SWEETWATER CREEK WATERSHED MANAGEMENT PLAN

(Chapters 1-15)

Submitted to:

Hillsborough County
Stormwater Management Section
601 East Kennedy Boulevard
Tampa, Florida 33601

Submitted by:

Ayres Associates Inc
8875 Hidden River Parkway, Suite 200
Tampa, Florida 33637

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EXECUTIVE SUMMARY

Introduction

In September 2003, Hillsborough County retained Ayres Associates Inc to update the Watershed Management Plan (WMP) for the Sweetwater Creek watershed, which was originally prepared in 2001. The main objective of this project is to perform water resources, natural systems assessment, Total Maximum Daily Load, and water quality modeling for the watershed and prepare its supporting documents.

This study does not include the task of updating hydrological and hydraulic models for the watershed. As a result, Chapters 1 through 6 of this report remain for the most part, similar to the original version prepared in 2001. Throughout the report, where water quantity is discussed, this was generally left unchanged. Chapters 7 through 15 have been added to the report to reflect recent watershed conditions and studies performed during this study.

Based on the information collected and the analysis performed, a series of alternatives were developed to address water quality issues within the watershed. Chapter 15 presents the recommended projects for water quality improvement. In addition, a cost estimate for each recommended project was prepared. Since no hydraulic analysis could be performed, the accurate project sizing was not known. Therefore, project costs presented in this report may be subject to adjustments, depending on their actual size and detailed designs.

Existing Condition

The Sweetwater Creek Watershed is located in northwest Hillsborough County in west central Florida. The overall watershed area is approximately 21.0 square miles. The watershed is located in an area roughly defined by Pocahontas Ave on the south, Webb Road on the west, Florida Avenue on the east, and Crenshaw Lake Road on the north. Flow originates in the northern headwaters of the basin and flows in a generally southwestern direction to the basin outfall at the confluence with Rocky Creek, located approximately 1/2-mile downstream (west) of Webb Road.

The southern part consists of an improved channel system with a number of control structures fed by a system of urban ditches and storm sewer systems. Major drainage features in the watershed include the two main channels that cross the watershed in a southwest regime, Channels G and H, and over 25 major lakes, ponds and borrow pits of over 10 acres each. The largest of these lakes include Lake Carroll, Lake Magdalene, White Trout Lake, Lake Chapman, Platt Lake, Bay Lake, Lake Ellen, Lake George, Bird Lake, and Boat Lake. Three major segments define the drainage system of the Sweetwater Creek Watershed--Channel G, Channel H, and Upper Sweetwater Creek.

Water Quality, Natural Systems, and TMDL Requirements

The assessment of existing water quality and natural systems for the watershed is presented in Chapters 7 and 8, respectively, while water supply issues are discussed in Chapter 9. The existing information was used to perform pollutant loading and removal modeling (Chapter 10). The modeling results were used to develop water quality level of service (LOS) that is discussed in Chapter 11. Public involvement process and survey of potential contaminant sources are described in Chapters 12 and 13, respectively. Subsequently, best management practices (BMPs) were developed to address existing water quality issues that are presented in Chapter 14. In selecting the location for final structural BMPs, attempts were made to identify and use available publicly owned properties. Additional exploratory site visits were also performed to examine the suitability of the sites for specific projects. Final recommendations along with individual preliminary cost estimates are presented in Chapter 15.

To meet water quality standards both the Federal (Clean Water Act [CWA]) and state (Chapter 62-302, Florida Administrative Code [F.A.C.]) rules apply, and certain actions must be taken to protect, restore, and maintain water quality. In addition, for the area of this project, discharges to surface waters are also regulated by the Florida Department of Environmental Protection (FDEP), Southwest Florida Water Management District (SWFWMD), Hillsborough County Environmental Protection Commission (HCEPC), and/or the US EPA, depending on types and magnitude of the discharge. Water quality assessment of the watershed and TMDL evaluations were conducted taken into considerations all the applicable regulations by collecting water quality data and using a water quality model described in Chapter 7. A brief summary is described below.

Overall Water Quality Level of Service (LOS)

Using an average score for all water quality parameters combined, the overall LOS score for the entire watershed is an F. The scores of F and D for total nitrogen, total phosphorus, and TSS dominate the entire watershed. The Sweetwater Creek watershed is heavily developed and primarily comprised of various types of residential, commercial and services, industrial, and highway/utility land uses. These land uses contribute large quantities of a mixture of pollutants into surface water bodies. The overall low LOS score for the entire watershed (F) indicates that most subbasins have been developed and extensive contiguous natural systems do not exist in the watershed.

Unless effective treatment measures are implemented, continued loading to surface waters in the watershed, and eventually into Old Tampa Bay, may result in significant water quality degradation. Efforts to reduce loading of pollutants to the Sweetwater Creek, channels, lakes, sinkholes, and groundwater should be incorporated into future management activities for the watershed. Reduction of pollutant loading should include implementation of local and regional stormwater best management practices (BMPs) to reduce or eliminate pollutant loading to receiving waters. To achieve this goal, a variety of BMPs, such as wet detention ponds, baffle boxes, alum treatment, improved wastewater treatment systems, and restoration of natural ecosystems may be used.

Natural System Conditions

The Sweetwater Creek watershed area encompasses 13,570 acres in Hillsborough County. The watershed contains plant communities, both terrestrial and aquatic, that provide a variety of important environmental functions, including habitat for listed species and other wildlife, stability for stream banks and lake shores, improvement of water and air quality, and moderation of water and air temperatures. However, plant communities have undergone several periods of significant alteration since the 1830's as land use in the watershed changed from original conditions to agriculture to the current suburban/urban uses. Land use shifts have left the watershed with substantially less acreage in native plant communities, impaired water quality in streams, degradation of all plant communities by non-native invasive plants, and highly disturbed stream banks and lake shores. Most populations of native wildlife have been reduced and/or eliminated. The changes to the natural system impact ecosystem behavior in ways that may alter water quality and viability of habitats. In order to remedy the adverse impacts to water quality, maintain healthy habitats, and meet the regulatory requirements, appropriate BMPs are recommended. Such recommendations are made based on the survey of existing natural conditions and water quality improvement goals.

Regulatory Background/TMDL

The Total Maximum Daily Load (TMDL) was originally promulgated as a part of the Federal Water Pollution Control Act and was later expanded by the Clean Water Act (CWA). The law requires states to define state-specific water quality standards for various designated uses and to identify water bodies that do not meet established water quality standards. Water bodies that do not meet such water quality standards as a result of human-induced conditions, are to be considered impaired.

In Florida, the TMDL process is multi-phased and includes identification, verification, and listing of impaired waterbodies, followed by the development and implementation of constituent-specific TMDL for different water quality parameters. Sweetwater Creek has recommended TMDLs for nutrients, coliforms (total coliforms), and dissolved oxygen and Channel G has recommended TMDLs for nutrients and dissolved oxygen by FDEP. US EPA reports Sweetwater Creek TMDL development for dissolved oxygen and Channel G TMDL development for dissolved oxygen and nutrients have been scheduled for 2008. Public water supply requirements have impacted water levels/quality in both the surface water system and aquifers in the Tampa Bay region and TMDL development for receiving waters will be required in the near future.

Pollutant Loading and Water Quality Level of Service (LOS)

The gross pollutant loading within the watershed was estimated based on the 2004 land use and soils characteristics. The 2004 land use map indicated 10 different land use categories that were evaluated for the pollutant loading model. Water quality evaluations were performed by assessing 12 water quality constituents in receiving waters. Gross pollutant loading was estimated by assuming no treatment of stormwater runoff. This parameter indicates the potential of each land use in yielding contaminants into the environment. To approximate the net pollutant loading within the watershed, the loading reduction due to the existing BMPs, was subtracted from the gross loading value for that watershed. Analyses were conducted at both watershed and subbasin levels. The details of these analyses are discussed in Chapter 10 of this report.

Based on these results, a water quality treatment level of service was determined at the subbasin and watershed levels within the Sweetwater Creek watershed. This type of analysis facilitates prioritization of water quality improvement alternatives for the watershed. Water quality treatment levels-of-service criteria were used as part of this study to allow comparisons of existing and proposed stormwater treatment conditions to pollutant loading goals and to help prioritize alternative BMPs throughout the watershed.

Three water quality constituents were identified and analyzed in greater detail due to their importance in local water quality management programs. These parameters included total suspended solids, total phosphorus, and total nitrogen. In addition, based on specific concerns, some subbasins required assessment of other parameters, including heavy metals and bacteria. Excess nitrogen can stimulate algal growth resulting in reduced light penetration through the water column, resulting in loss of seagrass. Other factors that affect light availability in the Bay are also of concern, including excess total suspended solids. Excess phosphorous can promote eutrophication and algal blooms, leading to degradation of water quality. Results from the pollutant loading model were used to develop LOS for each water quality constituents that are fully described in Chapter 11 of this report.

Structural BMP Alternatives

Analyses were performed using GIS to strategically locate structural BMP sites for water quality and natural systems improvements. Various methods were used to identify feasible alternative projects for implementation that are described extensively in Chapter 14. Water quality conditions were evaluated using the County's Water Quality Treatment Level of Service criteria and pollutant loading model. The proposed alternatives are developed to improve water quality and natural systems consistent with the overall goals of the County.

Recent aerial photos were used to identify the most suitable and cost-effective sites for implementation of structural BMPs. The main criteria for site selection included proximity to streams/rivers (500-meter buffer zone), open areas, and publicly owned properties that are readily available for stormwater treatment in the form of retention or detention facilities. Initially a total of 48 locations for potential siting of structural BMPs were identified. Of the 48 potential sites, 41 fall within the 500-meter buffer of major streams. GIS analyses were performed to verify that the identified sites had no existing construction and were open areas suitable for construction of a stormwater treatment facility. We surmised that land prices within this watershed are reasonable and therefore the government ownership criterion may be relaxed. The analysis showed that only 11 of the 48 identified sites met two of the three criteria (buffer requirement, government ownership, and open land). Further GIS analyses were performed to identify the parcels that were publicly owned. This resulted in 11 sites that met the 2 criteria. A field survey was conducted to examine the feasibility of placing BMPs at these 11 facilities. The survey indicated that all sites were feasible for stormwater treatment systems. These sites are recommended as potential structural BMPs locations based on the established criteria in this study. Site location, photos, maps and detailed preliminary cost estimates are described in Chapter 15. A brief summary of each site and total costs are presented below:

1. Dennison Road

This site is located adjacent to a residential property and is under private ownership. This site is mostly open, with a water feature located at the northern end of the property. While the open area of the site is sufficient for construction of a large retention pond, the wetland feature provides an opportunity for a wetland improvement/expansion project. The site is suitable for construction of a stormwater treatment and/or wetland expansion facility. The estimated cost of implementing such facility is $704,835.

2. Duque Road

This site contains some upland forested areas and a possible wetland system in the center of the parcel (presence of bald cypress dome). This site is mostly open, but some areas contain electrical towers. While the open area of the site is sufficient for construction of a large retention pond, the wetland feature provides an opportunity for wetland improvement and/or expansion project. This parcel is surrounded by agricultural and residential land uses that contributes large amounts of pollutants into the watershed’s surface waters. Construction of a treatment facility at this location would provide much needed treatment to the surrounding areas. The estimated cost of implementing this facility is $1,222,404.

3. Avila Subdivision

This site is a partial wetland located at the exit of the Avila subdivision and is divided by Lake Magdalene Boulevard. Two wetland systems (one on each side of the road) are connected by a double pipe. While this site is dominated by natural land use types, it is outgrown by vegetation. This site presents a perfect opportunity for a wetland enhancement project. The parcel is surrounded by mostly agricultural and residential land uses that contribute large amounts of pollutants into the watershed’s surface waters. Construction of a treatment facility at this location would provide much needed water quality treatment to the surrounding areas. The estimated cost of implementing this facility is $1,511,148.

4. Nebraska Avenue

This site consists of an undeveloped grassy parcel located near the junction of Nebraska Avenue and Florida Avenue. The site can be accessed via Lake Lane. The site contains some upland forested areas and a large wetland system in the center of the parcel. This site is mostly open and presence of surface water is noted. While the open area of the site is sufficient for construction of a large retention pond, the wetland feature provides an opportunity for wetland improvement or expansion project. This parcel is surrounded by agricultural and residential land uses that contribute large amounts of pollutants into the watershed's surface waters. Construction of a treatment facility at this location would provide much needed treatment to the surrounding areas. The estimated cost of implementing this facility is $1,055,622.

5. Grady 1

Field inspection of this site indicated that the feasible alternatives would consist of one of two smaller forested/wetland parcels separated by the Sweetwater Creek watershed. The parcel is located at the end of the Grady Street, is heavily wooded, and contains a small canal or a ditch at the back of the property. Because the parcel is overgrown with vegetation, we were unable to access the site. Bald cypress domes are present in the center of the area and at the edge of the parcel indicating the existence of wetland or surface water within the parcel. This area demonstrates a potential for a wetland improvement project or construction of a large retention pond. The surrounding areas are mostly residential, contributing large amounts of various pollutants into the watershed's surface water. A stormwater treatment system at this location would provide much needed water quality treatment to the surrounding areas. The estimated cost of implementing this facility is $912,476.

6. Grady 2

Field inspection of this site confirmed that the potential alternatives would have to consist of one of two forested/wetland parcels separated by the Sweetwater Creek watershed. This area demonstrates a potential for a wetland improvement project or construction of a large retention pond. The surrounding areas are mostly residential, contributing large amounts of various pollutants into the watershed's surface water. A stormwater treatment system at this location would provide much needed water quality treatment to the surrounding areas. The estimated cost of implementing this facility is $2,222,044.

7. Himes

This site is a large open undeveloped grassy parcel located near the junction of Broad Street and Himes Avenue. A large retention pond can be found directly to the west of the site. The site does not seem to provide an opportunity for improvement or an expansion of an existing wetland. While the existing stormwater retention pond provides water quality treatment to the surrounding areas, excavation of the site in question may provide additional treatment. Surrounding parcels consist mostly of built-up and residential land use types that contribute large amounts of pollutants into the watershed's surface waters. This site provides an excellent opportunity for improvement and expansion of an existing stormwater treatment facility. The estimated cost of implementing this facility is $2,116,341.

8. Linebaugh

This site contains an undeveloped open parcel located at the southeast of Linebaugh Avenue and Anderson Road intersection. The site is undeveloped and is overgrown with vegetation, demonstrating existence of some exotic species of plants along its perimeter. A small business building is located at the south edge of the parcel. The open area of the site is sufficient for construction of a large retention pond and the wetland feature located to the west of the site provides an opportunity for a wetland improvement and expansion project. This parcel is surrounded by industrial and residential land uses that contribute large amounts of pollutants into the watershed's surface waters. Construction of a treatment facility at this location would provide much needed treatment to the surrounding areas. The estimated cost of implementing this facility is $1,144,644.

9. Veterans

This site contains an undeveloped open parcel located to the west of the Veterans Expressway overpass over Sweetwater Creek. This parcel is adjacent to the Sweetwater Creek and is located at the back of a residential development. The open area of the site is sufficient for construction of a large retention pond. There is no wetland feature near the site that is suitable for a wetland improvement/expansion project. This parcel is surrounded by industrial and residential land uses that contribute large amounts of pollutants into the watershed's surface waters. Construction of a retention facility at this location would provide much needed water quality treatment to the runoff before it would enter Sweetwater Creek. The estimated cost of implementing this facility is $986,310.

10. Veterans - Park

This site is within 1/2 mile west of Site 9 described above. It has many of the same features and is suitable for a retention facility. Construction of a retention facility at this location would provide much needed water quality treatment to runoff before it would enter Sweetwater Creek. The estimated cost of implementing this facility is $2,945,276.

11. Armand

This site is a large undeveloped open parcel located at the corner of Armand Circle and Soccer Avenue. The site is located to the north of the Town'N'Country Greenway. This parcel is large in size; it is cleared with a forested portion to the east of the site. The parcel is a part of the Shimberg Park Sports Complex and is most likely used for such activities as soccer practice. A small trailer/mobile home, serving as an office, is located in the center of the parcel. The area is fenced out and is under private ownership. The location and size of the parcel make it a great site for a potential structural alternative. Surrounding areas mostly consist of residential land uses that contribute large amounts of pollutants into the watershed's surface waters. Construction of a retention facility at this location would provide water quality treatment to the runoff before it would enter Sweetwater Creek. The estimated cost of implementing this facility is $1,678,690.

In addition to the structural BMPs enumerated above, there are various state and local agencies that provide educational and outreach materials for the public at large and academic institutions. The specifics of these educational programs are presented in Chapter 15.

CHAPTER 1: INTRODUCTION

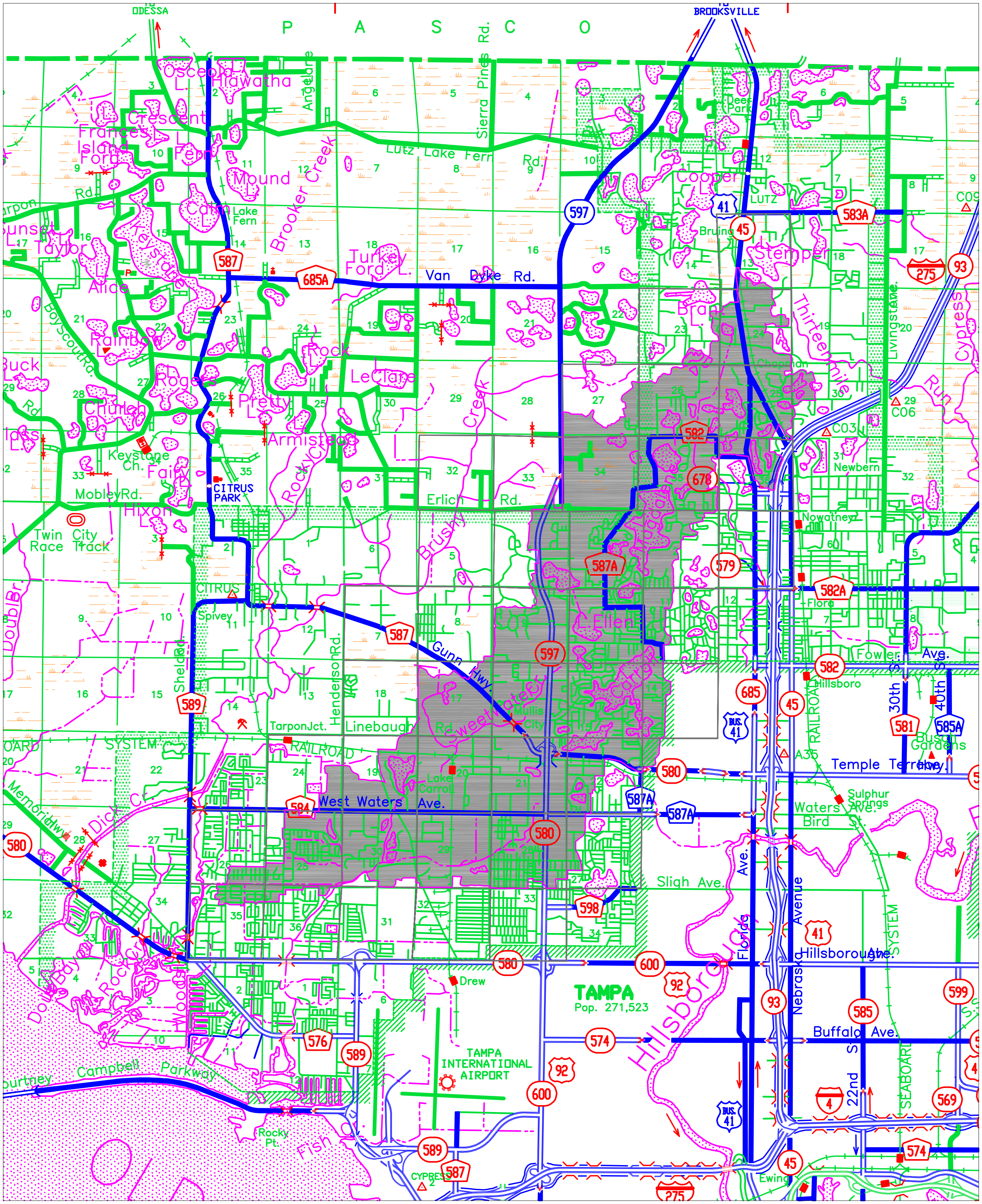
1.1 Project Location and Description

The Sweetwater Creek Watershed is located in northwest Hillsborough County in west central Florida. The overall watershed area is approximately 21.0 square miles. The watershed is located in an area roughly defined by Pocahontas Ave on the south, Webb Road on the west, Florida Avenue on the east, and Crenshaw Lake Road on the north. The drainage basin, as defined for this study, is shown in Figure 1-1. Flow originates in the northern headwaters of the basin and flows in a generally southwestern direction to the basin outfall at the confluence with Rocky Creek, located approximately 1/2-mile downstream (west) of Webb Road. The purpose of the study was to develop a Watershed Management Plan to address four main objectives including flood control, water quality, natural systems, and water supply conditions.

Sweetwater Creek

The Sweetwater Creek drainage basin is characterized by a flat topography, high water tables, and many natural lakes, depressions and wetlands. Historically, the basin consisted of an aggregation of lake and wetland systems overflowing through natural sloughs. However, due to development activities, the system has been drastically altered. Currently, the northern part of the basin consists mostly of lakes, ponds, and depressional areas interconnected with channels, culverts, and weir structures.

The southern part consists of an improved channel system with a number of control structures fed by a system of urban ditches and storm sewer systems. Major drainage features in the watershed include the two main channels that cross the watershed in a southwest regime, Channels G and H, and over 25 major lakes, ponds and borrow pits of over 10 acres each. The largest of these lakes include Lake Carroll, Lake Magdalene, White Trout Lake, Lake Chapman, Platt Lake, Bay Lake, Lake Ellen, Lake George, Bird Lake, and Boat Lake. Three major segments define the drainage system of the Sweetwater Creek Watershed. Please refer to Figure 1-2.



GENERAL LOCATION.DWG
DRAWN BY: DMT
SCALE: NTS

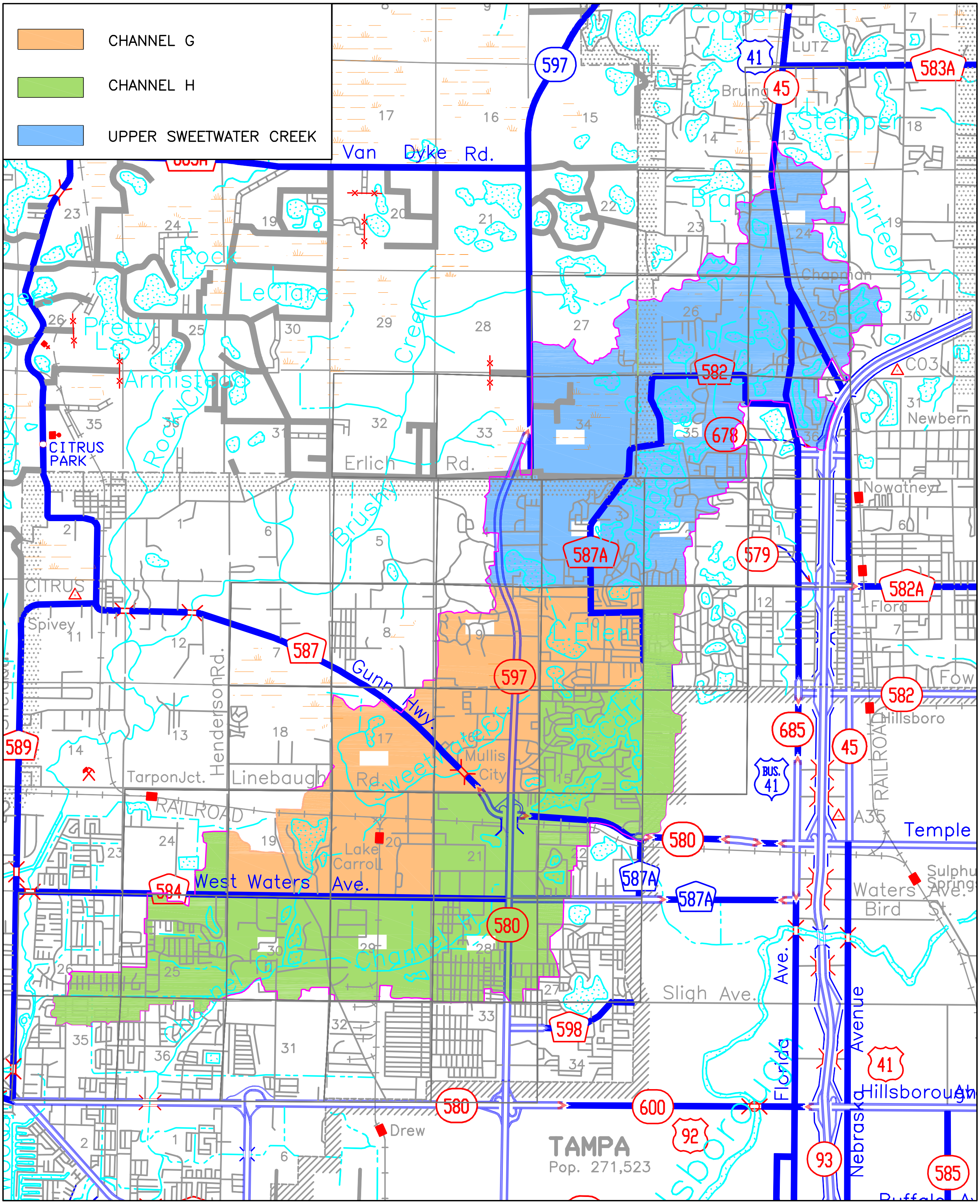
AYRES ASSOCIATES
8875 HIDDEN RIVER PARKWAY, SUITE 200
TAMPA, FLORIDA 33637
(813)978-8688 FAX: (813)978-9369

HILLSBOROUGH COUNTY
DIVISION OF ENGINEERING
PUBLIC WORKS DEPARTMENT
STORMWATER MANAGEMENT SECTION
601 E. KENNEDY BLVD./TAMPA, FLORIDA 33602/PH. 272-5912

LOCATION MAP

SWEETWATER CREEK WATERSHED MANAGEMENT PLAN

FIGURE NO.
1-1



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AYRES ASSOCIATES
8875 HIDDEN RIVER PARKWAY, SUITE 200
TAMPA, FLORIDA 33637
(813)978-8688 FAX: (813)978-9369

HILLSBOROUGH COUNTY
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STORMWATER MANAGEMENT SECTION
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WATERSHED REGIONS

SWEETWATER CREEK WATERSHED MANAGEMENT PLAN

FIGURE NO.
1-2

Channel G

The first primary segment is Channel G, which comprises approximately 3.0 square miles of drainage area in the southeast portion of the study area. This segment is a major man-made channel that was excavated in the mid-1960's as a part of the U.S. Soil Conservation Service's Upper Tampa Bay Watershed (UTBW) Project.

This project was halted short of its original goal in the late 1970s due to environmental concerns and only the lower portions of Channels G and H were completed. The work included extensive channelization, and several control structures and road crossing replacements. The Channel G segment extends from the basin outfall upstream to a location just upstream (east) of Benjamin Road. At this point the drainage system divides into two major branches; (1) the Channel H drainage basin, and (2) the upper Sweetwater Creek drainage basin.

Channel H

The Channel H basin comprises approximately 5.9 square miles of drainage area in the southern portion of the study area. The northernmost extent of the Channel H basin originates at Lake Carroll (south of Fletcher Avenue) and stormwater runoff flows southwesterly through a series of lakes, including White Trout Lake, before discharging to the channel system south of Busch Boulevard. The lower portion of Channel H is also a man-made channel that was excavated as part of the UTBW Project and extends from the Channel G confluence upstream to Dale Mabry Highway.

Upper Sweetwater Creek

The Upper Sweetwater Creek basin encompasses the remaining northern and western extents of the study area and comprises approximately 13.1 square miles of drainage area. The upper portion of this basin is characterized by numerous lakes and natural wetlands, which provide a great amount of storage capacity for excess floodwaters. Major lakes in this upper basin, beginning with Lake Lipsey at the southern extent, include Lake Ellen, Bay Lake, Lake Magdalene, Lake George, Platt Lake, Bird Lake, Lake Chapman, and Lake Estes.

The Upper Sweetwater Creek portion of the study area was the subject of a stormwater study conducted in 1983 for the Southwest Florida Water Management District (SWFWMD) in response to flooding that occurred in the basin during the summer of 1979. Subsequently, SWFWMD and Hillsborough County collaborated in the construction of the Sweetwater Creek Watershed Project in 1986 to implement this plan. This project extended and enhanced the original UTBW improvements. Channel excavation, structural improvements, and channel maintenance activities were constructed along the length of the primary drainage system extending from the Channel G confluence upstream to Bird Lake as a part of this project.

1.2 Current Management of the Watershed

For the purposes of flood control, the Southwest Florida Water Management District (SWFWMD) manages and operates Channel G and Channel H structures, as well as others throughout the watershed. The majority of the waters in the watershed are classified as Class III waters, indicating that they are suitable for recreation and the propagation and maintenance of a healthy, well balanced population of fish and wildlife.

The United States Army Corps of Engineers (USACOE), SWFWMD, the Florida Department of Environmental Protect (FDEP), and the Hillsborough County Environmental Protection Commission (EPC) all have various regulatory jurisdictions over the watershed.

1.3 Climate of the Sweetwater Creek Watershed

The climate is considered humid subtropical. Summers are warm and humid; however, during some months some areas of this region may fall below 64 degrees F, which makes this area humid subtropical versus tropical. Typical evaporation in the watershed ranges from 50 to 70 inches and the average rainfall is approximately 55 inches per year. By plotting typical rainfall and evaporation versus time in months, and considering soil moisture utilization, the water budget would suggest a water deficiency from January through June and a water surplus from June through October during the rainy season.

1.4 Historical Flooding

As one of the most highly urbanized watersheds historical flooding dates back as far as the early eighteen hundreds to as recent as El Nino during 1997 and 1998. Flooding has occurred, through storm surges which bring significantly high tides, rainfall, or a combination thereof. This flooding is typical of hurricanes or tropical storms. For hurricanes of equal intensity and size, the storm surge for the Gulf Coast of Florida can be expected to be higher than on the east coast due to the gently sloping bottom of the west coast versus the Atlantic side where water depth changes significantly over a short distance. For the Gulf Coast, historically, rainfall during a hurricane can range from 5 to 12 inches over the affected area, with the greatest amount occurring over the front quadrant of the hurricane. For the Hillsborough River, the minimum level of service for flood control will be for a 25-year storm event which equates to approximately 8 inches of rainfall. For a 100-year event the total predicted rainfall is estimated at 11.5 inches.

The National Weather Service has estimated the probability of a hurricane hitting the Tampa Bay area as 1 in 25, with the highest probability occurring in Miami at 1 in 6. Some of the historical storm or hurricane events that have directly hit or impacted the Tampa Bay area are outlined as follows:

- **The Storm of 1848** was the largest documented storm event that has occurred to date in the region where the tide rose to over 15 feet and Fort Brooke was devastated.
- **Hurricane of 1921** resulted in tides in excess of 10.5 feet with wind gusts of 100 mph. This event had a significant impact on the outfall of the Hillsborough River.
- **Hurricane Easy** in 1950, dumped 38.7 inches of rain in Yankeetown, located at the mouth of the Withlacoochee River. The excessive rainfall is believed to be due to the two completed loops the hurricane made around the area. Although not a direct impact to the Hillsborough River watershed, it suggests the potential for significant amounts of rain.
- **Hurricane Donna**, which occurred in September 1960 and made landfall south of the Tampa Bay area with a 100 mile swath and 166 mph winds, that dumped on average over 10 inches of rainfall within the Sweetwater Creek Watershed. The center of the storm passed between Lakeland and Plant City. Significant flooding occurred in the Sulphur Springs and Temple Terrace areas of Hillsborough County. As mentioned above, this event triggered the design and construction of the Tampa Bypass Canal which was completed during the early eighties.

- **EL Nino**, which occurred from September of 1997 through March of 1998, saturated the watershed which resulted in significantly high water elevations for the river and its tributaries. Significant documentation through stream gages and the Hillsborough County Emergency Operation Center (EOC) have documented both regional and local flooding areas within the watershed.

1.5 Scope of the Project

Ayres Associates was retained by Hillsborough County to update the Sweetwater Creek Stormwater Management Plan as a part of the County's overall stormwater management program and its goal to develop a countywide program. The intent of this project was to utilize the detailed hydrologic/hydraulic computer model originally generated by Parsons Engineering Science (Parsons ES), September 1998, and update the information to the current Hillsborough County standards. This project's intent was also to utilize the previous consultants survey information, data collection and report for purposes of updating and meeting our scope of services. It is not our intent to claim responsibility for the work previously conducted nor verify the data previously collected, but merely use it as the foundation for this update. This model was developed to establish existing conditions for the Sweetwater Creek drainage system infrastructure in terms of maximum water surface elevations and peak flows.

The scope of work includes the conversion of the existing model to a newer version of Hillsborough County's Stormwater Management Model (SWMM). The older version of SWMM was (v.4.31), Revision P (dated March 6, 1998), as developed by Hillsborough County, whereas, the newer version is (v.4.31b), (dated September 26, 2001). The SWMM computer model can be used to accurately represent the physical characteristics of the relatively complex hydraulic network in a basin. The major differences between the two versions are columns for entrance and exit loss values as well as a column for other losses, a pipe stretch function, and miscellaneous formatting changes. The pipe stretch function resolves stability problems by elongating a short unstable conduit and creating an equivalent longer pipe. The routine does this based on Checy's Law.

Ayres Associates also used solution technique number two (ISOL=2) which differs from the previous consultants use of solution technique zero (ISOL=0). ISOL equal to two is the iterative method for solving for solutions to the flow equation, whereas, ISOL equal to zero is the explicit method. The iterative method is much more stringent technique that amplifies instabilities.

Additional data requirements include the latest SWFWMD permit data and available construction drawings were acquired to define new County projects that have changed or altered the exiting stormwater management facilities. SWFWMD aerial topography, (1999) land use and soils mapping were used to provide hydrologic inputs for the computer model. The objective of the Watershed Management Plan was to describe the existing conditions of the watersheds as they relate to water quantity and flooding by evaluating the Level-of-Service (LOS) provided to residents of the area. LOS designations were established by the County to provide a means of individually rating sub-basins of a major watershed with respect to flooding concerns.

This study required a major modeling effort with the change in model versions and formats, Curve Numbers, solution techniques, and calibration events. Furthermore, major Capital Improvement Project plans were included in the model.

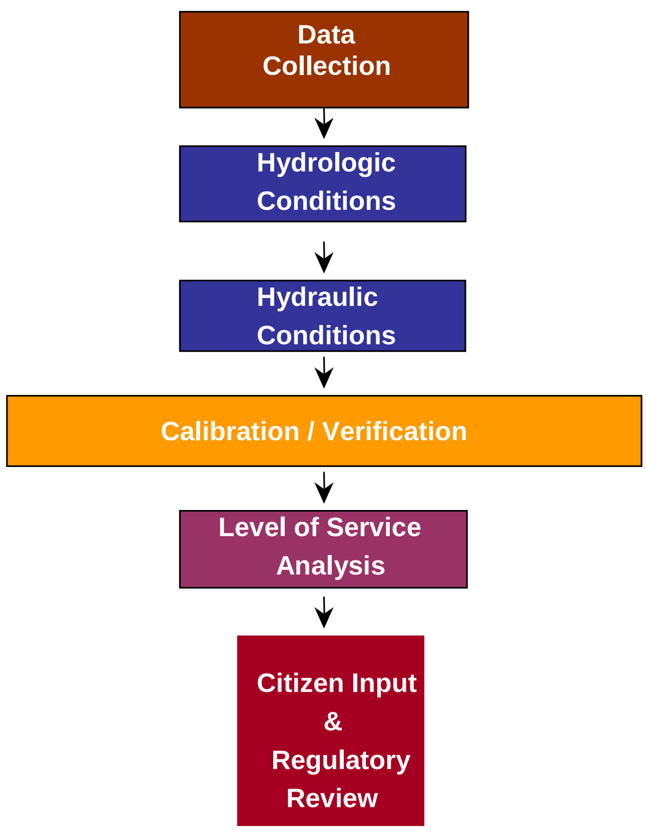
To assure its accuracy, the hydrologic/hydraulic model was calibrated to flows and flood elevations that were recorded for two EL Nino storm events (December 10-14, 1997 and December 25-27, 1997). The calibrated model was then used to simulate existing flooding conditions throughout the watershed for the 2.33-, 5-, 10-, 25-, and 100-year/24-hour duration design storm events. The resultant maximum flood elevations were examined with respect to street, yard and residential structure floor slab elevations in the study area to determine the flooding levels of service provided by the existing drainage system and to identify deficiencies and flooding problem areas.

The County has adopted a target level of service for the primary stormwater conveyance facilities in the watershed which will protect structures and limit flooding to streets and yards during the 10-year/24-hour duration design storm event.

The calibrated hydrologic/hydraulic model can be used to simulate various alternatives and determine their effectiveness. During this process, considerations should be made for environmental and water quality impacts, costs, right of way requirements, permitting, constructability, and public acceptance.

Any questions, comments, or other inquiries regarding the content of this report or the project in general should be directed to the Hillsborough County Public Works Department, Engineering Division, Stormwater management Section. The computer model, input/output data files, and drawings developed during the study are available, and will be provided upon written request.

The process for developing the watershed management plan is outlined in the flow chart. As indicated in the flow chart, the project considers public input a high priority to allow for continuous feedback on historical flooding, and other related concerns in the watershed.



Watershed Management Plan Development Process

1.6 Background and Data Collection

To properly describe the watershed area, a literature / data search was performed to compile the available information. This data included previous studies, existing survey information, land use and soils coverages, rainfall and streamflow data, construction plan information, historical flooding documentation, and field investigations. The following is a brief listing of the agencies that were contacted with requests for data:

- Hillsborough County
- Southwest Florida Water Management District (SWFWMD)
- United States Army Corps of Engineers (USACOE)
- Federal Emergency Management Agency (FEMA)
- United States Geological Survey (USGS)

1.7 Project Objectives

The Watershed Management Plan for Sweetwater Creek examined existing data, develop an accurate characterization of the watershed, and identify existing conditions. The Plan will provide balanced consideration to hydrology, land use, regulatory processes, flood control, soil conservation, water quantity, and overall community objectives.

General objectives of the management plan include the following:

- manage water resources comprehensively and cooperatively
- incorporate a process for public involvement and education about the Watershed
- designed so that no phase of plan implementation warrants a new or enhanced regulatory layer for public or private participants
- investigate and inventory existing drainage and stormwater management system using a Geographic Information System
- provide effective flood control protection for public and private property by identifying flood problem areas and assign levels of service for existing and future conditions

CHAPTER 2: GENERAL DESCRIPTION

The Sweetwater Creek Watershed (SWC) encompasses three distinct regions, Channel G, Channel H and the Upper Sweetwater Creek with all of their tributaries. Altogether there are 25 major lakes throughout the watershed. The largest of these lakes include Lake Carroll, Lake Magdalene, White Trout Lake, Lake Chapman, Platt Lake, Bay Lake, Lake Ellen, Lake George, Bird Lake, and Boat Lake. Figure 2-1 illustrates the location of the major conveyances within the overall watershed. The study regions are presented in this report in the order of their discharge from upstream to downstream.

