Myakka River
Comprehensive Watershed Management Plan

(Myakka River State Park Staff Photo)

Southwest Florida
Water Management District

2004

Myakka River Comprehensive Watershed Management Plan

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Cover photo: Lakeshore of Upper Myakka Lake in Myakka River State Park.
A map atlas was published (2001) to accompany a previous (unpublished) version of this plan.
This plan was developed to be a stand-alone document.

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Chapter 1 ~ Introduction

(Photo by: Larry Arrington from Myakka River State Park Website)

High Water at Myakka River State Park

~ Naturally occurring tannins stain the water of many Florida rivers.~

Chapter 1
Introduction

1.1 Comprehensive Watershed Management

The Comprehensive Watershed Management (CWM) initiative was established to improve the management of water and related natural resources within the Southwest Florida Water Management District (District or SWFWMD). This initiative employs a watershed-based approach to resource management. Staff from several disciplines and departments comprise the "watershed teams" that have been assigned to eleven primary watersheds (Figure 1-1). Local governments and other stakeholders within each watershed are also significant partners on these teams. The goals for the teams include:

- Collect, integrate and analyze the existing information pertinent to each watershed and create a data base for analytical purposes;
- Identify and prioritize existing and future water resource management issues relating to water supply, flood protection, water quality and natural systems (District Areas of Responsibility or "AORs");
- Develop preventative or remedial management actions to address these resource management issues;
- Identify funding sources and partnerships to support action plan projects;
- Implement and monitor the effectiveness of selected actions and the overall process and recommend potential revisions.

CWM provides an opportunity to enhance coordinated action between the District, local governments and others. It is a science-based approach, including the application of Geographic Information System (GIS) technology and other modeling tools within each watershed.

Each team has been charged with the development of a watershed management plan reflecting the results of this process. The CWM watershed plans are complex in the breadth and variety of issues that they encompass, but simple in intent and design. They analyze the wealth of information available in each area, identify issues and recommend specific actions to address these issues. The fundamental elements of the plans are the chapters that identify issues in each of the District's four AORs.

Specific and realistic actions to address each issue are presented within each AOR. Completed CWM plans become a part of the District Water Management Plan (DWMP) through incorporation by reference. These plans reflect a "snapshot-in-time" for the watershed and will be updated on a periodic basis.

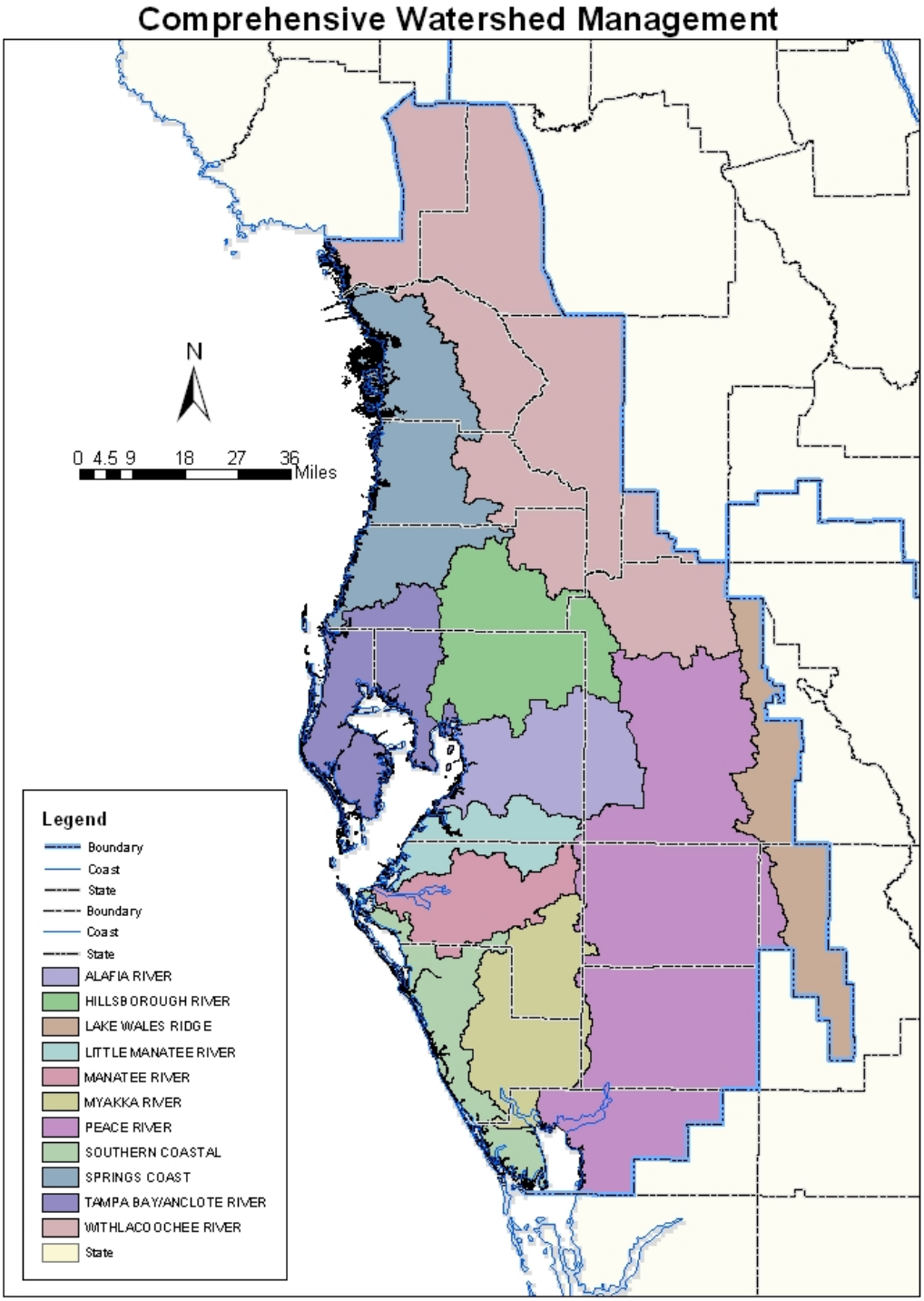


Figure 1-1. CWM Watersheds

1.1.1 Coordination with Local Governments and Other Agencies

A significant element of the CWM initiative is the active involvement of the local government(s) together with the District within a watershed. The District and local governments share the premise that resource management incorporates the desire for sustainability. Consequently, the need to revise their respective policies from time to time is on a parallel track. Scientific knowledge serves as the backbone for this process and allows us to achieve the desired watershed condition. The CWM Decision Support System flow chart is shown in Figure 1-2. Local governments have the greatest influence over future growth through their comprehensive plans and associated land development regulations. Partnering with local governments is essential to the success of the CWM initiative. Each team strives to have active participation by the local government(s) within their watershed. This includes involvement in issue identification, development of preventative or remedial strategies and coordinated implementation. Agencies which are, or will be, requested to participate in the CWM process include the Department of Environmental Protection, Department of Agriculture and Consumer Services, the Florida Fish and Wildlife Conservation Commission, regional planning councils, U. S. Army Corps of Engineers, National Estuary Programs where appropriate, citizen groups and others. The CWM initiative helps to ensure that comprehensive, coordinated analysis and decision-making take place. It fosters closer cooperation and partnership between the District, local governments and other stakeholders to help preserve and improve the quality of watersheds as growth and development take place in the future. It allows rational and logical resolution of problems based on science. Integrated plans are developed with actual implementation of strategies involving multiple parties.

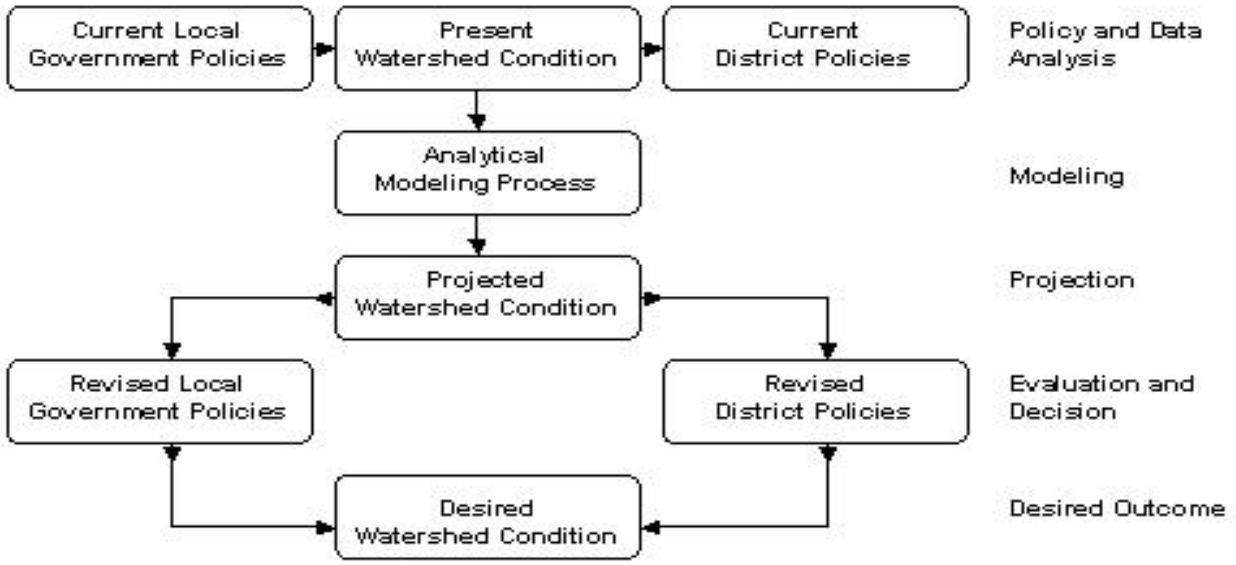


Figure 1-2. Decision Support System Flowchart

1.1.2 Implementation

Each watershed management team has suggested specific and realistic actions and tasks. A District senior management team (Steering Committee) prioritizes recommendations that the District is responsible for implementing. This Committee is responsible for determining priorities, directing them to the appropriate staff and board(s), and allocating staff time and resources. A significant means of implementation for the District is through the basin boards' cooperative funding program.

The intent is that recommendations that fall within the implementation responsibility of local governments or others will be similarly prioritized and implemented. A formal partnership or Memorandum of Understanding (MOU) between the District and participating parties may be proposed as a vehicle for coordinated implementation of the collaborative CWM planning efforts.

1.1.3 Future of CWM - A Watershed-based Partnership Approach

One of the most significant tools available to watershed teams is the District's GIS. The GIS is a database that is designed to efficiently store, retrieve, analyze and display mapped data. The ability to reference data by their location on the earth's surface provides an effective means of integrating data from many diverse sources. The GIS currently allows staff to integrate data from ground and surface water models, the District's Regulatory and Water Management Databases, and results from statistical analyses. This capability to integrate data from multiple sources allows staff to analyze previously undiscovered relationships between the data. For example, one might find a relationship between soil type, surface slope and vegetation cover that was not previously known. The GIS also provides a means of integrating disparate data such as census information and Federal Emergency Management Agency (FEMA) flood maps, allowing, for example, the analysis of per capita income of individuals living within the 100-year floodplain. The power of GIS lies in its ability to integrate numerical, statistical, engineering and spatial models and then dynamically depict and visually present scenarios. The GIS allows the CWM teams to analyze the best available information in such a way as to not only understand current conditions, but to also anticipate future conditions through scenario modeling.

Utilizing the GIS as a tool in the comprehensive watershed management initiative represents an evolution in direction for the District, providing the opportunity to enhance coordinated action between the District, local governments and others. This GIS-based analysis and planning has, to date, been applied only to a limited degree in selected watersheds. It is a major objective of the District that the use of the GIS, in conjunction with other modeling tools, be expanded and enhanced in a collaborative fashion with local governments and other participants for all eleven watersheds. Future updates to this Myakka River Comprehensive Watershed Management Plan will reflect progress made in further developing this GIS-based partnership approach.

The District is applying this CWM approach to 11 major watersheds to protect and/or restore their water resource assets. These 11 watersheds are an aggregate of the 16 that comprise the 16-county region as recognized by the Resource Regulation Department.

The CWM initiative will also produce several additional benefits. First, by focusing on smaller areas of the District, problems and solutions can be addressed within the constraints of limited funds. Secondly, the interconnective aspects of the watershed approach are more compatible with basic ecological principles. Evaluating the relationships between activities and natural systems will provide more effective surface water assessments and management plans. The links between terrestrial activities and habitats and their interactions with surface water bodies can be recognized. Thirdly, by clearly defining long-term goals the CWM plans will promote greater consistency in management planning and implementation and thus lead to more equitable management decisions.

1.2 District Mission and Goals

Chapter 62-40.432, Florida Administrative Code (F.A.C.) directs the water management districts and other state agencies to protect, preserve and restore the quality, quantity, and environmental values of water resources through watershed management planning and goals. The CWM initiative is a key component for the SWFWMD's accomplishment of this requirement. As with all District activities, the CWM initiative must also be consistent with the District's mission. The Governing Board of the SWFWMD has adopted a formal Mission Statement, as follows:

> "The mission of the Southwest Florida Water Management District (District) is to manage water and related natural resources to ensure their continued availability while maximizing environmental, economic and recreational benefits. Central to the mission is maintaining the balance between the water needs of current and future users while protecting and maintaining water and related natural resources which provide the District with its existing and future water supply.
>
> The Governing Board of the District assumes its responsibility as authorized in Chapter 373 and other chapters of the Florida Statutes by directing a wide range of programs, initiatives, and actions. These include, but are not limited to, flood protection, water use, well construction and environmental resource permitting, water conservation, education, land acquisition, water resource and supply development and supportive data collection and analysis efforts."

