	22,950	917	5,670,000	72,216	15,262	3,240,000	4,679
110 . Winkler Canal	977	59.7%	584	2,893	86,405	12	554,000	176	1,534	3,536	154	983,000	12,053	2,446	535,000	818
111 . Yellow Fever Creek	3,116	24.2%	754	6,075	104,000	13	877,000	186	2,056	5,644	173	1,990,000	20,686	3,685	604,000	944
Estuary	0	NA	NA	16,232	99,786	411	0	163	0	21,635	296	39,500,000	101,000	8,389	178,000	3,872
Total	**509,889**	**16.3%**	**83,072**	**901,418**	**11,629,463**	**2,069**	**109,124,787**	**18,337**	**273,003**	**830,521**	**18,153**	**353,940,000**	**2,982,123**	**530,628**	**59,630,526**	**97,789**
Total to the River	**335,971**	**16.8%**	**53,226**	**593,416**	**8,030,742**	**1,504**	**71,717,120**	**12,829**	**191,957**	**568,470**	**12,521**	**240,041,333**	**1,998,352**	**360,225**	**40,264,526**	**67,055**

Notes: 1. Existing BMPs are included and for Agricultural Land Use Their Efficiency was Reduced to One-Third That of Wet Detention Ponds.

2. "With WWTP" denotes Hydrologic Units with Wastewater Treatment Plant permitted flows and loads included; however, data are not available for COD and DP.

3. Flow includes baseflow, septic tank flows, stormwater runoff, Wastewater Treatment Plant permitted flows, and Lake Okeechobee releases (at S-77, Moore Haven).

4. "Total to the River" denotes the loads and flows from hydrologic units that discharge to the tidal river.

5. "Estuary" corresponds to the loads and flows from Wastewater Treatment Plants that discharge directly to the Caloosahatchee River.