2.1 Climate

The SWC is located in northwest Hillsborough County. The climate in this area can be classified as subtropical with average rainfall depths approaching 55 inches per year. The area of west central Florida, where these counties are located, experiences a rainy season extending from June to September. Hot and humid days with temperatures in the 90's are common during this rainy season. Also common during these months are late afternoon thunderstorms of high intensity and short duration.

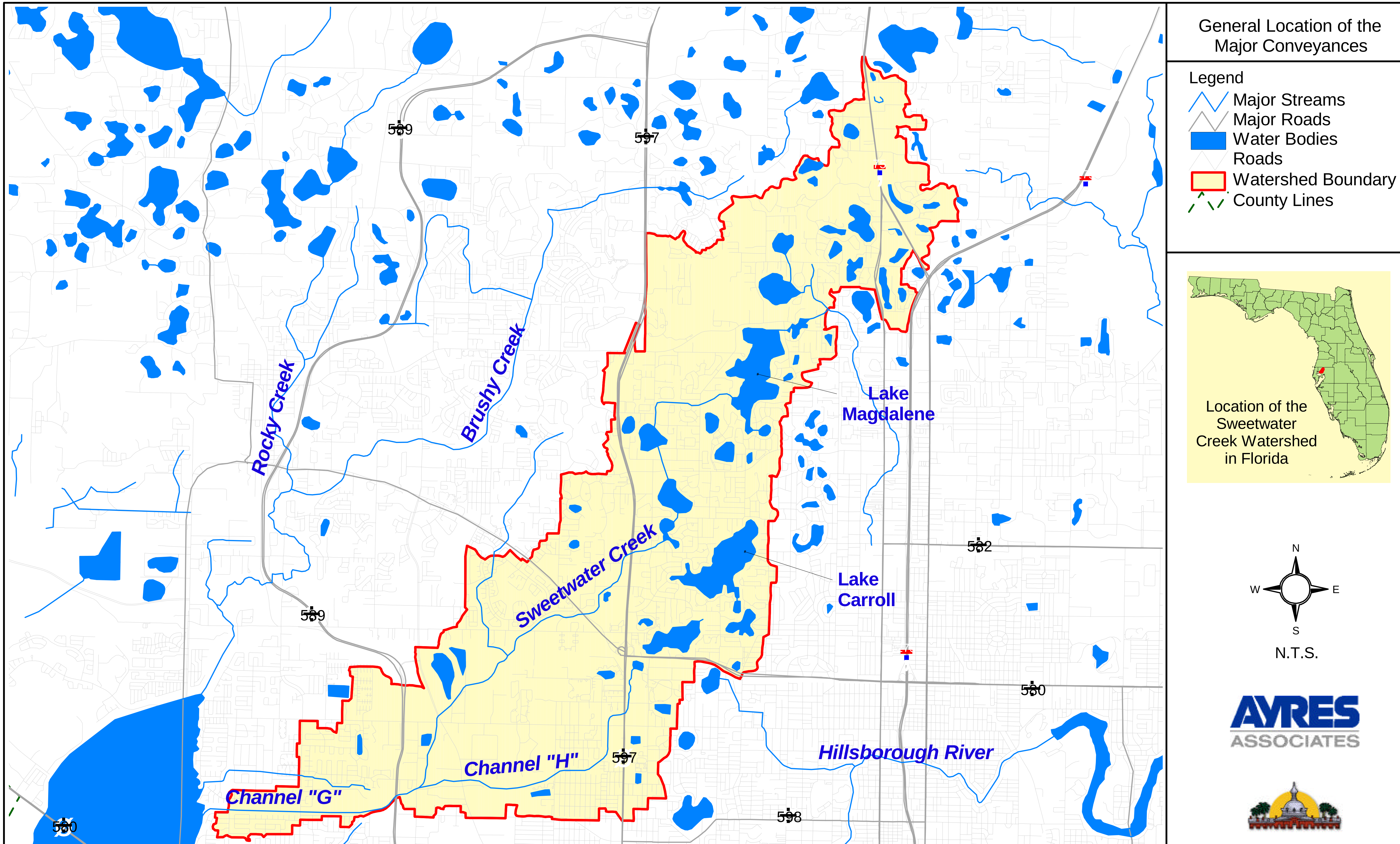
2.2 Topography

The topography of the overall SWC can be classified as relatively flat. The highest parts of the watershed, which are approximately at elevation 65 feet National Geodetic Vertical Datum (NGVD), occur the in Upper Sweetwater Creek region, located in the northern part of the county. The lowest portions of the watershed, at an approximate elevation of 5 feet NGVD, occur at the downstream extents of Channel G. The topography of the conveyances vary in elevation from approximately 59 feet NGVD near its headwaters to less than 0.0 feet NGVD near the downstream boundary.

2.3 Soils

There are over 28 different types of soils located within the SWC. The Natural Resource Conservation Service (NRCS) has mapped these soil types in soil surveys for Hillsborough County. The Geographic Information Systems (GIS) soil coverages were obtained from the SWFWMD.

The soil types contained in the watershed can be classified as belonging to one of four main hydrologic soil groups. Soils are grouped into four hydrologic soil groups A through D.



General Location of the Major Conveyances
Legend
Major Streams
Major Roads
Water Bodies
Roads
Watershed Boundary
County Lines
Location of the Sweetwater Creek Watershed in Florida
N
W
E
S
N.T.S.
AYRES ASSOCIATES
Rocky Creek
Brushy Creek
Sweetwater Creek
Lake Magdalene
Lake Carroll
Hillsborough River
Channel "H"
Channel "G"
589
597
582
580
598

Figure 2-1

These groups are directly related to a soil's runoff potential and are commonly used in hydrologic modeling to predict infiltration rates and moisture capacity. The major hydrologic soil groups are:

- Hydrologic Soil Group A (low runoff potential): Soils that have high infiltration rates even when thoroughly wetted and a high rate of water transmission. Typical maximum infiltration rate of 10 in/hr when dry and 0.5 in/hr when saturated.

- Hydrologic Soil Group B (moderately low runoff potential): Soils that have moderate infiltration rates when thoroughly wetted and a moderate rate of water transmission. Typical maximum infiltration rate of 8 in/hr when dry and 0.4 in/hr when saturated.

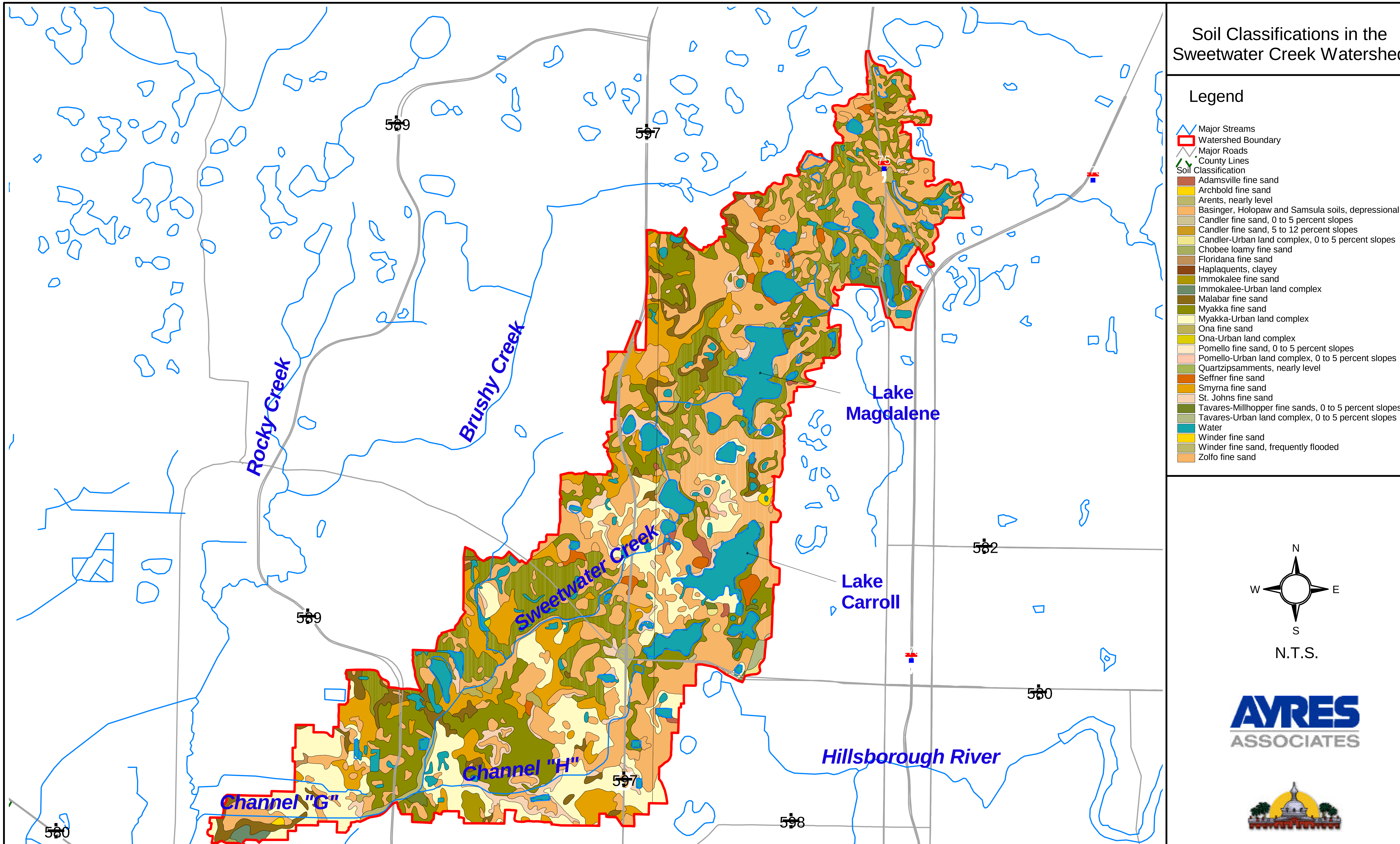
- Hydrologic Soil Group C (moderately high runoff potential): Soils that have a slow infiltration rate when thoroughly wetted and a slow rate of water transmission. Typical maximum infiltration rate of 5 in/hr when dry and 0.25 in/hr when saturated.

- Hydrologic Soil Group D (high runoff potential): Soils having very slow infiltration rates when thoroughly wetted and a very slow rate of water transmission. Typical infiltration rate of 3 in/hr when dry and 0.10 in/hr when saturated.

These hydrologic soil groups are commonly used in hydrologic analyses to estimate infiltration rates and soil moisture capacities. Soils within the Sweetwater Creek Watershed were categorized according to this hydrologic soil group classification system, as defined by the NRCS.

There are four different soil groups that SWC soils fall into: A, B/D, C, and D. Soils can also have dual classifications such as A/D or B/D. As is common in many cases in Florida, a dual hydrologic soil group classifications can also be assigned to soils that, during the wet season, are saturated throughout much of the soil column due to a high surficial water table (i.e. 'undrained'). Thus, during this time of year, infiltration is impeded and the soil acts as a D soil. However, during the rest of the year, when the water table is lower (i.e. 'drained'), the soil acts as a B soil. Figure 2-2 presents the hydrologic soils classification map of the Sweetwater Creek Basin which was developed for this study.

The distribution of hydrologic soil types within each subbasin was determined by intersection of the soil coverage in the GIS database with the digitized subbasin delineations. Table 2-1 lists the distribution of the hydrologic soil types within the watershed. It can be seen that nearly 53 percent of the watershed is comprised of soils which are classified as hydrologic soil group B/D, and a quarter (25%) of the basin is classified as hydrologic soil group D soils, which include both wetlands and waterbodies. There is virtually no hydrologic soil group A soil, which occur in the watershed. A composite breakdown of the hydrologic soil group acreage and percentages for the basin is as follows:



Soil Classifications in the Sweetwater Creek Watershed
Legend
Major Streams
Watershed Boundary
Major Roads
County Lines
Soil Classification
Adamsville fine sand
Archbold fine sand
Arents, nearly level
Basinger, Holopaw and Samsula soils, depressional
Candler fine sand, 0 to 5 percent slopes
Candler fine sand, 5 to 12 percent slopes
Candler-Urban land complex, 0 to 5 percent slopes
Chobee loamy fine sand
Floridana fine sand
Haplaquents, clayey
Immokalee fine sand
Immokalee-Urban land complex
Malabar fine sand
Myakka fine sand
Myakka-Urban land complex
Ona fine sand
Ona-Urban land complex
Pomello fine sand, 0 to 5 percent slopes
Pomello-Urban land complex, 0 to 5 percent slopes
Quartzipsamments, nearly level
Seffner fine sand
Smyrna fine sand
St. Johns fine sand
Tavares-Millhopper fine sands, 0 to 5 percent slopes
Tavares-Urban land complex, 0 to 5 percent slopes
Water
Winder fine sand
Winder fine sand, frequently flooded
Zolfo fine sand
589
597
Rocky Creek
Brushy Creek
Lake Magdalene
Lake Carroll
Sweetwater Creek
582
589
580
Hillsborough River
Channel "H"
597
Channel "G"
598
580
N
W
E
S
N.T.S.
AYRES ASSOCIATES

Figure 2-2

Table 2-1 Hydrologic Soils

Hydrologic Soil Group	Total Area (acres)	Percentage of Basin (%)
A	134	1.0
B/D	7,078	52.6
C	2,952	21.9
D	3,300	24.5

Soils in the basin consist predominantly of fine sands of the Zolfo and Myakka series. These poorly drained soils, formed in beds of sandy and loamy marine sediments, are categorized by the Natural Resources Conservation Service (NRCS) in hydrologic soil groups C and B/D, respectively.

2.4 Land Use / Coverage

For this project, existing land use conditions in the Sweetwater Creek Basin were defined by use of digital coverage obtained from the SWFWMD GIS database. The 1999 GIS coverage, which was the latest available coverage at the time of this study, is based on the Florida Land Use and Cover Classification System (FLUCCS). This database used a set of 51 different land use classifications to define the land use coverage within the watershed. The information in this database was used during the course of investigating existing conditions. Data in the SWFWMD FLUCCS coverage indicates that the SWC is fairly urban.

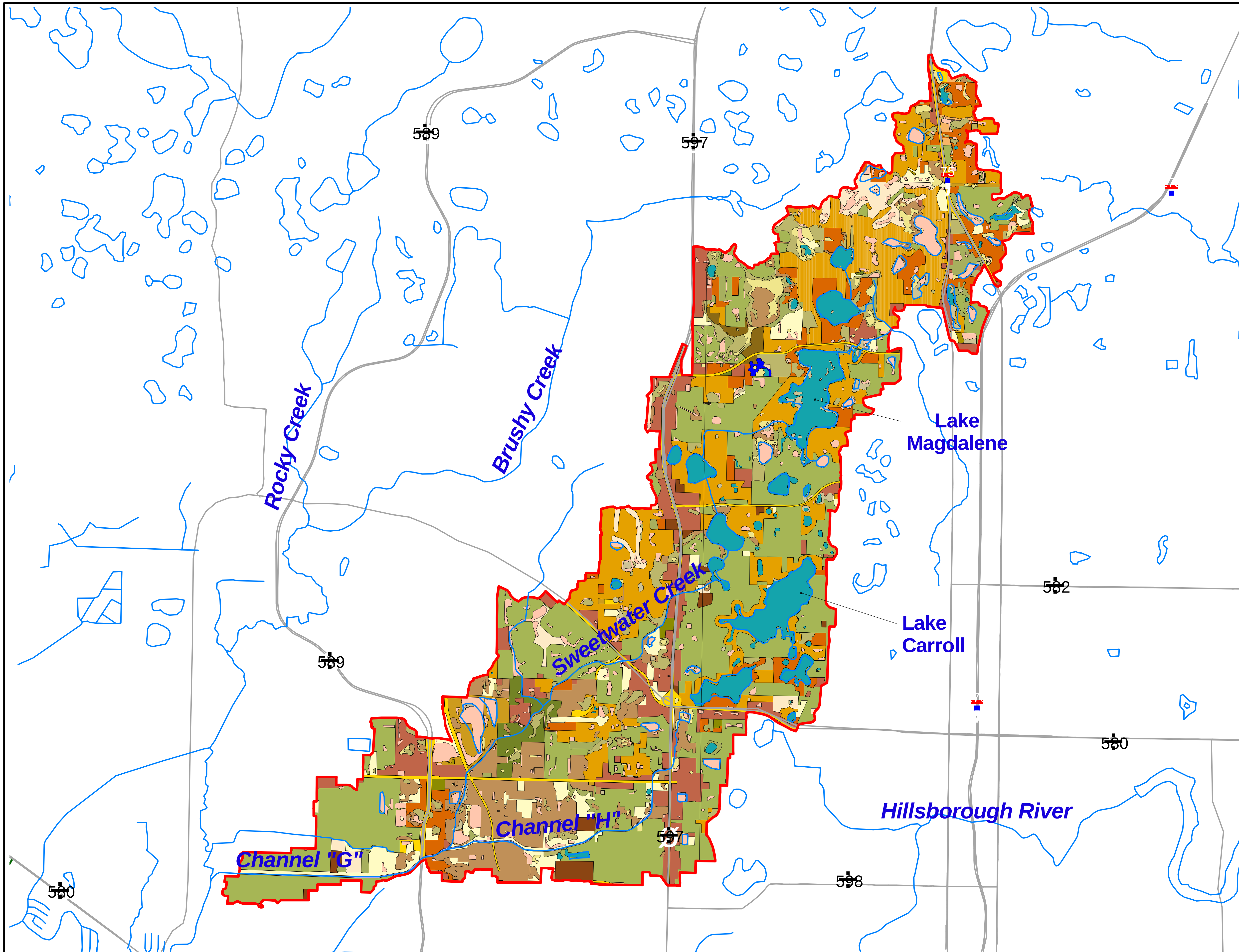
The resultant existing land use map of the Sweetwater Creek Basin that was used for model development purposes is shown in Figure 2-3. This land use coverage was intersected with the digitized subbasin delineations using GIS overlay techniques to develop an accurate measurement of the distribution of the various land use classifications within each of the defined 291 subbasins in the watershed. Table 2-2 presents a listing of the subbasin existing land use areas that were developed in this manner. The following table presents a composite breakdown of land use acreage and percentages in the Sweetwater Creek Basin.

Table 2-2 Land Use

Land Use Classification	Total Area (acres)	Percentage of Basin (%)
Commercial and Services	1062	7.89
Cropland and Pastureland	21	0.16
Cypress	355	2.63
Disturbed Land	14	0.10
Emergent Aquatic Vegetation	135	1.00
Extractive	99	0.73

Land Use Classification	Total Area (acres)	Percentage of Basin (%)
Freshwater Marshes	191	1.42
Hardwood Conifer Mixed	209	1.55
Industrial	680	5.05
Institutional	124	0.92
Intermittent Ponds	7	0.05
Lakes	865	6.43
Mixed Rangeland	52	0.39
Nurseries and Vineyards	26	0.19
Open Land	557	4.14
Other Open Lands (Rural)	10	0.07
Pine Flatwoods	0.3	0.002
Recreational	279	2.07
Reservoirs	725	5.38
Residential High Density	3782	28.09
Residential Low Density	765	5.68
Residential Med Density	2228	16.55
Row Crops	2	0.01
Shrub and Brushland	144	1.07
Stream and Lake Swamps	11	0.08
Streams and Waterways	37	0.27
Transportation	407	3.02
Tree Crops	156	1.16
Tree Plantations	4	0.03
Upland Coniferous Forest	2	0.02
Utilities	36	0.27
Wet Prairies	24	0.18
Wetland Coniferous Forests	1	0.01
Wetland Forested Mixed	455	3.38
Total (Acres)	**13465**	**100**
Total (Square Miles)	**21.04**	**100**

According to the SWFWMD FLUCCS mapping database, 28.09% of the Sweetwater Creek watershed is classified as high density residential. This classification includes areas of both multiple family and high-density single family residential development. Another 22.23% of the basin is classified as either low or medium density residential. Less than 4.5% of the watershed remains as open land. Approximately 20.78% of the basin is comprised of waterbodies and wetlands which serve to store stormwater runoff during extreme flooding events.



Detailed Land Use Classifications in the Sweetwater Creek Watershed

Legend

- Major Streams
- Watershed Boundary
- Major Roads
- County Lines

Land Use (1999) Classifications:

- COMMERCIAL AND SERVICES
- CROPLAND AND PASTURELAND
- CYPRESS
- DISTURBED LAND
- EMERGENT AQUATIC VEGETATION
- EXTRACTIVE
- FRESHWATER MARSHES
- HARDWOOD CONIFER MIXED
- INDUSTRIAL
- INSTITUTIONAL
- INTERMITTENT PONDS
- LAKES
- MIXED RANGELAND
- NURSERIES AND VINEYARDS
- OPEN LAND
- OTHER OPEN LANDS <RURAL>
- PINE FLATWOODS
- RECREATIONAL
- RESERVOIRS
- RESIDENTIAL HIGH DENSITY
- RESIDENTIAL LOW DENSITY < 2 DWELLING UNITS
- RESIDENTIAL MED DENSITY 2->5 DWELLING UNIT
- ROW CROPS
- SHRUB AND BRUSHLAND
- STREAM AND LAKE SWAMPS (BOTTOMLAND)
- STREAMS AND WATERWAYS
- TRANSPORTATION
- TREE CROPS
- TREE PLANTATIONS
- UPLAND CONIFEROUS FOREST
- UTILITIES
- WET PRAIRIES
- WETLAND CONIFEROUS FORESTS
- WETLAND FORESTED MIXED

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W E
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N.T.S.

AYRES ASSOCIATES

Figure 2-3

2.5 Physiography and Hydrology

Hillsborough County's 1998 model was modified to account for the relatively flat terrain. The modifications included altering the "shape factor" and corresponding dimensionless unit hydrograph ordinates. The Hillsborough County Stormwater Management Technical Manual indicates that a value of 256 with a corresponding dimensionless unit hydrograph is appropriate for the County. Therefore the program was uses the "256" shape factor and the recommended dimensionless unit hydrograph. An initial abstraction coefficient of 0.2 was used throughout this study. Initial abstraction is computed as the initial abstraction coefficient multiplied by the soil storage depth. The soil storage depth (S) is computed from the runoff curve number (CN) on the basis of the SCS methodology.

There are many lakes, wetlands, and depressions within the watershed. Several depressions can be attributed to the underlying limestone formations. There are 25 major lakes throughout the watershed.

Surface flows within the SWC vary by region. Flow is generally to the south and west. Hydrologically, surface flows within the watershed originate for the most part through stormwater runoff and wetland/ swamp discharge. There is some influence on surface water flows from groundwater.

2.6 Hydrogeology

The hydrogeologic flow system of the Tampa Bay region is comprised of the unconfined surficial and the semi-confined Upper Floridan aquifers. The surficial aquifer is comprised predominately of fine-grained sand deposits. Due to the geology of the region, the thickness of these sand deposits is highly variable. The direction of groundwater flow within this aquifer varies locally and is greatly influenced by topography. The freshwater Upper Floridan aquifer is separated from the brine-saturated Lower Floridan aquifer by the Middle Confining layer. The direction of groundwater flow within the Upper Floridan aquifer is generally towards the south and west.

CHAPTER 3: WATERSHED DESCRIPTION

3.1 Introduction

As mentioned in Chapter 2, the overall Sweetwater Creek Watershed (SWC) was divided into three regions. The watershed description of the Sweetwater Creek will be divided into these three regions. These regions share geographic, physical, and hydraulic similarities and are comprised of subwatersheds. The subwatersheds represent tributaries to the main conveyance ways. Plots of the hydraulic link-node diagrams for those subwatersheds included in the SWMM model can be seen in Appendix 3-1 through 3-3.

3.2 Channel G

The first primary segment is Channel G, which comprises approximately 3.0 square miles of drainage area in the southwest portion of the study area. In the mid-1960's as a part of the U.S. Soil Conservation Service's Upper Tampa Bay Watershed (UTBW) Project, this segment of channel was excavated. This project was halted short of its original goal in the late 1970s due to environmental concerns and only the lower portions of Channels G and H were completed. The work included extensive channelization, and several control structures and road crossing replacements. The Channel G segment extends from the basin outfall upstream to a location just upstream (east) of Benjamin Road. At this point the drainage system divides into two major branches; (1) the Channel H drainage basin, and (2) the upper Sweetwater Creek drainage basin.

3.3 Channel H

The Channel H basin comprises approximately 5.9 square miles of drainage area in the southeast portion of the study area. The northernmost extent of the Channel H basin originates at Lake Carroll (south of Fletcher Avenue) and stormwater runoff flows southwesterly through a series of lakes, including White Trout Lake, before discharging to the channel system south of Busch Boulevard. The lower portion of Channel H is also a man-made channel that was excavated as part of the UTBW Project and extends from the Channel G confluence upstream to Dale Mabry Highway.

3.4 Upper Sweetwater Creek

The Upper Sweetwater Creek basin encompasses the remaining northern and western extents of the study area and comprises approximately 13.1 square miles of drainage area. The upper portion of this basin is characterized by numerous lakes and natural wetlands, which provide a great amount of storage capacity for excess floodwaters. Major lakes in this upper basin, beginning with Lake Lipsey at the southern extent, include Lake Ellen, Bay Lake, Lake Magdalene, Lake George, Platt Lake, Bird Lake, Lake Chapman, and Lake Estes.

The Upper Sweetwater Creek portion of the study area was the subject of a stormwater study conducted in 1983 for the SWFWMD in response to flooding that occurred in the basin during the summer of 1979. Subsequently, SWFWMD and Hillsborough County collaborated in the construction of the Sweetwater Creek Watershed Project in 1986 to implement this plan.

This project extended and enhanced the original UTBW improvements. Channel excavation, structural improvements, and channel maintenance activities were constructed along the length of the primary drainage system extending from the Channel G confluence upstream to Bird Lake as a part of this project.

CHAPTER 4: HYDROLOGIC/HYDRAULIC MODEL METHODOLOGY

General Hydrology / Hydrologic Model Development

The U.S. Soil Conservation Service (SCS) Runoff Curve Number method was used to convert stormwater rainfall excess into runoff. This method uses soil and land cover characteristics to estimate runoff. The runoff hydrographs were developed using the SCS Dimensionless Unit Hydrograph Method. The Hillsborough County Stormwater Management Model (HCSWMM) utilizes a modified version of the U.S. Army Corps of Engineers (USACOE) HEC-1 computer program to generate runoff hydrographs.

The generated runoff hydrographs are assigned to the hydraulic model at specified, unique, junction locations. HCSWMM was utilized to route these inflows through the hydraulic system via a modified version of the Environmental Protection Agency (EPA) Stormwater Management Model v.4.31b (SWMM) Extended Transport Block (EXTRAN). Output from the model consists of detailed stage and discharge versus time predictions at distinct system locations.

The SWFWMD GIS data provided a soil coverage, which contains polygons with a unique map unit identifier (MUID) for each soil type. The SCS Soil Surveys of Hillsborough County was consulted to determine the descriptions of these soil types and their corresponding hydrologic soil grouping. Figures in Chapter 2 contain the MUID, description, and hydrologic soil groupings for the soils within the respective counties.

1999 land use coverage was also provided by SWFWMD, containing polygons with a unique identifier based upon the Florida Land Use Cover and Classification System (FLUCCS). Figure 2-3 in Chapter 2 reflects the FLUCCS codes and corresponding land use categories.

4.1 Hydrology

4.1.1 Hydrologic Model

The HEC-1 program used by HCSWMM is a widely distributed and used computer model for runoff hydrograph generation. It contains a number of options for different types of runoff volume computation and routing. HCSWMM utilizes HEC-1 and the corresponding runoff input data set to compute runoff hydrographs. To generate individual basin runoff hydrographs, HEC-1 requires values for storm duration, total rainfall depth, time of concentration, area, runoff curve number, initial abstraction, and shape factor. The formulation of each of these parameters is discussed below.

4.1.2 Rainfall Depths and Distribution

The depths for the 2.33-, 5-, 10-, 25-, and 100-year storm events were interpolated from isohyetal rainfall maps in the Southwest Florida Water Management District's (SWFWMD) 1998 Environmental Resource Permitting Information Manual (ERPM), respectively, the storm events have the following depths (in inches), 4.50, 5.50, 7.00, 8.00, 11.50. For each storm event, there are multiple isohyetal contours within the Hillsborough River Watershed boundaries that represent a discrete rainfall depth. Figures 4-1 through 4-5. To account for this variation, the isohyetal maps were digitized and overlaid on the basin delineations. By interpolating (visually), each basin was assigned a particular rainfall depth, based upon its proximity to the individual isohyetal contour.

The storm events were distributed over time with the SCS Florida Modified Type II rainfall distribution. The distribution was also taken from the SWFWMD ERPM.

4.1.3 Time-of-Concentration

The TOC for a basin is defined as the time to equilibrium of the basin under a steady rainfall excess, or the travel time of a wave to move from the hydraulically most distant point in the basin to the outlet. Simply stated, this is the time when the outlet "feels" the inflow from every portion of the basin.

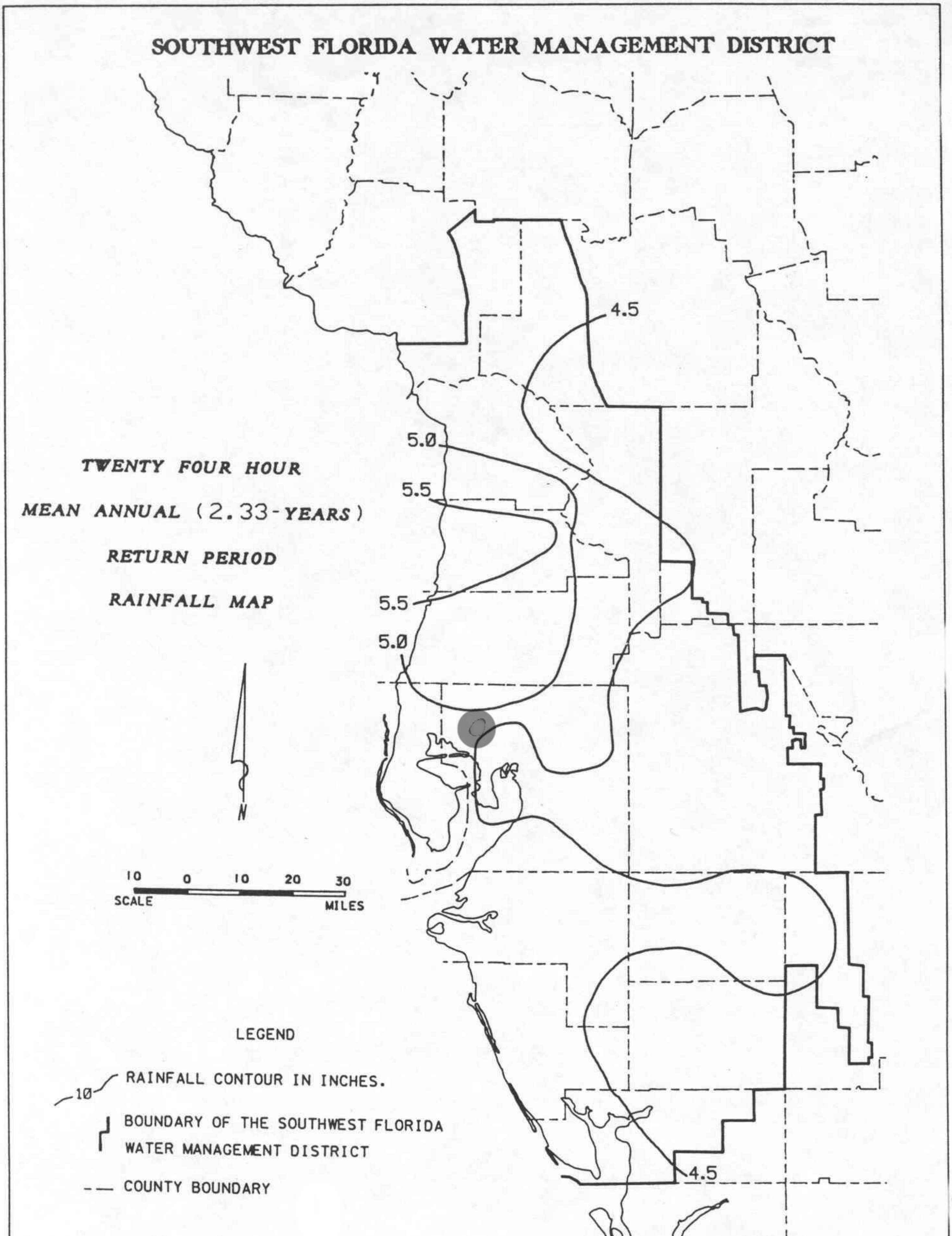
The TOC can be calculated in a variety of methods. The Hillsborough County Stormwater Technical Manual (SMTM) specifies breaking the flow path into its three main components: Overland flow, Shallow Concentrated Flow, and Channel / Pipe Flow.

The TOC is computed by summing all the travel times for consecutive flow components of the subbasin conveyance system. The SMTM provides methods for computing flow times for overland flow (sheetflow), shallow concentrated flow, and open channel flow as a function of slope and the type of flow path. The time of concentration for hydrologic modeling was calculated as the sum of both overland, shallow concentrated, and channel flow for the flow path identified for each catchment. As detailed in the SMTM, the overland flow component was calculated based on the kinematic wave solution applied to overland flow. The following formula was applied:

$$t = 0.93 \frac{L^{0.6} N^{0.6}}{I^{0.4} S^{0.3}}$$

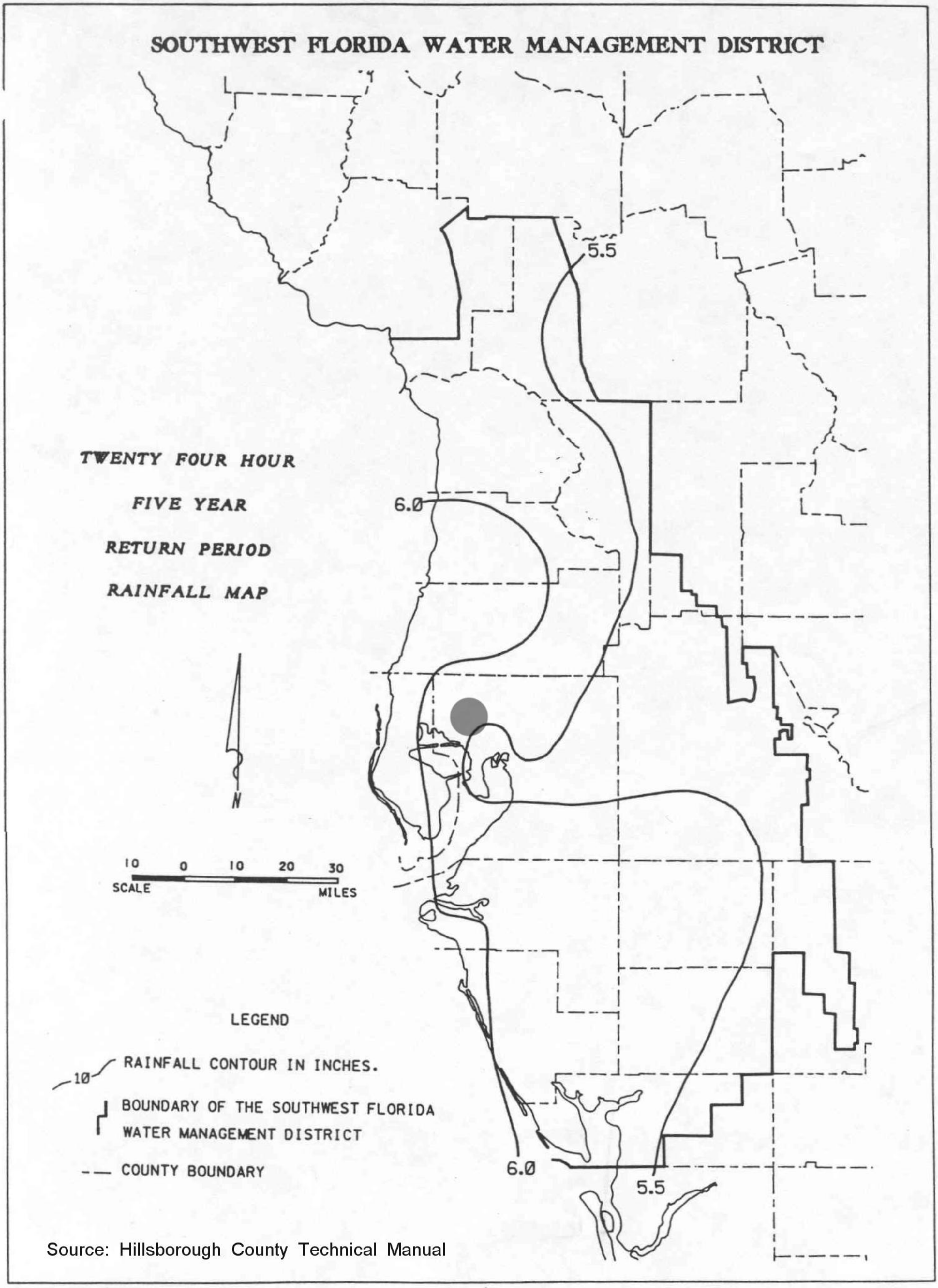
Where:

L = Length of overland flow (feet)
N = Manning's roughness coefficient for overland flow
S= Average overland flow Slope (feet/feet)
I = Rainfall intensity (inches/hour)