The State of Florida has a unique relationship with water. As a peninsula, the State is nearly surrounded by the sea and has 11,000 miles of coastline. Moreover, the quality of life in Florida is inseparably linked with its water resources. The majority of today's population and the trend of present growth patterns reflect coastal settlement, where freshwater is least abundant and natural systems such as estuaries and wetlands are most vulnerable. As a result, water management in the 2000s involves a challenge of

conflicting priorities to provide adequate water supplies for human needs, appropriate flood protection, and sound management of water quality and natural systems.

It is primarily the State's five water management districts, and the FDEP, that must meet this challenge and address the unique water resource issues of the various regions of our State. Federal, state, regional and local agencies responsible for land planning and development also have a significant role to play in protecting water-related resources.

The District Water Management Plan (DWMP) is a twenty-year comprehensive plan consistent with Chapter 373 of the Florida Statutes (F.S.) and Chapter 62-40, of the Florida Administrative Code (F.A.C.). The DWMP guides the District in accomplishing its water resource management responsibilities in:

- Providing a road map for the SWFWMD in managing and protecting water and related natural resources. It is the stated desire of the Governing Board to accomplish long-range planning in the best interest of the resource;

- Enhancing consistency and accountability among all five water management districts and FDEP through communication and coordination on common issues and responsibilities;

- Furthering the State Comprehensive Plan;

- Fostering coordination among the many levels of government, and better public understanding of water management policies and decisions; and

- Providing a compendium of water resource information to assure sound management, including but not limited to a 20-year District-wide water supply assessment, and identification and response to existing and potential areas where water resource problems have or will become critical.

The DWMP is a component of the Florida Water Plan. All five districts and the FDEP have worked closely together to achieve consistency among their plans. These plans reflect consensus on the four resource-based AORs (Water Supply, Flood Protection, Water Quality Management and Natural Systems Management), and the planning steps to be applied to each. In this way, the Florida Water Plan can accurately reflect regional differences, while communicating the basic policy direction for statewide water management.

1.2.1 Areas of Responsibility and Goal Statements

The District's mission is divided into four primary Areas of Responsibility (AOR). The AORs have been accepted by all five water management districts and the FDEP as representative of the District's collective water management agenda. This coordinated decision was a development step of the comprehensive 20-year DWMP. This format is now contained within Chapter 373, F.S. The four resource-based AORs cover all

aspects of water management and are strongly linked. For example, it is difficult and undesirable to separate the role of natural systems in assuring adequate water supplies for humans, or to sever the effects of flood protection actions on water quality downstream. As a result, some duplication is inevitable in dealing with complex water management programs that span more than a single area of responsibility.

The DWMP also identifies the need for watershed management and the development of watershed management plans. The Myakka River CWM plan addresses all four AORs in a comprehensive and integrated manner for the Myakka River watershed.

The general approach taken to develop the CWM Plan for the Myakka River watershed was to evaluate existing data and analyses, examine existing and proposed activities within the watershed, to develop a list of identified needs, and to develop a two-part program, one part to implement District efforts and activities and one part toward guiding local government and private sector activities and land use practices within the watershed. After initial data and literature search efforts within the District, state agencies, and local governments were involved to provide their input and guidance to the development of the plan. After local governments were recruited for the effort, citizens' groups were invited. Goals have been developed to establish the long-term direction of programs and activities that address water resource issues. The District-wide AOR goals and the respective goals for the Myakka River watershed are as follows.

1.2.1.1 Water Supply

The only major surface water withdrawal currently permitted in the Myakka River watershed is from the Big Slough Canal/Myakkahatchee Creek drainage system. An off-stream reservoir in the watershed is referenced in the District's Regional Water Supply Plan (RWSP) as a potential supply source for future potable water needs in the area and the City of North Port is investigating the use of aquifer storage and recovery wells (ASR) to store water during the wet season using excess flows from the Big Slough Canal/Myakkahatchee Creek.

District-wide Goal: To ensure an adequate supply of the water resource for all reasonable and beneficial uses, now and in the future, while protecting and maintaining the water and related resources of the District.

Water Supply Goals specific to the Myakka River watershed include:

- Maximize water conservation to lessen the need for additional sources and, when necessary, develop those sources with a strong focus on environmental preservation.

- Maintain healthy lakes, wetlands, and watercourses in areas of potential future water supply development and improve the condition of water resources in areas of previous impact.

- Improve integration of land use and water use planning.

1.2.1.2 Flood Protection

Tidal flooding occurs along the coast and within the lower reaches of the river. A very shallow slope to the main channel creates a wide floodplain and meandering main channel. The headwaters consist of large marshes or lakes. The system is rainfall driven with little influence from ground water springs. Flood problems occur when development is allowed in flood prone areas.

District-wide Goal: To minimize the potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood prone areas. The District shall give preference wherever possible to non-structural surface water management methods.

Flood Protection Goals specific to the Myakka River watershed Include:

- Develop a memorandum of understanding (MOU) with each county in the watershed. Each MOU will describe water storage and conveyance systems, and quantify their deficiencies. The MOU will explain the role of local governments and SWFWMD in flood protection. It will include a description of the local, intermediate and regional systems within the jurisdictional boundaries and detail the efforts necessary to update existing flood prone area information, including costs and shared projects.

- Assist local governments to prevent flood problems by limiting development in flood prone areas.

1.2.1.3 Water Quality

The basin in general has very good water quality, however, a portion of the Myakka River, predominantly within Myakka River State Park, has excessive growths of exotic water hyacinth and hydrilla. The primary cause of this problem is the fast growth rates of the plants coupled with stabilized water levels on this section of the river. These species can decrease dissolved oxygen levels by reducing light penetration, limiting the exchange of gases and reducing water circulation. Dense growths of water hyacinth and hydrilla can also increase sedimentation rates. The Big Slough Canal/Myakkahatchee Creek surface water system will typically experience a groundwater influence during dry periods of the year resulting in higher total dissolved solids (TDS), hardness and sulfates, accompanied by lower color. The degree of groundwater influence appears to be related to the number of consecutive dry months. An increase in rainfall will return water quality back to normal.

District-wide Goal: To protect water quality by preventing further degradation of the water resource and enhancing water quality where appropriate.

Water Quality Goals specific to the Myakka River watershed include:

- No net increase in nutrient loading to the Myakka River.
- Manage nutrient loads to eliminate hypereutrophic conditions in lakes, streams, and tributaries.
- Establish goals for pollutant loading to the Myakka River and other tributaries within the watershed.
- Prevent degradation of existing water quality and control exotic aquatic plants to reduce negative impacts on water quality.

1.2.1.4 Natural Systems

The good water quality of this watershed supports productive freshwater and estuarine habitats. The river within Sarasota County has been designated a State Wild and Scenic River. This designation confers Outstanding Florida Waters (OFW) classification to the entire portion of the river in Sarasota County. Because the Myakka Basin is relatively undeveloped and shelters a large diversity of habitats, many endangered and threatened plant and animal species are found there. It is also a popular recreation area.

District-wide Goal: To preserve, protect and restore natural systems in order to support their natural hydrologic and ecologic functions.

Natural Systems Goals specific to the Myakka River watershed include:

- Prevent and reduce the loss, alteration and fragmentation of natural habitats, particularly the remaining "core" habitats.
- Undertake habitat restoration and protective management in key resource areas, including the preservation and restoration of natural shorelines.
- Establish minimum flows and levels on waterbodies within the watershed.

These regional and watershed specific water management goals integrate the divergent functions of the District, local, other regional, state and federal agencies. This bridge creates common ground for consistent, coordinated action in the best interest of Florida citizens. The predominant theme of this watershed management plan is the effective integration of land use and water planning to achieve sound resource management and protection measures.

Chapter 2 ~ Watershed Description

(SWFWMD Staff Photo)

Aerial Photo of the Upper Myakka River Watershed

~ Rangeland and other agricultural land uses are typical here.~

Chapter 2
Myakka River Watershed Description

2.1 Location

The Myakka River Watershed, shown in Figure 2-1, extends approximately 600 square miles and includes lands in Manatee, Sarasota and Charlotte counties. The Myakka River flows nearly 66 miles from Myakka Head southwest to the Charlotte Harbor Estuary. Just downstream of Myakka Head, seven tributary creeks come together near Myakka City to form Flatford Swamp, a regionally important and unique surface water feature. Other important surface water features within the Myakka River Watershed include portions of Tatum Sawgrass, Upper Myakka Lake and Lower Myakka Lake. Much of the Myakka River has special protective designations. The 34-mile segment of the Myakka River in Sarasota County has been designated a Wild and Scenic River by the State of Florida. Together with the estuarine portions of the river, it is designated an Outstanding Florida Water (OFW) by the Florida Department of Environmental Protection (FDEP). The City of North Port utilizes the Big Slough Canal/Myakkahatchee Creek, a main tributary of the Myakka River, as a potable water supply source.

Land uses in the Myakka River Watershed are predominantly rural, except for the City of North Port and several large lot residential subdivisions. Development of the region has generally been limited to agricultural activities including improved pasture and vegetable row crops. Uplands within the watershed consist of pine flatwoods, rangeland, scrubby flatwoods, oak scrub, xeric hammock, mesic-hydric hammock, dry prairie and agricultural/developed lands. Wetlands include mixed hardwood swamps, freshwater marshes/wet prairies, saltwater marsh and mangrove swamps.

2.2 Climate

The climate of the Myakka River watershed is humid, near subtropical, characterized by high mean annual rainfall and temperatures. Warm humid summers and mild winters are the result of the watershed's southern peninsular location and the stabilizing effect of the Gulf of Mexico. Mean annual air temperature within Sarasota County, which encompasses the central portion of the watershed, is approximately 73 degrees Fahrenheit (^{o}F), with a mean daily temperature range from 84°F in summer to 61°F in winter. Along the coast, temperatures are slightly higher in the winter and lower in the summer due to the moderating effect of the Gulf of Mexico. Summer temperatures usually peak in the low to mid-90s but are moderated by frequent afternoon convective thundershowers. Winter temperatures can exhibit considerable variation throughout a single day with below freezing temperatures at night and increases of as much as twenty degrees or more through the late afternoon. Cold weather generally lasts for only a few days at a time as cold fronts move through the region and daylight temperatures rarely remain below freezing. Average low temperatures are near 50°F during the coldest months of December through February.

Figure 2-1. Myakka River Watershed

Rainfall averages around 51 inches per year and varies both seasonally and annually. April and November are the driest months as they are generally the least affected by rains preceding cold fronts or by local thundershowers. Late winter cold fronts cause a small increase in average rainfall in February and March. In a typical year, approximately 60 percent of the annual precipitation comes from convective storms during the four-month period from June through September. Periods of very heavy rainfall associated with the passage of tropical low pressure systems may occur during summer and early fall. Annual rainfall has ranged between 31 and 82 inches during the period from 1943 to 1995 at the Myakka River State Park weather station. The maximum daily rainfall was 10.1 inches recorded in September 1962. The dry season is from October to May. Often in the late spring, no measurable rainfall will occur for four to six weeks or more. This dry season coincides with the peak tourist season and also the time of greatest irrigation demand.

Evapotranspiration (ET) in the region is estimated to be approximately 39 inches per year. Rainfall that is not "lost" through ET is available for limited groundwater recharge or dissipates as runoff. ET rates are greatest in May and June and are lowest in December, with approximately 60 percent of the total yearly ET occurring during the six-month period between May and October (Dohrenwend 1977).

2.3 Physiography and Soils

The Myakka River Watershed is contained in three subdivisions of the central or mid-peninsular physiographic zone of Florida, predominantly Gulf Coastal Lowlands with the upper portion of the river, generally above the State Park, within the DeSoto Plain and a small part of the headwaters in the Polk Upland unit (White 1970). The Gulf Coastal Lowlands are characterized by flat topography with elevations generally below 40 feet and sandy, shelly, and silty sand soils with little organic matter. The DeSoto Plain consists of generally white sandy soils at elevations from about 40 to 100 feet. The watershed's maximum elevation is around 116 feet above the National Geodetic Vertical Datum (NGVD) in the northeastern part of the basin where terraces have eroded into rolling hills. The southwestern part of the basin is less than 20 feet above NGVD and has little local relief (Hunter 1990, 1993).

The soils found in the watershed generally fall into four broad classifications and three joint classifications:

Type A--High infiltration rate (excessively drained),
Type B--Moderate infiltration rate (moderately drained),
Type C--Slow infiltration rate (poorly drained),
Type D--Very slow infiltration rate (very poorly drained),
Type A/D (excessively drained to very poorly drained),
Type B/D (moderately drained to very poorly drained),
Type C/D (poorly drained to very poorly drained).