6. The total percent impervious is an area-weighted composite.

APPENDIX B

REQUIRED EFFICIENCY AND AREA RELATIONSHIPS OF FUTURE RETROFIT BMPs FOR THE STUDY AREA INCLUDING REDUCED IMPERVIOUSNESS

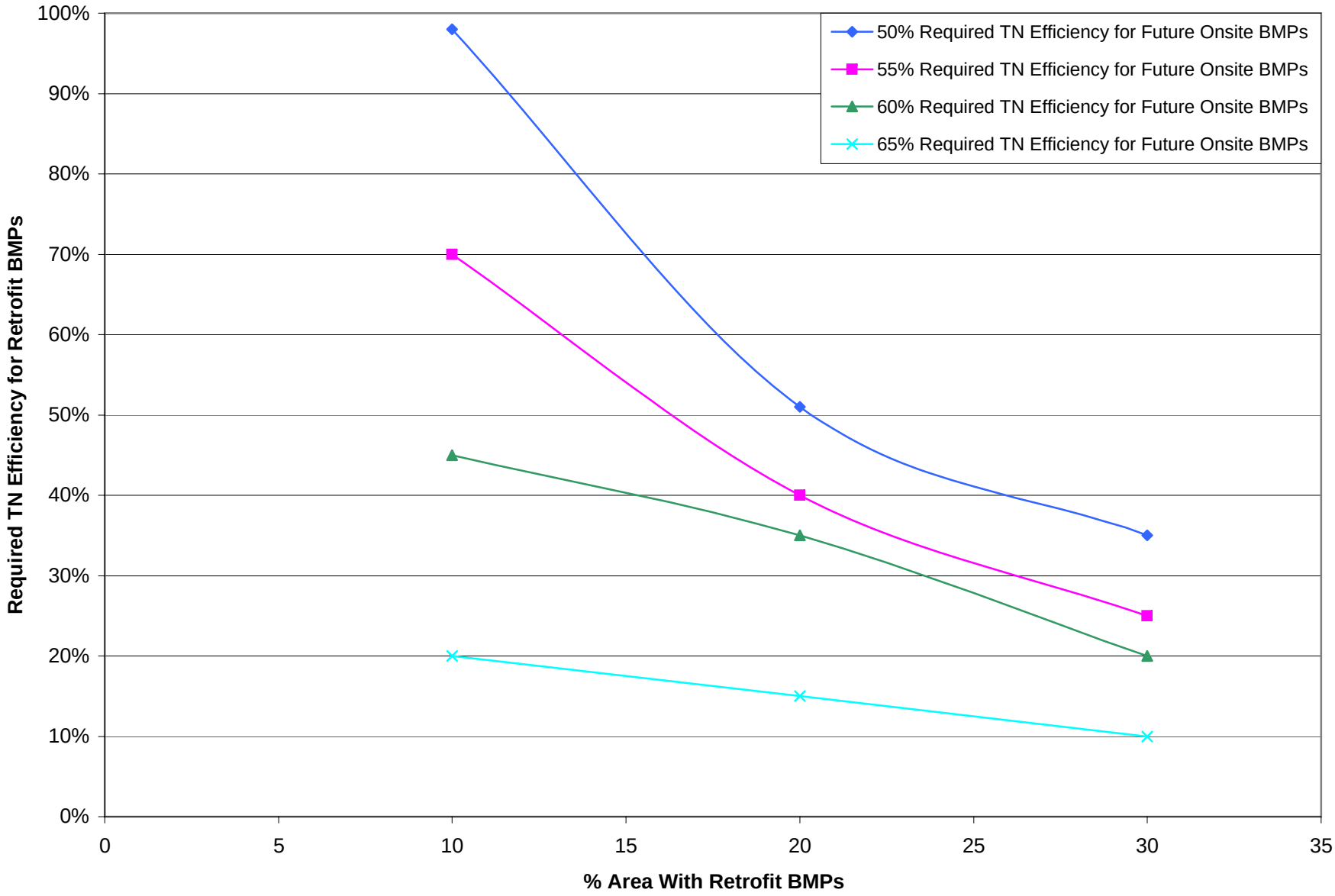

Figure B-1
Required Efficiency and Area Relationship of Future Retrofit BMPs for the East Caloosahatchee Subbasin Including Reduced Imperviousness and no C-43 Reservoir Benefit

CDM
Future Retrofit BMPs.xls

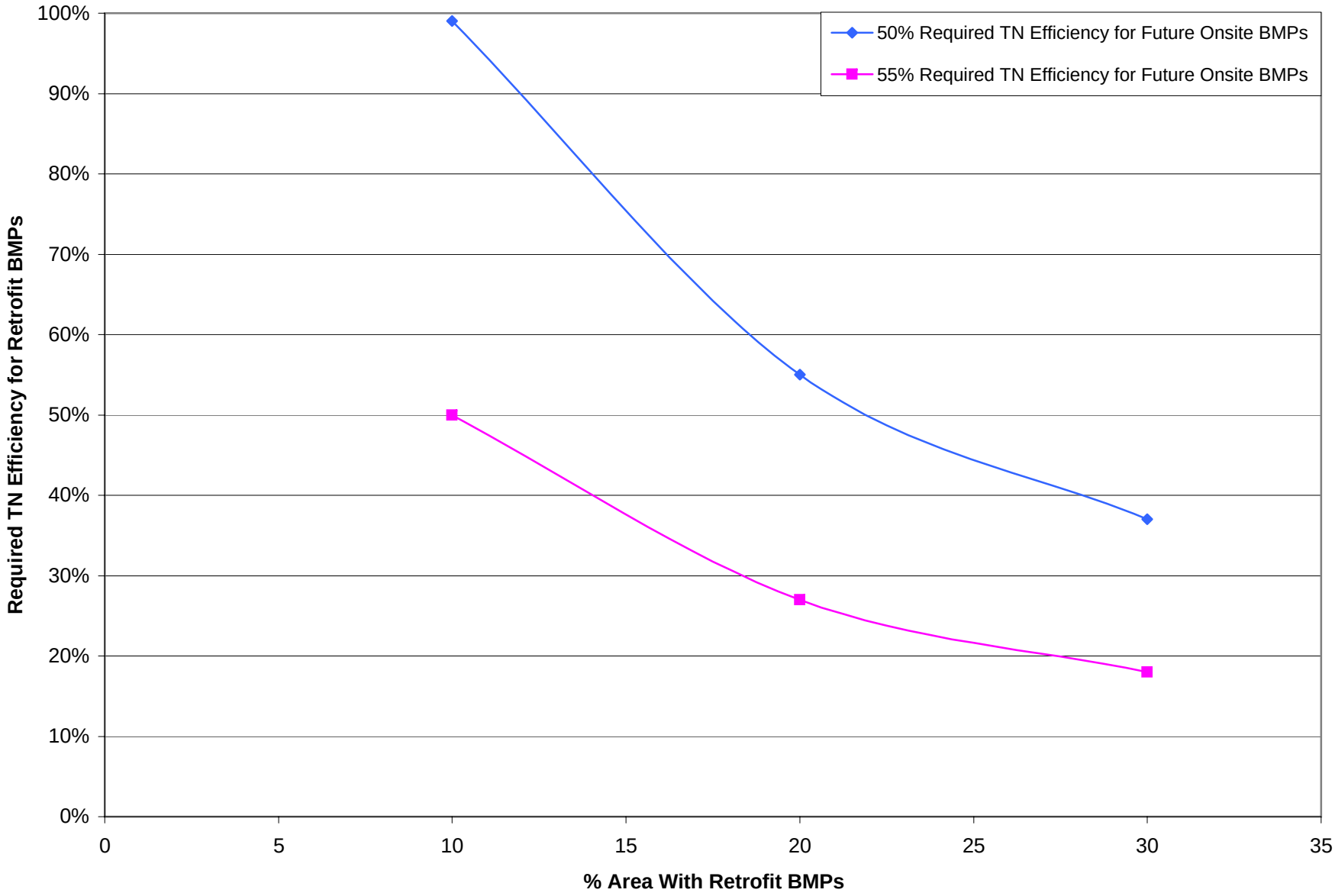

Figure B-2
Required Efficiency and Area Relationship of Future Retrofit BMPs for the West Caloosahatchee Subbasin Including Reduced Imperviousness and no C-43 Reservoir Benefit