Source: Hillsborough County Technical Manual

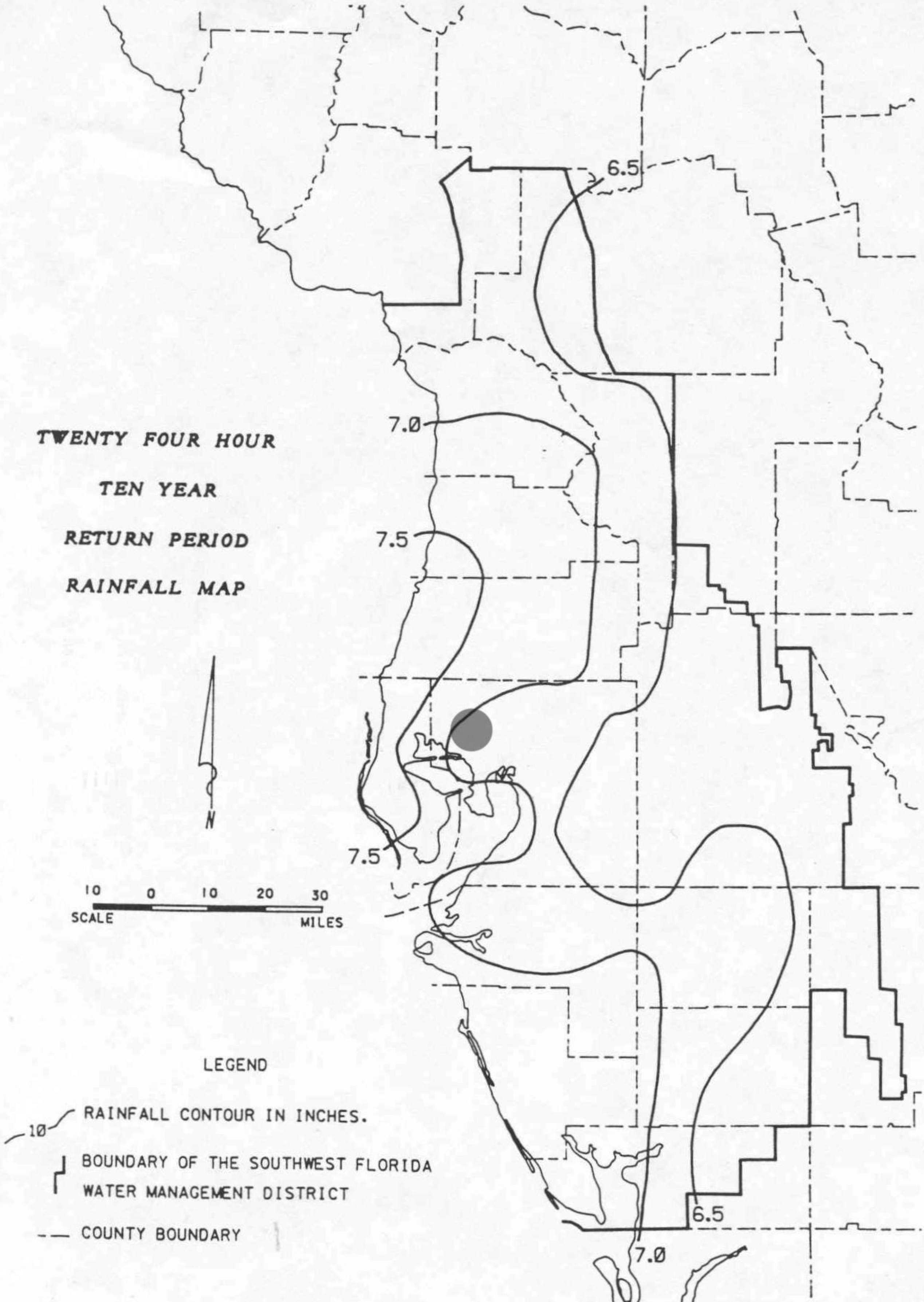
Figure 4-1



Source: Hillsborough County Technical Manual

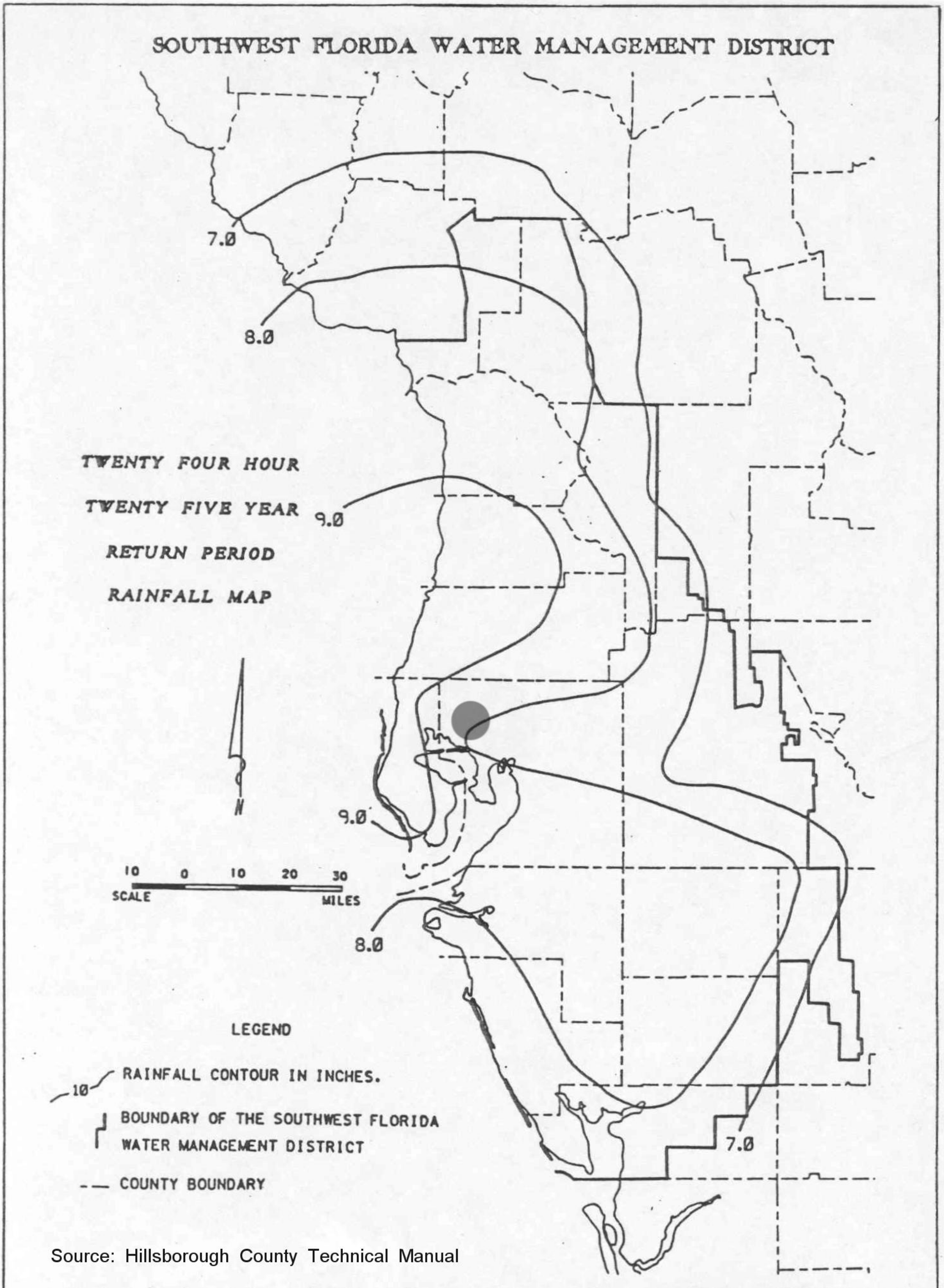
Figure 4-2

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



Source: Hillsborough County Technical Manual

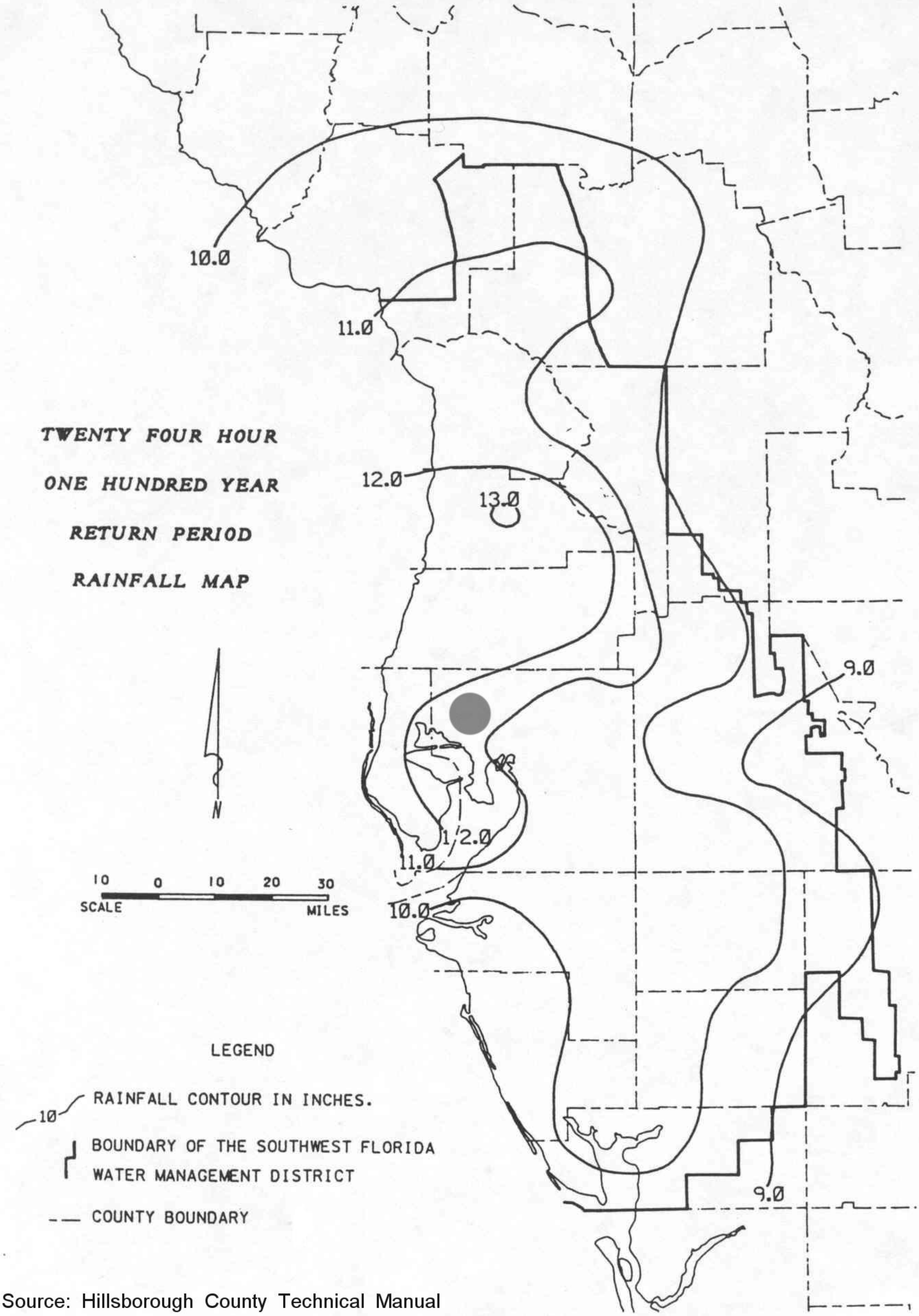
Figure 4-3



Source: Hillsborough County Technical Manual

FIGURE 4-4

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



Source: Hillsborough County Technical Manual

Figure 4-5

The lengths of overland flow and basin slope data were obtained the SWFWMD topographic aerials and USGS Quadrangle maps were utilized to delineate flow paths for the respective components in each basin. These flow paths were then measured for length and the respective calculations performed to obtain time-of-concentration values. Surface roughness, represented by the Manning's coefficient, n, was determined using literature values expressed as a function of land cover. The type of land cover for the subbasin overland flow path was identified from aerial mapping. The shallow concentrated and channel flow components of the time of concentration were calculated based on length and velocity. Again, the method outlined in the SMTM for shallow concentrated flow was used to calculate this component. The TOC for each subbasin was calculated by Parsons ES using the Hillsborough County AutoCAD LISP routine, which is set up to automate the SMTM methods previously described. The previous study performed by Parsons ES (1998) defined subbasin flow paths for each subbasin and defined the individual components of these paths, including the types and slopes, for the computation of the time of concentration. Subbasin TOC values are listed in Table 4-1.

Table 4-1 Sweetwater Creek Runoff Parameters

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
410010	410010	75	154	89.95	0.2	256
410030	410030	86	147.3	88.9	0.2	256
410040	410040	15	3.8	92.44	0.2	256
410050	410050	18	3.6	95.62	0.2	256
410055	410055	52	39.9	84.24	0.2	256
410060	410060	36	47.3	83.57	0.2	256
410065	410065	27	27.9	79.23	0.2	256
410070	410070	45	23.4	88.65	0.2	256
410090	410090	15	1.1	94.87	0.2	256
410100	410100	35	39.4	83.49	0.2	256
410104	410104	38	11.1	84.55	0.2	256
410106	410106	45	35.6	88.26	0.2	256
410120	410120	15	7.3	84.15	0.2	256
410122	410122	24	15.7	87.92	0.2	256
410126	410126	27	39.2	92.55	0.2	256
410130	410130	34	36.5	91.49	0.2	256
410140	410140	68	122	93.85	0.2	256
410145	410145	24	5.7	92	0.2	256
410148	410148	29	22	92.6	0.2	256
410150	410150	97	46.6	88	0.2	256
410165	410165	69	100	92.51	0.2	256
410170	410170	15	23.8	92.42	0.2	256
410185	410185	83	149.1	96.16	0.2	256
410188	410188	88	65.9	92.16	0.2	256
410190	410190	15	38.3	92.81	0.2	256
410210	410210	96	121.1	81.4	0.2	256
410217	410217	125	71.5	90.56	0.2	256
410218	410218	116	75.9	78.83	0.2	256
410235	410235	15	5.4	75.01	0.2	256

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
410238	410238	63	95.1	86.22	0.2	256
410240	410240	43	49.2	90.45	0.2	256
410242	410242	39	12.4	75.46	0.2	256
410243	410243	15	6.2	88.24	0.2	256
410244	410244	97	81.3	92.64	0.2	256
410245	410245	52	27.3	94	0.2	256
410246	410246	24	45.1	92.36	0.2	256
410247	410247	52	97	91.12	0.2	256
410248	410248	27	13	91.4	0.2	256
410249	410249	48	20.7	91.72	0.2	256
410250	410250	30	25.4	87.77	0.2	256
410255	410255	25	30.1	92.14	0.2	256
410270	410270	22	7	92.98	0.2	256
410275	410275	15	4	90.92	0.2	256
410276	410276	29	23.7	92.42	0.2	256
410277	410277	26	7.9	91.7	0.2	256
410278	410278	29	29	90.01	0.2	256
410279	410279	26	7.2	93.4	0.2	256
410282	410282	15	19.9	93.52	0.2	256
410284	410284	24	9.5	92.65	0.2	256
410285	410285	15	8.7	91.13	0.2	256
410288	410288	15	10	91.78	0.2	256
410291	410291	33	30.5	91.78	0.2	256
410292	410292	24	12.5	91	0.2	256
410295	410295	24	7.5	88.73	0.2	256
410296	410296	36	27.7	92.77	0.2	256
410297	410297	53	15.2	91.37	0.2	256
410299	410299	50	60.9	83.15	0.2	256
410300	410300	19	26.5	87.19	0.2	256
410320	410320	96	33.6	87.61	0.2	256
410330	410330	66	42.2	92.33	0.2	256
410332	410332	31	3.9	93.3	0.2	256
410335	410335	52	109.1	86.18	0.2	256
410336	410336	32	16.7	80.36	0.2	256
410337	410337	37	27.1	85.16	0.2	256
410338	410338	88	103.1	91.82	0.2	256
410340	410340	15	17.2	87.63	0.2	256
410341	410341	38	10.2	86.58	0.2	256
410342	410342	32	9.9	85.3	0.2	256
410343	410343	41	11.6	90.12	0.2	256
410344	410344	24	14.7	91.71	0.2	256
410345	410345	15	21.4	91.71	0.2	256
410346	410346	35	13.9	91.07	0.2	256
410347	410347	36	8.5	92.31	0.2	256
410348	410348	33	12.6	89.5	0.2	256
410360	410360	31	47	88.39	0.2	256
410390	410390	26	11.8	92.41	0.2	256
410410	410410	75	59.2	91.38	0.2	256

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
410430	410430	58	20.2	86.01	0.2	256
410450	410450	34	121.6	92.29	0.2	256
410460	410460	75	329.9	92	0.2	256
410462	410462	35	10	89.65	0.2	256
410464	410464	31	5.4	90.47	0.2	256
410466	410466	45	18.1	87.7	0.2	256
410469	410469	95	110.7	92.21	0.2	256
410470	410470	70	54.2	85.28	0.2	256
410480	410480	58	17.7	84.02	0.2	256
410500	410500	135	157.6	89.42	0.2	256
410501	410501	43	65.5	91.3	0.2	256
410503	410503	32	48.5	93.44	0.2	256
410510	410510	33	9	82.16	0.2	256
410530	410530	31	41.3	86.64	0.2	256
410535	410535	28	19.9	93.67	0.2	256
410540	410540	26	40.9	90.92	0.2	256
410548	410548	32	34.8	90.63	0.2	256
410560	410560	24	6	90.89	0.2	256
410570	410570	54	125.5	90.03	0.2	256
410580	410580	83	490.5	91.13	0.2	256
410581	410581	15	21.9	90.87	0.2	256
410582	410582	15	29.3	91.39	0.2	256
410583	410583	36	59.1	88.03	0.2	256
410584	410584	34	8.6	83.73	0.2	256
410585	410585	24	34.8	83.41	0.2	256
410586	410586	42	49.3	90.94	0.2	256
410590	410590	31	22.2	86.84	0.2	256
410600	410600	57	62.5	87.96	0.2	256
410607	410607	25	36.7	91.67	0.2	256
410610	410610	29	49	87.84	0.2	256
410620	410620	83	184.6	87.88	0.2	256
410630	410630	103	93.4	79.83	0.2	256
410631	410631	141	261.3	92.2	0.2	256
410633	410633	31	18.8	94.19	0.2	256
410635	410635	41	92	93.24	0.2	256
410637	410637	170	174.7	88.09	0.2	256
410639	410639	26	23.1	92.5	0.2	256
410645	410645	71	69.8	93.2	0.2	256
410650	410650	58	110.3	87.32	0.2	256
410657	410657	37	22.9	82.83	0.2	256
410660	410660	53	56.7	86.66	0.2	256
410665	410665	40	29.2	82.75	0.2	256
410670	410670	15	10.2	81.02	0.2	256
410680	410680	15	8.7	80.47	0.2	256
410682	410682	39	77.8	89.72	0.2	256
410684	410684	66	84.8	88.91	0.2	256
410800	410800	47	56.7	82.88	0.2	256
410801	410801	79	84.2	80.79	0.2	256

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
410810	410810	25	36.7	83.34	0.2	256
410820	410820	19	13.9	85.04	0.2	256
410830	410830	29	37.8	85.07	0.2	256
410832	410832	23	47	85.61	0.2	256
410840	410840	41	69.3	85.21	0.2	256
410847	410847	32	28.9	88.32	0.2	256
410850	410850	76	187.5	89.75	0.2	256
410852	410852	27	36.4	83.74	0.2	256
410854	410854	28	34.9	84.86	0.2	256
410856	410856	44	22.2	84.31	0.2	256
410857	410857	15	15.9	84.71	0.2	256
410858	410858	40	7.3	78.96	0.2	256
410860	410860	36	28.8	86.17	0.2	256
410865	410865	60	21.1	80.33	0.2	256
410870	410870	37	27	82.8	0.2	256
410880	410880	15	15.4	83.25	0.2	256
410900	410900	43	16.8	87.85	0.2	256
411010	411010	39	41.7	84.64	0.2	256
411015	411015	24	24	83.7	0.2	256
411020	411020	36	54.3	87.86	0.2	256
411025	411025	25	37.6	90.6	0.2	256
411040	411040	27	42.7	90.4	0.2	256
411042	411042	25	30	90.46	0.2	256
411044	411044	47	29.1	83.53	0.2	256
411046	411046	31	11.8	76.3	0.2	256
411060	411060	30	27.7	83.03	0.2	256
411065	411065	29	10.9	81.91	0.2	256
411066	411066	27	10.7	84.9	0.2	256
411070	411070	39	29.9	91.86	0.2	256
411074	411074	27	24.3	85.26	0.2	256
411075	411075	47	90.1	86.85	0.2	256
411080	411080	38	25	88.7	0.2	256
411085	411085	15	7.6	90.16	0.2	256
411090	411090	28	2.5	73.72	0.2	256
411110	411110	25	21.5	85.39	0.2	256
411111	411111	45	20.4	84.36	0.2	256
411115	411115	44	46.4	81.69	0.2	256
411116	411116	39	18.8	84.56	0.2	256
411120	411120	48	43.1	88.01	0.2	256
411122	411122	21	20.6	82.4	0.2	256
411125	411125	24	30.9	84.85	0.2	256
411127	411127	17	11.8	79.06	0.2	256
411130	411130	64	58.6	82.48	0.2	256
411135	411135	35	29.9	85.62	0.2	256
411138	411138	28	7.5	87.62	0.2	256
411587	411587	38	34.3	88.53	0.2	256
411589	411589	69	114.7	89.81	0.2	256
411700	411700	37	53.2	81.89	0.2	256

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
411710	411710	40	63.5	82.44	0.2	256
411720	411720	32	46.7	89.31	0.2	256
411730	411730	37	29.9	90.92	0.2	256
411920	411920	39	13.8	90.42	0.2	256
411945	411945	28	9.8	90.96	0.2	256
411960	411960	56	18.3	90.13	0.2	256
411970	411970	27	10.6	94.86	0.2	256
411975	411975	32	21	90.8	0.2	256
411981	411981	28	9	91.26	0.2	256
411983	411983	25	18	94.49	0.2	256
411986	411986	38	31	93.5	0.2	256
411987	411987	15	14.4	94.4	0.2	256
411990	411990	44	54.5	94.26	0.2	256
412940	412940	22	5.7	93.32	0.2	256
412960	412960	35	48.5	85.36	0.2	256
412980	412980	38	39.9	90.2	0.2	256
412990	412990	25	4.3	85.07	0.2	256
413900	413900	44	39.6	86.42	0.2	256
413910	413910	40	25.4	87.82	0.2	256
413911	413911	33	10.2	84.91	0.2	256
413912	413912	38	8.2	86.64	0.2	256
413913	413913	29	17.4	91.12	0.2	256
413916	413916	23	3.5	91	0.2	256
413917	413917	27	7.5	91.02	0.2	256
413918	413918	15	2.7	91.04	0.2	256
413930	413930	36	27.9	91.34	0.2	256
413940	413940	135	123.5	90.01	0.2	256
413944	413944	43	46.5	91.24	0.2	256
413946	413946	38	54.4	90.88	0.2	256
413960	413960	69	57.2	91.55	0.2	256
413962	413962	57	60.5	92.53	0.2	256
413964	413964	31	11.2	91.08	0.2	256
413966	413966	67	25.1	91.34	0.2	256
413968	413968	72	46.6	91.7	0.2	256
413980	413980	64	184.8	86.09	0.2	256
414050	414050	23	7.8	85.62	0.2	256
414100	414100	25	9.1	85.64	0.2	256
414150	414150	33	47.3	91.32	0.2	256
414155	414155	90	126.4	89	0.2	256
414205	414205	48	26.3	93	0.2	256
414250	414250	102	82.4	89.3	0.2	256
414300	414300	76	39.7	85.47	0.2	256
414343	414343	24	17.5	84.55	0.2	256
414345	414345	53	73.1	89.62	0.2	256
414350	414350	19	5.9	88.88	0.2	256
414351	414351	67	90.5	88.18	0.2	256
414354	414354	48	28.2	81.22	0.2	256
414357	414357	93	37.3	85.66	0.2	256

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
414359	414359	38	89.7	91.34	0.2	256
414360	414360	77	59	81.8	0.2	256
414362	414362	37	46.5	91.04	0.2	256
414365	414365	115	91.1	84.98	0.2	256
414366	414366	107	64	93.2	0.2	256
414368	414368	15	17.2	90.79	0.2	256
414450	414450	149	97.7	90.73	0.2	256
414500	414500	20	3.9	91.17	0.2	256
414510	414510	22	4.3	91.1	0.2	256
414520	414520	24	11.8	91.69	0.2	256
414530	414530	35	26.6	92.18	0.2	256
414540	414540	46	39.5	90.58	0.2	256
414560	414560	22	4.2	91.16	0.2	256
414570	414570	42	23.5	92.06	0.2	256
414580	414580	20	2.1	93.44	0.2	256
414582	414582	24	9.4	94.04	0.2	256
414590	414590	42	23.7	93.1	0.2	256
414592	414592	40	18.5	81.5	0.2	256
414600	414600	39	16.7	91.13	0.2	256
414650	414650	48	26.8	91.3	0.2	256
414660	414660	49	63.8	92.14	0.2	256
414670	414670	41	63.9	92.2	0.2	256
414680	414680	42	65.5	90.71	0.2	256
414700	414700	49	83.5	90.7	0.2	256
414710	414710	34	59.5	93.53	0.2	256
414720	414720	48	99.6	91.79	0.2	256
414760	414760	46	46.4	88.61	0.2	256
414850	414850	30	31.1	90.32	0.2	256
414855	414855	15	11.5	92.08	0.2	256
414900	414900	26	25	92.37	0.2	256
415150	415150	41	14.2	91.08	0.2	256
415170	415170	44	22.7	90.34	0.2	256
415185	415185	61	85.3	91.8	0.2	256
415190	415190	27	11	91.62	0.2	256
415195	415195	43	52	93.14	0.2	256
415199	415199	47	60.5	89.83	0.2	256
415200	415200	35	32.9	94.21	0.2	256
415210	415210	28	10.6	92.26	0.2	256
415270	415270	40	21.9	80.9	0.2	256
415276	415276	15	7.6	94.75	0.2	256
415277	415277	17	16.8	94.8	0.2	256
415279	415279	25	20.8	91.54	0.2	256
415280	415280	102	121.9	93.19	0.2	256
415300	415300	88	212.6	89.36	0.2	256
415304	415304	27	2.2	85.24	0.2	256
415305	415305	15	0.8	85.24	0.2	256
415306	415306	15	1.7	85.24	0.2	256
415307	415307	26	4.8	85.24	0.2	256

SUBBASIN	JUNC	TC	ACRE	CN	IACOEF	K
415309	415309	30	1.2	85.24	0.2	256
415310	415310	15	0.4	85.24	0.2	256
415311	415311	15	0.2	85.24	0.2	256
415312	415312	30	1.5	85.24	0.2	256
415320	415320	54	65.9	91.75	0.2	256
415350	415350	15	15.8	85.72	0.2	256
415400	415400	56	29.6	90	0.2	256
415500	415500	96	697.6	91.4	0.2	256
415505	415505	57	26.1	84.38	0.2	256
415510	415510	26	6.9	90.69	0.2	256
415515	415515	28	7.2	90.02	0.2	256
415520	415520	35	25.1	84.36	0.2	256
415530	415530	45	34.7	88.22	0.2	256
415540	415540	42	19.9	88.06	0.2	256
415545	415545	62	32.8	91.99	0.2	256
415550	415550	68	38.8	90.17	0.2	256
415600	415600	77	248.6	85.24	0.2	256
415600	415600	77	235.8	85.24	0.2	256
419902	419902	15	11.8	89.73	0.2	256
419910	419910	62	60	89.8	0.2	256
419920	419920	42	62.6	90.68	0.2	256
419922	419922	25	3.8	85.08	0.2	256
419924	419924	42	10.4	84.84	0.2	256
419926	419926	37	21.1	84.38	0.2	256
419928	419928	42	53.4	84.43	0.2	256
419929	419929	33	18.6	82.67	0.2	256
419935	419935	56	71.2	83.25	0.2	256
419942	419942	45	29.9	82.78	0.2	256
419946	419946	15	3.3	87.65	0.2	256
419950	419950	27	10.3	95.2	0.2	256
419955	419955	26	8.2	83.41	0.2	256
419960	419960	27	20.1	84.81	0.2	256
419965	419965	24	9.4	82.87	0.2	256
419970	419970	42	34.3	89.3	0.2	256
419980	419980	22	4.6	81.23	0.2	256

4.1.4 Basin Delineations

To provide the level of detail that was deemed necessary to accurately define and properly analyze the primary drainage facilities within the Sweetwater Creek watershed, the basin was divided into a total of 291 discrete subbasins that range in size from 2 to 696 acres. The average subbasin size is approximately 46 acres.

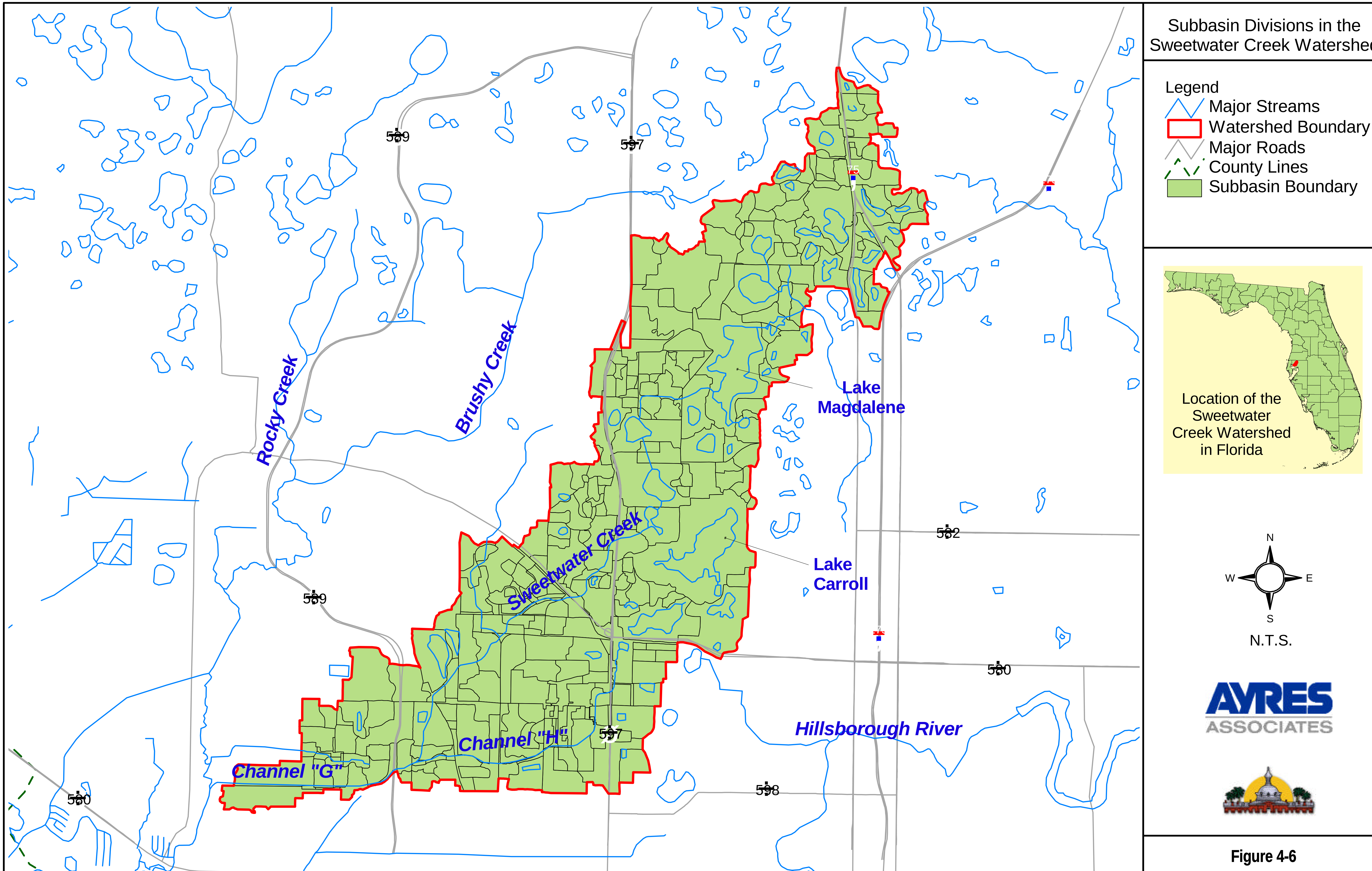
The delineation of individual subbasins was dictated to a large extent by the primary drainage network itself and the need to properly define the contributing drainage area into individual elements of the conveyance system and storage facilities. The determination of the basin boundaries within the watershed were made on the basis of the existing physical features such as the topography, storage areas, and conveyance elements (pipes, channels, etc.) which describe the hydraulic system. Subbasin designations were also selected to segregate drainage areas of homogeneous land use and/or define the complete contributing drainage area of a secondary drainage system at its outfall to the modeled primary network.

Figure 4-6 shows the delineation of the Sweetwater Creek basin into its 291 individual subbasins. The nomenclature convention for the SWMM model representation assigns the subbasin name corresponding to the model junction (node) that serves as the outfall for the subbasin. A 7 character numerical code nomenclature was used in model formulation. The first four digits refer to the major basin. In this case, "0414", and "0415" refers to the Channel H drainage basin, and "041X" refers to the Channel G and Upper Sweetwater Creek basins.

The means of defining subbasin boundaries employed a number of sources of information and methods. The principle source was SWFWMD one-foot contour aerial topographic mapping (1"=200' scale) of the watershed. This mapping shows overland topography, thus indicating direction of overland flow. In addition, various reports describing hydrologic studies conducted in the basin were reviewed and the information was incorporated into this study. However, much of the watershed is developed with a variety of residential, commercial, industrial, and institutional developments. As a result of this development, man-made secondary drainage systems comprising swales, gutters, storm sewer systems, ditches, and detention ponds have interrupted the natural overland flow patterns within the basin and, in many cases, diverted storm runoff in directions that are not readily apparent from inspection of the topographic mapping. It is also important to note that much of the SWFWMD mapping within the basin dates back as far as 1978. Therefore, new development that has occurred within the watershed since that time does not show on these maps. Such new development has resulted in the alteration of the original drainage patterns, including the integration of previously existing closed basins to the creek system.

To assist in the delineation of subbasin boundaries, available record drawings of county and state roads within the basin were also used to define the drainage facilities and contributing drainage areas that are served by these systems. This model incorporates a major review of record drawings of permitted stormwater management facilities within the basin on file with SWFWMD as a means of defining the drainage systems and contributing drainage areas for new development that did not show up on any of the other information sources.

Additionally, limited field inspections were utilized to resolve conflicting information from the collected information. The uncertainties for subbasin delineation were minimized by the use of recent aerial photographs. The current subbasin delineations provide adequate model accuracy for basin planning purposes, however, better definition will be needed if the model is to be used to evaluate hydraulic conditions for individual developments and secondary drainage systems.



Subbasin Divisions in the Sweetwater Creek Watershed

Figure 4-6

The delineated basins and subbasins were digitized in GIS format and combined with the County's base map. In this, manner it was possible to combine the subbasin data with base map information as well as with the land use and soil data provided by the County.

The resulting basin delineations were digitized utilizing ArcInfo (ESRI Version 7.0) for subsequent usage in runoff curve number determinations. Each basin was assigned a unique seven digit identifier as specified by the Hillsborough County Stormwater Management Master Plan Hydrologic and Hydraulic Model Set-up Standard, (Hillsborough County Stormwater Management Section, Engineering Division, Public Works Department, February 1999). All GIS data has been prepared in compliance with the GIS data format outlined by the Southwest Florida Water Management District Watershed Data Management System for Engineering, (SWFWMD Engineering and GIS Section, May 1999). These basin delineations were presented to Hillsborough County, on a subwatershed basis, for review and approval, prior to commencing the hydrologic and hydraulic modeling efforts.

4.1.5 Runoff Curve Numbers

The SCS Runoff Curve Number (CN) method was used to generate runoff from rainfall. The method estimates the runoff from soil and land cover characteristics. Runoff Curve numbers are assigned based upon the land use and hydrologic soil group. The runoff CN value is an index that represents the combined hydrologic effect of hydrologic soil group, cover type, land use, hydrologic condition, and antecedent soil moisture condition. Curve numbers were calculated over the course of this study for each subbasin by an area-weighted averaging procedure which assigned a universal CN value to each of the designated land use categories and then calculated the subbasin average based on the relative percentages of the various land uses within it.

The procedure used to obtain each subbasin CN was as follows. CNs were assigned to each land use category based on literature values for all soil types. A weighted land-use-based CN for each soil type was then calculated for each subbasin. Subsequently, the weighted land use CN was weighted again for each subbasin based on soil distribution.

The universal values, which were initially used to derive the subbasin area-weighted CN averages, are as shown in Table 4-2. In this table, a matrix is shown which relates the CN as a function of land use category and soil type. CN values are based on assumed average antecedent soil moisture conditions. The Soil Conservation Service definition of 'average' antecedent moisture conditions is when the total 5-day antecedent precipitation is between 0.5 and 1.1 inches. It is reiterated that these universal values were derived initially using literature values that were provided by SWFWMD. CN values were not changed during the calibration process.

Table 4-2 Standard Hillsborough County Curve Number Table

	Description		Soil Group						
		New Code	A	B	C	D	A/D	B/D	W
1	Residential LOW Density <2 DUA	1100	50	68	79	84	68	81.5	100
2	Residential MED Density 2->5 DUA	1200	57	72	81	86	72	83.5	100
3	Residential High Density	1300	77	85	90	92	85	91	100

	Description		Soil Group						
		New Code	A	B	C	D	A/D	B/D	W
4	Commercial and Services	1400	89	92	94	95	92	94.5	100
5	Industrial	1500	81	88	91	93	88	92	100
6	Extractive	1600	77	86	91	94	86	92.5	100
7	Institutional	1700	59	81	87	90	81	88.5	100
8	Recreational	1800	49	69	79	84	84	81.5	100
9	Open Land	1900	39	61	74	80	80	77	100
10	Cropland and Pastureland	2100	49	69	79	84	84	81.5	100
11	Row Crops	2140	49	69	79	84	84	81.5	100
12	Tree Crops	2200	44	65	77	82	82	79.5	100
13	Feeding Operations	2300	73	83	89	92	92	90.5	100
14	Nurseries and Vineyards	2400	57	73	82	86	86	84	100
15	Specialty Farms	2500	59	74	82	86	86	84	100
16	Tropical Fish Farms	2550	59	74	82	86	86	84	100
17	Other Open Lands (Rural)	2600	30	58	71	78	78	74.5	100
18	Herbaceous	3100	63	71	81	89	89	85	100
19	Shrub and Brushland	3200	35	56	70	77	77	73.5	100
20	Mixed Rangeland	3300	49	69	79	84	84	81.5	100
21	Upland Coniferous Forest	4100	45	66	77	83	83	80	100
22	Pine Flatwoods	4110	57	73	82	86	86	84	100
23	Longleaf Pine - Xeric Oak	4120	43	65	76	82	82	79	100
24	Upland Hardwood Forests - Part I	4200	36	60	73	79	79	76	100
25	Hardwood Conifer Mixed	4340	36	60	73	79	79	76	100
26	Tree Plantations	4400	36	60	73	79	79	76	100
27	Streams and Waterways	5100	100	100	100	100	100	100	100
28	Lakes	5200	100	100	100	100	100	100	100
29	Reservoirs	5300	100	100	100	100	100	100	100
30	Bays and Estuaries	5400	100	100	100	100	100	100	100
31	Wetland Hardwood Forests	6100	98	98	98	98	98	98	98
32	Bay Swamps	6110	98	98	98	98	98	98	98
33	Mangrove Swamps	6120	98	98	98	98	98	98	98
34	Stream and Lake Swamps (Bottomland)	6150	98	98	98	98	98	98	98
35	Wetland Coniferous Forests	6200	98	98	98	98	98	98	98
36	Cypress	6210	98	98	98	98	98	98	98
37	Wetland Forests Mixed	6300	98	98	98	98	98	98	98
38	Vegetated non-Forested Wetlands	6400	98	98	98	98	98	98	98
39	Freshwater Marshes	6410	98	98	98	98	98	98	98
40	Saltwater Marshes	6420	98	98	98	98	98	98	98
41	Wet Prairies	6430	98	98	98	98	98	98	98
42	Emergent Aquatic Vegetation	6440	98	98	98	98	98	98	98
43	Non-Vegetated	6500	98	98	98	98	98	98	98
44	Tidal Flats / Submerged Shallow Platform	6510	98	98	98	98	98	98	98
45	Shorelines	6520	98	98	98	98	98	98	98
46	Intermittent Ponds	6530	98	98	98	98	98	98	98
47	Beaches other than Swimming Beaches	7100	77	86	91	94	94	92.5	100
48	Disturbed Land	7400	77	86	91	94	94	92.5	100
49	Transportation	8100	81	88	91	93	88	92	100
50	Communication	8200	81	88	91	93	88	92	100
51	Utilities	8300	81	88	91	93	88	92	100

Curve Number Generation

Utilizing ARC-Info, the land use and soil coverage was intersected with each other to generate polygons consisting of a single land cover and soil type. These resulting polygons were then intersected with the basin delineations, further subdividing the polygons. This procedure results in the generation of unique polygons consisting of a single basin number, land use, and soil type. Table 4-2 contains the lookup table, provided by Hillsborough County, utilized to assign a runoff curve number to each unique polygon. These resulting curve numbers were then area weighted to develop individual basin curve number for use in the hydrologic modeling.