The majority of the watershed is classified as Type B/D, moderately to very poorly drained soils. These soils are generally level and sandy and are found in the extensive pine flatwoods and palmetto prairies of the watershed and associated low- lying areas as well as in oak/cabbage palm hammocks (SWFWMD 1988a,b,c). These soils are often used for improved pasture, agriculture and urban development. Type B/D soils are very prominent in the upper watershed where pockets of Type C, poorly drained soils, occur in flood plain, swamp and slough areas as well (SWFWMD 1988a,b,c). Type D soils with very slow infiltration rates, very poorly drained soils, are the second most prominent soil group of the watershed and are found mostly in flood plain forests, swamps, wetlands and tidal marshes (SWFWMD 1988a,b,c). This is clearly seen in the above referenced map, especially in the Sarasota County river segment and tributary watersheds. The watershed is very flat with subtle variations in topography that create many small depressions, sloughs and rises. These in turn form a fine mosaic of wetlands, uplands, hammocks and other vegetative associations with many ecotones, or areas of change between associations.

2.4 Surface Water Features

The Myakka River drainage basin consists of an approximate 600 square mile area in Manatee, Sarasota, Charlotte, and small parts of DeSoto and Hardee counties. Topographic relief within the basin varies from sea level to elevations of greater than 100 feet (above sea level) at the river's source near Myakka Head. In the vicinity where the Myakka River and Charlotte Harbor merge, topography is generally flat to gently sloping, with elevations varying from about 25 feet above sea level at the highest, to sea level at the Myakka River mouth and Charlotte Harbor.

The upland areas that the Myakka River drains are characterized by a high water-table and poor drainage due to underlying organic hardpan soils. Intermittently wet ponds dot the landscape. The water flowing in the Myakka River comes primarily from runoff. There is little evidence of artesian contributions to the river flow. The tributaries and sloughs of large streams are usually only a few feet deep.

Surface waters within the Myakka River watershed include numerous fresh and saltwater wetlands and several stream and slough systems. One of the most significant surface water features within the watershed is the confluence of seven streams to form the Flatford Swamp, which lies just upstream of State Road 70 near Myakka City in Manatee County. Other notable surface water features include Upper and Lower Myakka Lakes in the Myakka River State Park, Deer Prairie Slough/Creek in eastern Sarasota County and Big Slough Canal/Myakkahatchee Creek which begins in the southeastern part of Manatee County and flows through the City of North Port where it enters the estuarine portion of the river. Two surface water features unique to the area are Warm Mineral Springs and Little Salt Spring in North Port, which are the southernmost springs in the SWFWMD (Rosenau 1977).

The headwaters of the Myakka River are at about 115 feet above sea level. Myakka Head is within two miles of Horse Creek, which feeds into the Peace River. The river

channel south of Myakka Head is relatively straight, and the edge of its floodplain is at the 75-foot contour. Four creeks enter the river within four miles of Myakka Head: Johnson Creek, Wingate Creek, Taylor Creek, and Young's Creek. These tributaries to the river come together with several other creeks, Coker, Long, Maple and Ogleby, to form a confluential swamp, known as Flatford Swamp.

Ogleby Creek is the largest stream entering the river above Myakka Lake. Its watershed includes the community of Verna. A large marsh south of Verna is a result of the confluence of Ogleby Creek and the Myakka River. This wetland is two miles wide at its broadest east-to-west point. Southeast of the marsh is Myakka City at elevation 44 feet. Myakka City is built on level to gently sloping land with slow surface drainage and very slow internal drainage (FDEP 2003a).

Owen Creek enters Myakka River just east of Myakka City. This Creek originates in a marsh that stretches between Manatee and Hardee counties. The eastern portion of this marsh drains into Horse Creek, and the western portion flows into Owen Creek. From Myakka City to Tatum Sawgrass, the river drops 24 feet in elevation over a four and a half mile distance. The floodplain is an average of a half-mile wide up to this point. The floodplain then widens and the river's meanders become more pronounced and regular (FDEP 2003a).

Tatum Sawgrass is a 4,300 acre marsh at 16.5 feet elevation. The marsh can store the equivalent of 1.8 inches of rain over the entire upper watershed (235 square miles). It historically served to moderate the downstream effects of flooding and drought. If protected, Tatum Sawgrass could be a valuable watershed resource. The outlet of Tatum Sawgrass is through the Myakka River into Upper Myakka Lake (FDEP 2003a).

While there is some rural residential development, the upper watershed is predominantly undeveloped except for ranching and other agricultural activities. Agricultural activities are feasible because of drainage projects, such as in Ogleby and Owen Creek basins, that significantly change surface runoff patterns. Also, diking and ditching work in the Tatum Sawgrass area keeps the river water from slowly filtering through and dropping its nutrient load in the marsh.

Between Lower Myakka Lake and U.S. 41 two canals connect the Myakka River to coastal tributaries. Curry Creek/Blackburn Canal, the northern most, and Cow Pen Slough, a tributary of Shackett Creek, are located in the Southern Coastal CWM Watershed. These two surface water features drain to Dona and Roberts bays. These hydrologic alterations cause the two streams to exchange flow with the Myakka River at times. The United States Geological Survey (USGS) is monitoring flow in Cow Pen Slough and Sarasota County is monitoring flow in the Curry Creek/Blackburn Canal system to determine direction of flow and potential impacts to the Myakka River and the Dona and Roberts Bay system (Flannery 2004). This information can be used to assist the District in establishing and maintaining minimum flows and levels (MFLs) for the Myakka River.

Significant residential development in the Myakka River watershed is located immediately downstream of the U.S. 41 highway crossing on both sides of the river. Below U.S. 41, the river widens dramatically and is relatively shallow with a sandy bottom. Limited development occurs along the western riverbank to the Sarasota-Charlotte county line, in contrast to the eastern bank, which contains several large, fully built subdivisions. Between the Sarasota-Charlotte county line and the El Jobean Bridge (County Road 771), most of the native landscape has been replaced with bulkheads and finger canals associated with residential development. Downstream from El Jobean, the riverbanks are relatively natural as they widen into Charlotte Harbor.

2.4.1 Streams

Myakka River

The headwaters of the Myakka River are in eastern Manatee County near Myakka Head and the river flows approximately 66 miles in a southerly direction through Manatee, Sarasota, and Charlotte counties, where it empties into northwestern Charlotte Harbor. In the upper reaches near Myakka Head the river consists of a very narrow channel resembling a small creek. During the dry season, these reaches are often completely dry with no flow. In its meandering course, the Myakka River changes its character as it increases in size and passes through several natural lakes and swamps; different vegetative communities dominate its banks.

Tidal influence of the Gulf of Mexico extends more than 25 miles up the Myakka River to a water control structure located in the river channel, downstream of Lower Myakka Lake (Downs' Dam). Major tributaries of the Myakka River, Deer Prairie Creek (Slough) and Big Slough Canal/Myakkahatchee Creek, discharge into the river at a much lower reach, near and through the City of North Port, respectively.

Big Slough Canal/Myakkahatchee Creek

Big Slough Canal/Myakkahatchee Creek is a 21.5 mile long tributary creek of the Myakka River. The upper Big Slough Canal/Myakkahatchee Creek maintains its natural path and primary land use in the upper basin is agriculture. But the path and natural flow patterns of the lower reach have been altered through years of flood control activities in and around the City of North Port. The channelized portions of the creek are referred to as Big Slough. Approximately seven miles of Big Slough Canal/Myakkahatchee Creek wind through the incorporated parts of the City. A Sarasota County gauging station at Interstate Highway 75 represents a drainage area of 50 square miles.

Deer Prairie Slough/Creek

The Creek drains an area of 33 square miles in central Sarasota County, including the Carlton Reserve, the eastern portion of the Myakka River State Park, and agricultural lands. A salinity barrier near the mouth of the creek prevents brackish water from moving upstream.

2.4.2 Lakes

Upper Myakka Lake

Upper Myakka Lake is a large shallow karst feature, 875 acres in total. The lake's shores slope gradually down to deeper water. The lake ranges in depth from three to six feet. Above the lake, the hydraulic gradient of the Myakka River is always greater than one foot per mile. Beginning at the lake, a long flat plain with a gradient of less than a half-foot per mile stretches to the mouth of the river at Charlotte Harbor. The water of the lake used to leave by way of two channels at the southwest end of the Lake. Shep's Island split the water into its two channels, the present river channel and Vanderipe Slough. The two channels converged again above the Lower Myakka Lake. The land around the lake had been used as grazing land for cattle and horses before Myakka River State Park was established.

When the park was formed, an earthen dam was built across the branch of the river leading to Vanderipe Slough. The slough then became a seasonally flooded marsh. Later on, a concrete spillway was constructed across the river channel at the Lake's outlet. The purpose of the dam was to stabilize the lake level at a six foot depth to provide boating and fishing throughout the year.

Lower Myakka Lake

The main channel of the Myakka River from Upper Myakka Lake to Lower Myakka Lake meanders through a marshy area called Big Flats. The Lower Myakka Lake is within the Myakka River State Park Wilderness Preserve. Below this lake the river hammock closes in again along the river channel.

2.5 Hydrogeology

The Myakka River watershed is located within the Southern West-Central Florida Ground-Water Basin (SWCFGWB or the Basin), one of three distinct ground water basins within west-central Florida. No significant ground water flow crosses the basin boundaries; hence, all ground water is derived from recharge by rainfall within the Basin. Upper Floridan aquifer flow in the SWCFGWB is derived primarily from rainfall recharge that occurs in the Lake Wales Ridge area to the east and on a limited basis from the Green Swamp. Down gradient of these areas, ground water flows west and southwest toward and into the Gulf of Mexico (SWFWMD 1988a,b,c).

Within the SWCFGWB, the ground water system is divided into three main aquifers: the surficial, the intermediate and the Floridan. Each aquifer is separated by a confining layer of variable thickness and areal extent. The uppermost aquifer, the surficial, is largely undeveloped due to its small thickness and low permeability, except near the coast and in Charlotte County where ground water from deeper aquifers is too mineralized for potable use. The surficial aquifer occurs in the undifferentiated sands that overlie the watershed and generally varies from less than 25 feet in the southern areas to more than 50 feet in thickness in the northeastern areas of the Manatee

County. These sands yield limited quantities of water, primarily used for lawn irrigation, and are economically mined for their silica sand and shell hash content (SWFWMD 1988a,b,c).

Underlying the surficial aquifer is the intermediate or secondary artesian aquifer system, which occurs in the Hawthorn Group. The intermediate aquifer system is a moderately prolific, but highly developed source of water and is widely used for domestic and public supplies south of Polk County. Within the SWCFGWB, the intermediate aquifer averages 700 feet in thickness in southern Charlotte County, but thins toward the north. Within the Myakka River watershed, the intermediate aquifer varies in thickness from less than 200 feet to more than 350 feet (SWFWMD 1998). The upper Hawthorn consists of a green sand and clay containing black phosphate grains. This upper unit is sometimes included with the Bone Valley member and targeted for open pit phosphate mining. The lower Hawthorn is yellow to white sand, clay, and limestone residual from carbonate rock. The fine sand is quartz with black or brown phosphate. Lenses of pure limestone, clay and sand exist throughout the formation and domestic water well production occurs from the porous limestone layers.

The lowermost and most productive aquifer is the Floridan aquifer system. The Floridan aquifer is the primary artesian aquifer throughout Florida and much of the southeastern United States. It consists of two transmissive zones, the Upper Floridan and the lower Floridan aquifer, which are separated by the middle confining unit. This aquifer consists of a thick sequence of sedimentary rocks of Eocene to Miocene age. These chemically precipitated deposits of limestone and dolomite contain shells and shell fragments of marine origin, which accumulated throughout the Tertiary period. These limestone units comprise the Tampa, Suwannee, Ocala, and Avon Park formations. The Avon Park formation is the deepest containing potable water. The Floridan aquifer system thickens from approximately 1,200 feet in the northern areas of the watershed to more than 1,800 feet to the south. Generally, water quality in the Upper Floridan aquifer is good but it tends to deteriorate due to increasing mineralization as one moves south and toward the coast. The Upper Floridan is the major source of water for agriculture, industry and public supply, except in southern DeSoto and Charlotte counties and the coastal areas of Manatee and Sarasota counties where water quality is relatively poor (SWFWMD 1988a,b,c).

The Myakka River Watershed lies entirely within a region designated by the District as the Southern Water Use Caution Area (SWUCA). This is an area where the Floridan aquifer is well confined and highly transmissive. Thus, water withdrawals at a single point in the SWUCA can affect water levels over large areas. Additionally, most of the watershed above Upper Myakka Lake lies within the Eastern Tampa Bay Water Use Caution Area (WUCA) and abuts the Most Impacted Area (MIA), an area where no net increase in permitted quantities from the Upper Floridan aquifier is allowed. For a more detailed discussion of the SWUCA and other WUCAs, please refer to Chapter 3, Water Supply.

The Myakka River watershed provides little recharge to the Floridan aquifer, which is generally recharged along the sand ridges in the eastern part of the District. In this ridge area, the surficial aquifer is quite permeable, the intermediate aquifer is mostly absent and the confining layers and clays between the surficial and Floridan aquifers present in other parts of the SWUCA are thin to absent (SWFWMD 1998b).

2.6 Socio-economics

Florida's population and economy have increased greatly during the past generation and coastal communities have seen a major portion of that growth. The vast majority of the residents of Manatee, Sarasota and Charlotte counties live within a relatively narrow corridor roughly ten miles inland from the Gulf. Most of the future growth is expected to occur in this corridor as there is ample land available for development and local governments are trying to encourage and concentrate development where adequate infrastructure and public facilities already exist or are expected to be developed. This means that roughly the portion of the Myakka River watershed west and south of 1-75 will face continuing growth pressure. Rural areas east of I-75 are now also seeing increasing development, as agricultural lands are being converted to low density development. Much of the watershed, however, is likely to remain relatively undeveloped due to its agricultural character, the existence of the Myakka River State Park, the Myakka River State Forest and other public lands, and coordinated public and private conservation and management efforts by such groups as the Charlotte Harbor National Estuary Program, the Myakka River Management Coordinating Council, Friends of the Myakka and the Myakka Conservancy.