CDM
Future Retrofit BMPs.xls

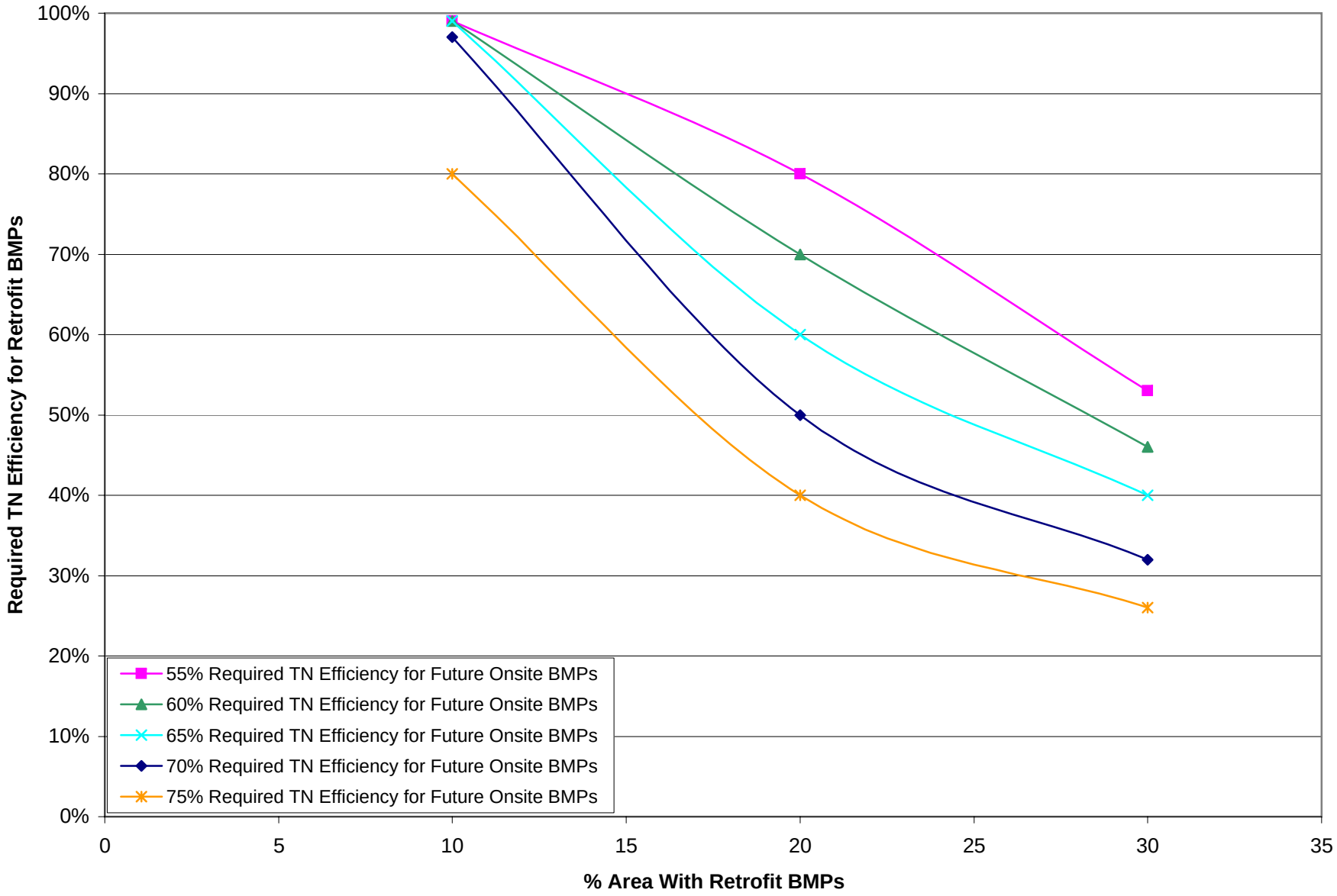

Figure B-3
Required Efficiency and Area Relationship of Future Retrofit BMPs for the Tidal Caloosahatchee Subbasin Including Reduced Imperviousness

CDM
Future Retrofit BMPs.xls