4.1.6 Initial Abstraction

An initial abstraction value of 0.2 is utilized throughout the study area as specified by Hillsborough County. Soil storage is computed as a function of the initial abstraction and runoff curve number according to SCS guidelines and literature. An initial abstraction ratio to define a certain volume of precipitation at the beginning of a storm event which will not appear as runoff. It represents hydrologic processes such as surface wetting, interception, and depression storage.

4.1.7 Shape Factor

For the SCS Unit Hydrograph Method, which the SWMM model uses, a non-dimensional unit hydrograph must be defined for each subbasin. Specifically, a unit hydrograph peaking factor must be specified. The selection of a unit hydrograph peaking factor depends on the geographical area and local conditions. For example, flatter coastal areas with above average depressional storage have been shown to have lower peaking factors than hillier regions. For use in the extremely flat terrain of the Sweetwater Creek basin, a unit hydrograph peaking factor of 256 was selected based on literature research and other model applications within south Florida watersheds, and as recommended in the County’s stormwater manual.

4.2 Hydraulics

4.2.1 Hydraulic Model

The most important aspect of any drainage basin master plan is the proper representation of the current flooding conditions throughout the watershed. A good understanding of basinwide hydrologic and hydraulic processes is necessary to determine the most effective means of controlling flooding and protecting public safety and environmental resources. These models are the main tools used to assess basin-flooding conditions and expected levels of service (LOS), and allow the evaluation of stormwater management options in the study area.

The Hillsborough County Storm Water Management Model utilizes a modified version of the Environmental Protection Agency (EPA) Stormwater Management Model v.4.31a (SWMM) Extended Transport Block (EXTRAN). The version utilized in this study was Hillsborough County SWMM 4.31b.

The hydrologic model output is delivered to EXTRAN, which is the hydraulic model and provides dynamic flood routing of flow through channels, lakes, and control structures such as bridges, culverts, storm sewers, weirs, pumps, and orifices. EXTRAN accounts for conservation of mass, energy, and momentum in its hydraulic algorithms, thereby representing looping, splits, flow reversals, etc. in the hydraulic system network should they occur. EXTRAN utilizes a numerical method to solve the St. Venant Equations for gradually varied, unsteady flow in open channels, and computes time dependent values for flow rate and water surface elevation.

Modifications within the County version, performed by County staff, include assigning entrance and exit loss coefficients, assigning reach numbers to weirs and orifices, provisions for modeling elliptical and arch pipes, and a "stretch" factor to elongate conduits that, left unaltered, would be numerically unstable. The addition of these parameters allows the preservation of the original input data for pipe length, geometry, and type.

4.2.2 Natural Channels

The EXTRAN model data requirements for the open channel reaches of the primary drainage system of the Sweetwater Creek watershed include channel cross-section information that is of sufficient detail to define not only the shape of the channel within the confines of its banks, but for a sufficient distance outward from the banks into the floodplain when deemed necessary. There were a variety of sources of channel cross section and drainage structure data that were utilized in the formulation of the EXTRAN model. This study used what we judged to be the most current, detailed, and representative source of information available for any particular reach of the open channel system. The data for the channel geometry was derived from a variety of locations. The first, and most prevalent, was from channel cross-section field survey data provided by the County and performed by the County survey team. Additional information was obtained from previous studies of specific channel reaches, or construction plans in particular locations. Previous studies include Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS), SWFWMD studies, and studies performed by other consultants for a variety of public clients. Channel geometry from these sources was supplemented with information taken from the SWFWMD topographic aerials for overbank detail. In some cases, channel cross sections were modified on the basis of model needs and other data sources for the same channel reach in an effort to obtain the best representation.

One of the most overlooked, but extremely important, parameters of the EXTRAN model representation of open channel reaches is the selection of an appropriate channel roughness coefficient, or Manning's n, value. This value is a measure of the relative degree of hydraulic efficiency (retardance) of a channel and is dependent upon factors such as the extent and type of channel vegetation, channel bottom material, channel irregularity, channel alignment, obstructions, and depth of flow.

Manning's roughness coefficients were evaluated from the following literature sources:

- Determination of Roughness Coefficients for Streams In West-Central Florida, US Geological Survey Open-File Report 96-226
- Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains, US Department of Transportation, Federal Highway Administration Report No. FHWA-TS-84-204
- Open Channel Hydraulics, 1959, V.T. Chow
- Handbook of Applied Hydrology, 1964, V.T. Chow

This information, combined with Ayres Associates staff's previous experience with channel systems throughout Florida, was utilized to set the initial values for Manning's roughness. These values were either confirmed or adjusted during the calibration / verification phase of the study.

4.2.3 Conduits

Like natural channel geometry, the data for conduits were taken from field survey information, and supplemented with information from previous studies or construction plans, when available.

For the EXTRAN model, equivalent conduits or pipes (through parallel and series equivalent pipes) were created to ensure model stability, account for local or transitional hydraulic head losses, and simplify the total number of conduits in the model. This was accomplished through established standard methods based upon Manning's equation. This equation for the calculation of frictional loss is the sole basis within EXTRAN for the calculation of total head loss in a closed conduit.

Equivalent conduits are needed for one or more of the following reasons:

- Produce an equivalent conduit to account for local losses in the existing conduit (sometimes called minor losses);
- Lengthen a conduit for model stability (wave celerity criterion);
- Produce an equivalent conduit to account for several existing conduits of equal size or geometry that are in parallel;
- Produce an equivalent bridge; and/or
- Produce an equivalent conduit to account for several existing conduits that are in series.

The data required for the entrance, exit, and bend losses were taken from the Florida Department of Transportation (FDOT) Drainage Manual for concrete box culverts, as well as concrete and corrugated metal pipe culverts. The "stretch" factor was set to ensure no culvert length would fall below 100'. The value of 100' was based on previous experience with model instabilities, and a desire to minimize the additional system volume introduced when elongating culverts.

It is necessary within the framework of the EXTRAN model to represent bridge structures as either an open channel or some combination of equivalent closed conduits. In the Sweetwater Creek model application, some bridge spans were modeled as their respective surveyed cross-section, with roughness for the piers, unless it was determined that, during expected flooding conditions, the bridge would be in a full flow condition (i.e. water would reach the low chord of the structure, creating a surcharge or pressure flow condition). In such cases, the bridge structures were entered into the model using the guidelines for an equivalent combination of box culverts with different dimensions and/or inverts. The procedure was to:

- Plot the bridge cross section, including piers and bridge low chord elevations
- Estimate a parallel set of box culverts which appear to fit the approximate flow area of the bridge opening at respective depths across the cross-section; and
- Calculate the hydraulic conveyance for the prototype bridge section and for the equivalent set of box culverts and adjust the parallel culvert dimensions (width, inverts, and/or depths) until the terms reasonably match.

4.2.4 Storage Facilities

To properly represent the hydrologic and hydraulic processes of stormwater runoff within a natural watershed, it is important that all significant storage facilities and their hydraulic functions be defined. This is especially important in the Sweetwater Creek watershed where most of the drainage throughout the basin is controlled by the natural lakes, ponds, and wetlands within the watershed. The EXTRAN model allows the user to specify a variable stage-area relationship at any model junction (node) that defines the storage properties at that point, be it a pond, lake, wetland, or other such open surface waterbody.

The SWFWMD topographic aerials were used to obtain stage-area values. For practical reasons, only the storage associated with the detailed hydraulically modeled portions of the system were included in the model. Storage in areas that were far removed from the modeled system was handled by adjustments to the hydrologic parameters during the calibration process, as discussed in Chapter 5.

4.2.5 Weirs

Control structures, roadway overtoppings, and overland flow basin transfers were simulated with broad crested or sharp crested weirs. Weir overflow elevations were obtained from field surveys, previous studies, construction plans, and SWFWMD topographic aerials. Weir widths were also scaled from the SWFWMD topographic aerials. The initial values for basin transfers and roadway overtoppings were adjusted during calibration and verification to provide more realistic results.

4.2.6 Orifices

Model stability forced all pond “Bleed Down” Orifices less than 1-foot in diameter to be removed from this analysis. The use of orifices to model flow conditions in a master planning level study is generally not practical. The normally small amounts of flow conveyed through the orifices in control structures are not significant enough to affect the peak stages and discharges predicted for the design storm events.

4.2.7 Initial Water Surface Elevations

The initial water surface elevations were estimated by evaluating the invert elevations of the channel bottom and conduit inverts. For design storm simulations, it was assumed that the starting water surface elevation was equal to the highest invert of the channels / conduits / control structures downstream of the junction. This procedure provided static water surface elevations within the hydraulic system that provided zero flow at the beginning of the design storm simulation, and allowed for discharge immediately upon introduction from the runoff hydrographs. Calibration events varied from this approach as described in Chapter 5.

4.2.8 Dummy Junctions and Conduits

Dummy junctions and conduits are used in EXTRAN for several reasons. One is to eliminate warnings within the EXTRAN output for a conduit whose invert is perched above the junction invert. A second reason is for a conduit whose crown is lower than the connecting conduit invert. Additional reasons for using dummy junctions and conduits include providing a means to introduce flow from an offline basin whose hydraulic connection is not being modeled in detail, and to allow for only one conduit to connect to an outfall junction. Dummy junctions and conduits are noted as such within the EXTRAN input data files through the use of comment lines.

4.2.9 Boundary Conditions

The EXTRAN model requires specification of hydraulic boundary conditions at all outfall points of the model schematic. In the Sweetwater Creek watershed application, the only basin outlet is located at the downstream end of Channel G where it discharges to Rocky Creek. A constant tailwater boundary condition representing the water elevation of Old Tampa Bay, a tidal waterbody, was specified at elevation 2.6 feet National Geodetic Vertical Datum (NGVD) for all model simulations. This elevation represents a high tide condition.

Another type of boundary condition is specified at model junction 410246, located in the Plantation residential development north of Linebaugh Avenue and east of Nixon Road. During sufficiently high flows, there is an overflow of stormwater runoff from the Rocky/Brushy Creek watershed at this location to the Sweetwater Creek watershed. Hillsborough County provided hydrographs of these flow excursions that were generated from its hydrologic/hydraulic model of the Rocky/Brushy Creek basin for design storm event simulations. These flows were entered into the Sweetwater Creek EXTRAN model as an inflow hydrograph boundary condition at this junction location.

4.2.10 Numerical Instability

In EXTRAN, the solution to the unsteady flow equations can be solved with an implicit or explicit numerical technique. These techniques inherently introduce numerical instabilities and eliminating them often requires the user to adjust the models' input parameters.

Adjustments can include varying the simulation time step, "stretching" conduits, modifying storage relationships, adjusting conduit slopes, changing weir lengths, and adjusting starting water surface elevations. Ayres Associates staff applied these techniques to achieve model stability.

4.2.11 Link-Node Diagrams

The hydraulic model of the Sweetwater Creek Watershed consists of the primary conveyance systems within the watershed. This includes lakes, wetlands, natural channels, pipes, bridges, and control structures. The EXTRAN model uses a link-node (conduit-junction) approach to simulate the hydraulics of the network. Junctions, or nodes, represent discrete locations where conservation of mass is maintained. Conduits, or links, represent the connections between those junctions. Thus, the model performs the required flow calculations for these connections to balance the water surface elevation within specific tolerances between junctions for each timestep.

Each junction and conduit was assigned a unique identifier as specified by the Hillsborough County Stormwater Management Master Plan Hydrologic and Hydraulic Model Set-up Standard, (Hillsborough County Stormwater Management Section, Engineering Division, Public Works Department, February 1999). Link-Node Diagrams for each individual subwatershed can be found in Appendix A.

CHAPTER 5: HYDROLOGIC/HYDRAULIC MODEL CALIBRATION & VERIFICATION

Model calibration refers to the adjustment of model parameters within reasonable limitations so that the model results (i.e., streamflows and water elevations) are in reasonable agreement with a set of measured data. A reasonable range of values for the adjustment of model parameters is established through the review of literature references, and adjustments outside of those ranges are made only if some unusual hydrologic or hydraulic condition exists. Ideally, the model is calibrated to several different storm events that represent a variety of volumes, intensities, and distributions. It is also desirable to calibrate to recorded flow and stage information at different locations within the prototype watershed.

The two primary data requirements for model calibration are gauged rainfall and streamflow for the study area. When selecting a calibration storm event, the rainfall and streamflow data must be sufficiently documented in appropriate time intervals so that variations in rainfall intensity and the associated runoff can be accurately simulated. Data should be recently acquired so that the current land use and hydraulic conditions existing in the study area are accurately represented. Additionally, to account for the non-uniform spatial distribution inherent in Florida precipitation patterns, it is desirable that rainfall data be collected at various station locations throughout the study area.

Calibration of the Sweetwater Creek watershed hydrodynamic model was performed using rainfall and streamflow gauging station data for the December 10-14, 1997 historical storm event, and the December 25-28, 1997 historical storm event as the basis for adjusting the initial model input data, including both hydrologic and hydraulic input parameters.

Using two calibration events, the Sweetwater Creek Stormwater Management Model (SWMM) model was successfully calibrated to emulate observed runoff responses. Rainfall depths and distributions were obtained from four rain gauges located in and around the watershed for calibration. The depths and distributions were then allocated to individual subbasins using the Thiessen Polygon method. The model calibration was performed to match computed stage, discharge, and runoff volume at 1 stream gauge located in Section 30, Township 28, and Range 18 (Storyboard 97).

Calibration began with subwatersheds and conveyance ways in the upstream systems, and successively worked downstream until the gauge data was replicated. Calibration was primarily accomplished by adjusting the watershed parameters and Runoff Curve Number (CN) until the simulation results reasonably matched the field measured values. Parameters related to channel roughness and starting water surface elevations were also adjusted to complete calibration. Table 5-1 summarizes Hillsborough County calibration criteria. Based on the County criteria, the Sweetwater Creek SWMM model is considered calibrated.

Table 5-1 Hillsborough County Calibration Criteria

Event Simulation	Tolerance From Observed		
	Stage	**Flow**	**Volume**
Calibration	≤ 0.5 ft	5% < X < 10%	< 10 %

5.1 Existing Conditions Data Collection

Model validity depended on the availability and quality of appropriate input and calibration data.

5.1.1 Selection

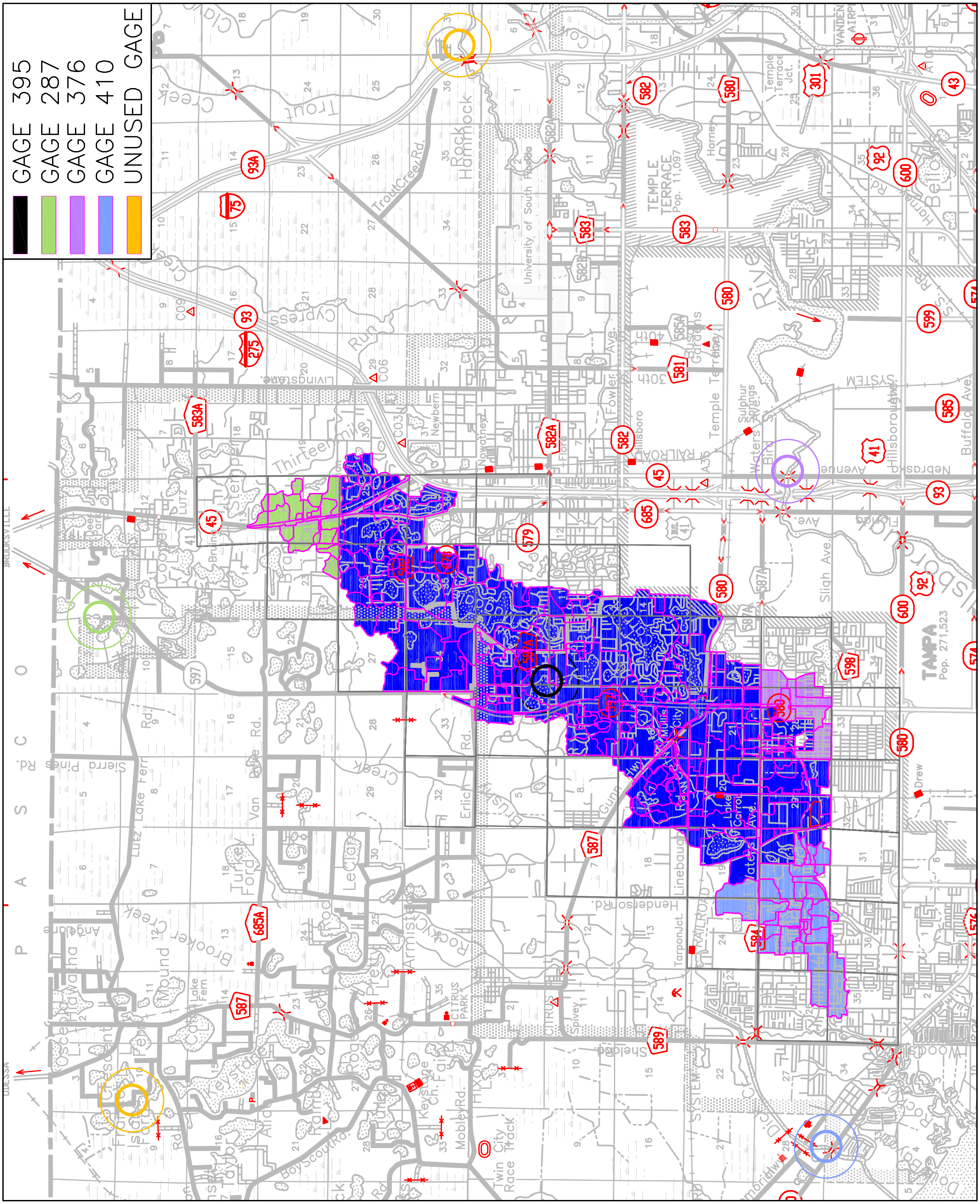
Calibration storm events were selected for flood magnitude, data availability and areal rainfall data coverage. Hourly and daily flow and stage records were obtained from U.S. Geological Survey (USGS) and Southwest Florida Water Management District (SWFWMD). Fifteen-minute, hourly and daily rainfall records were obtained from SWFWMD and the National Oceanic and Atmospheric Administration (NOAA).

Calibration to large magnitude storms was desired since the design storm events used for determining level of service and the flood plain are 25-year and 100-year events, respectively. Therefore, by sorting daily records for flows of large magnitude, potential events were initially identified. For the identified storms, daily rainfall records were then examined for correlation between rainfall and runoff magnitude and uniformity of areal rainfall distribution and AMC.

The four-day storm, which occurred, during December 10-14, 1997 was actually a series of individual storm events that occurred over a 120 hour period. The locations of the nearby gauges for which data were available are shown on the precipitation gauge location map shown in Figure 5-1. Total daily rainfall depths for these gauges are listed in Table 5-2. It should be considered that these are daily accumulations of recorded precipitation and that the time of day of gauge observation will differ between sites. The Thiessen Polygon method was computed for use in the model simulations.

Table 5-2 Total Precipitation Depth in Inches

Gauge Number	December 10-14th Storm Event (inches)	December 25-28th Storm Event (inches)
395	8.11	5.64
410	6.17	6.17
287	4.85	1.89
376	6.26	5.94



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DRAWN BY: DMT
SCALE: NTS

AYRES ASSOCIATES
8875 HIDDEN RIVER PARKWAY, SUITE 200
TAMPA, FLORIDA 33637
(813)978-8688 FAX: (813)978-9369

HILLSBOROUGH COUNTY
DIVISION OF ENGINEERING
PUBLIC WORKS DEPARTMENT
STORMWATER MANAGEMENT SECTION
601 E. KENNEDY BLVD./TAMPA, FLORIDA 33602/PH. 272-5912

PRECIPITATION GAGE LOCATIONS

SWEETWATER CREEK WATERSHED MANAGEMENT PLAN

FIGURE NO.
5-1

5.1.2 Antecedent Moisture Collection

AMC refers to the existing wetness of the basin prior to an event. Since AMC impacts basin storage, soil storage potential, and runoff response, it is an important consideration. AMC is generally classified on a scale of 1 to 3, which are summarized by Table 5-3. Design storm events generally assume AMC-2.

Table 5-3 Antecedent Moisture Conditions

AMC Class	Description	5-Day Antecedent Rainfall Criteria	
		Dormant Season	Growing Season
AMC-1	Low runoff potential. Dry soils.	Less than 0.5"	Less than 1.4"
AMC-2	Average runoff and soil moisture.	0.5" to 1.1"	1.4" to 2.1"
AMC-3	High runoff potential. Saturated soils.	Greater than 1.1"	Greater than 2.1"

Much of the Hillsborough River Basin is characterized by relatively flat topography and high ground water table. Consequently, rainfall depths less than those presented by Table 5-2 may result in runoff response similar to a higher AMC. The December 1997 calibration event was classified as AMC-3.

CN values require adjustment for AMC's other than normal AMC-2. These adjustments are typically made using lookup tables such as Table 5-4. In practice, intermediate CN and AMC values are interpolated.

Table 5-4 AMC Curve Number Lookup Table

AMC-2	AMC-1	AMC-3
0	0	0
5	2	13
10	4	22
15	6	30
20	9	37
25	12	43
30	15	50
32	16	52
34	18	54
36	19	56
38	21	58
40	22	60
42	24	62
44	25	64
46	27	66

AMC-2	AMC-1	AMC-3
60	40	78
62	42	79
64	44	81
66	46	82
68	48	84
70	51	85
72	53	86
74	55	88
76	58	89
78	60	90
80	63	91
82	66	92
84	68	93
86	72	94
88	75	95

AMC-2	AMC-1	AMC-3
48	29	68
50	31	70
52	32	71
54	34	73
56	36	75
58	38	76

AMC-2	AMC-1	AMC-3
90	78	96
92	81	97
94	85	98
96	89	99
98	94	99
100	100	100

(1985) SCS National Engineering Handbook, Section 4: Hydrology

5.1.3 Precipitation Data

Successful model calibration begins with accurate assignment of rainfall depth over time to the individual subbasins. Precipitation data from the four rainfall gauge stations plotted in Figure 5-1 was available for this analysis. For the selected calibration events, gauge coverage within the watershed was generally good.

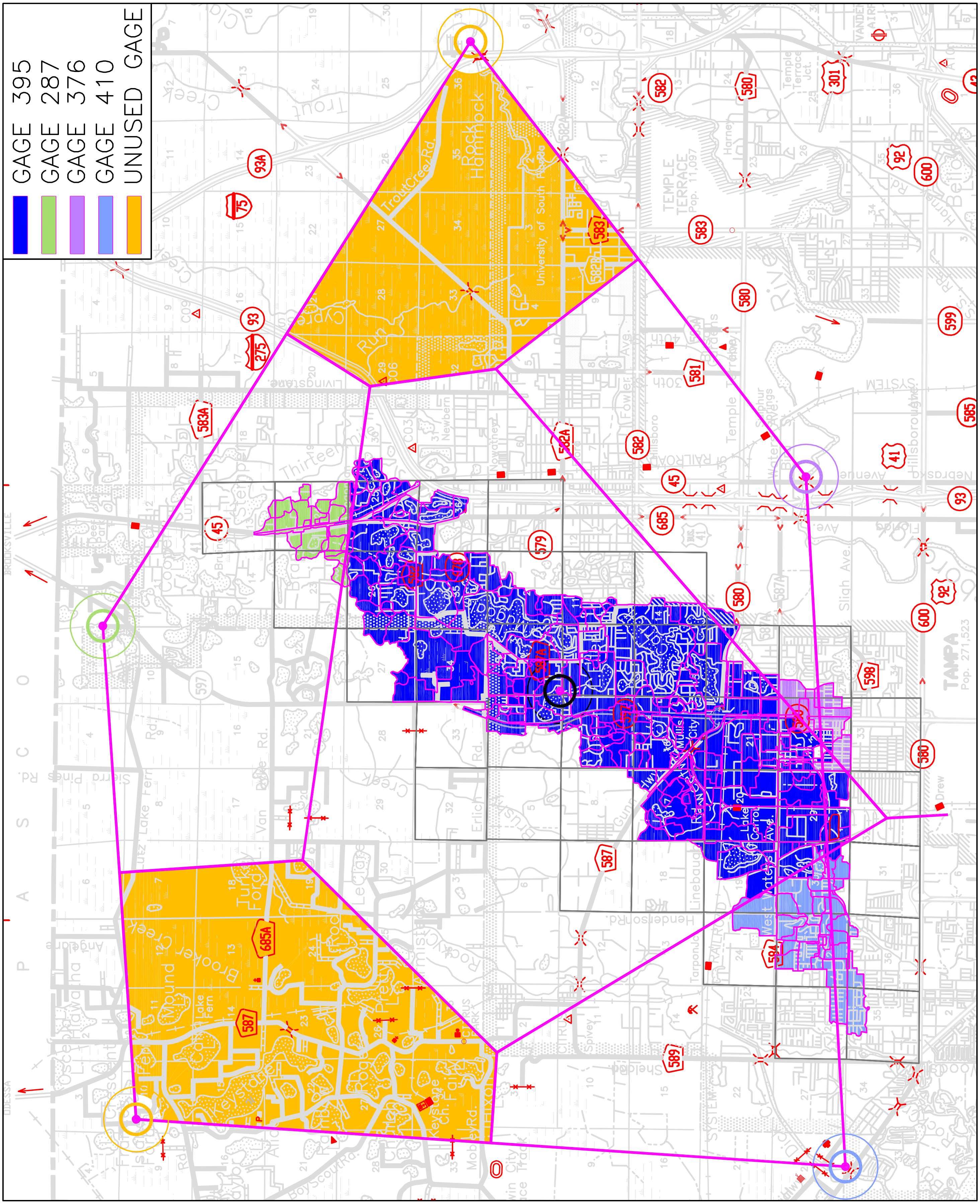
Before assigning rainfall to the subbasins, the available rainfall data was thoroughly reviewed for reliability and consistency. Gauge records with data missing at times other than that of principal rainfall were repaired by assuming the same precipitation depths reported at the nearest working gauge. This allowed use of the most site-specific information without reliance on questionable data. Several gauge records were simply deemed too unreliable or incomplete for use.

Calibration rainfall depths were obtained by summing the measured rainfalls at selected fifteen-minute, hourly, and daily rain gauges. Aerial assignment of rainfall depth from the gauges to the individual subbasins was accomplished using the Thiessen Polygon method. Connecting lines were drawn between adjacent rain gauge stations on a map. Perpendicular bisectors were then drawn to form polygons around each gauge. Subbasins mostly within a rain gauge polygon were assigned the rainfall depth from that gauge. Figure 5-2 present the Thiessen Polygon subbasin maps for depth from the December 1997 calibration events.

Calibration rainfall distributions were obtained from fifteen-minute and hourly rain gauges. Incremental rainfall depths were then accumulated on an hourly basis to develop cumulative rainfall distributions. Finally, these distributions were divided by total rainfall depth to create dimensionless distributions for model input.

5.1.4 Surface Water Data

Surface water data used in this analysis included records from 1 stream gauge sites located at a flow control structures. The gauge location is plotted in Figure 5-3.Stream gauge records were used to benchmark model calibration. Available data included continuous and peak condition measurements of stage and flow. Model calibration was mostly based on fifteen-minute data from continuous gauge stations. Daily and peak data was also consulted in lieu of unavailable fifteen-minute data. Flow and stage hydrographs were created from text files containing gauge data.



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SCALE: NTS

AYRES ASSOCIATES
8875 HIDDEN RIVER PARKWAY, SUITE 200
TAMPA, FLORIDA 33637
(813)978-8688 FAX: (813)978-9369

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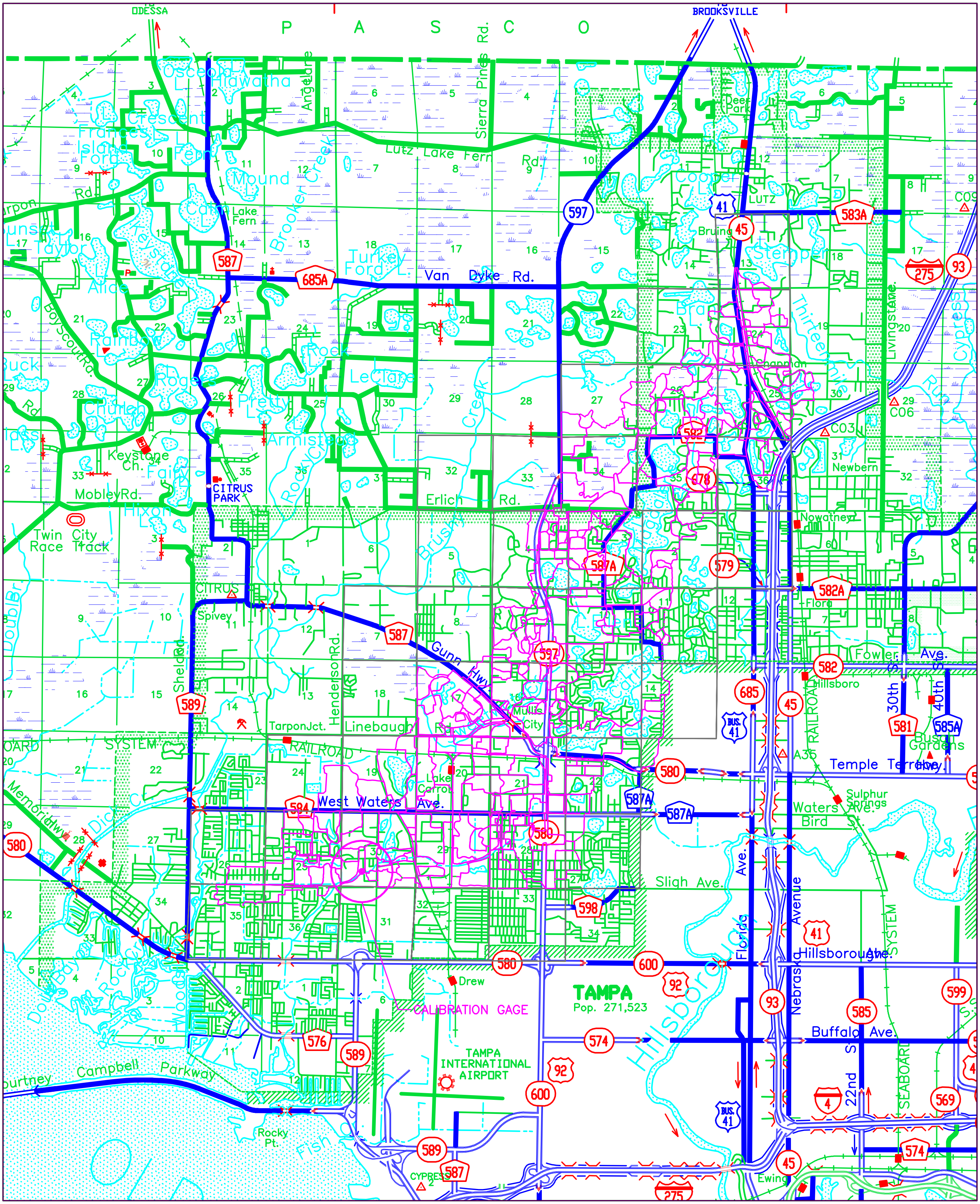
THIESSEN POLYGON DISTRIBUTION

SWEETWATER CREEK WATERSHED
MANAGEMENT PLAN

FIGURE NO.
5-2



GAGE LOCATION.DWG			FIGURE NO.
SCALE: NTS	HILLSBOROUGH COUNTY DIVISION OF ENGINEERING PUBLIC WORKS DEPARTMENT STORMWATER MANAGEMENT SECTION 601 E. KENNEDY BLVD./TAMPA, FLORIDA 33602/PH. 272-5912	CALIBRATION GAGE LOCATION MAP	5-3
AYRES ASSOCIATES 8875 HIDDEN RIVER PARKWAY, SUITE 200 TAMPA, FLORIDA 33637 (813)978-8688 FAX: (813)978-9369		SWEETWATER CREEK WATERSHED MANAGEMENT PLAN	N

5.2 Calibration Parameters and Methodology

The Hillsborough County Storm Water Management Model (HCSWMM) included hydrologic (RUNOFF) and hydraulic (EXTRAN) computational blocks. The overall HCSWMM model was methodically assembled from individual subwatershed models calibrated to emulate real flood events.

5.2.1 Hydrologic Parameters

HCSWMM's HEC-1 routine transforms rainfall into runoff and may be used for simple flow routing. In general, HCSWMM was calibrated to match stormwater volume, peak flow rate and flow hydrograph shape. Calibration parameters within the hydrologic portion of HCSWMM include:

- Time of Concentration (TOC): Effects start time of runoff response and hydrograph shape. Accounts for the travel time of unconcentrated flow.

- Runoff Curve Number, CN: Effects total runoff volume. Accounts for soil, land use, and Antecedent Moisture Condition characteristics.

- Unit Hydrograph Peaking (Shape) Factor, Pf, Effects hydrograph shape. Accounts for basin attenuation.

- Initial Abstraction, I_a, Effects initial runoff response and total runoff volume. In the Hillsborough County SWMM, I_a is not adjustable. Accounts for interception storage, evaporation, and evapotranspiration processes that reduce rainfall available for transform into runoff.

As was previously discussed, in the SWMM model calibration for the Sweetwater Creek basin, these parameters were initially derived using accepted methods and values derived from literature research and from past model applications in the region. Their final values were ultimately derived through the model calibration process.

The single most important parameter in the SCS Runoff Curve Number Method which governs the volume of stormwater runoff for a storm event is the runoff curve number. The other listed parameters will dictate the shape of the storm hydrograph and peak flows and flood elevations, but do not affect the volume of runoff.

While it is generally accepted practice to use times of concentration and unit hydrograph peaking factors as calibration parameters, this was not conducted for the calibration of the Sweetwater Creek model. Sensitivity analyses, conducted over what was considered reasonable ranges of these parameters, indicated that there was little effect in peak flow and flood elevation at the

Sweetwater Creek streamflow gauging stations by variation of these parameters. This is because of the large size of the basin upstream of the gauges and the great degree of detail that was included in subdividing the upstream subbasins and in defining the actual physical storage and hydraulic transport processes throughout the watershed.

As the Sweetwater Creek near Tampa USGS gauging station was our only gauge source, Ayres Associates placed a greater emphasis on it as the means for model calibration. The model was run for the simulated time period because of the need to consider both the peak conditions in the watershed and the recession limb of the flood hydrograph during calibration. Figures 5-4 and 5-5 show a comparison of the recorded and simulated stages and flows, respectively, at this gauging station. The model simulation is low at the initiation of the event because of groundwater baseflows in the watershed, which amounted to 58 cfs at this location. There is however very good correlation during peak conditions in both magnitude and timing. The total volumes of flow also agree well.

It is recommended that the County use the more recent flood events as a further means of model calibration and verification. SWFWMD currently operates an extensive SCADA network of precipitation and lake stage gauging stations which would provide an invaluable database by which the model could be further refined.

While there are few lake level data available for this historical period, the USGS was reporting daily lake elevations for Lake Carroll (Sta. No. 02306600), and SWFWMD was reporting daily lake elevations for Lake Magdalene at the time. The maximum elevations for several lakes were recorded. The model simulated peak elevations in these lakes, which appear to be somewhat high. It should be noted that the reported daily lake level data are instantaneous elevations at an unspecified time of day. Hence, the recorded values may not reflect the actual peak conditions that occurred. Also, as both lakes have operable control structures, it is likely that the control weirs were lowered at some point during this extreme storm event and the lakes were allowed to drain faster than the model simulation would represent.

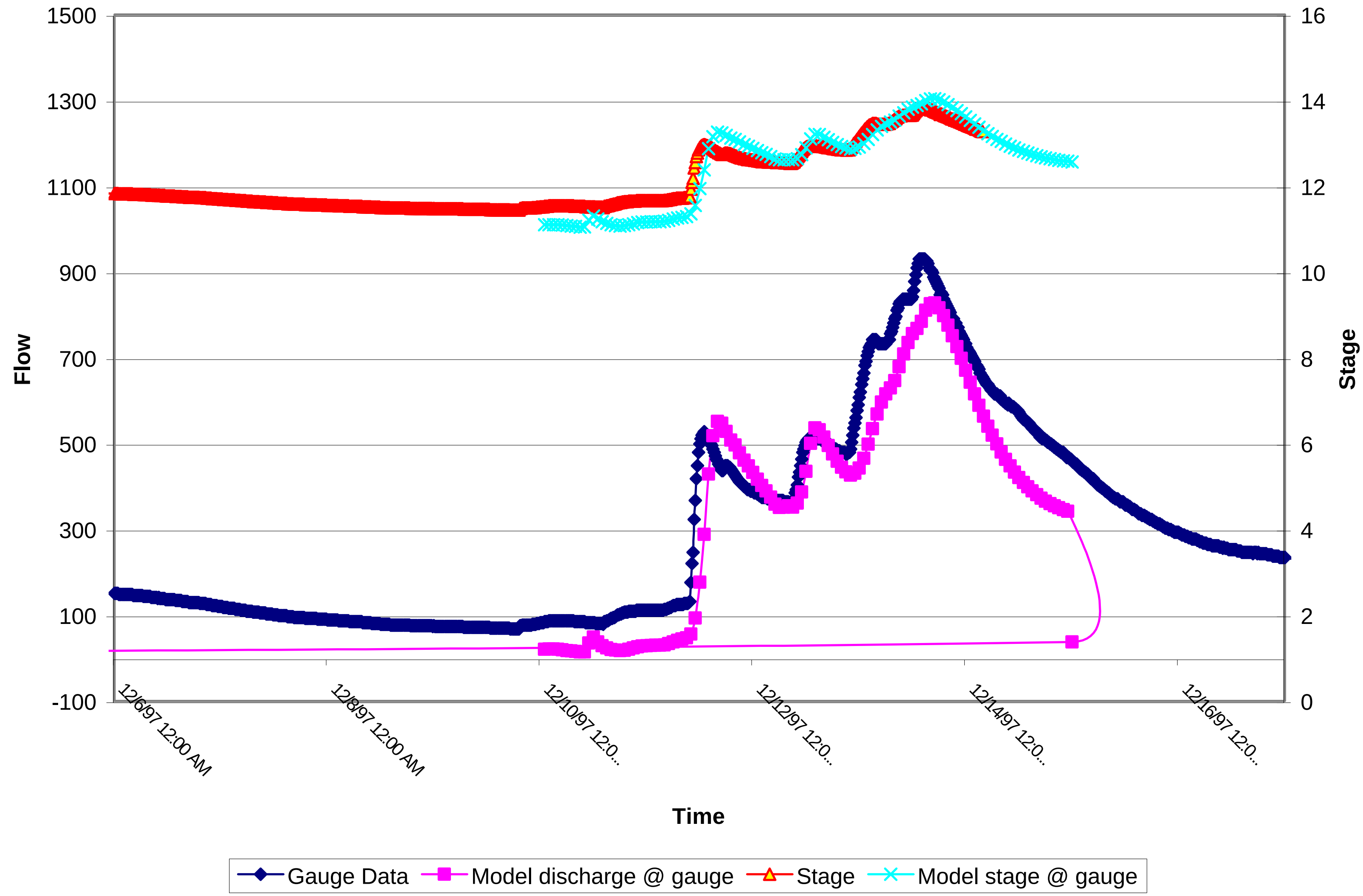
5.2.2 Hydraulic Parameters

The HCSWMM EXTRAN Block performs complex flow routing through channels, culverts, and reservoirs. Like the hydrologic portion, EXTRAN block was calibrated to match peak flow rate, runoff volume (at a particular location), and flow hydrograph shape. In addition, EXTRAN was calibrated to match observed stages. Calibration parameters within the EXTRAN Block include:

- Manning Friction Coefficient, n: Effects flow rate and stage. Accounts for roughness, irregularities, and obstructions within the conveyance system.