Several land acquisition projects are identified for the Myakka River watershed. They range from projects to preserve and protect natural areas, to projects important to natural systems restoration, water quality protection for Charlotte Harbor, and flood protection along the Myakka River.

2.6.1 Population

The region experienced substantial growth during the decade between 1990 and 2000. Manatee County's population grew by 22 percent, Sarasota County's grew by almost 18 percent and Charlotte County's population grew by 33 percent. As shown in Table 2-1, population growth in the region is expected to continue significantly. Additionally, these counties, especially the coastal areas, experience significant population increases from November through March of each year due to seasonal residents.

Table 2-1. Resident Population Estimates and Projections

Area	2002	2005	2010	2015	2020	2025
Manatee County	**277,362**	**292,000**	**318,300**	**343,400**	**368,700**	**393,100**
Sarasota County	**339,684**	**353,600**	**378,900**	**403,100**	**427,400**	**450,700**
Charlotte County	**148,521**	**156,700**	**171,300**	**185,400**	**199,400**	**212,900**
CWM Watershed	**49,540**	**51,762**	**55,778**	**59,628**	**63,484**	**67,189**

(Ayers & Assoc. 2003 and BEBR 2003)

2.6.2 Economy

Employment in Manatee, Sarasota and Charlotte counties is dominated by the service and retail industry sectors. This is typical of counties with resort communities and with large populations of retirees, seasonal visitors, tourists and other immigrants. Manufacturing plays a lesser, but still significant, role in Manatee County, due to the large presence of the agriculture industry and Port Manatee. Regionally, the public sector constitutes the next largest employment category.

2.6.3 Tourism

Tourism has a large influence of the economy of west central Florida. The role it plays impacts, both positively and negatively, the utilization and preservation of the region's natural resources. As the use and appreciation of the Myakka River system is intimately connected to Charlotte Harbor, this discussion focuses on the greater Charlotte Harbor watershed, not just the Myakka River. The Charlotte Harbor estuarine complex is one of Florida's least-spoiled systems, despite large population increases, primarily because its recreational values are recognized by its citizenry and have been largely protected from the obvious impacts of development.

The most notable public recreation area in the greater Charlotte Harbor watershed is the Myakka River State Park, the largest park in the state system. The park provides many outdoor recreational opportunities including hiking, camping, fishing, canoe rentals, and wildlife observation. The park is a favorite among bird watchers due to its variety and quality of habitats. The park hosts nearly a quarter of a million visitors each year (Myakka River State Park 1998).

The major recreational activities of the Harbor complex are sport fishing, recreational boating, beach use, bird/wildlife observation, and enjoying scenic vistas. As an indicator of the popularity of aquatic outdoor activities, Sarasota County has 60 marinas with 3,035 wet-slips and 2,841 spaces in dry storage (Sarasota County 1997). The two counties in the Myakka River watershed bordering the Harbor, Sarasota and Charlotte, have more than 30,000 registered boats and some 37 boat ramps, not all of which, however, are located within the Harbor's watershed. Due to the presence of the intracoastal waterway, virtually every marina and boat ramp in the region has access to Charlotte Harbor and the Myakka River. The commercial value of Charlotte Harbor and by proxy, the Myakka River lies in its tourism and recreational value, although commercial fishing and sports guide businesses are significant.

The great abundance and economic value of the water, wildlife and fisheries resources highlight the need for comprehensive management of the entire Charlotte Harbor system. This is particularly true for the Myakka River watershed, as the Myakka has more freshwater wetlands than any other Harbor sub-area, as well as extensive tidal wetlands.

2.7 Land Use, Growth and Development

The District's Geographic Information System (GIS) contains current land use/land cover and future land use designations, respectively based on 1999 data and Comprehensive Plans of counties within the watershed. It should be noted that these current and future land use estimates are only generally comparable as they are based upon data sets created by different agencies under differing sets of assumptions. The 1999 current land use and land cover data were interpreted from color infrared aerial photographs, ground truthed and classified according to the Florida Department of Transportation's Florida Land Use, Cover and Forms Classification system (FLUCCS). The 2010 Future Land Use map was generated by the Southwest Florida Regional Planning Council around 1993 for a statewide effort to combine all of the future land use maps for every local government to look at general development patterns around the State. Combining many maps into one general map required grouping many varied land use categories, residential density classifications, planning time frames, and other data into manageable categories. The result is a very generalized map and it should be looked upon as an indicator of future development potential, not necessarily estimated future development (SWFRPC 1993).

The Myakka River watershed reflects a wide variety of land uses and conversions of natural lands as a result of residential, commercial, and agricultural development. Applying the Florida Department of Transportation's Land Use, Cover and Forms Classification System to 1999 aerial photographs, urban and built-up lands comprised approximately 24,280 acres, or nearly 7 percent of the watershed total area, agriculture comprised about 104,000 acres (27.4 percent of the watershed), rangeland some 61,500 acres (16.2 percent), upland forests some 67,500 acres (17.8 percent), and wetlands some 79,880 acres (21 percent), as shown in Table 2-2. Overall, about 58 percent of the watershed consists of natural lands and the rest is either urban, open platted or agricultural land. Land Use and Land Cover is illustrated in Figure 2-2.

It should be noted, however, that many of the areas now designated as "natural" were in the past logged, farmed, ditched or otherwise altered from their original predevelopment condition even though they may be considered high quality natural habitats today.

2.7.1 Urban Development

Urban development within the watershed is typical of historical patterns, where coastal and riverine areas were developed first as they served as transportation corridors. Later development of railroads and highway systems followed this pattern due to the physical barriers of waterways, the need to serve existing and growing populations, and the desirability of waterfront areas. These transportation systems also link coastal communities with the interior of the State to open it up for development. The majority of the urban and built up lands occur in the southern portions of the watershed. As of 1997, the City of North Port had some 48,046 acres. More than 90 percent of the City was owned by General Development Corporation, much of it platted and sold for residential development (North Port 1997). The majority of these lots remain vacant

and the City has annexed thousands of additional acres, much of it platted. Adjacent areas also developed by the General Development Corporation in Charlotte County contain tens of thousands of vacant platted residential lots. In 1997, Charlotte County had almost 250,000 lots, more than 50 percent of them vacant (Charlotte County 1997). Commercial development is generally limited to main thoroughfares, especially U.S. 41, the Tamiami Trail.

Table 2-2. 1999 Land Use and Land Cover for the Myakka River Watershed

MYAKKA RIVER CWM – 1999 LAND USE/LAND COVER		
1999 LAND USE/LAND COVER	ACRES	PERCENT
Urban and Built-up (Residential, Commercial, Industrial, Institutional, Recreational)	**24,515**	**6.4**
Mining	**2,118**	**0.6**
Agriculture	**104,814**	**27.4**
Rangeland	**61,995**	**16.2**
Upland Forest	**68,015**	**17.8**
Water	**10,473**	**2.7**
Wetlands	**80477**	**21.0**
Open and Disturbed Land	**27,992**	**7.3**
Transportation/Communication/Utilities	**1,947**	**0.5**
Total Land Use/Land Cover	*382,346	100

(SWFWMD 2004a)

* NOTE: Discrepancies in total acreage (between tables) occur due to differences in acreage calculations for different data layers.

As part of the local government comprehensive planning and land development regulation process, future land use needs are estimated on the basis of projected population growth and appropriate levels of development required to adequately serve the increase. Future land use within the Myakka River watershed (Table 2-3) is expected to be similar to existing uses with some notable exceptions. The River has been designated a Wild and Scenic River within Sarasota County. A protection zone was created there within which land uses and development proposals must undergo a higher level of scrutiny in the development permitting process. Development must adhere to higher performance standards in terms of setbacks, stormwater management, buffering, and other criteria specified in Sarasota County's Land Development Regulations (further discussed in Chapter 6 - Natural Systems). Additionally, the mining of phosphate is planned for in the extreme northern and eastern portions of the watershed.

2.7.2 Natural Environment and Native Ecosystems

The Myakka River watershed encompasses a wide variety of native Florida ecosystems and natural lands. It is for this very reason that the Myakka River State Park was established and the District and others have purchased additional land for preservation.

To date, the District has acquired 36,512 acres in the watershed, 27,711 acres of which were purchased in fee simple and 8,801 acres were protected by less-than-fee methods (SWFWMD 2003a).

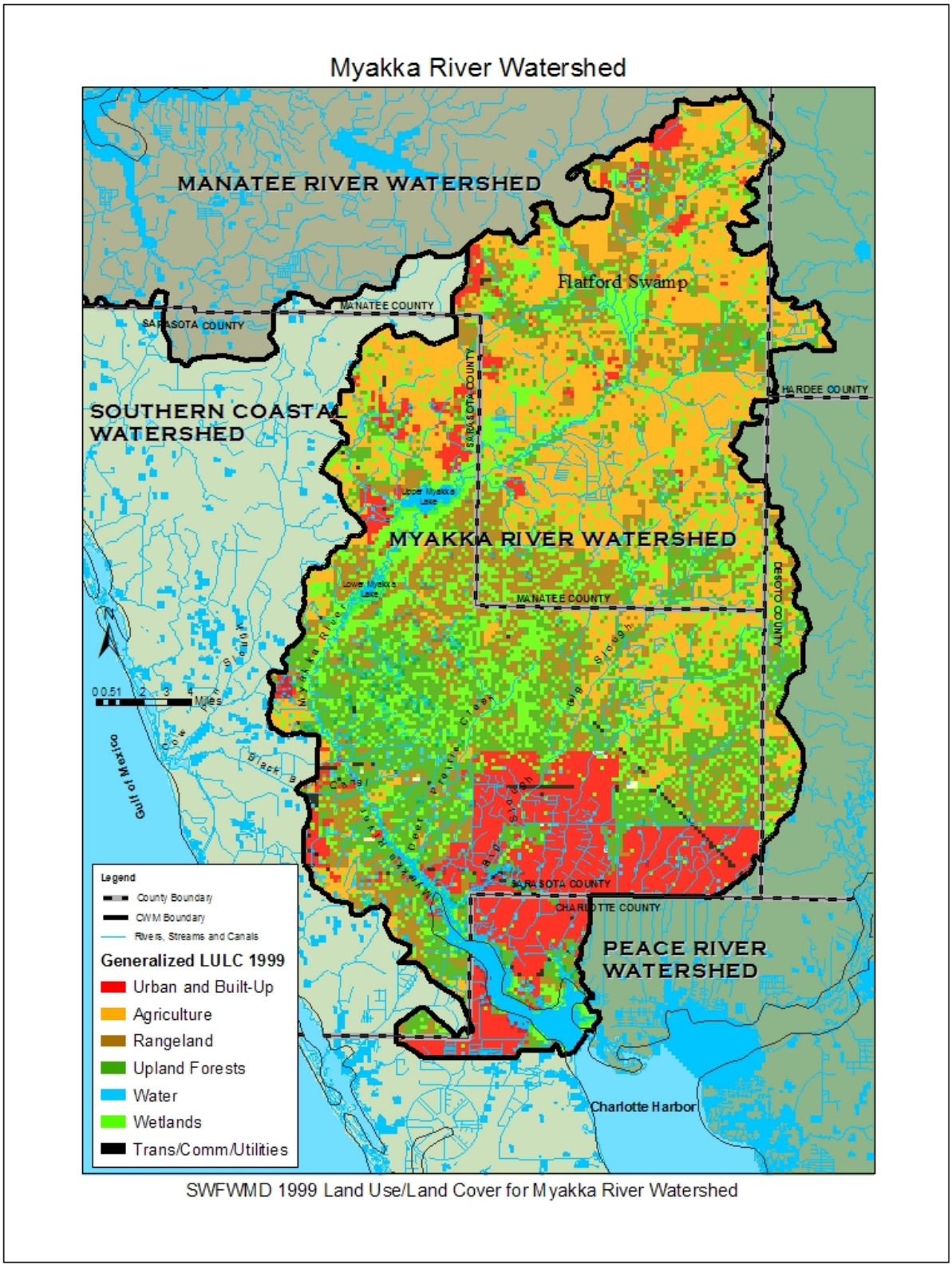


Figure 2-2. 1999 Land Use and Land Cover in the Myakka River Watershed

Through its Environmentally Sensitive Lands Purchasing Program (ESLPP), Sarasota County has protected more than 35,500 acres in the Myakka River watershed (Ryan 2004). The Manatee County Board of County Commissioners created the Environmental Lands Management and Advisory Committee (ELMAC) in 1992. The ELMAC identifies environmentally sensitive lands for acquisition and less-than-fee protection. However, Manatee County does not have an ongoing, county-wide funding program for land acquisition (Manatee County Website). While most large tracts of public land in Charlotte County were purchased with state or federal funds, the County does have an Environmental Lands Acquisition Advisory Council (ELAAC) to help county staff in identifying environmentally sensitive lands. The county also established a trust fund to purchase identified lands. The City of North Port has been active in purchasing land within the 25-year floodplain of Big Slough Canal/Myakkahatchee Creek and using transfers of development rights (TDRs) to protect the creek.