- Starting Water Surface Elevation: Effects stage and runoff volume. Accounts for surface storage not included in the fixed initial abstraction parameter described above. Examples of this surface storage are those wetlands, lakes, and ponds that have capacity to accept runoff prior to discharging into the main conveyance system.

FIGURE 5-4


Flow
Stage
Time
1500
1300
1100
900
700
500
300
100
-100
16
14
12
10
8
6
4
2
0
12/6/97 12:00 AM
12/8/97 12:00 AM
12/10/97 12:0...
12/12/97 12:0...
12/14/97 12:0...
12/16/97 12:0...
Gauge Data
Model discharge @ gauge
Stage
Model stage @ gauge

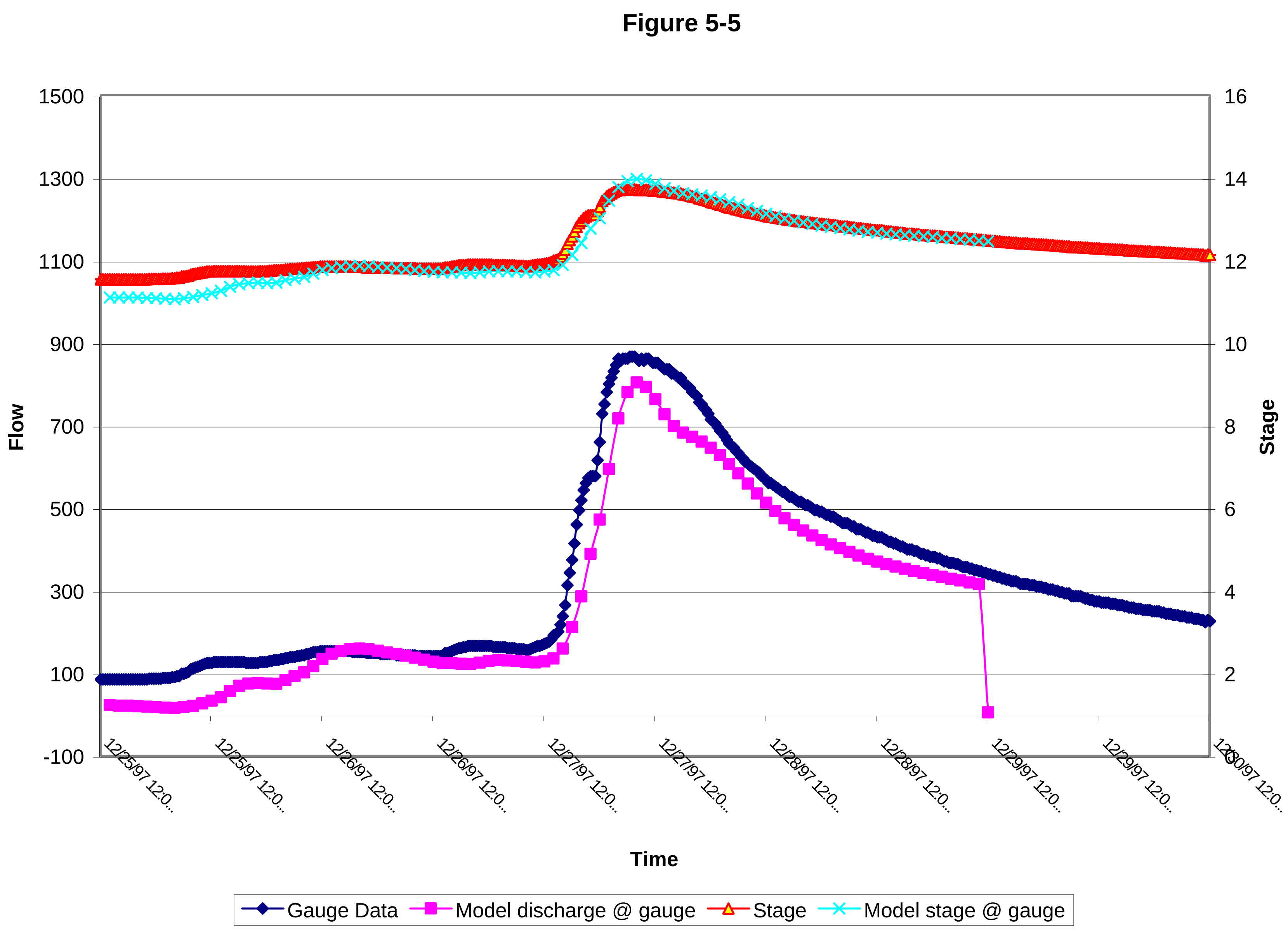


Figure 5-5
Flow
Stage
Time
1500
1300
1100
900
700
500
300
100
-100
16
14
12
10
8
6
4
2
0
12/25/97 12:0...
12/25/97 12:0...
12/26/97 12:0...
12/26/97 12:0...
12/27/97 12:0...
12/27/97 12:0...
12/28/97 12:0...
12/28/97 12:0...
12/29/97 12:0...
12/29/97 12:0...
12/30/97 12:0...
Gauge Data
Model discharge @ gauge
Stage
Model stage @ gauge

5.2.3 Calibration Methods

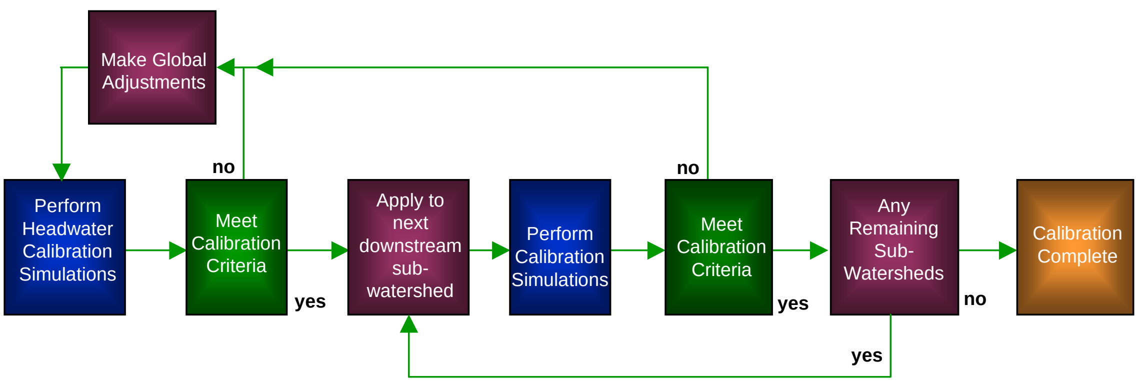
The Sweetwater Creek SWMM model was systematically assembled and calibrated according to County calibration criteria (See Table 5-1). Calibration was performed according to the following simplified procedure:

1. Calibrate headwater subwatersheds to upstream gauges.

2. Determine global calibration parameter adjustments and apply to all subwatersheds.

3. In downstream direction, calibrate additional subwatersheds contributing to next stream gauge. Adjustments should be relatively minor and physically justifiable. If not, revise global calibration parameter adjustments.

4. Following calibration to downstream gauge, verify calibration to upstream gauges. If new calibration unacceptably affects upstream gauge calibration, revise global calibration parameter adjustments. Otherwise, repeat steps until entire watershed is calibrated.



Example of Calibration Procedure

5.3 Existing Conditions Model Calibration

Following the calibration procedure and the completion of the existing conditions modeling, two different models were prepared. One containing the existing conditions at the time of study (calibration events), and a version with post EL Nino Capital Improvement Projects (CIP). The constructed CIP projects were included to further refine the model for purposes of design storm events.

CHAPTER 6: EXISTING CONDITIONS LEVEL OF SERVICE

6.1 Standard Design Storm Events

Hillsborough County specified that six design storm events be applied to the Sweetwater Creek Watershed and the response of the system be evaluated. Those design storm events are as follows:

- 2.33-year, 24 hour duration (Mean Annual)
- 5-year, 24 hour duration
- 10-year, 24 hour duration
- 25-year, 24 hour duration
- 100-year, 24 hour duration

Specific parameters for the design storm events include the use of the SCS Type II, Florida Modified rainfall distribution and Antecedent Moisture Condition II (normal). For information regarding the selection of the rainfall depths associated with each design storm, refer to Section 4.1.2.

6.2 Existing Conditions Model Simulation Results

The hydrodynamic model calculated time varying flows and elevations for the detailed portions of the watershed, as indicated in the Link-Node diagrams presented in Appendix 3-1 through 3-3. Complete, time-varying, output can be found in the electronic output files for each of the modeled design storms. Plots of the hydraulic grade lines for these design storm events are located in Appendix 6-1.

6.3 Level of Service (LOS) Analysis

The Hillsborough County Comprehensive Plan, Stormwater Element contains definitions for the level of service flood protection designations. These definitions specify that a storm return period, storm duration and a letter designation are required to define a level of flood protection. The flood level of service designations contained in the Comprehensive Plan are A, B, C, and D, with A representing the highest service level and D the lowest. These levels are not strictly defined, and require a quantitative interpretation for analysis.

The LOS designations in the Comprehensive Plan assume that the finished floor elevations of structures are higher than the surrounding adjacent property, which in turn are higher than the roads in the area. This assumption cannot be applied to all locations within Hillsborough County, a specific example would be those locations that were constructed prior to the currently adopted development standards.

It is possible to have a basin where the roads do not flood, yet the sites / structures do. This requires the evaluation of the roads, sites, and structures independently for the determination of the level of service designation.

To establish the LOS for each individual drainage basin and thus the LOS for the subwatershed, landmark elevations were determined. Roadway overtopping elevations were taken from field survey or construction plans where available. The Hillsborough County (1997) (1"=200') and SWFWMD topographic (date varies ~ 1978) (1"=200') aerials were consulted for the site and structure landmark elevations. The County aerials were reviewed for any structures located within 1000' on either side of the hydraulically modeled conveyance system. SWFWMD Topographic maps were then consulted to select the lowest of the identified structures. The lowest contour closest to the identified structure was selected as the site elevation and the finished floor elevation was set to be one foot above that site elevation. Areas where no structures existed within the specified range were not assigned elevations for site or structure and will be reported as LOS A.

The following discussion lists the Hillsborough County Comprehensive Plan LOS Definitions and indicates the quantitative interpretation of the same:

A - No Significant Flooding

i) No flooding of roadways
ii) No flooding of structures
iii) 3" or less above site

B - No Major Residential Flooding

i) 3" or less above road crown
ii) No flooding of structures
iii) 3" to 6" above site

C - No Significant Structure Flooding

i) Greater than 3" above road crown
ii) No flooding of structures
iii) Greater than 6" above site

D - No Limitation of Flooding

i) Structure Flooding

Hillsborough County has specified that the 25-year, 24 hour / Level B should be the target LOS for this study. The following discussions base their analysis upon this specification. LOS designations were assigned to the individual drainage basins, the subwatersheds and the regions. The LOS of a region is reflective of the worst case for each subwatershed within the region, and the LOS for each subwatershed is reflective of the worst case for each individual basin within the subwatershed.

The methodology used to assess the flooding levels of service provided within the Sweetwater Creek basin drainage system was to examine the most recent SWFWMD aerial 1-foot contour topographic maps (1”=200’ scale) and compare the SWMM model results of the design storm events to land surface elevations at selected points throughout the basin. Survey data and/or as-built construction plans were also utilized in this effort when they were available.

The first step of this process was to examine the topographic maps to select the appropriate locations for this comparison. This was generally accomplished by proceeding along the hydraulic network and examining the areas of development that were hydraulically connected to each of the individual model junctions. Within the areas of hydraulic connection, individual locations of development were demarcated and a set of three elevations recorded. The first elevation that was determined was that which was deemed to represent “significant street flooding” at that location as a means of defining the flooding LOS Level A criterion. As one can see, this term has an element of subjectivity in its definition which could be interpreted to mean the elevation at which a significant portion (generally 10%) of the aerial extent of the streets within the area would have some depth of water up to the crown of the road. Thus, a small, isolated low spot in a road profile would not necessarily define the point of “significant street flooding” in a given area. The road crown was used as the basis of assessment because the spot elevations that are shown on the SWFWMD topographic maps are usually located at the center of the road alignment.

The second elevation, which was required for the LOS analysis, is that which was deemed to represent “major residential yard flooding”. Again, determination of this elevation required much subjective judgment in examination of the aerial topographic maps. Where possible, the yard elevations were assessed by topographic contours and spot elevations on the maps. In lieu of this, an elevation 0.5 feet higher than the street elevation was used as a reasonable estimate of this LOS Level B criterion.

The final elevation, which was recorded, was the hardest one of all since the aerial topographic mapping provides no means of determining an elevation for “significant structure flooding”. The general rule of thumb that was used to estimate this elevation was to assume an elevation a minimum of either 0.5 feet above the yard flooding elevation or 1.0 feet above the street flooding elevation.

Both Ayres Associates and the previous consultant utilized this general methodology to define the flooding LOS elevations at 272 locations throughout the Sweetwater Creek basin. These locations are listed in Table 6-1. Due to the high degree of uncertainty in the derivation of these elevations, it is emphasized that the assessment of the flooding LOS provided within the basin and the identification of problem areas herein is only cursory. This assessment should be supplemented with further investigations in the form of field surveys of streets and residential floor slab elevations to confirm the existence and/or magnitude of LOS deficiencies and flooding problems.

Once the set of street, yard, and structure flooding elevations were determined and compared to the model results for the 2.33-, 5-, 10-, 25-, and 100-year design storm events, it is a relatively simple procedure to assign the appropriate flooding LOS provided at each individual location.

6.4 Level of Service (LOS) Determinations

Table 6-1 shows the level of service that is currently being estimated for each of the 272 locations identified within the watershed. As previously discussed, the County has adopted a minimum basin wide goal of Level B for the 10-year, 24-hour design storm event. Based on this criterion, there are only eight locations identified in LOS table where the County's minimum acceptable level of service is not met. Additionally, the level of service matrix is also a useful way of identifying additional problem areas and showing the severity of a flooding problem. For instance, even though the adopted County LOS criterion is for yard flooding during the 10-year storm event, chronic flooding of a street for the 2-year or 5-year storm event might be judged to be as important an issue.

Similarly, structural flooding during the 25-year storm event might also be designated as an equal problem. The analysis does not show cases of structural flooding likely to occur during the more frequent storms. One of the reasons for this conclusion is probably the lack of surveying data to assess structural flooding in more detail. Another reason is that this study encompassed strictly the capacity analysis of the main basin drainage system. Flooding problems could also be caused by constrictions in the secondary system, which was not part of this study. However, the solution of those problems is much less complicated if the primary system has the capacity to accept the additional runoff flows.

Table 6-1
SWEETWATER CREEK BASIN
EXISTING CONDITIONS LEVELS OF SERVICE ANALYSIS

SB NO.	LOCATION DESCRIPTION	NEW MODEL JUNCTION	STREET FLOODING ELEV., ft NGVD	YARD FLOODING ELEV., ft NGVD	STRUCTURE FLOODING ELEV., ft NGVD	24-HOUR DURATION DESIGN STORM MAXIMUM FLOOD ELEVATION, ft NGVD					LEVEL OF SERVICE (LOS)				
						2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR	2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR
71	Elm St	410010	7.8	8.5	9.0	3.27	3.63	4.16	4.53	6.34	A	A	A	A	A
71	Webb Rd	410010	7.6	8.0	9.0	3.27	3.63	4.16	4.53	6.34	A	A	A	A	A
71	Woodbridge Blvd	410010	9.5	10.0	11.0	3.27	3.63	4.16	4.53	6.34	A	A	A	A	A
85	Barry Rd @ Armand Circle	413912	16.5	17.0	18.0	14.07	14.36	14.72	14.93	16.03	A	A	A	A	A
85	Barry Rd @ Overbrook Dr	413913	17.0	17.5	18.5	14.47	15.02	15.89	16.18	16.36	A	A	A	A	A
85	Barry Rd @ Williams Dr	413910	18.0	19.0	20.0	10.20	10.97	12.18	13.55	16.02	A	A	A	A	A
85	Brookview Circle @ Oak Vista Circle	413946	17.5	18.5	19.0	14.99	15.65	16.37	16.57	18.34	A	A	A	A	B
85	Fountain Av @ Hanley Rd	410030	9.0	9.5	10.5	5.37	6.19	7.17	7.73	10.01	A	A	A	A	C
85	Fountain Av @ Running Woods Dr	410070	14.0	14.5	15.0	6.62	7.59	8.74	9.43	12.08	A	A	A	A	A
85	Greenshire Dr	413962	19.5	20.5	21.5	16.51	17.37	18.61	19.45	21.62	A	A	A	A	D
85	Kirkwood Dr	413962	20.0	20.5	21.0	16.51	17.37	18.61	19.45	21.62	A	A	A	A	D
85	Malvern Circle	413968	19.5	20.0	21.0	19.72	19.81	19.90	19.95	21.74	B	B	B	B	D
85	Mitchell Circle	413940	17.0	18.5	20.0	14.41	15.19	16.03	16.47	18.33	A	A	A	A	B
85	Morgan Woods Elem	410055	13.5	15.0	15.5	8.44	8.96	9.88	10.67	12.92	A	A	A	A	A
85	Rustic Dr	413944	17.0	18.0	19.5	14.91	15.57	16.28	16.48	18.34	A	A	A	A	C
85	Sunshine Circle @ Nova Circle	413946	17.0	17.5	18.0	14.99	15.65	16.37	16.57	18.34	A	A	A	A	D
85	Vassar Circle	413966	19.5	20.0	21.5	18.10	18.42	18.83	19.50	21.72	A	A	A	B	D
85	Woodbridge Blvd @ Hanley Rd	410030	10.5	11.0	11.5	5.37	6.19	7.17	7.73	10.01	A	A	A	A	A
85	Woodbridge Circle @ Hanley Rd	410040	14.0	14.5	15.0	5.41	6.24	7.22	7.79	10.16	A	A	A	A	A
96	Anderson Rd	410170	26.2	N/A	N/A	20.41	20.64	21.75	22.40	24.49	A	A	A	A	A
96	Florida Mining Blvd	410210	29.0	N/A	N/A	23.63	24.66	25.77	26.34	27.24	A	A	A	A	A
96	SCL RR @ Linebaugh Av	410188	32.5	33.5	34.5	23.56	25.03	25.82	26.24	27.15	A	A	A	A	A
96	Waters Ave	410160	26.2	N/A	N/A	20.11	20.28	21.03	21.43	23.10	A	A	A	A	A
96	Waters Av @ Twelve Oaks Blvd	413980	22.8	23.8	24.5	21.83	22.85	24.36	24.82	25.46	A	B	C	D	D
97	Barry Rd @ Benjamin Rd	410100	19.5	20.2	20.6	13.31	13.71	14.26	14.85	16.45	A	A	A	A	A
97	Barry Rd @ Daquiri	413910	17.0	17.5	18.0	10.20	10.97	12.18	13.55	16.02	A	A	A	A	A
97	Benjamin Rd @ Sitka Dr & Ann Ballard	410140	22.0	22.5	23.0	18.76	18.85	19.37	19.62	20.37	A	A	A	A	A
97	Crenshaw Rd	414050	21.0	21.5	22.0	17.00	17.77	18.68	19.18	20.95	A	A	A	A	A
97	Flea Market	410140	22.0	22.5	23.0	18.76	18.85	19.37	19.62	20.37	A	A	A	A	A
97	Oak Cluster Dr	413930	18.8	19.3	20.0	10.99	11.79	12.88	13.99	16.47	A	A	A	A	A
97	Oak Trace Condo	413960	22.5	23.0	23.5	16.48	17.34	18.56	19.36	21.57	A	A	A	A	A
97	Pioneer Industrial Park	410106	19.5	19.5	20.0	16.77	17.04	17.42	17.65	18.36	A	A	A	A	A
97	Pioneer Industrial Park	410126	21.0	22.0	23.0	19.22	19.99	21.25	21.66	22.91	A	A	B	B	C
97	Sitka St	413950	22.5	22.5	23.0	16.09	16.66	17.35	17.79	20.06	A	A	A	A	A
107	Bramblebrush St	410248	40.0	41.0	42.0	36.44	37.18	37.74	37.91	38.87	A	A	A	A	A
107	Carrollwood Oaks	410282	36.5	37.0	37.5	33.13	33.40	33.82	34.36	36.13	A	A	A	A	A
107	Cypress Tree Dr/Ridge Rd/Gunn Hwy	410299	46.5	47.0	47.5	44.66	44.89	45.23	45.54	46.58	A	A	A	A	B
107	Delmar Circle @ Mill Pond Ln	410276	36.0	36.8	37.5	33.70	34.42	35.39	36.02	36.29	A	A	A	B	B
107	Fairfield Village Dr	410245	38.5	39.0	40.0	36.44	37.18	37.72	37.87	38.57	A	A	A	A	B
107	Glen Ellen Dr	410247	39.0	39.5	40.0	36.44	37.18	37.74	37.90	38.84	A	A	A	A	A
107	Glenaire Ct @ Plantation Blvd	410278	37.5	39.0	40.0	33.87	34.75	36.09	36.94	37.53	A	A	A	A	B
107	Greenaire Dr	410246	38.5	39.0	40.0	36.47	37.22	37.82	38.05	38.84	A	A	A	A	B
107	Grove Point Dr	410296	43.0	43.5	44.0	39.40	40.39	41.65	41.90	42.22	A	A	A	A	A
107	Linebaugh Av	410243	37.6	N/A	N/A	34.49	34.80	35.48	36.38	37.42	A	A	A	A	A
107	Linebaugh Av	410275	34.8	37.0	37.5	32.27	32.77	33.14	33.51	35.03	A	A	A	A	B
107	Linebaugh Av @ Plantation Blvd	410277	35.3	36.8	37.5	32.71	32.91	33.55	33.97	35.99	A	A	A	A	B
107	Mill Pond Ln	410270	36.3	37.0	37.5	31.44	32.21	33.04	33.47	34.96	A	A	A	A	A
107	Plantation Blvd @ Ashbourne Circle	410297	43.5	44.0	44.5	41.10	42.22	43.16	43.27	43.53	A	A	A	A	B
107	Plantation Blvd @ Chadbourne Dr	410244	39.0	39.5	40.5	35.01	35.19	35.64	36.50	37.83	A	A	A	A	A
107	Plantation Blvd @ Willowbrae Dr	410292	37.0	38.0	39.5	34.38	35.11	36.38	36.78	37.35	A	A	A	A	B
107	Rosemont Dr @ Glenaire Ct	410279	39.5	40.0	41.5	37.33	37.49	37.77	38.07	38.91	A	A	A	A	A
107	Springridge Dr @ Springwood Dr	410249	38.0	38.5	39.5	36.44	37.18	37.78	37.94	38.85	A	A	A	A	C
107	Westwood Plaza	410299	47.5	48.0	49.0	44.66	44.89	45.23	45.54	46.58	A	A	A	A	A
107	Windrush Dr @ Shadberry Dr	410284	36.3	36.8	37.5	31.88	32.72	33.73	34.30	36.12	A	A	A	A	A
107	Wingate Dr	410291	36.3	36.8	37.5	34.27	34.96	36.19	36.65	37.32	A	A	A	B	C
108	Cedarwood Village	414368	38.5	39.0	39.5	37.53	37.80	38.38	38.85	39.14	A	A	A	B	C
108	Chadbourne Village @ Sugarmill Dr	410240	33.0	33.5	34.5	30.41	31.10	31.80	32.20	33.51	A	A	A	A	C
108	Florida Mining	410210	32.5	33.0	33.5	23.63	24.66	25.77	26.34	27.24	A	A	A	A	A
108	Humphrey St	414360	34.0	34.5	35.0	32.00	32.38	32.94	33.37	34.40	A	A	A	A	B
108	Quail Oaks Apts & Cypress Lakes Apts	410238	35.0	35.5	36.0	30.72	31.30	32.10	32.53	33.77	A	A	A	A	A
108	Quail Oaks Apts & Cypress Lakes Apts	414359	35.0	35.5	36.0	31.03	31.51	32.22	32.60	34.37	A	A	A	A	A
108	Rail Yard	410238	36.0	36.0	36.5	30.72	31.30	32.10	32.53	33.77	A	A	A	A	A
108	SCL RR	410240	37.4	N/A	N/A	30.41	31.10	31.80	32.20	33.51	A	A	A	A	A
108	Sunshine Industrial Park	410217	30.0	30.5	31.0	29.54	29.75	30.04	30.20	30.66	A	A	B	B	C
108	Trask St Comm Complex	410250	34.5	35.0	35.5	31.38	32.15	32.98	33.41	34.84	A	A	A	A	B
108	Trask St Comm Complex	414366	36.5	37.0	37.5	33.90	34.26	34.78	35.10	36.14	A	A	A	A	A
108	Waters Av	414359	36.4	N/A	N/A	31.03	31.51	32.22	32.60	34.37	A	A	A	A	A
109	Anderson Rd Bridge	414150	24.8	N/A	N/A	20.93	21.60	22.52	23.16	24.06	A	A	A	A	A
109	Auto Storage	414250	27.6	28.5	29.5	25.70	26.40	27.27	27.82	29.37	A	A	A	B	C
109	Custom Industrial Park	414205	28.2	28.8	29.8	25.38	25.66	26.07	26.33	27.22	A	A	A	A	A

Table 6-1
SWEETWATER CREEK BASIN
EXISTING CONDITIONS LEVELS OF SERVICE ANALYSIS

SB NO.	LOCATION DESCRIPTION	NEW MODEL JUNCTION	STREET FLOODING ELEV., ft NGVD	YARD FLOODING ELEV., ft NGVD	STRUCTURE FLOODING ELEV., ft NGVD	24-HOUR DURATION DESIGN STORM MAXIMUM FLOOD ELEVATION, ft NGVD 2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR	LEVEL OF SERVICE (LOS) 2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR
109	E Crenshaw St	414150	24.7	25.0	26.0	20.93	21.60	22.52	23.16	24.06	A	A	A	A	A
109	Leto HS	414345	29.5	30.5	31.5	26.39	27.10	27.99	28.54	30.03	A	A	A	A	B
109	Manhattan Av	414592	31.5	N/A	N/A	30.66	31.05	31.43	31.68	32.09	A	A	A	B	B
109	Manhattan Palms Apt	414345	28.5	29.0	29.5	26.39	27.10	27.99	28.54	30.03	A	A	A	B	D
109	Savarese Circle	414250	27.8	28.5	29.5	25.70	26.40	27.27	27.82	29.37	A	A	A	B	C
109	SCL RR Bridge	414300	33.6	N/A	N/A	25.72	26.43	27.30	27.84	29.39	A	A	A	A	A
109	Tampa West Blvd	414155	26.5	27.0	27.5	22.70	23.77	25.31	26.31	27.21	A	A	A	A	C
109	Woodland Center Blvd	414357	32.5	33.0	33.5	30.42	30.85	31.41	31.70	32.69	A	A	A	A	B
109	Woodland Center Blvd @ Woodland Corp. Center	414351	31.5	32.0	32.5	26.67	27.58	28.77	29.31	30.81	A	A	A	A	A
109	Woodland Corp. Center	414354	31.5	32.0	32.5	28.17	28.57	29.13	29.75	31.58	A	A	A	A	B
119	Brentwood Dr @ Brentwood Pl	411987	58.0	58.2	58.7	55.12	55.41	55.76	55.95	56.51	A	A	A	A	A
119	Brentwood Dr @ Thornwood Pl	411981	55.7	56.0	56.5	53.58	53.84	54.19	54.45	55.22	A	A	A	A	A
119	Dale Mabry Hwy @ Ehrlich Rd	411990	58.3	58.7	59.2	52.06	52.59	53.28	53.63	54.49	A	A	A	A	A
119	Dale Mabry Hwy @ Village Dr	411990	60.5	62.0	62.5	52.06	52.59	53.28	53.63	54.49	A	A	A	A	A
119	Ehrlich Rd @ Bay Lake	410500	54.0	54.0	54.5	46.35	46.63	47.18	47.55	48.63	A	A	A	A	A
119	Ehrlich Rd @ Village Estates Place	411950	53.5	54.0	54.5	53.19	53.60	54.10	54.37	54.96	A	B	C	C	D
119	Handy Dr @ Little Bay Lake	410501	52.0	52.0	53.0	47.41	47.60	47.70	47.76	48.65	A	A	A	A	A
119	Marketplace North II Comm Center	411983	58.5	59.0	59.5	55.03	55.33	55.87	56.25	57.53	A	A	A	A	A
119	Monarch Dr	411930	53.0	54.5	55.0	52.78	53.42	54.06	54.32	54.84	A	B	B	B	C
120	Carrollwood Village Ct	419924	42.5	43.0	44.0	39.73	40.28	41.80	42.20	43.15	A	A	A	A	C
120	Carrollwood Village Dr	419910	42.0	43.0	44.0	39.04	39.22	39.63	39.92	41.07	A	A	A	A	A
120	Carrollwood Village Dr	419928	42.5	43.5	44.0	40.15	41.02	41.82	42.20	43.14	A	A	A	A	B
120	Carrollwood Village Dr	419960	44.2	44.5	46.0	41.31	41.80	43.71	44.69	45.49	A	A	A	C	C
120	Carrollwood Village Dr @ Old Orchard Dr	419935	44.0	44.5	45.5	40.19	41.09	42.19	42.97	44.66	A	A	A	A	C
120	Clendenning Dr	419920	43.0	43.0	44.0	39.52	39.73	39.87	40.03	41.15	A	A	A	A	A
120	Colby Rd @ Orange Grove Rd	410430	44.5	45.0	46.0	40.14	40.69	41.81	42.59	44.10	A	A	A	A	A
120	Countrywood Dr @ Orange Grove Rd	410460	44.5	44.5	45.5	42.40	42.84	43.42	43.54	44.40	A	A	A	A	A
120	Dale Mabry Hwy	419920	43.8	N/A	N/A	39.52	39.73	39.87	40.03	41.15	A	A	A	A	A
120	Fletcher Av @ Village Centre	419970	52.0	53.0	54.0	52.59	52.73	52.94	53.04	53.29	B	B	B	C	C
120	Golf Crest Circle	419942	46.5	47.0	48.0	44.05	44.52	45.27	45.57	46.02	A	A	A	A	A
120	Golf Crest Terrace	419926	45.5	46.0	47.0	40.03	40.90	41.81	42.20	43.15	A	A	A	A	A
120	Main Street Shopping Ctr	419920	43.0	43.5	44.0	39.52	39.73	39.87	40.03	41.15	A	A	A	A	A
120	Mission Bell Sq @ Stall Rd	410460	46.0	46.5	49.5	42.40	42.84	43.42	43.54	44.40	A	A	A	A	A
120	Moran Rd @ Bay Lake Ln	410500	49.5	49.5	50.0	46.35	46.63	47.18	47.55	48.63	A	A	A	A	A
120	Oakhurst Terr	419928	42.0	42.5	44.0	40.15	41.02	41.82	42.20	43.14	A	A	A	B	C
120	Stillwater Dr	419950	42.0	43.0	44.0	39.52	39.73	39.87	40.03	41.15	A	A	A	A	A
120	Water Oaks Ln	419929	45.0	46.0	47.0	43.05	43.15	43.33	43.41	43.61	A	A	A	A	A
121	Butia Pl @ Schefflera Rd	410246	41.8	42.0	42.5	36.47	37.22	37.82	38.05	38.84	A	A	A	A	A
121	Carrollwood Ln @ Linebaugh Av	415320	38.5	39.5	41.0	36.55	36.92	37.50	37.93	39.54	A	A	A	A	C
121	Casey Rd	410310	36.8	37.0	38.0	33.75	34.24	34.90	35.20	37.13	A	A	A	A	C
121	Cedar Hollow Ln @ Hudson Ln	410360	38.0	38.5	39.0	35.68	36.10	36.83	37.47	39.29	A	A	A	A	D
121	Country Oaks Dr	410337	44.5	44.5	45.5	42.65	42.98	43.45	43.76	44.60	A	A	A	A	C
121	Dale Mabry Hwy @ Lake Carroll Way	410344	38.0	39.0	40.0	36.31	36.93	39.56	39.60	39.71	A	A	C	C	C
121	Dale Mabry Hwy, Hudson Ln, Rainbow Village	410400	43.4	43.5	44.5	38.81	39.23	40.04	40.59	41.77	A	A	A	A	A
121	Dibbs Plaza	410338	36.5	37.0	38.0	34.11	34.64	35.33	35.69	37.65	A	A	A	A	C
121	Fairway Plaza	410338	38.0	38.5	39.0	34.11	34.64	35.33	35.69	37.65	A	A	A	A	A
121	Fairway Plaza @ Dale Mabry Hwy	410343	39.0	39.0	40.0	35.32	35.60	35.99	36.24	37.00	A	A	A	A	A
121	Floyd Rd	410350	39.0	39.0	40.0	34.80	35.49	36.40	37.14	39.06	A	A	A	A	C
121	Floyd Rd @ Juniperus Pl	410348	45.0	45.0	45.5	41.22	41.44	41.80	42.06	42.97	A	A	A	A	A
121	Galleria Rd	419910	42.8	43.5	44.0	39.04	39.22	39.63	39.92	41.07	A	A	A	A	A
121	Grady Av	419910	42.0	42.0	42.5	39.04	39.22	39.63	39.92	41.07	A	A	A	A	A
121	Grady Av @ Hudson Terrace	410341	43.0	43.0	43.5	39.84	40.13	40.52	40.75	41.45	A	A	A	A	A
121	Gunn Hwy	410330	37.0	37.0	38.0	33.89	34.43	35.19	35.55	37.54	A	A	A	A	C
121	Hubert Av	410332	38.5	39.0	40.0	37.74	37.82	38.75	39.10	39.80	A	A	B	C	C
121	Hudson Ln	410335	39.5	39.5	40.2	38.52	38.81	38.94	39.12	39.83	A	A	A	A	C
121	Hudson Ln	410380	42.3	N/A	N/A	37.07	37.65	38.49	38.91	39.99	A	A	A	A	A
121	Lincoln Oaks @ Galleria Rd	419902	40.0	40.5	41.5	37.69	37.90	38.74	39.21	40.11	A	A	A	A	B
121	Northrop Terrace @ Hudson Ln	410335	39.8	40.5	41.0	38.52	38.81	38.94	39.12	39.83	A	A	A	A	B
121	Oakbrook Rd	410338	36.5	37.0	38.0	34.11	34.64	35.33	35.69	37.65	A	A	A	A	C
121	Schefflera Rd @ Orange Grove Dr	410347	43.5	43.5	44.5	40.97	41.27	41.66	41.90	42.74	A	A	A	A	A
121	Summer Oak Dr	410335	39.5	40.0	41.0	38.52	38.81	38.94	39.12	39.83	A	A	A	A	B
122	Busch Blvd @ Dale Mabry Hwy	415290	40.0	N/A	N/A	36.01	36.36	36.77	37.05	38.00	A	A	A	A	A
122	Cedarwood Village	410255	35.5	36.0	36.5	34.08	34.48	35.08	35.51	36.40	A	A	A	B	C
122	Cedarwood Village	414366	35.5	36.0	36.5	33.90	34.26	34.78	35.10	36.14	A	A	A	A	C
122	Cortez of Carrollwood Condos	415185	36.0	36.5	37.5	33.76	34.06	34.48	34.74	35.63	A	A	A	A	A
122	Dale Mabry Hwy @ Humphrey St	415250	34.5	35.0	35.5	32.09	32.46	33.06	33.39	34.57	A	A	A	A	B
122	Dale Mabry Hwy @ Lazy Ln	415280	37.0	37.5	38.0	33.25	33.41	33.64	33.79	34.58	A	A	A	A	A
122	Fashion Square Mall	415200	36.0	36.0	37.5	32.43	32.82	33.42	33.90	36.00	A	A	A	A	C
122	Grady Av @ Waters Av	414760	34.5	35.0	35.5	32.71	33.45	34.05	34.10	34.23	A	A	A	A	A
122	Himes Av	415250	35.5	N/A	N/A	32.09	32.46	33.06	33.39	34.57	A	A	A	A	A
122	Hubert Av @ Waters Av	414530	33.0	33.5	34.5	31.48	31.82	32.11	32.32	32.81	A	A	A	A	A
122	Humphrey St @ Manhattan Av	414361	34.0	34.0	34.5	33.54	33.65	33.88	34.13	34.69	A	A	A	C	D
122	Lazy Ln	414355	36.0	36.5	37.0	30.20	30.52	30.90	31.06	32.19	A	A	A	A	A

Table 6-1
SWEETWATER CREEK BASIN
EXISTING CONDITIONS LEVELS OF SERVICE ANALYSIS

SB NO.	LOCATION DESCRIPTION	NEW MODEL JUNCTION	STREET FLOODING ELEV., ft NGVD	YARD FLOODING ELEV., ft NGVD	STRUCTURE FLOODING ELEV., ft NGVD	24-HOUR DURATION DESIGN STORM MAXIMUM FLOOD ELEVATION, ft NGVD					LEVEL OF SERVICE (LOS)				
						2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR	2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR
122	Lois Av @ Waters Av	414540	33.5	34.0	34.5	32.28	32.99	33.85	33.94	34.08	A	A	B	B	C
122	Lonetree Ln	415300	37.0	37.0	37.5	36.34	36.58	36.97	37.22	38.09	A	A	A	C	D
122	Montecitos Apts/Jasmine Pond	414362	35.3	35.5	36.0	33.55	33.67	33.95	34.26	35.21	A	A	A	A	A
122	Mullins Rd @ Thatcher Av	414364	34.3	34.5	34.8	33.72	34.06	34.29	34.38	35.23	A	A	A	B	D
122	Premiere North Exec.Center @ Linebaugh Av	410338	37.5	38.0	38.5	34.11	34.64	35.33	35.69	37.65	A	A	A	A	B
122	Waters Av @ Grady St	414900	34.5	35.0	36.0	27.95	28.53	29.30	29.82	31.25	A	A	A	A	A
122	Whisper Lake Condos	415170	37.5	38.5	39.5	37.13	37.35	37.64	37.83	38.83	A	A	B	B	C
123	Manhattan Av @ Bird St	414530	30.8	32.8	33.5	31.48	31.82	32.11	32.32	32.81	B	B	B	B	C
123	Broad St @ Blossom Ave	414700	32.5	33.0	33.5	27.75	28.34	29.09	29.58	30.99	A	A	A	A	A
123	Broad St @ Himes Av	414680	37.0	37.5	38.0	36.29	36.56	36.65	36.69	36.78	A	A	A	A	A
123	Cameron Av @ River Cove Dr	414590	30.5	31.0	32.0	30.09	30.25	30.47	30.61	31.25	A	A	A	B	C
123	Clark Av @ Broad St	414650	32.5	32.5	33.0	27.55	28.18	28.98	29.42	30.80	A	A	A	A	A
123	Cortez Av @ Blossom Ave	414710	32.0	32.5	33.0	28.18	28.78	29.56	29.70	31.00	A	A	A	A	A
123	Dale Mabry Hwy @ Broad St	414670	35.5	36.0	36.5	34.34	34.76	35.43	35.83	36.29	A	A	A	B	C
123	Idell St @ Hubert Av	414515	31.2	31.5	32.0	29.56	30.01	30.64	31.48	31.92	A	A	A	B	C
123	Manhattan Av @ Broad St and Hamilton	414450	29.5	30.0	30.5	27.03	27.73	28.60	29.04	30.50	A	A	A	A	D
123	Marigold Av @ Nome St	414580	32.5	32.5	33.0	28.72	29.08	29.62	29.95	31.14	A	A	A	A	A
123	Sam's Club	414800	33.5	34.0	34.5	27.91	28.51	29.28	29.78	31.21	A	A	A	A	A
123	Sitka St @ Manhattan Av	414520	31.0	31.5	32.5	30.05	30.75	31.55	31.80	32.17	A	A	C	C	C
123	Sitka St @ Cameron & Lois Av	414590	30.5	31.0	32.0	30.09	30.25	30.47	30.61	31.25	A	A	A	B	C
123	Thatcher Av	414570	31.0	31.0	31.5	28.62	28.96	29.50	29.83	31.06	A	A	A	A	C
123	Thatcher Av @ Broad St	414650	31.5	32.0	32.5	27.55	28.18	28.98	29.42	30.80	A	A	A	A	A
123	Waters Place Apts	414855	32.5	33.0	33.5	31.13	31.43	31.87	32.19	33.50	A	A	A	A	D
131	Grass Lake Dr. @ North Lakes	410682	54.2	55.0	55.5	50.30	50.55	50.90	51.13	51.95	A	A	A	A	A
131	North Lakeview Dr @ Dale Mabry	410635	57.7	58.0	58.5	53.91	54.31	54.87	55.24	55.83	A	A	A	A	A
131	North Lakeview Dr @ North Lakes	410633	55.1	55.6	56.1	53.71	54.10	54.66	54.82	55.28	A	A	A	A	B
131	Viny Ct @ Cedarwood Subd.	410684	54.5	55.2	55.7	50.30	50.55	50.90	51.13	51.94	A	A	A	A	A
132	Cozumel Dr @ Bearss Av	410631	55.5	57.0	57.5	53.53	53.88	54.31	54.55	55.28	A	A	A	A	A
132	Hoedt Rd @ Hamilton Village	410639	57.5	58.0	58.5	54.70	54.99	55.43	55.72	56.74	A	A	A	A	A
132	Lake Palencia Apts	410645	56.8	56.8	57.5	55.67	55.95	56.36	56.63	57.53	A	A	A	A	D
132	Smitter Rd @ Lake Magdalene	410583	54.8	55.5	56.0	50.94	51.35	51.95	52.36	53.62	A	A	A	A	A
133	Cherry Creek Dr	410540	51.7	53.0	53.5	50.18	50.52	50.98	51.26	52.16	A	A	A	A	B
133	Cherry Creek Dr @ Cascade Ln	412980	52.5	54.0	54.5	50.87	51.41	52.16	52.61	53.95	A	A	A	B	B
133	Ehrlich Rd @ Bay Lake	410510	52.0	53.0	53.5	46.38	46.66	47.21	47.57	48.66	A	A	A	A	A
133	Foxridge Circle	410535	52.2	53.0	53.5	50.72	51.10	51.54	51.76	52.35	A	A	A	A	B
133	Gibbons Pass @ Lake George	410469	52.0	53.0	53.5	45.38	45.72	46.22	46.55	47.69	A	A	A	A	A
133	Lake Dr @ West Lake	410575	53.1	54.0	54.5	49.88	50.11	50.45	50.64	51.41	A	A	A	A	A
133	Lake Magdalene Blvd S. of Smitter Rd	410580	52.7	53.0	53.5	49.89	50.12	50.46	50.65	51.44	A	A	A	A	A
133	Lake Magdalene Dr @ Lake Magdalene Manors	410580	51.6	53.0	53.5	49.89	50.12	50.46	50.65	51.44	A	A	A	A	A
133	Nundy Ln @ Bay Lake	410500	48.5	48.5	48.5	46.35	46.63	47.18	47.55	48.63	A	A	A	A	D
133	Taralawn Ct @ Tarawood	410548	53.8	54.5	55.0	51.66	52.12	52.87	53.37	54.08	A	A	A	A	B
133	Westmoreland Rd	412960	53.3	54.0	54.5	53.09	53.40	53.81	54.09	54.73	A	B	B	C	D
134	Country Woods Dr @ Lake Lipsey	410450	43.5	43.5	44.0	41.99	42.24	42.64	42.93	44.36	A	A	A	A	D
134	Fletcher Av @ Orange Grove Rd	410470	50.0	50.5	51.0	42.48	42.99	43.71	44.01	45.50	A	A	A	A	A
134	Gaines Ct	415500	46.0	46.0	46.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
134	Graham Ln @ Vera Av	415500	46.3	47.0	47.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
134	Kruger Ln	415500	50.7	51.2	51.7	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
134	Lake George Ln @ Lake George	410469	50.4	52.0	52.5	45.38	45.72	46.22	46.55	47.69	A	A	A	A	A
134	Lake Lipsey Rd	410450	45.0	45.5	46.2	41.99	42.24	42.64	42.93	44.36	A	A	A	A	A
134	Lancer Dr	415540	53.4	53.4	54.0	47.72	48.05	48.52	48.83	50.25	A	A	A	A	A
134	Moran Rd @ Bay Lake outfall	410477	49.9	50.0	50.5	42.87	43.08	43.48	43.73	44.51	A	A	A	A	A
134	Orange Grove Rd @ Lake Ellen	410460	44.3	44.5	45.0	42.40	42.84	43.42	43.54	44.40	A	A	A	A	B
134	Paddock Rd @ Lake Ellen Dr	410466	51.5	52.0	52.5	44.79	44.97	45.28	45.49	46.21	A	A	A	A	A
134	Stall Road @ Lake Ellen	410460	42.2	42.2	42.9	42.40	42.84	43.42	43.54	44.40	C	C	D	D	D
134	Stonebrook Ln @ Lake Ellen	410460	46.7	47.5	48.0	42.40	42.84	43.42	43.54	44.40	A	A	A	A	A
135	Carrollview Dr @ Samara Dr	415500	40.0	40.5	41.0	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
135	Carrollwood Dr @ Lake Carroll Way	415500	42.0	43.0	43.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
135	Carrollwood Dr @ Orange Grove Rd	415500	42.0	43.0	43.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
135	Carrollwood Dr @ Peacock Ln	415500	44.0	45.0	45.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
135	Carrollwood Dr @ Sabal Dr	415500	40.8	42.0	42.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
135	Carrollwood Ln NW of White Trout Lake	415320	39.0	40.0	41.0	36.55	36.92	37.50	37.93	39.54	A	A	A	A	B
135	Hampton Pl @ White Trout Lake	415300	42.0	43.0	43.5	36.34	36.58	36.97	37.22	38.09	A	A	A	A	A
135	Lacera Dr @ Lake Carroll	415500	39.5	40.5	41.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	B
135	Linthicum Pl @ White Trout Lake	415300	44.8	45.5	46.0	36.34	36.58	36.97	37.22	38.09	A	A	A	A	A
135	McFarland Rd @ Lake Lipsey	410450	43.7	45.0	45.5	41.99	42.24	42.64	42.93	44.36	A	A	A	A	B
135	McFarland Rd @ Orange Grove Rd	410410	44.0	45.0	46.0	39.74	40.26	41.30	42.00	43.32	A	A	A	A	A
135	White Trout Ln @ Lake Elaine	415350	40.4	41.0	41.5	37.47	37.67	37.94	38.12	38.77	A	A	A	A	A
135	Woodson Way @ Lake Avis	415400	40.6	41.0	41.5	37.53	37.74	38.07	38.26	39.03	A	A	A	A	A
136	Barcelona Apts	415195	42.5	43.0	44.0	40.53	41.17	42.26	42.57	43.00	A	A	A	B	C
136	Buschwood Office Park @ Himes Av	415270	41.8	42.5	43.0	36.94	37.41	38.15	38.43	40.02	A	A	A	A	A

Table 6-1
SWEETWATER CREEK BASIN
EXISTING CONDITIONS LEVELS OF SERVICE ANALYSIS

SB NO.	LOCATION DESCRIPTION	NEW MODEL JUNCTION	STREET FLOODING ELEV., ft NGVD	YARD FLOODING ELEV., ft NGVD	STRUCTURE FLOODING ELEV., ft NGVD	24-HOUR DURATION DESIGN STORM MAXIMUM FLOOD ELEVATION, ft NGVD					LEVEL OF SERVICE (LOS)				
						2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR	2.33-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR
136	Carrollwood Station Apts	415279	48.5	49.5	50.5	45.47	45.79	46.27	46.58	47.58	A	A	A	A	A
136	Manors @ White Trout Lake	415300	38.0	38.0	40.0	36.34	36.58	36.97	37.22	38.09	A	A	A	A	C
136	Post Village Apts	415199	43.5	44.0	45.0	42.61	42.89	43.25	43.33	43.52	A	A	A	A	B
144	Sandy Pines Dr S. of Crenshaw Lake Rd	410854	55.7	56.0	56.5	53.03	53.51	54.22	54.69	56.31	A	A	A	A	C
145	Avila Blvd	410832	54.0	55.0	55.5	51.06	51.53	52.34	52.90	54.84	A	A	A	A	B
145	Guisando Av @ Avila GCC	410852	54.0	55.0	55.5	52.55	52.94	53.53	53.94	55.38	A	A	A	A	C
145	Indian Mound Rd	410655	53.2	54.0	55.5	51.11	51.31	51.55	51.68	52.16	A	A	A	A	A
145	Lake Byrd Dr North of Bird Lake	410650	50.5	50.5	51.2	50.17	50.44	50.82	51.12	51.96	A	A	C	C	D
145	Lake Magdalene Blvd @ Chancery Pl	410650	53.0	53.0	53.5	50.17	50.44	50.82	51.12	51.96	A	A	A	A	A
145	Parrilla Dr @ Avila GCC	410658	53.2	54.0	55.5	51.34	51.71	52.28	52.61	53.85	A	A	A	A	B
145	Sonsoles De Avila @ Sloan Lake	410847	54.0	55.5	56.5	51.04	51.18	51.41	51.58	52.46	A	A	A	A	A
145	Taray De Avila @ Fish Lake	410840	53.5	56.0	56.5	50.22	50.50	51.14	51.54	52.56	A	A	A	A	A
145	Teepee Dr	410684	53.7	54.0	54.5	50.30	50.55	50.90	51.13	51.94	A	A	A	A	A
145	Villarreal Dr @ Avila Dr	410830	53.3	54.0	54.5	50.20	50.47	51.01	51.36	52.15	A	A	A	A	A
145	Millan De Avila	410665	53.2	55.0	55.5	52.16	53.00	54.26	54.63	54.82	A	A	B	B	B
146	Albright Dr S. of Bearss Av	410590	52.0	52.5	53.0	49.90	50.14	50.48	50.66	51.53	A	A	A	A	A
146	Assembly Grounds Rd	410615	52.2	53.5	54.5	50.00	50.30	50.70	51.11	51.95	A	A	A	A	A
146	Balsawood and Wedgewood Roads	410589	51.0	52.0	52.5	49.90	50.15	50.57	50.86	51.89	A	A	A	A	B
146	Bearss Ave @ Rome Av	410580	52.0	52.0	52.5	49.89	50.12	50.46	50.65	51.44	A	A	A	A	A
146	Country Lakes	410610	51.5	52.0	52.5	50.11	50.26	50.64	50.77	51.84	A	A	A	A	B
146	Hardy Dr	410589	51.8	52.5	53.0	49.90	50.15	50.57	50.86	51.89	A	A	A	A	B
146	Lake Magdalene Blvd @ Platt Lake	410620	53.7	53.7	53.7	50.00	50.30	50.70	51.11	51.95	A	A	A	A	A
146	Lake Magdalene Blvd	410630	54.2	54.5	55.0	53.24	53.71	54.40	54.81	55.09	A	A	B	C	D
146	Lake Magdalene Blvd	410810	52.8	54.0	54.5	50.17	50.41	50.92	51.24	51.99	A	A	A	A	A
146	Woodway Dr @ Almondwood Dr	410800	52.7	53.0	53.5	50.17	50.41	50.92	51.23	51.96	A	A	A	A	A
146	Woodway Dr @ Woodbriar Village	410810	52.8	53.5	54.0	50.17	50.41	50.92	51.24	51.99	A	A	A	A	A
147	Cherrywood Ave @ Lakewood Ave	410589	52.0	52.2	53.0	49.90	50.15	50.57	50.86	51.89	A	A	A	A	A
147	Lake Magdalene Cir	410580	53.0	53.0	53.5	49.89	50.12	50.46	50.65	51.44	A	A	A	A	A
147	Rome Ave @ Kaye Dr	410589	52.5	52.5	53.5	49.90	50.15	50.57	50.86	51.89	A	A	A	A	A
147	Shady Shores Dr @ Cape Bend Ave	410586	53.0	53.5	54.0	49.90	50.15	50.57	50.86	51.89	A	A	A	A	A
148	Howard Ave	415500	49.0	49.0	49.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
148	Lake Ellen Dr N. of Lake Carroll	415500	52.4	53.0	53.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
148	Magdalene Shores	415550	54.2	54.7	55.2	47.72	48.04	48.52	48.83	49.88	A	A	A	A	A
148	South Village Av @ Magdalene Shores	415530	51.8	52.0	52.5	48.31	48.84	49.60	50.08	50.91	A	A	A	A	A
148	Woodleigh Av @ Seaman Rd	415510	53.8	54.3	54.8	45.72	46.07	46.58	46.91	50.65	A	A	A	A	A
149	Carroll Pl and Circle Dr	415500	43.4	44.0	44.5	37.70	37.96	38.35	38.61	39.53	A	A	A	A	A
149	Hidden Lake Dr @ Boat Lake	415600	42.7	43.0	43.5	36.63	37.12	37.84	38.31	39.84	A	A	A	A	A
149	Lake Dr W. of Armenia Av	415505	42.0	43.8	44.3	42.12	42.57	42.69	42.83	43.16	B	B	B	B	B
157	Chapman Lake Rd	411066	56.3	56.3	57.5	55.46	55.80	56.35	56.72	57.84	A	A	C	C	D
157	Debuel Rd @ Hwy 41	411127	61.2	61.5	62.5	60.24	60.61	61.15	61.49	61.58	A	A	A	B	C
157	Dennison & Warren Rds @ Hwy 41	411074	61.0	61.0	61.5	56.72	56.91	57.20	57.38	58.00	A	A	A	A	A
157	Duque Rd @ Hwy 41	411115	59.5	60.0	60.5	57.12	57.38	57.74	57.94	58.68	A	A	A	A	A
157	Lynette Dr	411116	59.2	59.5	60.5	58.11	58.53	58.59	58.67	58.84	A	A	A	A	A
157	Orangewood Dr @ Lake Estes	411075	57.5	57.5	58.0	55.53	55.83	56.37	56.74	57.88	A	A	A	A	C
157	Myrtle Ridge Rd @ Hwy 41	411120	61.5	61.8	62.5	57.45	57.79	58.27	58.57	59.62	A	A	A	A	A
157	Surrey Ln @ Dubuel Rd	411125	61.5	62.0	62.5	57.52	57.79	58.27	58.57	59.62	A	A	A	A	A
157	Melba Ln & Busto Dr	411135	58.5	58.5	59.0	56.24	56.71	57.40	57.82	59.06	A	A	A	A	D
158	Chapman Rd @ Windsor Park Dr	411018	58.0	58.5	59.0	54.16	54.16	54.16	54.16	54.86	A	A	A	A	A
158	Highland Ave & Lake Magdalene Blvd	410801	55.5	55.5	56.0	50.17	50.41	50.91	51.23	51.97	A	A	A	A	A
158	Hanna Rd	411010	58.0	N/A	N/A	51.49	51.85	52.35	52.68	54.07	A	A	A	A	A
158	Hayes Rd @ Lake Evans	411700	54.8	54.8	55.0	49.40	49.72	50.23	50.55	51.62	A	A	A	A	A
158	Lake Dr W @ Chapman Lake	410850	53.5	53.5	54.0	50.60	50.99	51.48	51.77	52.76	A	A	A	A	A
158	Linwood Terrace @ Hanna Rd	411010	56.4	56.4	57.0	51.49	51.85	52.35	52.68	54.07	A	A	A	A	A
158	Taray De Avila @ Fish Lake	410840	53.5	56.0	56.5	50.22	50.50	51.14	51.54	52.56	A	A	A	A	A
159	Hayes Rd @ Long Lake	411710	54.8	54.8	55.0	49.49	49.74	50.11	50.36	51.19	A	A	A	A	A
159	Nottinghill Dr @ Faircloth Estates	410801	54.5	55.0	55.5	50.17	50.41	50.91	51.23	51.97	A	A	A	A	A
159	Lakeshore Villas @ Lake Evans	411720	52.0	52.0	53.0	51.09	51.51	52.12	52.51	53.75	A	A	C	C	D
159	Sinclair Hill Dr E of Florida Av	411730	53.7	55.5	56.0	49.49	49.74	50.11	50.36	51.19	A	A	A	A	A

CHAPTER 7: EXISTING WATER QUALITY CONDITIONS

7.1 Overview

The Sweetwater Creek (SC) watershed is located roughly between Pocahontas Avenue on the south, Webb Road on the west, Florida Avenue on the east, and Crenshaw Lake Road on the north (Figure 7-1) in Hillsborough County. It heads in the vicinity of the intersection of US 41 and Debuel Road in northern Hillsborough County and flows southwesterly to confluence with Rocky Creek at a point approximately 0.5 mile of Webb Road. Between its confluence with Rocky Creek and a point just upstream of Benjamin Road, Sweetwater Creek is referred to as Channel G, a canal constructed in the 1960s. Heading in the Lake Carroll area, Channel H intersects Sweetwater Creek from the east.

Prior to the permanent settlement of Hillsborough County in the first half of the 19th century, approximately 68% of the land in the Sweetwater Creek watershed was occupied by soils that supported two land cover types: the primary upland community, pine flatwoods (FLUCFCS 411), and longleaf pine-xeric oak (FLUCFCS 412). The remainder of the land in the watershed was occupied by stream and lake swamp (FLUCFCS 615), cypress swamps (FLUCFCS 621), wetland forested mixed (FLUCFCS 630), and herbaceous wetlands (FLUCFCS 641, 643, 644). The swamps bordering Sweetwater Creek, itself and the 37 lakes in the watershed were significant contiguous wetlands in the watershed and provided water quality benefits.

By 1910, Hillsborough was the most populous county in the state, and considerable development of roads and railroads had occurred. By 1916, in the Sweetwater Creek watershed, the current main roadways (Gunn Highway, North Boulevard, Dale Mabry Highway, Armenia Avenue, US 41, Bearss Avenue) were hard surface facilities, and important secondary roads such as Lake Magdalene Boulevard and Crystal Lake Road were in place. At least three churches, one cemetery, and one school existed. Several hundred homes had been constructed, and one railroad line traversed the watershed at the present location of Busch Boulevard. Agriculture had became established on the uplands located near lakes and streams, with citrus occupying the highest elevations and crops and pasture occupying the lands at lower elevations. By 1950, agriculture accounted for 32% of the lands in the watershed, while uplands were reduced from approximately 68% to 38% of the watershed. By 2004, the percent coverage of the watershed by uplands was further reduced to 2.4%.

Location of the Sweetwater Creek Watershed

Figure 7-1

AYRES ASSOCIATES

Surface Water Resources - The surface water systems in the 21-square mile Sweetwater Creek watershed include streams, canals, ponds, and lakes.

Streams – In the Sweetwater Creek watershed, there are two named streams: Sweetwater Creek, which is also referred to as Channel G along its lower reach; and Channel H, most of which is an artificial canal built in the 1960s. The channel of Sweetwater Creek has been greatly modified by diversion, straightening, and deepening, a process that began after 1916 and was well along by 1938. Major alterations were done in the 1960s, as part of a Soil Conservation Service (now NRCS) Upper Tampa Bay Project. The Creek now serves as an urban drainage facility.

Lakes - In the Sweetwater Creek watershed, there are 37 named lakes of which 16 have surface areas > 10 acres (Table 7-1).

Table 7-1 Lakes in the Sweetwater Creek Watershed having Surface Areas >10 Acres

LAKE	ACRES	LAKE	ACRES
Bay	36	George	21
Bird	23	Lipsey	35
Boat	34	Little Bay	12
Carroll	191	Lord	12
Chapman	17	Magdalene	238
Ellen	53	Platt	63
Estes	13	West	17
Gass	19	White Trout	77

Reservoirs - Reservoirs are artificial impoundments of water constructed in association with agricultural and residential development in the watershed; residential reservoirs are managed to provide aesthetic or stormwater management functions. In the Sweetwater Creek watershed, there are over 24 named surface water management facilities that participate in the County's Adopt-A-Pond program (Table 7-2) and numerous, unnamed such ponds.

Table 7-2 Stormwater Ponds in the Adopt-A-Pond Program

POND	POND
Adair Family	Magdalene Reserve
Deer Creek	Manor Oaks
Dorothy Thomas School	Mossvale Lane
East Village	Oakview Terrace
Greco-Sherman Group	Pico Pond
Hunters Lake	Reynoldswood Pond
Lake Chapman Subdivision	Tarawood
Lake Ellen Circle	The Manors at White Trout
Lake Ellen Woods	Thompson East
Lake Magdalene Woods	Twelve Oaks Lake
Lake Morley Improvements	Twelve Oaks - smaller
Lakeville	Windsor Park

Estuary – The Sweetwater Creek watershed as a whole contributes flow to Rocky Creek via Channel G. Rocky Creek contributes flow to Old Tampa Bay north of the Courtney Campbell Causeway by means of the original Rocky Creek channel and the man-made Channel A. Therefore, Sweetwater Creek watershed no longer has a direct estuarine component of its own.

The water bodies in the Sweetwater Creek watershed occupy approximately 8% of the watershed. While not a major watershed component in terms of areal coverage, these water resources are of critical importance, and the improvement of existing water quality conditions as well as the conservation and restoration of these resources are the subjects of a number of ongoing planning activities and action projects for this area including:

- Florida Department of Environmental Protection (FDEP) Impaired Waters and Total Maximum Daily Load (TMDL) Program
- Hillsborough County's Comprehensive Plan (Stormwater Management, Conservation and Aquifer Recharge, and Coastal Management Elements)
- Southwest Florida Water Management District's Tampa Bay/Anclote River Comprehensive Watershed Management Plans (CWM)
- Southwest Florida Water Management District's Minimum Flows and Levels (MFL) Program
- Southwest Florida Water Management District's Surface Water Improvement and Management (SWIM) Program for Tampa Bay
- Southwest Florida Water Management District's Northern Tampa Bay Phase II Program
- Tampa Bay Estuary Program's Comprehensive Conservation Management Plan

Both federal (Clean Water Act [CWA]) and state (Chapter 62-302, Chapter 62-303, and Chapter 62-304 Florida Administrative Code [F.A.C.]) initiatives have been developed to protect, restore, and maintain surface waters. During the 1997 session, the Florida Legislature amended the Water

Resources Act (Chapter 373.036, Florida Statute) and clarified responsible agencies' roles relating to water supply planning. The primary goals of these initiatives have been to provide mechanisms for water supply assessment and to maintain water quality conditions that protect both human health and fish and wildlife populations. A classification system has been developed by the FDEP that designates a surface water body based upon the water body's designated use (Table 7-3). Each classification specifies minimum water quality criteria that must be met by surface waters falling in that classification. These criteria are consistent with minimum federal standards set by the U.S. Environmental Protection Agency (US EPA) (Appendix 7-1)[1]. Waters in the Sweetwater Creek watershed are classified as Class III (62-302 F.A.C. amended 09JAN06).

Discharges to surface waters are regulated by the FDEP, Southwest Florida Water Management District (SWFWMD), Hillsborough County Environmental Protection Commission (HCEPC), and/or the US EPA, depending on the type and magnitude of a particular discharge. Comprehensive stormwater regulation is also required under Section 402(p) of the CWA, and cities/municipalities with populations greater than 100,000 are required to develop and implement stormwater plans under Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater regulations. Phase II of the NPDES program, which was implemented in 2004, required smaller communities to obtain a permit and develop a program for water quality improvement.

Table 7-3 Surface Water Classifications Developed under Chapter 62-302, F.A.C.

SURFACE WATER CLASSIFICATION	DESIGNATED USE	CRITERIA
CLASS 1	Potable Water Supplies	Very stringent
CLASS 2	Shellfish Propagation or Harvesting	Stringent
CLASS 3	Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife	Moderately stringent
CLASS 4	Agricultural Water Supplies	Less stringent
CLASS 5	Navigation, Utility and Industrial Use	Less stringent

The following section provides a brief discussion of the Federal and Florida rules and regulations in regard to water quality protection.

7.1.1 Regulatory Background

The Total Maximum Daily Load (TMDL) requirements were originally promulgated as a part of the Federal Water Pollution Control Act of 1972 and were later expanded by the Clean Water Act (CWA) of 1977 and the Water Quality Act (WQA) of 1987. The law requires states to define state-specific water quality standards for various designated uses and to identify water bodies that do not meet established water quality standards (Subsection 303(d)). Water bodies that do not meet such water quality standards as a result of human-induced conditions are to be considered impaired. An updated list of impaired water bodies must be presented by the state to the

[1] Appendix 7-1 – FDEP Surface water classification chart

Environmental Protection Agency (EPA) every two years and must designate which of the listed impaired water bodies will require implementation of the TMDL process. State of Florida issued a full 303(d) planning list in 2002 and has been producing basin-specific 303(d) impaired waters lists recently in accordance with the Florida Watershed Restoration Act (FWRA, Chapter 403.067, Florida Statute).

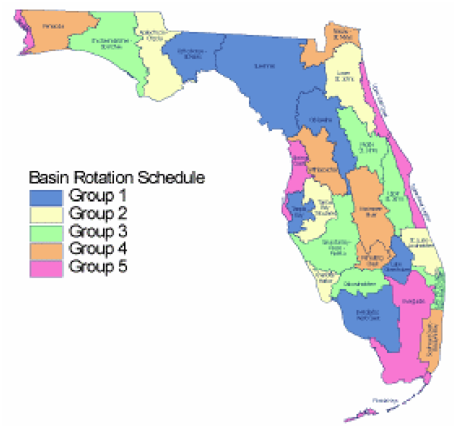
In Florida, the TMDL process is multi-phased and includes identification, verification, and listing of impaired waters, followed by the development and implementation of constituent specific TMDL (e.g., DO, TN, etc.). As a first step, FDEP develops a planning list of impaired waters based on existing data. FDEP then prepares a verified list following the collection of additional corroborating water quality, biological, or other data. The verified list is then adopted by the FDEP Secretary as the basin specific 303(d) list to be sent to EPA in compliance with the CWA. Once a water body is placed on the verified list of impaired waters, the next phase of the TMDL process is to develop a TMDL, including the initial allocation of allowable loads. The next step in the TMDL process is the development of the Basin Management Action Plan (BMAP), or the TMDL implementation plan, in which detailed allocations of allowable loadings for point and non-point sources (NPS) for a specific water quality constituent is done and load reduction strategies are evaluated. Florida's TMDL development and implementation process includes the following phases:

Phase 1: Data Compilation and Assessment
Phase 2: Collection and Assessment of Additional Data
Phase 3: Determination of Total Maximum Daily Load
Phase 4: Development of Allocation and Basin Management Action Plan (BMAP)
Phase 5: Implementation of the TMDL and BMAP

The process for the determination of impaired waters is described in the Impaired Water Rule, 62-303 FAC. In Phase 3, the TMDL is estimated, generally with the use of mathematical models associated with water quantity and quality data and watershed information. Details of the applicable models and input requirements are discussed in the FDEP, TMDL Protocol version 6.0 (2006). This section is adopted from the FDEP, TMDL protocol for completeness.

Once the TMDL is established in Phase 3, the allowable loads are allocated in Phase 4 to both the point and non-point sources for each specific water quality constituent. Point sources would include domestic and industrial wastewater and National Pollutant Discharge Elimination System (NPDES), industrial and municipal separate storm sewer systems (MS4s), and stormwater discharges. Non-point sources would include septic tanks, agricultural, silvicultural, atmospheric, and natural flora and fauna discharges, as well as legacy sediment effects. One or more implementation plans are then developed to define how each source will be controlled to achieve the allocated load. For contributing pollutant sources under NPDES permits, the allocation will be achieved through permit-specified effluent limitations and load reductions. For other sources, such as agricultural areas that are not regulated by NPDES permits, load allocations will be achieved through non-regulatory programs based on the implementation of Best Management Practices (BMPs) associated with each crop type. Lastly, in Phase 5 of the TMDL process, the implementation of the

BMAPs are initiated. FDEP uses the concept of watershed approach to implement the TMDL program that is briefly described here.



To implement the watershed approach for all water bodies in Florida, FDEP has divided each of the six FDEP Districts into five geographically based groups of watersheds. A map of the groups is shown in the inset and a table that lists the groups by basin and district is provided below (Table 7-3a). As illustrated in Table 7-3b, the five phases of the State's TMDL program for each group are completed in annual cycles, starting with Group 1.

FDEP Basin Rotation Schedule (Source: FDEP, 2007)

For each TMDL completed under the phased watershed management approach outlined above, a technical analysis of the assimilative capacity of the subject water segment in question may be conducted. The assimilative capacity is the total amount of a pollutant that can be discharged into a water segment without causing use impairment. Thus, the assimilative capacity, as a result, is numerically equivalent to that segment's TMDL with a Margin of Safety (MOS). To determine the assimilative capacity, the fate of the total loading to a water segment may be compared to water quality criteria and other environmental targets to test for use impairment. Such comparisons are usually done using water quality data and hydraulic-hydrologic-water quality modeling tools.

Table 7-3a Watersheds Listed by Group and FDEP District

YEAR*	00 01	01 02	02 03	03 04	04 05	05 06	06 07	07 08	08 09	09 10
Group 1	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Group 2		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2	Phase 3	Phase 4
Group 3			Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2	Phase 3
Group 4				Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2
Group 5					Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1
	1st Five-Year Cycle – High Priority Waters					**2nd Five-Year Cycle – Medium Priority Waters**				

Table 7-3b Schedule of Phases for Each Group

DEP District	Group 1 Basins	Group 2 Basins	Group 3 Basins	Group 4 Basins	Group 5 Basins
NW	Ochlockonee-St. Marks	Apalachicola-Chipola	Choctawhatchee-St. Andrews Bay	Pensacola Bay	Perdido Bay
NE	Suwannee	Lower St. Johns		Nassau-St. Marys	Upper East Coast
Central	Ocklawaha	Middle St. Johns	Upper St. Johns	Kissimmee	Indian River Lagoon
SW	**Tampa Bay**	**Tampa Bay Tributaries**	Sarasota Bay-Peace-Myakka	Withlacoochee	Springs Coast
S	Everglades West Coast	Charlotte Harbor	Caloosahatchee	Fisheating Creek	Florida Keys
SE	Lake Okeechobee	St. Lucie-Loxahatchee	Lake Worth Lagoon-Palm Beach Coast	Southeast Coast - Biscayne Bay	Everglades

Groundwater resources – The groundwater resources in the watershed have been developed for potable supply, irrigation, and industrial use. The groundwater system is composed of water contained in two aquifer units - the surficial and Floridan aquifers. The surficial aquifer is composed variously of clastic deposits of medium to fine-grained materials including quartz sand, silty sand, kaolinitic clay, gravel, shell, and limestone. The surficial aquifer supplies comparatively small volumes of water for domestic use and lawn watering. Composed of limestone and dolomite beds ranging in thickness from 1,000 – 1,200 feet, the Floridan Aquifer is the chief source of groundwater production, and the Upper Floridan is the aquifer zone used commonly in the watershed for larger scale supply purposes.

Springs - No springs are reported in the watershed.

Sinks - At least 33 sinks have been reported in the watershed by the Florida Sinkhole Research Institute.

Groundwater in the Sweetwater Creek watershed is of critical importance for potable water supply and for the maintenance of salinity patterns in Upper Old Tampa Bay and the lower reaches of Rocky Creek. The conservation and protection of these resources are important components of a number of ongoing planning activities and action projects for this area including:

- Hillsborough County's Comprehensive Plan (Stormwater Management, Conservation and Aquifer Recharge, and Coastal Management Elements)
- Southwest Florida Water Management District's Tampa Bay/Anclote River Comprehensive Watershed Management Plans (CWM)
- Southwest Florida Water Management District's Northern Tampa Bay Phase II Program

Both federal (Clean Water Act [CWA]) and state (Chapter 62-302, Florida Administrative Code [F.A.C.]) initiatives have been developed to protect, restore, and maintain ground waters. During the 1997 session, the Florida Legislature amended the Water Resources Act (Chapter 373.036, Florida Statute) and clarified responsible agencies' roles relating to water supply planning.
The primary goals of these initiatives have been to provide water supply assessment and water quality conditions that protect human health. A classification system has been developed by the FDEP that designates groundwater based upon its designated use (Table 7-4).

Table 7-4 Groundwater Classifications Developed under Chapter 62-520, F.A.C.

GROUNDWATER CLASSIFICATION	DESIGNATED USE	CRITERIA
CLASS F-1	potable water use in single source aquifer, having TSS < 3,000 mg/L and reclassified as such by the ERC	Very stringent
CLASS G-I	potable water use in single source aquifer, having TSS < 3,000 mg/L	Stringent
CLASS G-II	potable water use in single source aquifer, having TSS < 10,000 mg/L unless otherwise classified by the ERC	Moderately stringent
CLASS G-III	Non-potable water use; groundwater in unconfined aquifers with TSS >10,000 mg/L, or with TSS of 3,000 – 10,000 mg/L and having no future use as potable supply or designated as exempt aquifer	Less stringent
CLASS G-IV	Non-potable water use; groundwater in confined aquifer with TSS > 10,000 mg/L	Less stringent

7.1.2 Existing Literature

Numerous reports and data sources, including those listed below, were reviewed to determine existing water quality conditions, historical trends, water quality models, areas of concern, relevant issues, and ongoing management activities in the Sweetwater Creek watershed:

- FDEP 2002 Update to Florida's List of Impaired Waters, as amended on March 11, 2003
- FDEP 2004 305(b) Report
- Hillsborough County Environmental Protection Commission (HCEPC) Annual Water Quality Reports
- Hillsborough County Watershed Atlas
- Hillsborough County Comprehensive Plan

- Hillsborough County Water Department Water Quality Reports
- Hillsborough River Greenways Task Force Ecosystem Protection Plan
- SWFWMD's Tampa Bay/Anclote Comprehensive Watershed Management (CWM) Plan
- SWFWMD's Save Our Rivers Five Year Work Plan
- SWFWMD's Tampa Bay Surface Water Improvement and Management (SWIM) Plan for Tampa Bay
- SWFWMD's Groundwater Quality of the Southwest Florida Water Management District, Central Region
- Tampa Bay Estuary Program (TBEP) Comprehensive Conservation Management Plan (CCMP) and related technical reports
- United States Environmental Protection Agency Total Maximum Daily Load Reports
- University of Florida LAKEWATCH Annual Data Summary for 2004

Water quality data were obtained from Florida LAKEWATCH and Hillsborough County Watershed Atlas for all parameters and all stations lying within the Sweetwater Creek watershed boundary. The majority of data obtained from the Hillsborough County Watershed Atlas originated from USGS, SWFWMD, HCEPC, and LAKEWATCH.

7.1.3 Water Quality Contaminants

Despite relatively stringent regulatory criteria (e.g., Chapter 62-302, F.A.C.), contaminants are found in streams and lakes which sometimes exceed allowable regulatory limits. Surface waters in the watershed are the receiving water bodies for untreated and partially treated stormwater runoff from lands that are developed (86%) for commercial, residential, and industrial purposes. Runoff contains complex mixtures of nutrients (i.e., nitrogen and phosphorus compounds), toxic organic substances (pesticides, herbicides, industrial chemicals, oils and greases), metals, solids (trash, litter), and particulates from eroded soils. All of the agricultural development and much of the urban/suburban development within the watershed preceded regulations implemented in the 1970s and 1980s to protect water quality. While regulations have been implemented for 20-30 years and there are stormwater treatment projects underway within the watershed, contaminants occur in the surface waters of the Sweetwater Creek watershed. These are described below:

- **Nutrients**, compounds of nitrogen and phosphorus, are derived from several sources, including:

    - fertilizers applied to landscapes around homes, golf courses, parks, residential complexes, and commercial facilities
    - animal excrement from pets, feral animal, and wildlife
    - wastewater treatment facilities, including septic tanks
    - atmospheric deposition in rainfall that contains combustion products from incinerators and electric generating plants

    Such compounds can cause an overabundance of nuisance aquatic weeds and blooms of algae and blue-green bacteria (aka, blue-green algae) in surface waters. In addition to unsightly appearance and taste/odor problems, the most injurious result of excessive algal and bacterial growth is the depression of dissolved oxygen in affected waters. Low dissolved oxygen (<5.0 mg/liter of water) contributes directly to fish kills, stress to all aquatic organisms, and a decline in fishery quality. In addition, some blue-green bacteria produce toxins that are harmful to humans and other animals. The Class III water bodies criterion for DO, as established by Subsection 62-302.530(31), F.A.C., states that DO shall not on average be less than 5.0 mg/L in a 24-hour period, and shall not be less than 4 mg/L at any time, and that normal daily and seasonal fluctuations above these levels shall be maintained. In Florida waters due to warm temperatures (subtropical climate), nitrogen and phosphorus are most often the limiting nutrients, and nitrogen is typically the limiting nutrient in most Florida estuaries. There is a general understanding in the scientific community that nitrogen is the principal cause of nutrient over-enrichment in urban water courses and coastal systems. Determining the limiting nutrient in a water body can be accomplished by calculating the ratio of nitrogen to phosphorus. When the ratios of total nitrogen (TN) to total phosphorus (TP) in a water body is less than 10 then it is classified as nitrogen limited. If nitrogen is the limiting nutrient, reductions in TN loadings would be expected to result in decreases in algal growth, and are measured as decreases in chlorophyll *a* levels. Reductions in TN loading are also expected to result in additional benefits for other water quality parameters of concern, including DO and biochemical oxygen demand (BOD). Reductions in nitrogen will result in lower algal biomass levels in the water column; lower algal biomass levels will result in smaller diurnal fluctuations in DO, fewer algal-based total suspended solids, and reduced BOD. The expectation that reductions in nitrogen loading will provide improvements in other water quality parameters is supported by a statistical evaluation of water quality data through a simple linear regression of chlorophyll *a* versus BOD**.**

Processes that consume oxygen from the water column, such as the microbial breakdown of organic material and sediment oxygen demand (SOD), are fairly constant over the short term. Algal populations, however, can increase rapidly, and the production of oxygen as a result of photosynthesis during daylight hours and the respiration or consumption of water from the water column at night can result in large diurnal fluctuations of DO in the water column. Portions of increased algal biomass will also become part of the organic material that will be broken down by microbes or settle to the bottom. Therefore, management of nutrients in the watershed to maintain the assimilative capacity of receiving waters will improve the water quality by preventing algal growth and maintaining required DO levels for the aquatic life.