Table 2-3. 2010 Generalized Future Land Use for the Myakka River Watershed

GENEALIZED FUTURE LAND USE - MYAKKA RIVER CWM		
FLU CATEGORY	ACRES	PERCENT
Agriculture	**142,229**	**37.61**
Low Density Residential	**93,922**	**24.84**
Medium Density Residential	**35,768**	**9.46**
High Density Residential	**2,335**	**0.62**
Commercial/Office	**4,873**	**1.29**
Industrial	**41**	**0.01**
Institutional	**5,298**	**1.40**
Mixed Use	**4,021**	**1.06**
Preservation/Conservation	**66,139**	**17.49**
Recreation/Open Space	**11,878**	**3.14**
ROW	**8,409**	**2.22**
Water	**3,211**	**0.85**
Total Future Land Use	*378,124	100

(SWFWMD 2004a)

* NOTE: Discrepancies in total acreage (between tables) occur due to differences in acreage calculations for different data layers.

Due to past development practices, many of the natural systems in the watershed have been impacted, yet about 58 percent of the watershed is still considered "natural." Of these natural areas, rangeland comprises about 16 percent of the watershed, upland forest approximately 18 percent, and wetlands about 21 percent. Natural areas and habitats form the dynamic mosaic, characteristic of Florida, where small changes in elevation, soils and hydrology create many ecotones and subtle transitional habitats. The dynamic interactions of fire and water are a major factor influencing the overall composition and distribution of the watershed's natural systems.

According to 1999 land use and cover analysis as shown in Table 2-2, about 27.4 percent of the land within the watershed was developed for agricultural uses and approximately 6.4 for urban uses. Within this region characterized by expanding

population growth, urban land development and intensifying agricultural uses, large areas of swamps, marshes and forested uplands still remain undeveloped along the Myakka River and its principal tributaries. Natural undeveloped lands (uplands and wetlands) and rangelands (used for cattle grazing) scattered throughout the area, comprise 57.8 percent of the watershed. This is illustrated in Table 2-4.

Table 2-4. Natural Systems in the Myakka River Watershed

FLUCCS Code – Land Cover	Total Acres	% Natural Land Cover	% Total Watershed
300 Rangeland	61,538	28.05	16.22
310 Herbaceous	1,921	0.09	0.51
320 Shrub and Brushland	57,481	26.20	15.15
330 Mixed Rangeland	2,136	0.97	0.56
400 Upland Forest	67,506	30.77	17.79
410 Upland Coniferous Forest	1,915	0.87	0.50
411 Pine Flatwoods	47,647	21.72	12.56
420 Upland Hardwood Forest	2,817	1.28	0.74
434 Hardwood-Conifer Mixed Forest	14,621	6067	3.85
500 Water	10,394	4.74	2.74
600 Wetland	79,882	36.42	21.05
610 Wetland Hardwood Forest	412	0.19	0.11
611 Bay Swamp	320	0.15	0.08
612 Mangrove Swamp	782	0.36	0.21
615 River/Lake Swamp	27,691	12.62	7.30
620 Wetland Coniferous Forest	312	0.14	0.08
621 Cypress	1,131	0.52	0.30
630 Wetland Forested Mix	674	0.31	0.18
641 Freshwater Marsh	39,121	17.83	10.31
642 Saltwater Marsh	1,689	0.77	0.45
643 Wet Prairie	6,683	3.05	1.76
644 Emergent Aquatic Vegetation	965	0.44	0.25
651 Tidal Flats	86	0.04	0.02
653 Intermittent Ponds	16	0.01	<0.01
Natural Land Cover	219,320	100	57.80
Total Watershed Area	*379,455		100

(SWFWMD 2004a)

* NOTE: Discrepancies in total acreage (between tables) occur due to differences in acreage calculations for different data layers.

2.7.3 Agriculture

Agriculture is by far the largest single developed land use in the region as well as in the watershed. However, it is not as prominent as it was in the past, and its role is

continually diminishing as urban uses encroach into agricultural areas. For the 1994 crop year, agriculture in Manatee County consisted primarily of vegetable crops, citrus, and livestock; livestock in Sarasota County; and citrus, livestock and watermelons in Charlotte County (Florida Agricultural Statistics Service 1996a, b, c). Overall, agricultural land comprises approximately 104,000 acres, nearly 28 percent of the total land area, within the watershed. Another 61,500 acres (16 percent) are used for grazing under the classification of rangeland (Table 2-2).

2.7.4 Transportation

There are several major transportation corridors that pass through the Myakka River watershed and eight major roadways: one interstate highway, one federal highway, three state roads (S.R.) and three county roads (C.R.) that bridge the river. Although I-75 and U.S. 41 (Tamiami Trail) are generally north-south routes, they cross the lower portion of the watershed in an east-west direction as they go around Charlotte Harbor. U.S. 41 roughly parallels the coastline until reaching the City of Venice where it turns eastward and passes through the southern portion of the City of North Port before again turning south. I-75 parallels U.S. 41 several miles inland and generally follows the same orientation, crossing the northern side of the City of North Port before turning south.

U. S. Highway 41, the Tamiami Trail, has long served as the main local north-south route and is the most heavily urbanized roadway in the region. It was originally the main highway before the interstate system was built and was instrumental in bringing growth and development to the area. Today, I-75 is the major north-south road providing the bulk of through traffic and commerce, connecting the three major counties in the watershed with areas both north and south as well as to Ft. Lauderdale on east coast. U.S. 41 also crosses the Everglades south of I-75 to reach Miami.

Several minor roadways go north-to-south in the watershed and some of these may have potential for future expansion. In the northern part of the watershed, Wauchula Road runs down the east side of the Flatford Swamp, between Myakka Head on S.R. 64 and Myakka City on S.R. 70, crossing the Myakka River below the Flatford Swamp. The road serves local, rural uses and should continue to do so. About seven miles to the west, Verna Road runs south about three and a half miles from S.R. 70 to Sarasota C.R. 780 where C.R. 780 continues south about three miles to cross the Myakka River and turns east to connect to S.R. 70 at the DeSoto County line. The road currently serves predominantly local, rural uses but it does serve as a connector into the City of Sarasota and the area has been seeing some large lot development of homes and ranchettes.

The central portion of the watershed does not have any through north-south roads except for the main road through the Myakka River State Park, between the main entrance on S.R. 72 and an entrance used on weekends on C.R. 780. In the southern portion of the watershed, North River Road runs along the western side of the river from I-75 about five miles to U.S. 41 where it becomes C.R. 777 (South River Rd.) and goes

on south and then west to connect to C.R. 775/S.R. 776, the main coastal road in the area. Additionally, in the segment of North River Road from Venice Avenue to U.S. 41, there is a pattern of increasing very low and low density residential development.

Several major east-west corridors connect coastal areas to the interior of the State. In the northern part of the watershed, S.R. 64 crosses the river just before Myakka Head and connects the City of Bradenton to Zolfo Springs in central Hardee County and Avon Park in Highlands County. S.R. 70 crosses the river at Myakka City and runs from Bradenton to the City of Arcadia, the county seat of DeSoto County and eventually to Florida's east coast at the City of Fort Pierce. As S.R. 70 is part of the Florida Intrastate Highway system, long-term transportation plans call for its widening and improvement to facilitate movement between Florida's coastal areas and interior.

In the central part of the watershed, C.R. 780 (Fruitville Road) crosses the Myakka River near the Sarasota-Manatee County line and connects the City of Sarasota to Old Miakka in the eastern part of Sarasota County and eventually to S.R. 70 at the Manatee-DeSoto County line. S.R. 72 begins in Sarasota, crosses the river just east of the entrance to the Myakka River State Park and connects to S.R. 70 just west of Arcadia. In the southern part of the watershed, C.R. 776 goes from U.S. 41 in Port Charlotte south-southwest to the Cape Haze Peninsula, crossing the Myakka River at El Jobean. The road serves as a major evacuation route.

Chapter 3 ~ Water Supply

(SWFWMD Staff Photo)

Aerial Photo of the Peace River/Manasota Regional Water Supply Authority Intake Structure

~ The Peace River supplies water to many in the Myakka River watershed.~

Chapter 3
Water Supply

3.1 Introduction

3.1.1 Hydrologic Setting

The Upper Floridan aquifer (UFA) is the principal source of ground water in the Myakka River watershed. Under natural conditions the aquifer is well confined and in poor hydraulic connection to the surface water systems. Natural recharge to the UFA within the Myakka River watershed is almost non-existent. The principal recharge area for the aquifer in this region is located in Highlands and Polk counties to the east and northeast. Because of poor water quality in the UFA, the intermediate aquifer system (IAS) is an important -- though less productive -- source of water in the region. The IAS also functions as a major confining unit between the UFA and the surficial aquifer system (SAS), which is near the land surface. Most surface water and groundwater interaction occurs principally between the surface water bodies (lakes and rivers) and the IAS and the SAS.

Water quality is the principal constraint on the ground-water supply. In Sarasota and Charlotte counties, raw UFA water is above the drinking water standard of 500 milligrams per liter (mg/l) in total dissolved solids (TDS) and deteriorates from north to south. The poor water quality requires extraordinary treatment for public supply water use. Water quality of the SAS and IAS is generally of acceptable quality but degrades in the coastal areas and with depth in the IAS.

The Myakka River is about 66 miles in length and has a drainage area of about 600 square miles. The river has an average flow of 251 cubic feet per second (cfs) at the Sarasota gauge and a maximum recorded flow of 8,670 cfs for the period of record. The differences between dry and wet season flows are extreme with 73 percent of the river's flow occurring from July through October. During the dry season it is common for the Myakka River to experience zero flow, particularly in the months of April and May. Water quality during high flows is good, but during low flow periods the water quality is poor due to the contributions of ground-water and runoff from agricultural operations (Hammett 1988). The river is not currently used as a source of water supply, although several analyses have been conducted over the years to quantify the potential of the river to supply water, most recently as part of the District's 2001 Regional Water Supply Plan.

3.1.2 The Southern Water Use Caution Area

The District's Governing Board declared the Southern Water Use Caution Area (SWUCA) in 1992. A "water use caution area" is designated where water resource

problems are critical or are expected to become critical in the next 20 years (Rule 62-40.520(2), F.A.C.). Encompassing approximately 5,100 square miles, the SWUCA includes all of DeSoto, Hardee, Manatee and Sarasota counties and portions of Charlotte, Highlands, Hillsborough and Polk counties. SWUCA water resource concerns include decreased flow in the upper Peace River, the decline of lake levels along the Highlands Ridge, where most Floridan aquifer recharge occurs, and advancing coastal saltwater intrusion into the Floridan aquifer. These problems all stem from long term declines in potentiometric levels in the Floridan aquifer caused primarily by increased ground-water withdrawals.

The establishment of the SWUCA was the culmination of a long process of technical study, stakeholder input and policy deliberation. Two other water use caution areas, the Eastern Tampa Bay and Highlands Ridge WUCAs, were established in 1989. In assessing management options to address resource issues in these areas, the District Governing Board and staff came to the conclusion that withdrawals throughout the southern ground-water basin were contributing to the observed problems. Consequently, the SWUCA was designated to incorporate the two existing WUCAs and the remainder of the southern ground-water basin.

The District Governing Board's initial effort to address the resource problems through rulemaking occurred in 1994. Rules adopted at that time would have established a minimum level for the Floridan aquifer and put into place a number of other regulatory enhancements to reduce water use. These rules were challenged by a number of parties, however, and a lengthy administrative process ensued. Ultimately, the science behind the rules was upheld, but some rules were held invalid. Others were upheld and went into effect in January 2003. In 1998, partly in response to state legislation that provided new water supply policy direction, the District launched a reevaluation of the SWUCA and potential management options. This effort culminated in the development of a draft SWUCA Recovery Strategy in November 2003. The Recovery Strategy is discussed in more detail later in this chapter.

3.1.3 Water Use, Reuse, and Conservation

3.1.3.1 Estimated Water Use

At this time, there are no published estimates of water use in the Myakka River Watershed. The District currently is engaged in a water use tracking project that involves the development of new software tools to extract water use data spatially and temporally. Once this project is complete, it will be possible to generate water use estimates for specific geographic areas. Previous estimates have shown agriculture to be the predominant water use in the watershed. Although the estimates have not been updated, agricultural water use still is thought to be the largest category of water use. Agriculture is concentrated in the upper portion of the watershed, with vegetables, tomatoes and citrus being the primary crops.

Public Supply withdrawals are the next largest category within the watershed. Public Supply facilities are described in the next section. Table 3-1 shows annual average estimated water use by use type for each of the three counties containing a majority of the watershed. In future revisions to this plan, water use will be estimated for the watershed area.

Table 3-1. Estimated Water Use In Charlotte, Manatee and Sarasota Counties (million gallons per day [mgd]).

Category	Charlotte	Manatee	Sarasota
Agriculture	17.65	94.85	6.49
Public Supply	14.37	37.05	31.67
Domestic Self-Supply	4.07	0.48	0.66
Industrial/Commercial	0.02	0.24	0.18
Mining/Dewatering	0.52	0.45	0.46
Recreational/Aesthetic	2.93	4.58	7.50
Total	39.55	137.66	46.97

(SWFWMD 2003b)

3.1.3.2 Reuse

An increasingly important component of water supply in Florida is the reuse of reclaimed water. Reclaimed water is wastewater that has received at least secondary treatment and is reused after flowing out of a domestic wastewater treatment plant (WWTP). Reclaimed water is not used for potable water supply, but helps to offset potable water use. Common uses of reclaimed water include industrial use, power plant cooling, agricultural and landscape irrigation.