- **Total suspended solids (TSS)** may cause high biological or chemical oxygen demand that also can reduce the availability of oxygen in the water for aquatic life. Metals and injurious organic compounds that are toxic in high concentrations are often bound to TSS and can be found in the sediments of receiving waters as a result of having been washed into a lake or stream in stormwater runoff. Excessive TSS concentrations also reduce water clarity and affect aquatic plant communities and may interfere with the feeding efficiency of filterfeeding aquatic insects and shellfish. High TSS in a lake or stream also increase the tendency of the water to heat during the day, further reducing the water's ability to hold oxygen.

- **Metals**, including mercury, lead, and copper, can reach levels that are toxic to many fish, amphibians, and aquatic insects. In some cases, metals such as mercury may accumulate in fish, posing a threat to human health if contaminated fish are consumed regularly.

- **Toxicants**, organic contaminants, and pesticides (which include insecticides, herbicides, and fungicides) can be found in residential, commercial, industrial, and agricultural areas, which can potentially be transported to surface waters via stormwater runoff. Though often undetectable in the water column, some compounds (e.g., pesticides) and their derivatives may accumulate in sediments in concentrations that are harmful to aquatic life.

- **Pathogens**, which may include bacteria, viruses, and protozoa, can cause a number of human diseases including respiratory and gastrointestinal ailments, skin rashes, and eye and ear infections. Transport of pathogens can occur via stormwater runoff or groundwater (from inadequately constructed septic tank systems) to surface waters. Illnesses may occur if pathogens are ingested either through accidental contact by recreational users of lakes and streams or through ingestion of inadequately treated drinking water. Pathogenic organisms are not routinely monitored by most water sampling agencies, except for potable water supplies. Indicators of pathogen contamination include total and fecal coliform bacteria that are tested by some agencies (e.g., health departments) at public bathing beaches and in ambient water quality monitoring programs. Efforts are currently underway by the US EPA to adopt standards for two new indicators, *E. coli* and the enterococcal group.

- **Litter, trash**, and other discarded solid objects originate from humans around shopping and commercial areas, industrial sites, landfills, automobiles, and overflowing trash cans. Litter poses a health and safety risk to humans and aquatic animals and impairs the aesthetic and economic values of neighborhoods, streams, and lakes.

- **Radioactive contaminants** originate from natural sources and from mining activities. Such contaminants can pose a health risk to humans, depending on the particular radioactive material(s) present.

7.1.4 Pollution Sources and Transport

Excess nutrients, pathogens, and toxic contaminants can follow several different pathways to the streams, lakes, and groundwater in the Sweetwater Creek watershed including:

1. untreated stormwater runoff from urban, residential, commercial, and agricultural land uses;
2. contaminated sediments which may be re-suspended during high flow or wind events in streams and lakes/bays, respectively;

3. atmospheric deposition (primarily nitrogen oxides and certain heavy metals like mercury which can be transported to the creeks and lakes in rainfall and dryfall);
4. failing septic tanks, which may contribute significantly to nitrogen and pathogen loading, although only 24% of homes in the County remain on on-site septic systems at this point;
5. animal waste from pets, feral dogs and cats, and wildlife; and
6. untreated domestic wastewater which may occur as accidental discharges during heavy rainfall events from waste water treatment and transport facilities.

Of these, the primary sources of nutrients in surface water are believed to be the first three items above listed with the bulk (98%) of the nutrient load being generated from urban lands and highways in the watershed.

In addition to items 1 - 6 above, groundwater in the watershed can also be contaminated from saltwater intrusion from lateral movement from Old Tampa Bay and from vertical, although the latter is probably not significant. Using the DRASTIC methodology, the vulnerability to contamination of the Floridan Aquifer in the watershed has been estimated at 159 on a relative scale of <79 to >200, 200 being areas of highest vulnerability to pollution. The DRASTIC index was computed using data from the following factors: the depth to water in the aquifer, net recharge (0 inches/year in the watershed), aquifer and soil media, topography, the impact of the vadose zone, and hydraulic conductivity. Using the same methodology, the vulnerability of the surficial aquifer was estimated as 181 (Kelley, 1988).

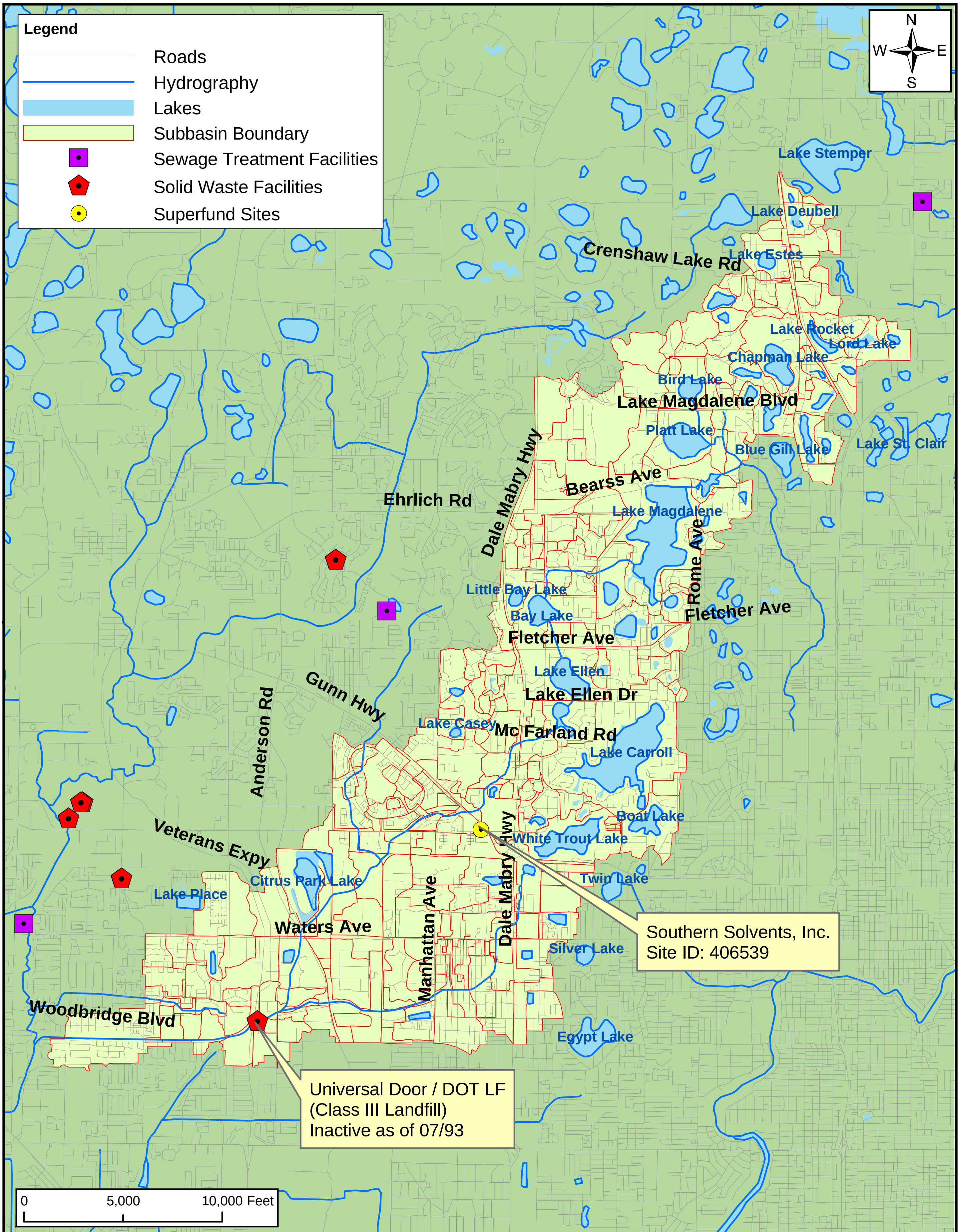
7.1.5 Superfund/Landfills/Point Sources

Superfund sites - A survey of US EPA's National Priority List indicated that there is one site, Southern Solvents, Inc. located at 4109 Linebaugh Avenue.

Landfills and other waste facilities – There are no active solid waste facilities in the watershed (FDEP, 2006).

Point sources – There are no permitted active domestic sewage treatment facilities in the watershed. There are three permitted industrial waste sites in the watershed. There are 10 hazardous materials sites listed in the FGDL as located in the watershed. There are six reported toxic release sites listed in the watershed. There are at least 17 permitted surface water management systems in the watershed (FDEP, 2006).

Figure 7-2 shows the location of the Superfund Sites, Solid Waste Facilities, and Sewage Treatment Facilities in the watershed.



Location of the Superfund Sites, Solid Waste Facilities, and Sewage Treatment Facilities in the Sweetwater Creek Watershed

Figure 7-2

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7.1.6 Other Issues

- **Contaminated sediments** - Although we have no specific data on sediments in the Sweetwater Creek watershed to indicate specific issues, it is helpful to indicate that recent studies in the Tampa Bay area have identified the presence of contaminated sediments in several areas of the Bay (Long et al., 1991 and 1994; Long and Greening, 1999, Grabbe and Barron, 2002). Of the areas sampled, Old Tampa Bay, the receiving water body for Lower Sweetwater Creek, had consistently lower levels of polychlorinated biphenyls (PCBs), organochlorine pesticides, and polycyclic aromatic hydrocarbons (PAHs) than other segments of the Tampa Bay system. While PCBs and PAHs were detected in sediment in the estuaries of Rocky Creek and Channel A, concentrations exceeded national standards for sediment quality in less than 30% of the samples tested. Few, if any, samples have been taken within the Sweetwater Creek watershed to evaluate sediment quality, but since contaminated sediments have been detected within the Bay, it is recommended that all contributing areas be sampled for potential contaminated sediment flux to the Bay. A number of management activities have been proposed to reduce contaminant loading to Hillsborough Bay, including source reductions and stormwater treatment. Such activities may be needed for all sources of inflow to the Bay. A sediment sampling plan may be needed to determine whether a sediment TMDL is warranted for this watershed.

- **Mercury in fish** – Old Tampa Bay north of Courtney Campbell Causeway (WBID 1558I), the outfall for Rocky Creek which is the outfall for Sweetwater Creek, is impaired for mercury in fish tissue, and a TMDL for that parameter is scheduled for development in 2011.

7.1.7 Total Maximum Daily Loads (TMDLs)

Section 303(d) of the Clean Water Act includes a requirement for states to identify, list, and prioritize waters for which water quality standards are not being protected by technology-based effluent limitations. Based on the priorities reported, each state must develop Total Maximum Daily Loads (TMDLs) for those waters that do not meet applicable water quality standards. The TMDL process quantifies and allocates the amount of a pollutant that can be assimilated by a waterbody. The process also identifies the source(s) of the pollutant and recommends appropriate regulatory actions to achieve compliance with water quality standards. A TMDL can be expressed as the sum of all point sources (waste load allocations or WLAs), non-point sources (load allocations or LAs), and an appropriate margin of safety (MOS), as shown below:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

The calculation must also account for seasonal variation in water quality. Nationally, the issues that are implicated in the most impaired waterbodies/segments include: sediments, nutrients, pathogens, low dissolved oxygen, and metals.

In the TMDL process, watersheds are evaluated using the following phased approach:

- Phase 1 - Initial Basin Assessment
- Phase 2 - Coordinated Monitoring
- Phase 3 - Data Analysis and TMDL Development
- Phase 4 - Basin Management Plan Development
- Phase 5 - Begin Implementation of Basin Management Plan
- Linkage to TMDL Implementation

Figure 7-3 displays the location of watersheds scheduled for TMDL development as of 2002 in the US EPA 303(d) report for Florida and their WBIDs. The Sweetwater Creek watershed is now divided into the following WBIDs relating to TMDLs: 1516 and 1563.

Currently (March 2003), Sweetwater Creek has recommended TMDLs for Nutrients, coliforms (total coliforms), and DO and WBID 1563 (Channel G) has recommended TMDLs for nutrients and DO by FDEP (Table 7-5).

It should be noted that Old Tampa Bay north of Courtney Campbell Causeway (WBID 1558I), the outfall for Rocky Creek, is impaired for coliforms in shellfish, and a TMDL for this parameter is scheduled for development in 2008.

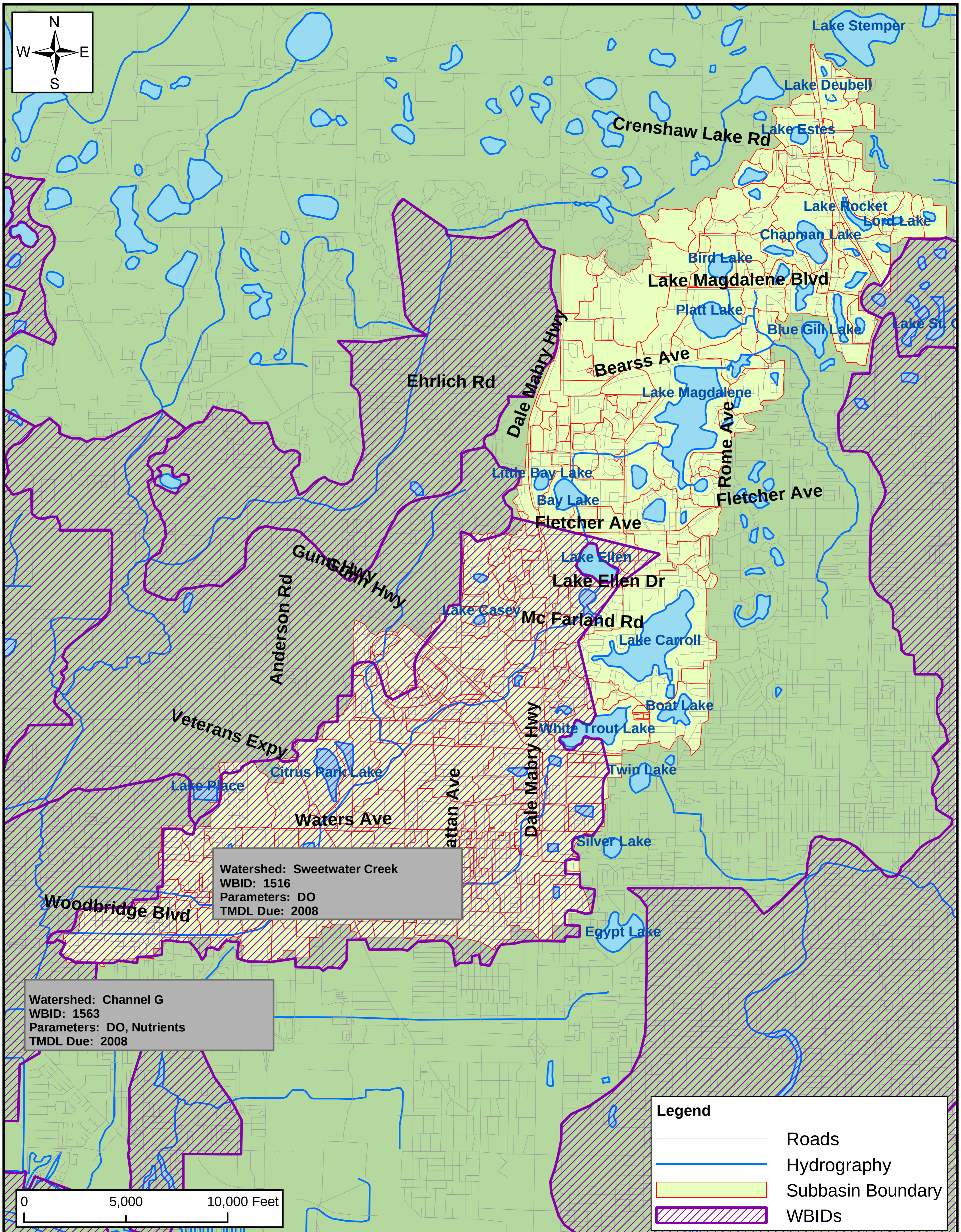
Sweetwater Creek TMDL development for DO and Channel G TMDL development for DO and nutrients have been scheduled for 2008 (Table 7-2). Refer to Appendix 7-2 for a complete list of waterbodies and their corresponding TMDL schedule.

Table 7-5 List of 303(d) Waterbodies and their Schedules in the Sweetwater Creek Watershed

Name	WBID	FDEP		US EPA	
		Parameters	Schedule	Proposed TMDL	Approved TMDL
Sweetwater Creek	1516	Nutrients (chl a), Coliforms (Total Coliform), DO, Nutrients (Historical Chlorophyll)	2008	DO, 2008	None
Channel G	1563	Nutrients (chl a), DO	2008	DO, Nutrients, 2008	None

1-FDEP parameters and schedule based on FDEP Verified List of Impaired Waters for the Group 1 Basins (including amended order – March 2003) G1CompositeVerifiedList_2-7-05.xls

2-US EPA TMDLs based on information downloaded on Nov 2007 APPROVED/DISAPPROVED by EPA on JUN-11-2003, Section 303(d) List Fact Sheet for Watershed TAMPA BAY



Location of WBIDs as they pertain to the Sweetwater Creek Watershed

Figure 7-3

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The FDEP will be evaluating various areas of the state based on a “rotating watershed” approach (Livingston, 2000). FDEP’s assessment study for the Tampa Bay area, which includes Sweetwater Creek, was issued in February 2004.

7.2 Water Quality Conditions in the Sweetwater Creek Watershed

7.2.1 Overall Data Assessment Methodology

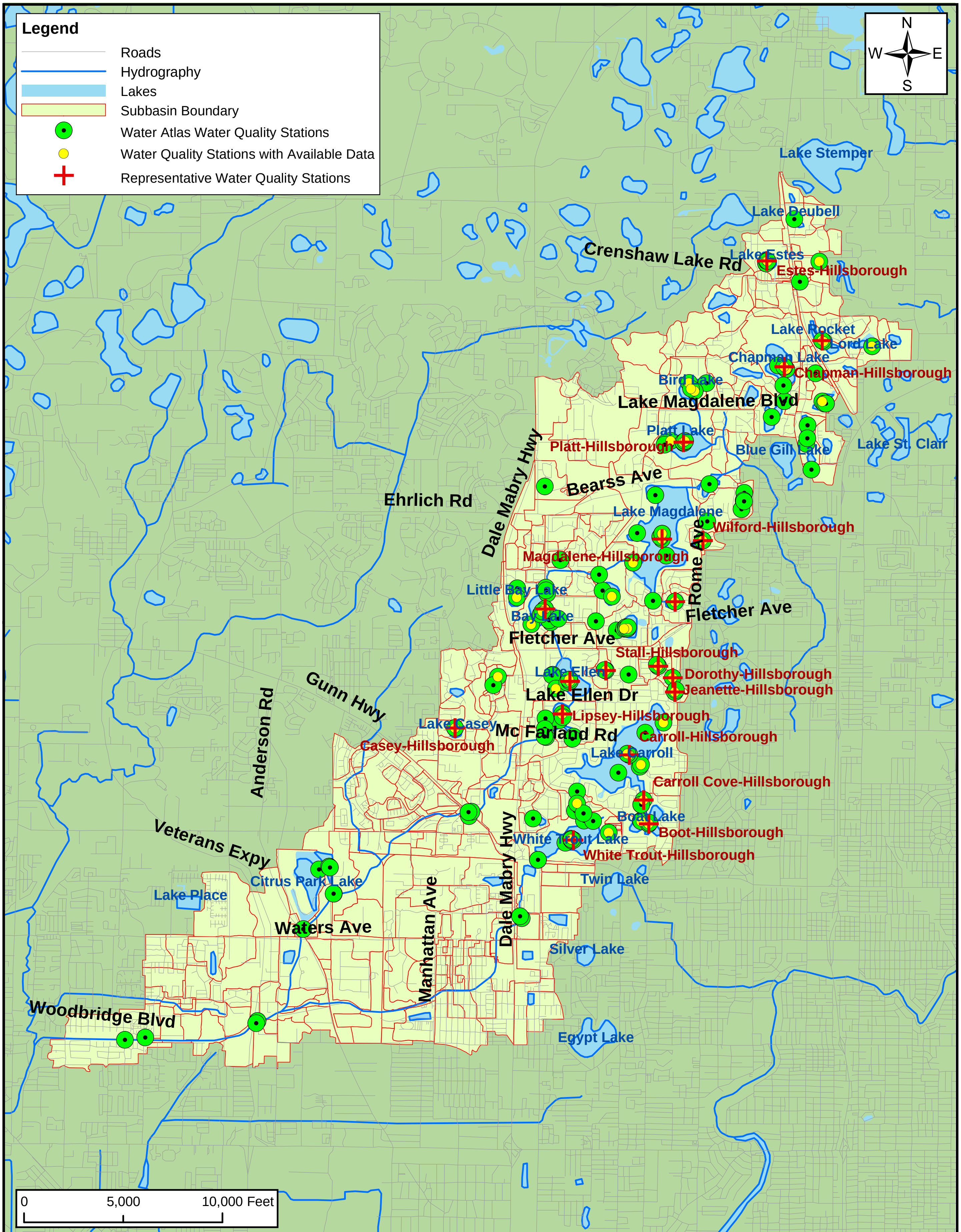
Station Selection - Locations of all surface water and ground water quality sampling stations evaluated in this chapter are shown in Figures 7-4 and 7-5.

Data sets from HCEPC, FDEP, SWFWMD, USGS, LAKEWATCH, or STREAM WATERWATCH were examined for this report. Data were available over the period 1968 through mid-2005 for the database as a whole; however, the most extensive database existed for Sweetwater Creek at Anderson Road (HCEPC #142) and seven of the 37 lakes in the watershed. Only these stations had at least 20 data points per parameter; these stations are the “representative” stations discussed in next section of this report and are listed in Table 7-6. Data are available for several other stations, including 20 other lakes in the watershed, Channel G, but the data are not extensive.

It is important to note that the data sets used for this evaluation were the most current available at the time at the start of the project. More recent sample data is available, but not included in this analysis.

Table 7-6 Water Quality Sampling Stations in the Sweetwater Creek Watershed containing at least 20 data points per parameter and number of samples/parameter

Station ID	Number of samples/parameter								
	DO	BOD5	pH	TN	TKN	TP	Chl a	Fecal Coli	Total Coli
Sweetwater Cr @ Anderson Rd (HCEPC #142)		182		168		179	246		
Lake Carroll	101			101		111	101		
Lake Chapman						130	128		
Lake Ellen				27		30			
Lake Estes				91		94	94		
Lake Lipsey				54		54	51		
Lake Magdalene	37			203		211	180		
Lake White Trout				85		87			



Location of the Surface Water Quality Sampling Stations in the Sweetwater Creek Watershed

Figure 7-4

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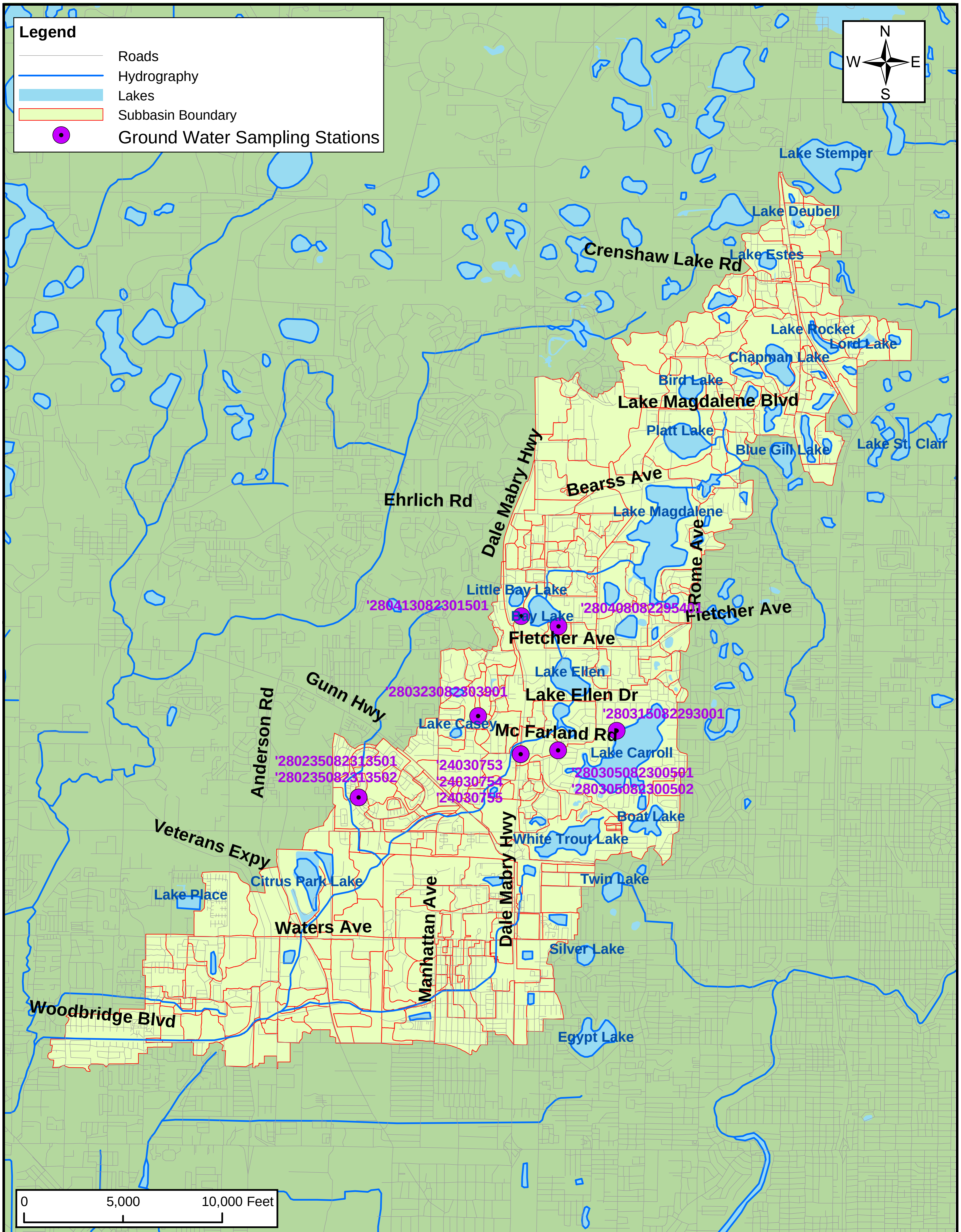

Location of the Groundwater Sampling Stations in the Sweetwater Creek Watershed

Figure 7-5

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Data are discussed in two different time frames:

1. Annual averages for the period of record in order to determine overall trends, and
2. Recent data from 2005 to examine trends, if any, shown by the newest data.

The discussion focuses on five parameters due to their significance in assessing the conditions of a water body and because they are used in the calculations of some important quality indices. The parameters are: dissolved oxygen (DO), biochemical oxygen demand (BOD), nutrients (total nitrogen and total phosphorous, designated by TN and TP, respectively), and chlorophyll a (chl a). Data for DO, however, was not extensive except for two lakes: Magdalene and Carroll.

7.2.2 Water Quality Conditions and Trends

7.2.2.1 Surface Waters

Lakes - In order to evaluate and compare lake water quality throughout Florida, the FDEP makes use of a Trophic State Index (TSI). Initially developed by Carlson (1977), the TSI is a number generated by inserting values for three water quality indicators (total phosphorus concentration, chlorophyll a concentration, and Secchi depth) into an equation modified from the original to include total nitrogen concentrations and exclude the Secchi depth measurement. Today, the TSI is interpreted as follows: a TSI between 0 and 59 is ***good***, while a value between 60 and 69 is ***fair,*** and 70 to 100 is ***poor.*** Of the 37 named lakes in the watershed, 22 have water quality data sufficient to calculate at least one value for TSI. Other lakes have data from isolated sampling episodes. This discussion is based upon data from University of Florida LAKEWATCH, USGS, and SWFWMD.

Trophic State Index (TSI) – Data to calculate TSIs for 22 lakes in the watershed were collected at various times during the period 1989 - 2005. TSI values ranged from a low of 35.6 (Carroll Cove) to a high of 66.5 (Chapman) (Table 7-7). The recent values placed most lakes in the ***good*** category. Lakes in the ***fair*** category included: Chapman and Stillwater. Average TSI values placed most lakes in ***good*** category with the exception of Jennette and Stillwater which were in the ***fair*** category.

Table 7-7 TSI Values for 22 Lakes in the Sweetwater Creek Watershed

LAKE	TSI recent	TSI Average or range	LAKE	TSI recent	TSI Average or range
Bay	46.4	51.7	Jennette	44.5	59.8
Bird	56.3	56.3-57.2	Lipsey	50.9	50
Boat	54.8	43	Little	53	49.2
Carroll	36.9	33.6	Lord	57.5	54.4
Carroll Cove	35.6	40.9	Magdalene	36.7	36.8
Casey	53.4	46	Platt	51.5	47.8
Chapman	66.5	50.9	Rocket	47.6	47.1
Dorothy	57.5	58.1	Stall	44.8	44
Ellen	45	N/A	Stillwater	61.6	65.3
Estes	47.9	49.7	White Trout	43	38.8
George	37	47.8	Wilford	47.9	43.7

Seven lakes showed a recent TSI that was lower than the average TSI, suggesting a possible improving trend, while 10 lakes showed a recent TSI that was higher than the average TSI, indicating a possible declining trend in water quality conditions. Four lakes showed no trend in TSI (Table 7-8).

Table 7-8 Comparison of Recent TSI Values with Average TSI Values for 22 Lakes in the Sweetwater Creek Watershed

$TSI_{recent} \leq TSI_{average}$	$TSI_{recent} \geq TSI_{average}$	$TSI_{recent} \approx TSI_{average}$
Bay	Boat	Ellen
Carroll Cove	Carroll	Magdalene
Dorothy	Casey	Rocket
Estes	Chapman	Stall
George	Lipsey	
Jennette	Little	
Stillwater	Lord	
	Platt	
	White Trout	
	Wilford	

Seven lakes had data from a period of time sufficient to allow the collection of a substantial number of samples for some parameters (Table 7-9). The highest average value for chlorophyll a (chl a) was reported for Lake Chapman; Chapman also had the highest total phosphorous (TP) reported. Lake Estes reported the highest total nitrogen (TN); however, the TN value for Lake Chapman was not available. All seven lakes had substantial concentrations of TN, and all seven had TSI values ranging either in the ***fair*** category or in the upper half of the ***good*** category, suggesting that the addition of more phosphorous to the system could increase the tendency towards hypereutrophic (higher TSI) conditions in area lakes.

Table 7-9 Average Values from Period of Record Data and Number of Samples (N) for Selected Parameters for Seven Lakes in the Sweetwater Creek Watershed

LAKE	Chl a (µg/L)		DO (mg/L)		TN (µg/L)		TP (µg/L)	
	Average	*N*	*Average*	*N*	*Average*	*N*	*Average*	*N*
Carroll	3.77	101	8.4	14	490.2	101	25.08	111
Chapman	40.7	128	7.4	5	N/A	N/A	37.9	130
Ellen	N/A	N/A	7.6	4	732.9	27	21.1	30
Estes	11.8	94	5.6	3	899.2	91	31.9	94
Lipsey	11.6	51	N/A	N/A	885.5	54	30.6	54
Magdalene	4.6	180	7.3	37	792.9	203	15.5	211
White Trout	N/A	N/A	8.4	3	511.0	85	13.9	87

Streams

***Sweetwater Creek* -** The stream sampling station having sufficient data for analysis was Sweetwater Creek at Anderson Road (HCEPC #142) located 0.75 mile from the Creek's junction with Channel G. The Creek is a freshwater stream from its head to the Channel G junction. This station has been sampled over the period 1988 to the present time. This discussion is based chiefly on the HCEPC data set and that of the STREAM WATERWATCH program.

The Florida Water Quality Index (WQI) developed by Hand et al. (1992) is used to assess and compare water quality within watersheds. Table 7-10 provides the WQIs for this reach of Sweetwater Creek. The WQI is interpreted as follows: between 0 and 45 is ***good,*** while a value between 45 and 60 is ***fair,*** and >60 is ***poor****.* Table 7-10 shows that the seasonal average WQI for the reach of Sweetwater Creek represented by HCEPC #142 is highest during the wet season (Jul-Sep) and lowest during the drier times of the year (Apr-Jun and Jan-Mar), suggesting that water quality declines in the Creek during periods of high storm water runoff. Of the WQIs from 2002 through 2005, 50% were in the ***good*** range, 36% were in the ***fair*** range, and 14% were in the ***poor*** range.

Table 7-10 Average Seasonal Water Quality Indices (WQIs) for Sweetwater Creek at Anderson Road (HCEPC #142), 2002 - 2005

Season	Sweetwater Cr @ Anderson Rd (HCEPC #142)				
	2002	2003	2004	2005	Seasonal Average
Apr - Jun	38	34	43		38.3
Jan - Mar	40	53	44	41	44.5
Jul - Sep	47	69	62		59.3
Oct - Dec	38	58	57	53	51.5

Dissolved Oxygen and Biochemical Oxygen Demand (Figures 7-5a; Table 7-11)
Less than 10 values for DO were reported in the data sets available; therefore, DO is not discussed in this report.

Period of Record data (1988-2004) for BOD are shown in the form of annual averages (Figure 7-5a). A visual inspection of the data indicates that BOD averaged between 1.0 and 2.4 milligrams per liter (mg/L) over the 17-year period. Peak concentrations occurred in 1989 and 2001. A linear trend analysis indicates an overall improving trend (lower BOD concentrations) over the reporting period.

Recent data (Jan-Apr 2005) for BOD indicated that BOD ranged between 0.0 mg/L and 1.0 mg/L and met FDEP water quality criteria (5.0 mg/L) over the reporting period (Table 7-11).

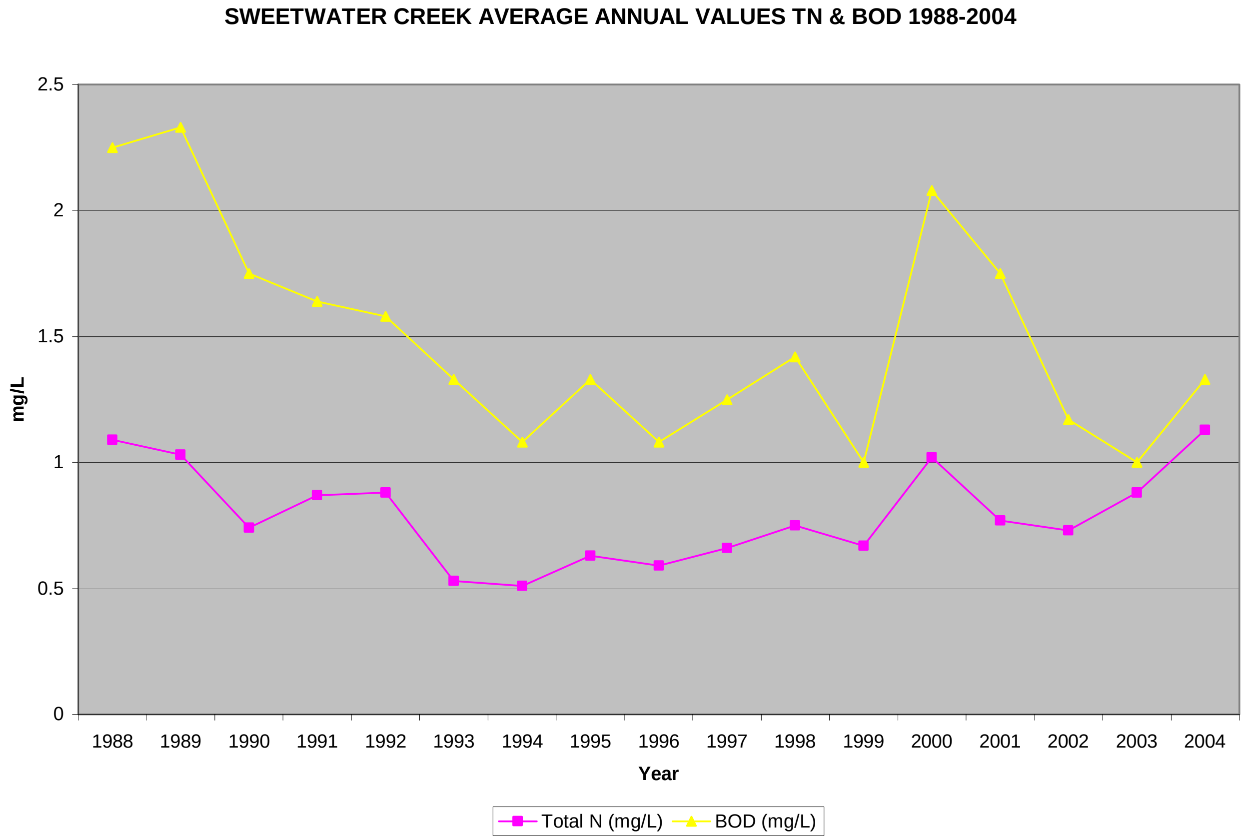

Figure 7-5a Period of Record Annual Average Values for BOD (yellow line) for Sweetwater Creek at Anderson Road, (HCEPC #142)

Table 7-11 Recent Values for BOD for Sweetwater Creek at Anderson Road, (HCEPC #142)

DATE	PARAMETER	CONCENTRATION (mg/l)
1/4/2005	BOD5_mgl	0.0
2/2/2005	BOD5_mgl	1.0
3/1/2005	BOD5_mgl	1.0
4/6/2005	BOD5_mgl	1.0

Chlorophyll a (Figures 7-6; Table 7-12)

Period of record data are presented as annual averages for 1988-2004 (Figure 7-6). During that period, chl a concentrations ranged from 2.5 µg/L to 16.0 micrograms per liter (µg/L). Peak concentrations were reported in 1993 and 2001. A linear trend analysis indicated an increase in chl a concentrations over the period 1988 – 2004.

Recent data for this station (Table 7-12) includes only two samples. In those samples, very low concentrations of chl a were reported; they ranged from 0.1 to 1.1 µg/L.

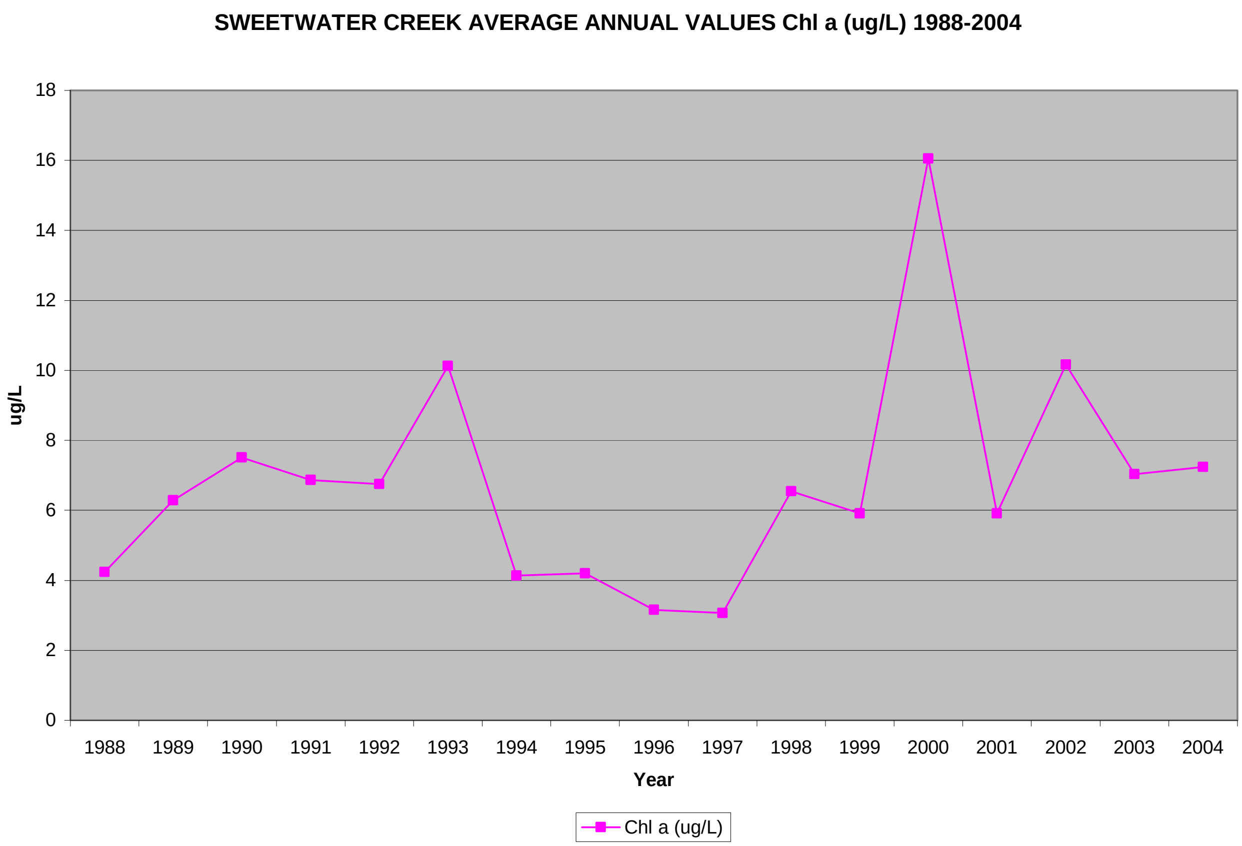

Figure 7-6 Period of Record Annual Average Values for chl a at Sweetwater Creek at Anderson Road, (HCEPC #142)

Table 7-12 Recent Data for chl a for Sweetwater Creek at Anderson Road, (HCEPC #142)

DATE	Chl a (µg/L)
1/4/05	0.1
2/2/05	1.1

Total Nitrogen (Figure 7- 7, Table 7-13)
Period of record data for TN were available for 1988-2004 (Figure 7-7). TN concentrations ranged from 0.5 to 1.2 mg/L. Peak concentrations occurred in 2001 and 2004. A linear trend analysis indicated neither an increasing trend nor a decreasing trend in TN concentrations.

Recent data for TN (Table 7-13) ranged from 0.65 to 0.9 mg/L, which represents a significant increase over the concentrations reported during the entire period of record. However, it should be noted that data for only two samples were available.

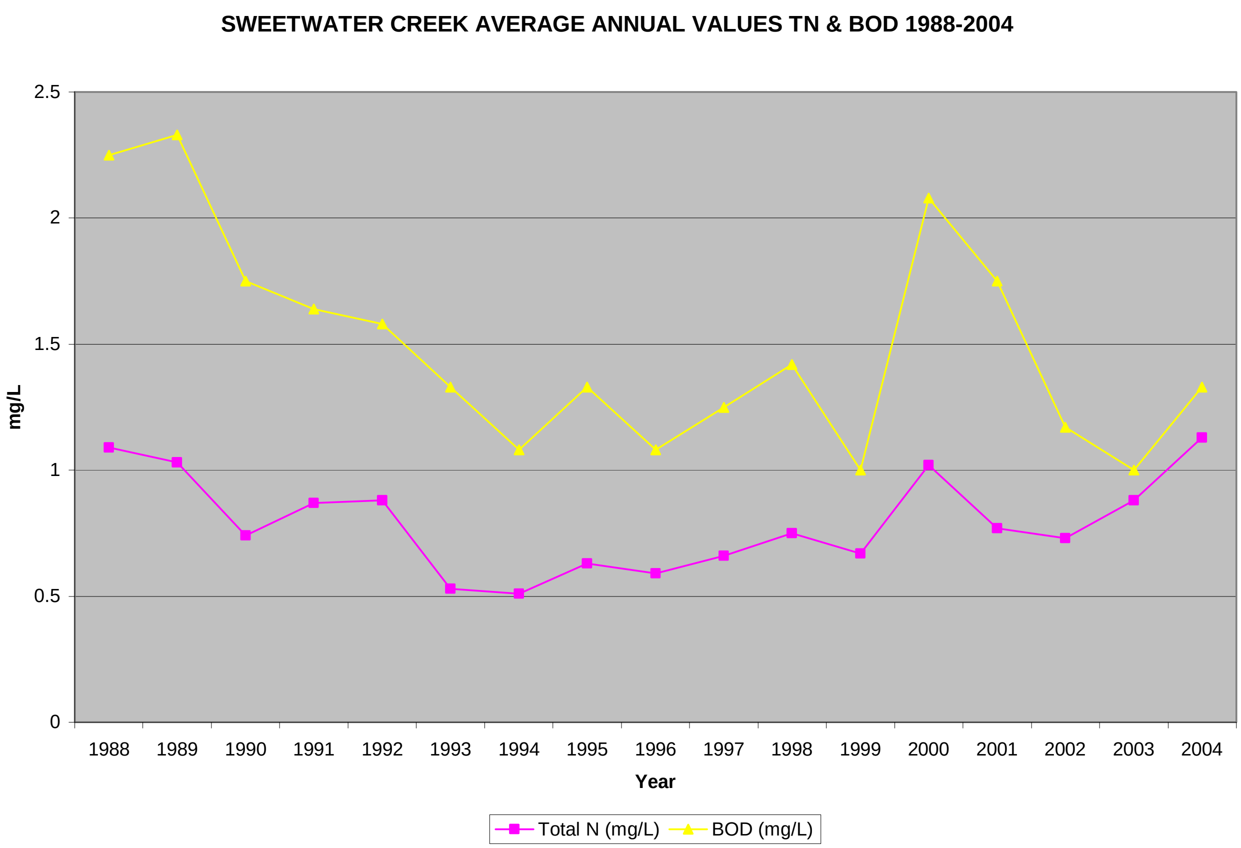

Figure 7-7 Period of Record Annual Average Values for TN (pink line) at Sweetwater Creek at Anderson Road, 1988-2004 (HCEPC #142)

Table 7-13 Recent Data for TN for Sweetwater Creek at Anderson Road, (HCEPC #142)

DATE	TN (mg/L)
1/4/05	0.9
2/2/05	0.65

Total Phosphorous (TP) (Figures 7-8, Table 7-14)

Period of record data for TP are available from 1990 to 2004 (Figure 7-8). TP concentrations ranged from 0.01 to 1.05 mg/L with a peak in 1990. A linear trend analysis indicated a steep decline in TP concentrations from 1990 to 1993. Following that decline, a steady increase in TP occurred through 2004.

Recent data for TP (Table 7-14) ranged from 0.04 to 0.05 mg/L for two samples taken in early 2005. These values are consistent with the period of record data set.

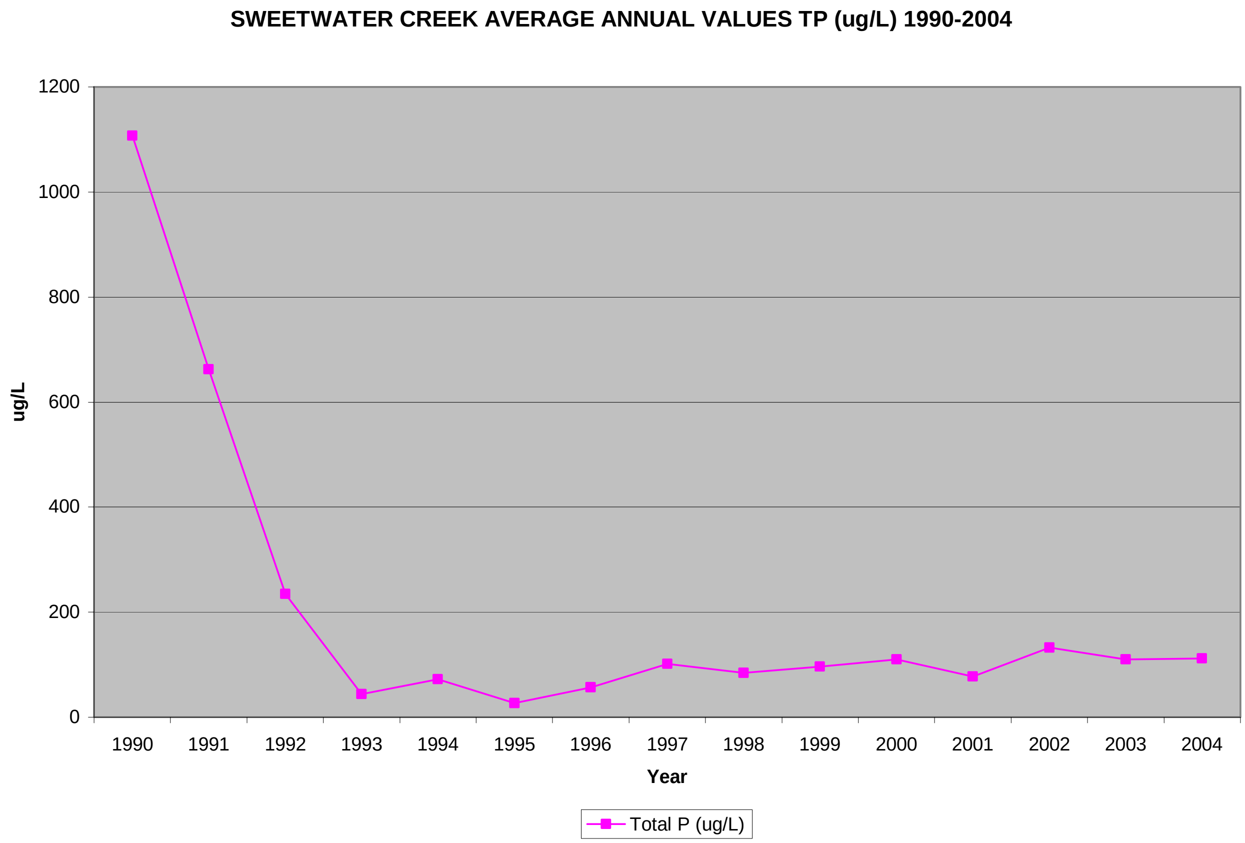

Figure 7-8 Period of Record expressed as Annual Averages for TP Sweetwater Creek at Anderson Road, 1990-2004 (HCEPC #142)

Table 7-14 Recent Data for TP at Sweetwater Creek at Anderson Road, (HCEPC #142)

DATE	TN (mg/L)
1/4/05	0.05
2/2/05	0.04

Bacterial Quality: Total Coliform (Figure 7-9)

Period of record annual average data for total coliform are available for 1990-2001 (Figure 7-9). Concentrations ranged from 900 colonies/100 ml to 8500 colonies/100 ml. From the beginning of the sampling period to 1993, a slight decline in total coliform was noted. This decline was followed by a consistent trend in total coliform concentrations on the order of 1000 colonies/100 ml through 1997. Between 1997 and 2000, a substantial increase in total coliform concentrations was reported. From 2000 to 2001, the end of the record, a slight decline occurred.

Recent data for total coliform were not available; the period of record data discussed above also represents the most recent data.

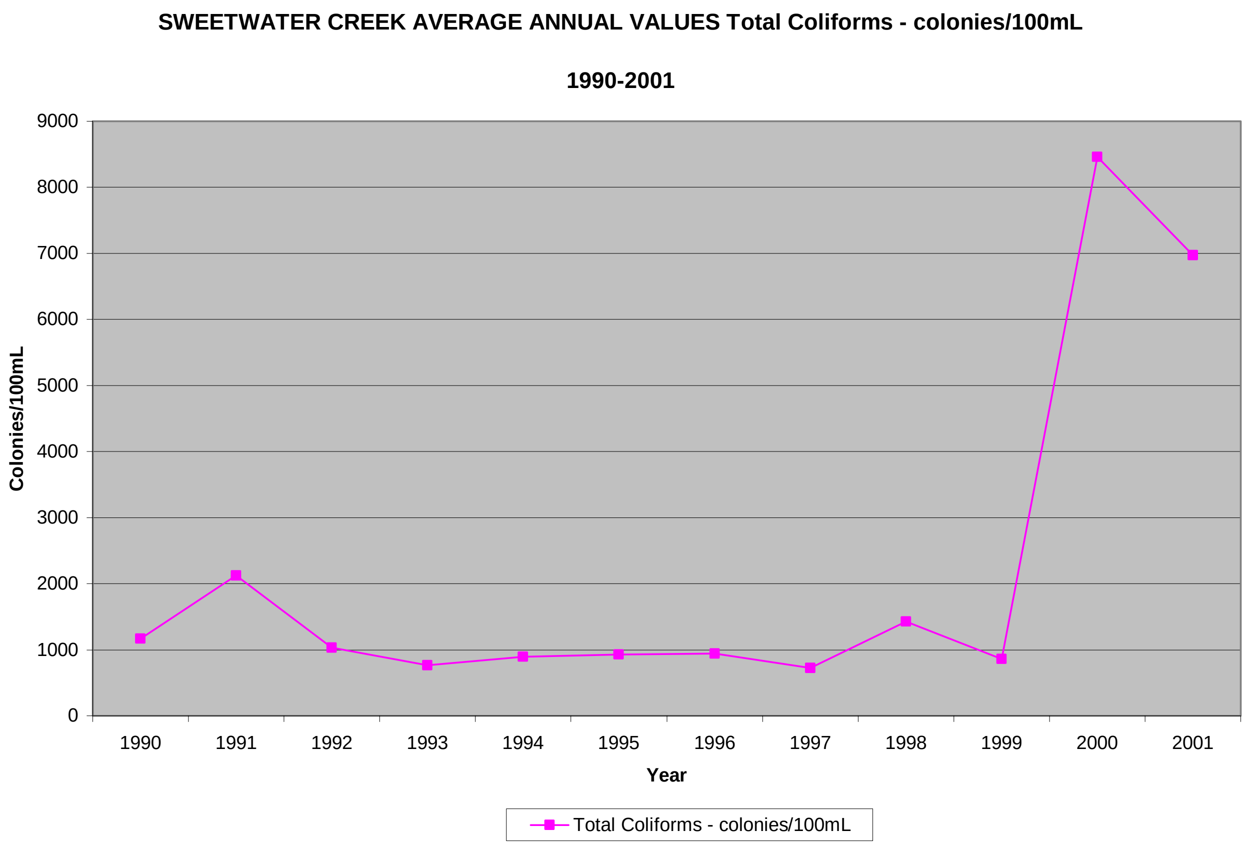

Figure 7-9 Period of Record Data as Annual Averages for Total Coliform Concentrations in Sweetwater Creek at Anderson Road, 1990-2001 (HCEPC #142)

Channel G - Data sufficient to calculate WQI values were also available for Channel G at Hanley Road (HCEPC #162) for the period October 2002-December 2005 (Table 7-15). WQIs varied widely, from a low value of 23 to an extremely high value of 90 for the seven samples. Highest WQI values occurred in the wet season and immediately following the wet season, suggesting that water quality declines in Channel G during periods of high storm water runoff.

Recent (2005) data for several parameters were available (Table 7-16). These data indicate that DO in Channel G has failed to meet FDEP water quality standards in 91% of the samples taken. DO ranged between a low of 1.9 mg/L to a high of 6.23 mg/L. Chlorophyll a (chl a) ranged from 1.9 µg/L to 22.4 µg/L, indicating that biological productivity varied widely over the sampling period. TP was represented by only one sample in January when the TP concentration was 50 µg/L (0.05 mg/L). TN ranged from a low of 576 µg/L (0.57 mg/L) to a high of 1010 µg/L (1.01 mg/L). Nutrient (TN, TP) concentrations appear to be sufficient to support a high level of biological productivity at times. The WQIs from Table 7-15 also indicate that conditions in the canal are highly variable, and the canal can reach hypereutrophic conditions at times.

Table 7-15 Average Seasonal Water Quality Indices (WQIs) for Channel G at Hanley Rd (HCEPC #162), 2002 - 2005

	Channel G (HCEPC #162)			
Season	2003	2004	2005	Seasonal average
Apr - Jun		30	50	40
Jan - Mar		23	65	44
Jul - Sep			87	87
Oct - Dec	50		90	70

Table 7-16 Recent Data for Channel G (HCEPC #162)

Sample_date	BOD5_mgl	Chla_µgl	DO_mgl	TN_µgl	TP_µgl
1/4/2005	1	1.9	2.35	1010	50
2/2/2005	1		4.14	810	
3/1/2005	1	12.9	3.94	965	
4/6/2005	2	12	6.23	576	
5/4/2005	2	22.4	2.34	720	
6/2/2005	1	10.2	2.98	780	
7/5/2005			3.13	960	
8/2/2005			3.72	850	
9/6/2005			4.07	750	
10/5/2005	1		1.9	750	
11/2/2005			3.22		
AVG	1.285714	11.88	3.456364	817.1	50
N	7	5	11	10	1

Groundwater

The RULES of the ENVIRONMENTAL PROTECTION COMMISSION of HILLSBOROUGH COUNTY (CHAPTER 1-5 – WATER QUALITY STANDARDS, Amended 11/10/04) have adopted the groundwater quality standards, groundwater classifications, and criteria established or adopted in Sections 62-520.400, 62-520.410, 62-520.420, 62-520.430, and 62-520.440, F.A.C. as amended on 12/9/1996.

The Sweetwater Creek watershed is located within the Tampa Bay/Anclote River (TB/A) watershed. The useable aquifer system within this area consists of the Surficial Aquifer System (SAS) and Upper Floridan Aquifer (UFA). Groundwater within this area (from the UFA) provides a dependable potable water supply and is available through much of the TB/A watershed. For residential and industrial uses, groundwater (mostly from the Floridan Aquifer) is withdrawn. The Water Management District has recognized groundwater as a limited resource, therefore, intending to reduce stress on groundwater by assisting large water users in developing alternative resources (e.g., sea water desalination). Groundwater in the Sweetwater Creek watershed interacts with surface water in wetlands, Sweetwater Creek and Channels H and G, the 37 lakes in the watershed, and numerous artificial ponds. Ongoing management activities for the region's water supplies are discussed in more detail in Chapter 9.

To protect groundwater resources, in 1983, the Florida Legislature passed the Water Quality Assurance Act, which required FDEP to "Establish a ground-water quality monitoring network designed to detect or predict contamination of the state's water resources" (403.063, F.S.). In agreement and cooperation with the SWFWMD, the Ambient Ground-Water Quality Monitoring Program (AGWQMP) was implemented to satisfy the statutory requirements. The FDEP has also implemented a sophisticated ground water protection program based on groundwater classifications, water quality standards, and monitoring regulations. The state also administers the federally-delegated Underground Injection Control (UIC) Program, which protects the quality of underground sources of drinking water, and prevents degradation of other aquifers adjacent to injection zones. The FDEP exercises regulatory authority over groundwater quality under Chapter 62-520, F.A.C., which is augmented by monitoring and permitting activities (for withdrawals) through each of the state's water management districts. In Florida, groundwater standards are equivalent to drinking water standards.

In addition to the regulatory activities described above, the FDEP has developed specific rules under 62-521.200, F.A.C. for wellhead protection to protect potable water wells from contamination, and subsequent replacement or restoration due to contamination. This statewide wellhead protection program includes criteria for delineating wellhead protection areas, and FDEP imposed permitting and monitoring requirements within these wellhead protection areas. Hillsborough County has also developed a Wellhead Protection Program similar to the FDEP program.

The quality of groundwater is directly related to the quality of the recharge water, porous media, and the resident time for groundwater in the media. Stormwater runoff, pesticide application to land, surface and underground chemical spills, and saltwater intrusion also impact the quality of groundwater, locally or regionally. Water quality within the Northern Tampa Bay area is generally good in the aquifers above the middle confining unit of the Floridan Aquifer system (SWFWMD, 1996). The groundwater quality is typically a calcium bicarbonate water of relatively low total dissolved solids (TDS). Groundwater near the coastal areas is generally higher in TDS.

Very little water quality data were available for groundwater in the watershed, and the data are insufficient to make definite conclusions regarding the current quality status of the aquifers. Generalized data are available for the upper Floridan in the watershed (Kelley, 1988) for the following parameters: total dissolved solids, total hardness, chloride, and sulfate (Table 7-17). In addition, some data are available for the Carrollwood Water System for 2004 (Table 7-18).

Table 7-17 Generalized Data for Water in the Upper Floridan Aquifer in the Sweetwater Creek Watershed (Kelley, 1988)

Parameter	Concentration (mg/L)
Total dissolved solids	300 > 500
Total hardness	200 > 250
Chloride (Cl^-)	250
Sulfate (SO_4^-)	50

Table 7-18 Data for the Carrollwood Water System in the Sweetwater Creek Watershed (Hillsborough County Water Department, 2004)

Parameter	90^{th} percentile result	Range of Results	Level Detected
Nitrate (as N) (mg/L)		0.016 – 0.021	
Cadmium (Cd) (µg/L)		Not detected – 0.7	
Copper (Cu) (mg/L)	0.6		
Lead (Pb) (µg/L)	3.0		
Fluoride (mg/L)			0.1
Sodium (Na) (mg/L)		5.0 – 5.9	
Radium 226 + 228 (pCi/L)		1.8 – 2.1	
Alpha emitters (pCi/L)		2.0 – 2.6	

7.3 Overall Trends and Summary

7.3.1 Overall Water Quality Issues/Areas of Concern

The primary water quality issues/areas of concern for water resources in the Sweetwater Creek watershed are related to both long-term and short-term impacts of the highly urbanized nature of the landscape, the potential for future growth, the alterations made in the stream channel and estuarine system. The overriding area of concern is untreated stormwater runoff from areas developed prior to the implementation of effective surface water management regulation. This condition is widespread throughout the watershed and has resulted in negative impacts to Sweetwater Creek and coastal Old Tampa Bay where both water quality and habitat have been impaired. Several chemical/physical parameters are of concern in water bodies that receive untreated stormwater, particularly dissolved oxygen, nitrogen, and phosphorous. Other parameters that have been problematic in the past include total dissolved solids, turbidity, toxic metals, and toxic organic substances (e.g., insecticides, herbicides, fungicides).

As urbanization and commercial development in the watershed continue, other adverse impacts to both water quality and habitat may occur or increase in areas already experiencing problems, including:

- Increased impervious surface area (construction of roads, buildings, etc.)
- Continued diversion of surface runoff and natural flow from their historic path and away from receiving water bodies
- Increased potential for sinkhole development due to the excess drawdown at wellfields
- Excessive impact on groundwater quality through introduction of pollutants via sinkholes
- Increases in peak flows which can cause stream bank erosion, sedimentation, and increased pollutant loading
- Increases in surface water pollution from stormwater runoff

Based on the County's future land use plan for the area, these activities are anticipated to occur at various locations in the watershed and are anticipated to cause similar negative trends in water quality. Development of both non-structural and structural best management practices (BMPs) will be necessary to reduce pollutant loading to the tributaries in these subwatersheds in order to comply with TMDL requirements. Currently, Sweetwater Creek has recommended TMDLs for nutrients, total coliforms, and dissolved oxygen and Channel G has recommended TMDLs for nutrients and dissolved oxygen by FDEP.

Estimates of pollutant loading are developed in Chapter 10 of this report, followed by an evaluation of water quality treatment level of service for this watershed (Chapter 11). A list of recommended management activities along with specific, strategically-located alternatives to alleviate water quality problems and pollutant loading will be developed in subsequent chapters of this report.

The available surface water and ground water quality information from the Sweetwater Creek watershed requires augmentation in order to become a valuable tool in water management decisions. Based on available information, it can be concluded that problems exist in localized areas with some nutrients, BOD, coliform bacteria, and chl a. In the absence of sufficient data, it cannot be determined whether problems exist with other chemical/physical parameters as well. There is a clear need for a well planned and executed water quality monitoring and data management program that is conducted on a long-term basis.

7.4 Bibliography

The attached bibliography includes a list of references used for this study and additional references that could be cited by readers.

Ayres Associates, 1995, An Estimate of Nutrient Loadings from Wastewater Residuals Management and Onsite Wastewater Treatment Systems in the Tampa Bay Watershed. Ayres Associates, Tampa, Florida.

Canfield, D.E., Jr. 1981, Chemical and Trophic State Characteristics of Florida Lakes. Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

Canfield, D.E., Jr. and M.V. Hoyer, 1988a. Regional geology and the chemical and trophic state characteristics of Florida lakes. Lake and Reservoir Management, 4: 21-31.

Canfield, D.E., Jr. and M.V. Hoyer, 1992. Aquatic macrophytes and their relation to the limnology of Florida lakes. Final report. Bureau of Aquatic Plant Management, Florida Department of Natural Resources, Tallahassee, Florida.

Canfield, D.E., Jr., K.A. Langland, S.B. Linda, and W.T. Haller, 1985. Relations between water transparency and maximum depth of macrophyte colonization in lakes. J. Aquat. Plant Manage. 23: 25-28.

Carlson, R.E. 1977, A trophic state index for lakes, Limnology and Oceanography 22: 361-369.

Chapter 62-302 F.S. Surface Water Quality Standards.

Chapter 62-520 F.S. Ground Water Classes, Standards, and Exemptions.

Dixon, L.K., 1994. Literature compilation and data synthesis for atmospheric deposition to the Tampa Bay watershed. Mote Marine Laboratory Technical Report #370. Tampa Bay National Estuarine Program, St. Petersburg, Florida.

Doolittle, J., G. Schellentrager, and S. Ploetz, 1989. Soil Survey of Hillsborough County, Florida. U.S. Department of Agriculture, Soil Conservation Service.

Florida Department of Environmental Protection, 1996. Development of the stream condition index (SCI) for Florida. Technical Report of the Stormwater and Nonpoint Source Management Section. Tallahassee, Florida.

Florida Department of Environmental Protection. March 11, 2003. Amendments to FDEP 2002 Update to Florida's 303(d) List of Impaired Waters submitted to US EPA October 01, 2002. FDEP. Tallahassee, FL.

Florida Department of Environmental Protection. 2004 305(b) report and 303(d) List. FDEP. Tallahassee, FL.

Florida Department of Environmental Protection. September 15, 2004. TMDL Report – Total Coliform and Fecal Coliform TMDL for Lower Sweetwater Creek (WBID 1570A). FDEP. Tallahassee, FL.

Florida Department of Environmental Protection. September 15, 2004. TMDL Report – Nutrients TMDL for Lower Sweetwater Creek (WBID 1570A). FDEP. Tallahassee, FL.

Florida Department of Environmental Protection. January 13, 2006. Wastewater Facility Regulation Database (WAFR). FDEP. Tallahassee, FL.

Frazer, T. K., 1999. Nutrient assimilation capacity of five Gulf coast rivers. Annual project summary, Southwest Florida Water Management District, Tampa, Florida.

Gallovay, David, Jones, D.R., and Ingebritsen, S.E., United States Geological Survey, 1999. Sinkholes, West-Central Florida, A Link Between Surface Water and Ground Water, Excerpt From Circular 1182.

Goetz, C.L., R.C. Reichenbaugh, and J.K. Ogle, 1978. Water Supply Potential of the Lower Hillsborough River, Florida, 1976. WRI Report 78-29, U.S. Geological Survey.

Gold, M., M. Bartlett, J. Dorsey, and C. McGee, 1990. An assessment of inputs of fecal indicator organisms and human enteric viruses from two Santa Monica storm drains: Technical Report. Santa Monica Bay Restoration Project.

Grabe, S.A., and J. Barron. 2002. Status of Tampa Bay Sediments: Polycyclic aromatic hydrocarbons, organochlorine pesticides, and polychlorinated biphenyls – 1993, 1995-99. Hillsborough Environmental Protection Commission. Tampa, FL.

Haile, R. W., J. Alamillo, K. Barrett, R. Cressey, J. Dermond, C. Ervin, A. Glasser, N. Harawa, P. Harmon, J. Harper, C. McGee, R. C. Millikan, M. Nides, and J. S. Witte, 1996. An epidemiological study of possible adverse health effects of swimming in Santa Monica Bay. Final Report. Santa Monica Bay Restoration Project. 211 pp.

Hand, J., M. Paulic, 1992. 1992 Florida Water Quality Assessment, 305(b) Technical Appendix. Florida Department of Environmental Regulation, Tallahassee.

Hand, J., J. Col, and E. Grimison, 1994. Central Florida District Water Quality Assessment 305(b) Technical Appendix. Bureau of Surface Water Management, Florida Department of Environmental Protection, Tallahassee.

Henderson, S. E., R. D. Hayes, Y. E. Stoker. 1958. Hydrology of Lake Carroll, Hillsborough County, Florida. WRI-83-4261. United States Geological Survey. Tampa, FL.

Hillsborough County City-County Planning Commission, 1985. Understanding the Hillsborough -- Searching for Answers on River Resource Management. Hillsborough County City-County Planning Commission, Tampa, Florida.

Hillsborough County Environmental Protection Commission, 1998. Surface Water Quality 1995-1997, Hillsborough County, Florida. Hillsborough County Environmental Protection Commission, Tampa, Florida.

Hillsborough County Water Department. 2004. Water Quality Report: Carrollwood Water System. HCWD. Tampa, FL.

Hillsborough River Greenways Task Force, 1995. An Ecosystem Plan for the Upper Hillsborough River: Issue Analyses, Action Plans, and Recommendations. The Florida Greenways Program of 1000 Friends of Florida and the Conservation Fund, Florida.

Huber, W.C., P.L. Brezonik, J.P. Heany, R.E. Dickinson, S.D. Preston, D.S. Dwornik, and M.A. DeMaio. 1983. A classification of Florida lakes. University of Florida Water Resources Research Center. Publication No. 72. Gainesville, Florida.

Institute for Food and Agricultural Sciences. 2005. Florida LAKEWATCH Annual Data Summary, 2004. University of Florida. Gainesville, FL.

Jones, G.W., E.C. DeHaven, L. Clark, J.T. Rauch, and C.G. Guillen. 1990. Groundwater Quality of the Southwest Florida Water Management District: Central Region. Southwest Florida Water Management District, Brooksville, FL.

Kelley, G.M. 1988. Groundwater Resource Availability Inventory: Hillsborough County, Florida. Southwest Florida Water Management District. Brooksville, FL.

Kurz, R. C. 1998. A comparison of rapid sand filtration, alum treatment, and wet detention for the removal of bacteria, viruses, and a protozoan surrogate from stormwater. Technical Report. Southwest Florida Water Management District. Brooksville, FL.

Livingston, E.H. 2000. Florida's Rotating Basin Approach: Towards Better Integration, Coordination, and Cooperation. Technical Presentation. Bureau of Watershed Management, Florida Department of Environmental Protection, Tallahassee, Florida.

Long, E. R., D. M. MacDonald, and C. Cairncross. 1991. Status and trends in toxicants and the potential for their biological effects in Tampa Bay, Florida. NOAA Technical Memorandum NOS ORCA 58. National Oceanic and Atmospheric Administration. Silver Spring, MD.
Long, E. R., D. A. Wolfe, R.S. Carr, K. J. Scott, G. B. Thursby, H. L. Windom, R. Lee, F. D. Calder, G. M. Sloane, and T. Seal. 1994. Magnitude and extent of sediment toxicity in Tampa Bay, Florida. NOAA Technical Memorandum NOS ORCA 78. National Oceanic and Atmospheric Administration. Silver Spring, MD.

Long, E. R. and H. S. Greening. 1999. Chemical Contamination in Tampa Bay: Extent, toxicity, potential sources and possible sediment quality management plans. NOAA Special Report. Silver Spring, MD.

Metcalf and Eddy, Inc. 1983a. Water Quality Assessment of the Lower Hillsborough River. Report submitted to the City of Tampa, Florida, by Metcalf and Eddy, Inc., Boston, Massachusetts.

Metcalf and Eddy, Inc. 1983b. Tampa Nationwide Urban Runoff Program - Phase II Final Report. Report submitted to the City of Tampa by Metcalf and Eddy, Inc., Boston, Massachusetts.

Mote Marine Laboratory. 1984. Biological and Chemical Studies on the Impact of Stormwater Runoff upon the Biological Community of the Hillsborough River, Tampa, Florida. Report submitted to the City of Tampa Department of Public Works by Mote Marine Laboratory, Sarasota, Florida.

Parsons Engineering Science, Inc. 1998. Sweetwater Creek Basin Stormwater Management Master Plan. Report prepared for Hillsborough County. Tampa, FL.

Paulic, M., and J. Hand. 1994. Florida Water Quality Assessment 1994 305(b) Report. Bureau of Surface Water Management, Florida Department of Environmental Protection, Tallahassee.

Pollman, C. Export of atmospherically derived nitrogen in the Tampa Bay watershed *in* Treat, S. F. 2003. Tampa BASIS 4. Tampa Bay Estuary Program. Tampa, Fl. pp. 127 – 135.

Poor, N., S. Campbell, and H. Kay. Source attribution for the atmospheric deposition of polycyclic aromatic hydrocarbons (PAHs) to Tampa Bay *in* Treat, S. F. 2003. Tampa BASIS 4. Tampa Bay Estuary Program. Tampa, Fl. pp. 136 – 144.

Rose, J.B. "Tampa Water Resource Recovery Pilot Project Microbiological Evaluation." in Tampa Water Resource Recovery Project Pilot Studies. Final Report to the City of Tampa. Tampa: CH2M Hill. 1993.

Rosenau, J.C., G.L. Faulkner, C.W. Hendry, Jr., and R.W. Hull. 1977. Springs of Florida. Bulletin No. 31 (Revised). Bureau of Geology, Department of Natural Resources, Tallahassee.

Southwest Florida Water Management District. 1991. Groundwater quality in the Southwest Florida Water Management District. Southwest Florida Water Management District, Ambient Groundwater Quality Monitoring Program. Brooksville, FL.

Southwest Florida Water Management District. 1992. Tampa Bay Surface Water Improvement and Management Plan. Southwest Florida Water Management District, SWIM Department, Tampa.

Southwest Florida Water Management District. 1995. Surface Water Improvement and Management (SWIM) Plan for Lake Thonotosassa. Southwest Florida Water Management District, SWIM Department, Tampa.

Southwest Florida Water Management District. 1996. Northern Tampa Bay Water Resources Assessment Project, Volume I: Surface water/ Groundwater Interrelationship, SWFWMD, Resource Evaluation Section, Brooksville, Florida.

Southwest Florida Water Management District. 1996. Northern Tampa Bay Water Resources Assessment Project, Volume II: Saline water intrusion and water quality. SWFWMD, Resource Evaluation Section, Brooksville, Florida.

Southwest Florida Water Management District. 1999. Contribution of total nitrogen loading to the Hillsborough River Reservoir from Crystal Springs. Technical Report. Ambient Groundwater Monitoring Program, Tampa, Florida.

Southwest Florida Water Management District. 2000. Hillsborough River Comprehensive Watershed Management Plan. Brooksville, Florida.

Southwest Florida Water Management District. 2000. Origin of nitrate in groundwater discharging from Crystal Springs. Technical Report. Water Quality Monitoring Program, Tampa, Florida.

Southwest Florida Water Management District. 2000. Tampa Bay/Anclote Comprehensive Watershed Management Plan -Draft. Brooksville, Florida.

Subsurface Evaluations, Inc. 1992. Dataset containing a point coverage of sinkhole locations for the State of Florida. Subsurface Evaluations, Inc. 3206 Swann Ave, Tampa, FL 33609. As included in the Florida Geographic Data Library, 431 Architecture Building, PO Box 115706

Swancar, A. and C. B. Hutchinson. 1992. Chemical and Isotopic Composition and Potential for Contamination of Water in the Upper Floridan Aquifer, West-Central Florida, 1986-89, U.S. Geological Survey Open-File Report 92-47.

Tampa Bay National Estuary Program. 1996. Charting the Course for Tampa Bay -- Comprehensive Conservation and Management Plan. Tampa Bay National Estuary Program, St. Petersburg.

Tampa Bay Estuary Program. 1996. Toxic Contamination Sources Assessment: Task 1 – Risk Assessment for Chemicals of Potential Concern and Methods for Identification of Specific Sources. Technical Report #09-96 of the Tampa Bay National Estuary Program. Prepared by Parsons Engineering Science (R. McConnell, R. DeMott, and J. Schulten).

Tampa Bay Estuary Program. 1997. An Analysis of the Effects of Freshwater Inflows on Salinity Distributions, Dissolved Oxygen Concentrations, and Habitat Characteristics of the Hillsborough River and Palm River/Tampa Bypass Canal. Technical Report #08-97 of the Tampa Bay National Estuary Program. Prepared by Coastal Environmental/Post, Buckley, Schuh and Jernigan, Inc.

Tampa Bay Estuary Program. 1998. Interpretation of Bulk Atmospheric Deposition and Stormwater Quality Data in the Tampa Bay Region. Technical Report #04-98 of the Tampa Bay Estuary Program. Prepared by Mote Marine Laboratory and Camp Dresser and McKee, Inc. for the Tampa Bay Regional Planning Council and the Tampa Bay Estuary Program (L.K. Dixon, M.G. Heyl, and S. Murray).

Tampa Bay Estuary Program. 1999. Impacts of Atmospheric Deposition on Stormwater Quality. Technical Report #03-99 of the Tampa Bay Estuary Program. Prepared by BCI Engineers & Scientists, Inc. and PBS&J for the Tampa Bay Estuary Program (M.P.Timpe and R.T. Pribble).

Tampa Bay Estuary Program. 1999. Atmospheric Deposition Contributions to Nitrogen and Phosphorus Loadings in Tampa Bay: Intensive Wet and Dry Deposition Data Collection and Analysis August 1996-July 1998. Technical Report #05-99 of the Tampa Bay Estuary Program. Prepared by Janicki Environmental (R.J. Pribble and A.J. Janicki).

United States Department of Agriculture. 1916. Field Operations of the Bureau of Soils, 18th Annual Report, Soil Survey of Hillsborough County, Florida. Soil Conservation Service. pp.749 – 786.

United States Department of Agriculture. 1958. Soil Survey of Hillsborough County, Florida. Soil Conservation Service. Washington, DC.

United States Department of Agriculture. 1989. Soil Survey of Hillsborough County, Florida. Soil Conservation Service. Washington, DC.

US EPA. 2004. Draft Total Maximum Daily Load (TMDL) for Nutrients and Dissolved Oxygen in Rocky Creek, Tampa Bay Basin. US EPA Region IV. Atlanta, GA.