The District conducts an effective program to promote reuse. Regulatory requirements for water use permittees and financial assistance through the basin boards' Cooperative Funding Program are two mechanisms that encourage the development of reuse systems. Regulatory policies require permitted water users to use the lowest quality of water appropriate for the specific use and, in WUCAs, to conduct feasibility studies and implement reuse if technically, economically and environmentally feasible. Basin boards typically fund up to 50 percent of the cost of feasibility studies, reuse system design; construction of pumping, storage, and transmission facilities; and the development of reuse master plans. The District now places greater emphasis on reuse efficiency, in addition to increasing the utilization of WWTP flows. The greater the efficiency of reuse, the more potable water can be offset. Table 3-2 summarizes 2000 reuse data for the three counties containing the majority of the watershed.

3.1.3.3 Water Conservation

Stressed resources in the SWUCA have prompted an increasing emphasis on water conservation to help stretch limited water supplies. The District promotes water conservation on several fronts. Some of the key District programs include:

Table 3-2. Reuse information for Charlotte, Manatee and Sarasota Counties.

County	Number WWTPs	Number Providing Reuse	WWTP Capacity (mgd)	Wastewater Flow (mgd)	Reuse Capacity (mgd)	Reuse Flow (mgd)
Charlotte	10	6	11.82	7.46	2.83	1.91
Manatee	5	5	39.10	25.87	29.98	15.06
Sarasota	19	15	33.05	21.39	15.98	9.49
Total	34	26	83.97	54.72	48.79	26.46

(SWFWMD 2003c)
WWTPs – Wastewater Treatment Plants.
Wastewater Flow – Volume of treated effluent from WWTPs.
Reuse Capacity – The physical capacity of reuse facilities to supply reclaimed water.
Reuse Flow – The actual amount of reported reclaimed water use.

- Cooperative funding by the basin boards of water conservation projects such as plumbing replacement, landscape irrigation improvements, industrial/commercial efficiency improvements, demonstration projects, education and others.
- Leak detection and water audit services through an urban mobile lab.
- Agricultural efficiency and alternative source programs.
- Education programs for youths and adults.
- An extensive conservation library and staff technical assistance.
- Regulatory initiatives through water use permitting, year-round water conservation rules, and water shortage rules.

In the southwest part of the District, which includes the Myakka River watershed, conservation gains have been significant over the past 20 years. The region's public supply systems have some of the lowest per capita water use rates in the state. Agricultural water users and industry, particularly phosphate mining, also have become much more efficient.

3.1.4 Public Water Supply Facilities in the Watershed

Public water supply facilities in the watershed include the City of Sarasota's Verna wellfield, which is adjacent to the Sarasota-Manatee county line and straddles the watershed divide in the northwest portion of the watershed. The wellfield is permitted for 6.0 mgd. Estimated actual use in 2001 was 5.1 mgd.

Sarasota County is permitted to withdraw 7.3 mgd from the T. Mabry Carlton Memorial Reserve well field located in central Sarasota County and entirely within the watershed. Estimated actual use in 2001 was 7.2 mgd.

The City of North Port is permitted to withdraw 2.1 mgd from Big Slough Canal/Myakkahatchee Creek. Actual use in 2001 was estimated at 1.2 mgd. This is the only surface water withdrawal in the watershed for public supply. Because flows in the creek are highly variable, the City's use of this source is constrained by a lack of storage volume. The District and the City have shared funding of a project to determine the

feasibility of constructing an aquifer storage and recovery well to allow water to be stored in a deep, non-potable aquifer. This project, if successful, will boost the City's capacity by one to two mgd.

Both the City of North Port and Sarasota County receive a portion of their water supply from the Peace River/Manasota Regional Water Supply Authority. The Authority has a major regional facility outside the watershed in DeSoto County to treat and store water from the Peace River. Water is stored in an off-stream reservoir and also underground in aquifer storage and recovery wells. The Authority also is the primary water supplier for Charlotte County.

3.2 Studies, Reports and Data

A great deal of published information exists that is relevant to water supply in the Myakka River watershed area. Some of that information is summarized in this section.

3.2.1 Previous Studies

SWFWMD, 1998b. *SWFWMD Water Supply Assessment*.

> During its 1997 session, the Florida Legislature amended Chapter 373, Florida Statutes to clarify the water management districts' responsibilities relating to water supply planning and water resource development. The legislation required the District to prepare a District-wide Water Supply Assessment. The purpose of the assessment was to determine the adequacy of water sources to meet anticipated demands and sustain natural systems. For areas where sources are not adequate to meet projected needs, a detailed regional water supply plan is required.
>
> The District completed its assessment in 1998, evaluating water demand projections and available sources through the year 2020 in four planning regions. Existing and anticipated water sources were found inadequate to meet the projected demand in three of the four planning regions. Consequently, the District began work on a Regional Water Supply Plan for these areas, including the entire SWUCA, including the Myakka River watershed, as well as the Northern Tampa Bay area.

SWFWMD, 2001. *Regional Water Supply Plan*.

> The District's Regional Water Supply Plan (RWSP) covers a ten county area from Pasco in the north to Charlotte in the south. The RWSP is the latest comprehensive water supply planning document for the entire southern District, as well as the Northern Tampa Bay area. It contains an assessment of projected water demands and potential sources of water to meet these demands for the period from 1995 to 2020. The RWSP provides a framework for future water management decisions in areas of the District where the hydrologic system is stressed due to ground-water withdrawals. The RWSP identifies potential options for additional water supply but does not attribute a preference to those options. The plan anticipates that a majority

of the additional demand will be met with alternative water sources (i.e., sources other than fresh ground water) in the planning region.

The RWSP is based on a number of technical studies sponsored by the District specifically for the purpose of preparing the plan. These studies will not be enumerated here individually, but it should be recognized that they represent much of the latest technical information on water supply for the region. All of the studies are referenced in the RWSP. The RWSP is updated every five years, with the next update scheduled by the end of 2005.

Greeley and Hansen, LLC, 2003. *Regional System Planning and Engineering Study: Phase I – Assessment of Existing Supplies.* Prepared for the Water Planning Alliance through the Peace River/Manasota Regional Water Supply Authority.

The four members of the PR/MRWSA (Charlotte, DeSoto, Manatee and Sarasota counties) and nine other local governments and water suppliers have joined together to sponsor a major regional water supply planning study for the four county Authority area. The Phase I report assesses future water supply needs and inventories existing water supplies in the planning area. Phase II, underway as of this writing, will identify and prioritize specific source options to meet future needs.

SWFWMD, 1993b. *Eastern Tampa Bay Water Resource Assessment Project Report*.

This was a key technical report for the Eastern Tampa Bay WUCA. It concluded that saltwater intrusion would continue in the Upper Floridan aquifer if 1989 water use levels persisted. Additional findings confirmed that groundwater levels at any location in the southern ground-water basin are affected by cumulative groundwater withdrawals throughout the basin. These findings, apparent before the completion of the project, were part of the basis for declaration of the SWUCA in 1992.

3.2.2 Additional Information and Data

3.2.2.1 SWFWMD Data

The SWFWMD maintains two pertinent data bases with data related to water supply: the Water Management Data Base (WMDB) and the Regulatory Data Base (RDB). The District has a comprehensive hydrologic conditions monitoring program. Conditions that are monitored include rainfall, evaporation, lake levels, groundwater levels, spring flow, various water quality parameters, and river discharge and stage elevation. These data are in the WMDB.

Hydrologic data are also collected by the District through regulatory programs and are maintained in the RDB. Public supply permittees and all permittees located in water use caution areas must report ground and surface water withdrawals where permitted withdrawals exceed 0.1 mgd. Other water use permittees are required to report

pumpage if permitted withdrawals are greater than 0.5 mgd. Selected water use permittees are also required to report water levels and water quality data.

The District compiles an annual *Estimated Water Use* report containing detailed and summary information on water use in six major water use categories: public supply, domestic self-supply, recreational/aesthetic, agricultural, mining/dewatering, and industrial/commercial. Data are broken down by county and WUCA, but not by CWM watershed. Information on permitted water quantities and water withdrawals is also included. Because of the effort required to compile this extensive data, reports for a given calendar year are published two to three years after the end of that year.

3.2.2.2 U.S. Geological Survey (USGS) Data

The USGS also maintains a database that includes surface water flows and stages, rainfall, ground-water levels, and water quality information. The agency monitors several sites within the Myakka River watershed. These data may be accessed via the Internet at http://waterdata.usgs.gov/fl/nwis/rt.

3.2.2.3 Local Government Information

Each local government in the state is required to prepare a comprehensive plan addressing future land use, resource conservation, infrastructure and other matters. Comprehensive plans are in place for each of the local governments with jurisdiction over a portion of the Myakka River watershed. These plans all contain information on water supply (focusing on public supply). In 2002, the Florida legislature passed new water supply planning provisions that require local governments to include in their comprehensive plans more detailed water supply planning in the form of Ten-Year Water Supply Work Plans. The Work Plans are intended to provide more specific information on future water demands and the sources that will be utilized to meet those demands. Local governments are required to consider the District's Regional Water Supply Plan and coordinate with the District in the preparation of their Work Plans. Work Plan development is well underway by many of the local governments in the Myakka region. By statute, the plans must be adopted by December 1, 2006.

In addition to comprehensive plans and Ten-Year Water Supply Work Plans, some local governments have other water supply plans. Sarasota County, for example, contracted with a consultant in the late 1990s to prepare a Water Supply Master Plan for the county. The plan addresses potable water demands through 2030 and identifies and ranks some 25 supply alternatives.

3.3 Regulatory Framework

Water supply is regulated primarily by the District and the Florida Department of Environmental Protection (FDEP). In this section, key regulatory programs are briefly described.

3.3.1 SWFWMD Regulations

3.3.1.1 Water Use Permitting (40D-2, F.A.C)

The authority to regulate the withdrawal, use and transport of water is reserved exclusively to FDEP and the water management districts (Sections 373.217 and 373.223, F.S.). The District's water use permitting rules are codified in Chapter 40D-2, F.A.C. The District generally requires permits for withdrawals that average 100,000 gallons per day or greater. Permit applicants must demonstrate that their proposed water use is reasonable and beneficial, in the public interest, and will not interfere with any existing legal use of water. District rules specify thirteen conditions of issuance that must be met in order to satisfy these criteria (Rule 40D-2.301, F.A.C.).

Special rules apply to water use permits within Water Use Caution Areas. The Myakka River watershed is entirely within the Southern WUCA and approximately the northern third of the watershed is within the Eastern Tampa Bay WUCA. The most significant WUCA rule is the prohibition on new permitted quantities within the "Most Impacted Area" (MIA) of the ETBWUCA. Only a very small portion of the watershed is within the MIA; however, the rules also prohibit withdrawals from confined aquifers outside the MIA that would cause a potentiometric surface drawdown of 0.2 feet or greater within the MIA. These stringent standards are designed to slow the inland movement of the freshwater/saltwater interface, commonly referred to as saltwater intrusion. Another rule in the ETBWUCA limits public supply permittees to a maximum per capita use rate of 150 gallons per capita per day. This standard is currently proposed for the entire SWUCA as part of the rulemaking associated with the SWUCA Recovery Strategy.

Some of the key existing rules applicable to the entire SWUCA include the following.

- Public supply utilities must adopt water-conserving rate structures to encourage conservation.
- Permittees for all use types must assess the feasibility of reuse and implement reuse where economically, environmentally and technically feasible.
- Alternative sources (e.g., reclaimed water) must be metered and use reported to the District.
- Coastal applicants for large quantities in the industrial and public supply categories must investigate the feasibility of using desalinated water.
- Most agricultural users are permitted for average rainfall conditions with an allowance of additional quantities during drought conditions and freezes. This provides an incentive to conserve and helps to reduce the large gap between permitted quantities and actual use.
- All uses greater than 100,000 gallons per day must be metered and usage reported to the District.
- Water conservation plans are required for all permits in the Industrial, Mining/Dewatering, and Recreational/Aesthetic categories and for all golf course permits.

3.3.1.2 Year-Round Water Conservation Measures (40D-22, F.A.C.)

The District's year-round water conservation rules are intended to promote the long-term sustainability of water resources through water use efficiency. Measures contained in the rule are aimed at reducing wasteful irrigation practices and encouraging lawn and landscape drought conditioning. The rules apply to all water users in the District. The key provisions in the rules prohibit irrigation between the hours of 10:00 a.m. and 4:00 p.m. and limit irrigation to a maximum of two days per week, which are specified based on address numbers. Exceptions are provided for new plantings and special rules apply to golf courses and to agriculture.

3.3.1.3 Water Shortage Plan (40D-21, F.A.C.)

Each water management district in the state is required to have a water shortage plan. The plan is implemented when the District Governing Board determines that insufficient water is available to meet permitted demand or when a temporary reduction in water use is necessary to protect water resources from serious harm. The plan provides for a variety of measures that may be implemented, depending on the severity of the water shortage. Measures are specific to various classes of water use.

3.3.1.4 Well Construction Permitting

Well construction permitting is intended to ensure that water wells are located, constructed, maintained, used, and abandoned in a manner that protects water resources. This chapter of District rules also incorporates certain FDEP rules by reference, including those that regulate water well contractor licensing. Permits are required for the construction, repair, modification or abandonment of water wells. Standards are provided in the rules for casing and liner pipes, grouting and sealing, and for plugging of abandoned wells.

Sarasota and Manatee counties have their own well construction regulation programs. In these two counties only, the District has delegated its authority for well permitting by formal agreement. Manatee County handles well permits through its Environmental Action Commission. In Sarasota County, the County Health Department administers the program.

3.3.1.5 Minimum Flows and Levels (40D-8, F.A.C.)

Minimum flows and levels (MFLs) are statutorily defined as the limit beyond which further withdrawals would be significantly harmful to the water resources or ecology of the area. The District has established many minimum flows and levels in the Northern Tampa Bay area. Minimums for the Floridan aquifer, the upper Peace River and certain lakes in Highlands and Polk counties are scheduled to be established in 2004. A full schedule for water bodies throughout the District is submitted annually for state approval. Additional information on MFLs can be found in the Natural Systems chapter of this plan.

3.3.2 Department of Environmental Protection Regulations

The FDEP has the primary role of regulating public water systems in Florida. The state's Safe Drinking Water Act (sections 403.850-403.864, F.S.) is the basis for FDEP's programs in this area. FDEP rules adopt the national primary and secondary drinking water standards of the Federal Government and create additional rules to fulfill state requirements. They are contained in Chapters 62-550, 62-555, and 62-560, F.A.C. addressing drinking water standards and monitoring, permitting and construction of public water supply systems, and requirements for systems that are out of compliance, respectively. FDEP has delegated permitting and enforcement responsibilities for the drinking water program to certain county health departments in Florida, including those in Manatee and Sarasota counties.

Another important regulatory role for FDEP in the water supply arena involves its underground injection control program. The program regulates the underground disposal or storage of appropriately treated fluids in order to protect underground sources of water supply. This includes the regulation of aquifer storage and recovery (ASR) wells, which represent an important component of the regional water supply system operated by the Peace River/Manasota Regional Water Supply Authority. More information on ASR is provided in subsequent sections of this chapter.

3.4 Other Resource Management Initiatives

3.4.1 SWUCA Recovery Strategy

In November 2003 the District released the first draft of its SWUCA Recovery Strategy. The District Governing Board is expected to approve a final Recovery Strategy in 2004. The goals of the Recovery Strategy are to accomplish the following in an economically, environmentally and technologically feasible manner:

(1) Restore minimum levels to priority lakes in the Lake Wales Ridge by 2015;
(2) Restore minimum flows to the upper Peace River by 2015;
(3) Reduce the rate of saltwater intrusion in coastal Hillsborough, Manatee and Sarasota counties by achieving the proposed minimum aquifer levels for saltwater intrusion by 2020; and,
(4) Ensure that there are sufficient water supplies for all existing and projected reasonable-beneficial uses.

Development of the Recovery Strategy by the District has been guided by several principles:

(1) Contribute significantly to resource management and recovery;
(2) Protect investments of existing water use permit holders;
(3) Allow for economic expansion and new economic activities;
(4) Ensure that the Strategy is based on the best available science, and that the science will be extensively peer reviewed;
(5) Attempt to minimize the need for rule revisions;

(6) Provide financial and regulatory incentives to maximize the benefits of public and private partnerships;
(7) Ensure the Recovery Strategy is expeditiously implemented in a timeframe that is practical; and,
(8) Seek consistency with recovery strategies developed elsewhere in the state.

The two major approaches to the Recovery Strategy are managing groundwater withdrawals and implementing water resource development projects. These two approaches work together to achieve the District's goals.

Some of the needed reductions in groundwater withdrawals will be accomplished as land uses transition from agriculture to residential and commercial. Agriculture relies almost exclusively on local ground water. The Recovery Strategy focuses on meeting these new land use water needs with alternative sources, including surface water (mostly capturing a small portion of the high flows of rivers), conservation, reclaimed water and desalinated seawater. In the interior communities of the SWUCA, where these alternative sources are more limited, increasing public supply demands can be met, at least in part, by the conversion of the existing agricultural uses. Lessening the competition for ground water, coupled with basin-wide conservation, regulatory enhancements and other management actions, will make ground water available for those that lack access to economically, technically and environmentally feasible alternatives.

Water resource development actions identified in the Recovery Strategy include a series of projects to be implemented in the upper Peace River watershed and within the watersheds of priority lakes in Highlands and Polk counties. These projects are intended to restore perennial flow to the upper Peace River and restore lake levels in the Lakes Wales Ridge.

Existing District rules are sufficient to accomplish the vast majority of what is contemplated in the Recovery Strategy. Included in these existing rules are requirements that the applicant conserve water, maximize the use of reclaimed water, use the lowest quality water appropriate for the use, and demonstrate the withdrawal will not adversely impact water resources or related natural resources. These requirements can be very effective in encouraging communities to focus on supplies other than the Floridan aquifer.

While existing rules meet most of the area's needs, the Recovery Strategy also includes rule enhancements, primarily to adopt the MFLs and specify the means by which permitting will occur while the area is in recovery. The additional rules are targeted for Governing Board adoption in late 2004.

3.4.2 Regional Water Supply Plan

As noted earlier, the District's Regional Water Supply Plan (RWSP), approved by the District Governing Board in 2001, covers a ten county area from Pasco in the north to

Charlotte in the south. Water demand projections from the RWSP for the three main counties of the watershed are shown in Table 3-3.

These projected total demand figures are currently being revised as part of the 2005 update of the RWSP and will likely decrease. The greatest decrease in projected demands will likely be in the agricultural use sector. The current RWSP projects an increase in agricultural use in the SWUCA of almost 87mgd from 2000 to 2020. In the draft SWUCA Recovery Strategy, no increase in total SWUCA agricultural demand is projected through the year 2025. This is based upon more recent trend analysis and is anticipated to be reaffirmed in the RWSP update. The Recovery Strategy also concludes that 2025 Public Supply demand for the four-county area of Charlotte, DeSoto, Manatee and Sarasota will exceed existing permitted and funded sources by only two mgd. It also concludes that this small deficit could easily be met through additional conservation.

Table 3-3. Water Demand Projections by County (mgd average annual).

County/ Category	2000	2010	2020	Additional Demand
Charlotte				
Agriculture	**25.3**	**28.7**	**30.6**	**5.3**
Public Supply	**18.4**	**23.2**	**28.2**	**9.8**
Industrial/Commercial	**1.6**	**1.7**	**1.8**	**0.2**
Recreational/Aesthetic	**2.6**	**3.5**	**4.5**	**1.9**
Sub-Total	**47.9**	**57.1**	**65.1**	**17.2**
Manatee				
Agriculture	**113.1**	**122.2**	**128.6**	**15.5**
Public Supply	**38.3**	**44.9**	**51.1**	**12.8**
Industrial/Commercial	**8.3**	**8.8**	**9.3**	**1.0**
Recreational/Aesthetic	**5.2**	**7.0**	**8.8**	**3.6**
Sub-Total	**164.9**	**182.9**	**197.8**	**32.9**
Sarasota				
Agriculture	**15.9**	**17.3**	**19.0**	**3.1**
Public Supply	**51.6**	**62.3**	**74.7**	**23.1**
Industrial/Commercial	**0.9**	**1.0**	**1.0**	**0.1**
Recreational/Aesthetic	**9.7**	**11.6**	**13.5**	**3.8**
Sub-Total	**78.1**	**92.2**	**108.2**	**30.1**

(SWFWMD 2001)

The RWSP contains a lengthy list of source options that could be utilized to help meet the projected demand. Sources were categorized by type, resulting in five major categories: surface water/stormwater, reclaimed water, water conservation, brackish ground water, and seawater desalination. Although fresh ground water will continue to play a significant role in meeting future demands in the watershed and throughout the RWSP planning area, this source was not investigated in detail, since the currently permitted quantities are considered to be unsustainable in light of existing or proposed minimum flows and levels that are not currently being met. Of particular relevance to this CWM plan are the RWSP water supply options involving the Myakka River. The primary option discussed would involve diversion of water from the river in the vicinity of

the I-75 bridge during high flows. Water would be stored in an off-stream impoundment near the diversion site then treated, filtered, disinfected and stored via ASR wells in the brackish Avon Park formation (part of the Floridan aquifer). Water could then be withdrawn when needed, treated and distributed via existing distribution systems. The RWSP conservatively estimates the practical annual average yield at 15 mgd. Like all surface water projects in the RWSP, in the absence of established minimum flows for the river, this option assumes no withdrawals when flows are at or below the P85 criterion, which is the flow equaled or exceeded 85 percent of the time during the period of record. It also assumes a maximum withdrawal of 10 percent of the total daily flow for those days when the P85 flow is exceeded. These criteria were applied to ensure that natural systems would be protected along the river itself and in the downstream estuary.

The RWSP acknowledges some key issues that would need to be addressed prior to considering the Myakka River source option. Among these are the river's Wild and Scenic designation and Outstanding Florida Water status. It also is noted that the Blackburn Canal and diversions from the Flatford Swamp would have to be factored in to calculations of available quantities from the river.

The RWSP is scheduled for update by the end of 2005. Some preliminary work has been accomplished for this update, some of which is reflected in the regional water supply planning component of the draft SWUCA Recovery Strategy.

3.4.3 Peace River/Manasota Regional Water Supply Authority

The Peace River/Manasota Regional Water Supply Authority (PR/MRWSA or Authority) was created under the provisions of section 373.1962, F.S. as a voluntary regional partnership of four member counties -- Charlotte, DeSoto, Manatee and Sarasota. The mission of the Authority is to provide its members with reliable supplies of high-quality water in a way that both protects and preserves the environment. The Authority operates a regional water facility on the Peace River near Fort Ogden in DeSoto County. Water currently is supplied to three of the member governments – Charlotte, DeSoto, and Sarasota counties, and the City of North Port.

The Authority currently has a water use permit from the District allowing an annual average withdrawal of 32.7 mgd. Because the flow of the Peace River is highly variable, the Authority relies on water storage to ensure a reliable, year-round water supply. Up to 10% of river flow is permitted to be withdrawn when the measured flow at the Arcadia gauge is at least 130 cubic feet per second. Raw water can be stored in a surface water reservoir to later be treated and distributed to meet demand. Most of the Authority's storage capacity is underground in a deep, non-potable aquifer.

Aquifer storage and recovery (ASR) technology is key to the Authority's ability to meet the demands of its wholesale customers, particularly during the dry season when withdrawals from the river often are not permissible. Water is taken from the river (when available) to replenish the reservoir. Water for treatment is pumped from the surface water reservoir, treated to potable standards and delivered to the public, with excess

water injected via ASR wells into the storage zone deep underground. When needed, the water is pumped out of the ASR wells, disinfected, retreated if necessary, and distributed to the Authority's customers.

The Authority currently is planning an expansion of its facilities to better meet future water demand in the region. Storage capacity in the surface water reservoir may be increased up to 18,000 acre-feet (about six billion gallons). A total of forty-seven ASR wells are permitted. These wells are planned to be constructed in phases into the future to provide more underground storage capability and more flexibility in recovering stored water. The water treatment plant also will be expanded.

3.4.4 Water Planning Alliance

The Alliance is a voluntary planning body formed to work collectively on water supply issues facing the four-county region encompassed by the Peace River/Manasota Regional Water Supply Authority. It is governed by one elected official from each participating local entity — Charlotte, DeSoto, Manatee and Sarasota counties; the cities of Arcadia, Bradenton, North Port, Palmetto, Punta Gorda, Sarasota and Venice; the Town of Longboat Key; and the Englewood Water District. The Alliance is sponsoring a two-phase regional system planning and engineering study. Phase I, recently completed, involved a compilation of available data on water resources, supply infrastructure, demand projections for a 20 year planning horizon (2003-2023), conservation, and reuse. The results of this first phase showed that the collective water supplies of the region would exceed the collective demand in 2013, or 2018 if the Authority's current expansion project was included. This information was developed with the caveat that the water supply systems of the Alliance members are not all interconnected.

Phase II of the study is currently underway and is aimed at developing future water supply options for the region and criteria for evaluating and prioritizing these options. One source of potential projects will be the District's RWSP. The study is targeted for completion by the end of 2004.

3.4.5 District Funding Programs

The District provides funding assistance for water supply-related projects through several avenues.

<u>New Water Source Initiative (NWSI)</u>
NWSI is a financial incentive program initiated by the District in 1994 to help develop sustainable, non-traditional alternatives to ground-water use. The District Governing Board has budgeted $10 million annually and this amount is matched collectively by the basin boards for a total of $20 million per year. NWSI funding is currently committed through 2007. Projects are typically funded on a cost-share, 50-50 basis.

Cooperative Funding Program
Since 1987, the District's basin boards have offered funding assistance to local governments and other entities for a variety of projects deemed to benefit the water resources of the District. This program has been instrumental in promoting the development of reclaimed water systems throughout the District. Several types of water conservation projects have also received cost-share funding.

Water Supply and Resource Development (WSRD) Program
The District established the WSRD program in 2000 to provide funding for projects of regional significance on a matching, flexible basis to complement the NWSI and Cooperative Funding programs. It is anticipated that the Governing Board and basin boards will collectively contribute at least $6 million annually to this fund.

Florida Forever
The Florida Forever Act, passed in 1999, makes funding accessible to the District for land acquisition, water resource development, ecosystem restoration, and related purposes.

Facilitating Agricultural Resource Management Systems (FARMS) Program
FARMS is a cost-share reimbursement program to promote best management practices (BMPs) for agriculture in the SWUCA. Funding is provided through a partnership of the District and the Florida Department of Agriculture and Consumer Services (FDACS). Eligible projects must provide one or more resource benefits that include water quality improvement, reductions in Floridan aquifer withdrawals, and/or conservation, restoration, or augmentation of the area's water resources and ecology.

One of the priority areas for the FARMS program is the Upper Myakka River watershed. As discussed further in the natural systems chapter of this plan, excess ground water in the Flatford Swamp area of the watershed has resulted in an extensive tree die-off. Funding available through the FARMS program helps agriculturalists construct tailwater recovery systems, surface-water catchment basins and other infrastructure to recycle water and use stormwater. Two predecessor projects to the FARMS program in this area, Faulkner Farms and Pacific Tomato Growers, have resulted in a reduction in ground-water use of nearly two million gallons per day. The FARMS Program is discussed in more detail in Chapter 6 – Natural Systems.

3.5 Water Supply Issues

3.5.1 Issue: Environmental Constraints on Ground Water Supplies

Background: Since the 1980s, the District has been studying the effects of declining ground-water levels in what is now known as the Southern Water Use Caution Area (SWUCA). As noted in the Introduction section of this chapter, these declines have caused saltwater intrusion into the Floridan aquifer, reduced flows in the upper Peace River, and lowered lake levels along the Lake Wales Ridge. Of these three major resource problems, salt-water intrusion is the primary concern associated with ground-

water withdrawals in the Myakka River watershed. The District's approved schedule for establishing minimum flows and levels calls for a minimum aquifer level to be set for the Floridan aquifer in the coastal SWUCA area in 2004. The proposed level is intended to limit the inland movement of the salt water/fresh water interface over the next 50 years to minimize the number of wells at risk of water quality degradation. The proposed minimum level is a key standard in the overall SWUCA Recovery Strategy, which will guide the management of ground-water withdrawals throughout the SWUCA.

Strategy: Finalize and implement the District's SWUCA Recovery Strategy.

Actions:

- Establish minimum flows and levels in accordance with the approved schedule.
- Adopt and implement water use permitting rule enhancements as described in the SWUCA Recovery Strategy to meet future water demand while achieving established minimum flows and levels.
- Update the District's Regional Water Supply Plan every five years.
- Develop alternative water sources to meet the needs of growth, reserving limited ground water for users that have no other feasible options.
- Continue to expand water conservation programs in all use sectors.
- Expand the use of reclaimed water with an emphasis on effectively offsetting potable use, particularly the use of ground water.
- Continue the FARMS program to assist the agricultural community in making efficiency improvements and enhancing water quality.

3.5.2 Issue: Protection of the Myakka River

Background: The Myakka River has been identified in several studies over the years, including the District's RWSP, as a potential potable water source. This has sparked considerable opposition among some interest groups in the region. Concerns range from the seasonality of the river's flows to the need to understand and take into account past alterations to the hydrologic regime of the watershed. Some have advocated a prohibition on withdrawals from the river until minimum flows are established by the District. Others have called for a comprehensive study to better understand the hydrology and ecology of the river and its tributaries.

Strategy: Continue to improve knowledge of the Myakka River system and ensure that any proposals to develop surface water supplies are thoroughly assessed for potential impacts to the river's natural resources and receiving estuary.

Actions:

- Establish Minimum Flows for the Myakka River in accordance with the approved schedule.

- Seek opportunities to expand available knowledge of the river's flow regimes and natural systems.

- Ensure that water use permit applications contain adequate information to assess potential impacts and that they conform to all rule requirements.

3.5.3 Issue: Linking Land and Water Planning

Background: One of the key concerns that has arisen with growth management in Florida is that planning for water supplies is not adequately integrated with planning for land development. Over the years, various initiatives have been aimed at improving this linkage, most recently the 2002 legislation that requires local governments to prepare water supply work plans and consider the Regional Water Supply Plans of the water management districts in the development of such plans. Planning for water supply on a regional basis also can help to ensure the availability of water to meet growing demand. The District has previously funded water planning activities by the Peace River/Manasota Regional Water Supply Authority and is currently contributing to the Water Planning Alliance water supply plan (see description in this chapter).

Strategy: Enhance coordination between the District, the Peace River/Manasota Regional Water Supply Authority, and local governments.

Actions:

- Expand District outreach and technical assistance efforts to local governments to support the preparation of state-mandated water supply work plans.

- Continue regionally coordinated water supply planning efforts such as the Water Planning Alliance and implement projects and programs to ensure an adequate supply of water to meet projected needs.

- Update the District's Regional Water Supply Plan every five years.

- Seek to better interconnect water supply systems in the region to enhance reliability and efficiency.

- Implement conservation and reuse programs to reduce the need for costly water supply development projects.

Chapter 4 ~ Flood Protection

(Photo from www.tallytownredcross.com/nff.html)

A Flooded Florida Home

~ Flooding of low-lying areas is typical during summer and hurricane season.~

Chapter 4
Flood Protection

4.1 Introduction

The District's overall goal regarding flood protection is to minimize the potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood prone areas, giving preference wherever possible to non-structural surface water management methods. One of the primary concerns in watershed management is to understand the functions of the floodplain and to provide safeguards, not only from damages when flooding occurs, but also for natural systems and habitats. Floodplain management must recognize the importance of lessening the damage potential to life and property by the restoration of the natural resources and functions of the floodplains.

Approaches to flood protection/flood management must recognize flooding as a natural occurrence in the hydrologic cycle. Flood-prone lands serve several valuable functions. They provide temporary natural storage of runoff from uplands and overflow from water bodies. This helps to regulate the timing, velocities, and levels of flood discharges while recharging groundwater resources. They also help maintain water quality and provide habitat for fish and wildlife. Flood-prone lands include not only wetlands but also the less frequently flooded lands that make up the floodplain, areas of the watershed subject to over-bank flooding an average of once every 100 years. Both are important in flood mitigation by providing storage for the necessary periodic inundations.

Flooding along the Myakka River results from runoff and stream overflow, and from tidal surge in the coastal areas due to hurricanes and tropical storms. Storms that produce flooding in one area may not produce flooding in other parts of the basin. The Myakka River floodplain varies in width from less than one mile in the upper basin to more than three miles in the lower basin. Topographic relief averages 1.8 ft./mile and is greater in the upper basin than in the lower. The Myakka River may be affected by high tides for more than four miles upstream from U.S. Highway 41 and the may be affected by tides more than five miles upstream from the Venice By-Way (Hammett, et. al. 1978).

About five miles southwest of Myakka City, the Myakka River traverses about 0.5 miles of the lower Tatum Sawgrass area, a large depression about 14 square miles in size. A system of dikes and ditches was constructed to protect the area from moderate floods to allow for agricultural development. The resulting loss of storage and attenuation provided by Tatum Sawgrass has increased downstream flood peak discharges and flood heights. Additionally, both agricultural and urban development in other parts of the watershed have changed the volume and timing of runoff when compared to historical patterns.

4.1.1 Overview of Surface Water Drainage

As noted in earlier chapters, the Myakka River drainage basin consists of an approximate 600 square mile area in Manatee, Sarasota, Charlotte, and small parts of DeSoto and Hardee counties. Topographic relief within the basin varies from sea level to elevations of greater than 100 feet (above sea level) at the river's source near Myakka Head. In the vicinity where the Myakka River and Charlotte Harbor merge, topography is generally flat to gently sloping, with elevations varying from about 25 feet above sea level at the highest, to sea level at the Myakka River mouth and Charlotte Harbor.

The upland areas that the Myakka River drains are characterized by a high water-table and poor drainage due to underlying organic hardpan soils. Intermittently wet ponds dot the landscape. The water flowing in the Myakka River comes primarily from runoff. There is little evidence of artesian contributions to the river flow. The tributaries and sloughs of large streams are usually only a few feet deep.

The headwaters of the Myakka River are at about 115 feet above sea level. Myakka Head is within two miles of Horse Creek, which feeds into the Peace River. The river channel south of Myakka Head is relatively straight, and the edge of its floodplain is at the 75 foot contour. Four creeks enter the river within four miles of Myakka Head: Johnson Creek, Wingate Creek, Taylor Creek, and Young's Creek. These tributaries to the river come together with several other creeks, Coker, Long, Maple and Ogleby, to form a confluential swamp, known as Flatford Swamp.

Surface waters within the Myakka River watershed include numerous fresh and saltwater wetlands and several stream and slough systems. One of the most significant surface water features within the watershed is the confluence of seven streams to form the Flatford Swamp, which lies just upstream of State Road 70 near Myakka City in Manatee County. Other notable surface water features include Upper and Lower Myakka Lakes in the Myakka River State Park, Deer Prairie Slough/Creek in eastern Sarasota County and Big Slough Canal/Myakkahatchee Creek which begins in the southeastern part of Manatee County and flows through the City of North Port where it enters the estuarine portion of the river. Two surface water features unique to the area are Warm Mineral Springs and Little Salt Spring in North Port, which are the southernmost springs in the SWFWMD (Rosenau 1977).

Tatum Sawgrass is a 4,300 acre marsh at 16.5 feet elevation. The marsh can store the equivalent of 1.8 inches of rain over the entire upper watershed (235 square miles). It historically served to moderate the downstream effects of flooding and drought. If protected, Tatum Sawgrass could be a valuable watershed resource. The outlet of Tatum Sawgrass is through the Myakka River into Upper Myakka Lake.

Between Lower Myakka Lake and U.S. 41 two canals connect the Myakka River to coastal tributaries. Curry Creek/Blackburn Canal, the northern most, and Cow Pen Slough, a tributary of Shackett Creek, are located in the Southern Coastal CWM

Watershed. The two surface water features drain to Dona and Roberts bays. Hydrologic alteration, canal construction, causes the two streams to exchange flow with the Myakka River at times.

Throughout the watershed, drainage projects have significantly changed surface runoff patterns. Diking and ditching work in the Tatum Sawgrass area keeps the river water from slowly filtering through and dropping its nutrient load in the marsh.

Significant residential development in the Myakka River watershed is located immediately downstream of the U.S. 41 highway crossing on both sides of the river. Below U.S. 41, the river widens dramatically and is relatively shallow with a sandy bottom. Limited development occurs along the western riverbank to the Sarasota-Charlotte county line, in contrast to the eastern bank, which contains several large, fully built subdivisions. Between the Sarasota-Charlotte county line and the El Jobean Bridge (County Road 771), most of the native landscape has been replaced with bulkheads and finger canals associated with residential development. Downstream from El Jobean, the riverbanks are relatively natural as they widen into Charlotte Harbor.

4.2 Studies, Reports and Data

4.2.1 Previous Studies

There are few studies that detail flood elevations for the Myakka River watershed as the area is generally sparsely inhabited. Portions of the watershed have been studied, especially in the lower parts where more urban development has occurred. The following section provides a brief synopsis of some of the reports which have been written about the watershed.

4.2.1.1 Streamflow Studies

Bridges, W. C., 1982. *Technique for estimating magnitude and frequency of floods on natural-flow streams in Florida.* Water-Resources Investigations Report 82-4012, U. S. Geological Survey.

> A multiple linear regression analysis was used to develop the regional equations relating natural-flow streams' peak discharge to basin characteristics. The state of Florida was divided into three hydrologic regions. The significant independent variables were drainage area, channel slope, and lake area in the regions. The regression analysis technique was then applied to estimate flooding for specific recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. The Myakka River near Sarasota was one of those in the study.

Hammett, K. M., 1988. *Land use, water use, streamflow, and water-quality characteristics of the Charlotte Harbor inflow area, Florida.* Open-File Report 87- 472, U. S. Geological Survey.

The report described land use, water use, streamflow, and river water quality in the Charlotte Harbor inflow area; discussed some of the relations between land use, water use, streamflow, and river water quality; and presented potential changes in land use, water use, streamflow, and river water quality resulting from increasing growth and development. In one section, statistics of streamflows of the Myakka River were reported. A trend analysis indicated that there was no significant (increasing/decreasing) trend in Myakka River data.

Hammett, K. M., 1992. *Physical processes, salinity characteristics, and potential salinity changes due to freshwater withdrawal in the tidal Myakka River, Florida.* Water Resources Investigation Report 90-4054, U. S. Geological Survey.

This study presented the relationship between freshwater inflow, tide and salinity to demonstrate the potential effects on the system. The study was undertaken due to Sarasota County's evaluation of the Myakka River as a potential source for municipal water supply. The Myakka River is one of the three main tributaries to Charlotte Harbor. The other two tributaries are the Peace and Caloosahatchee rivers. Reducing freshwater inflow to the tidal reach of the river could alter salinity patterns in the reach, thereby affecting associated ecosystems.

Reducing freshwater inflow by five percent and maintaining minimum monthly flows would result in a 0.5-ppt line of equal salinity moving upstream an average of 0.1 miles. A ten percent diversion of freshwater would result in saltwater moving upstream an average of 0.2 miles and a maximum of 0.7 miles. Diverting 25 percent of freshwater at the upstream end of the tidal reach, which would exceed current regulatory limits, would allow the 0.5-ppt line of salinity to move upstream an average of 0.6 miles and a maximum of 1.9 miles.

Levesque, V. A. and K. M. Hammett., 1997. *Comparison of two methods for estimating discharge and nutrient loads from tidally affected reaches of the Myakka and Peace Rivers, West-Central Florida.* Open-File Report 97-118, U. S. Geological Survey.

The study presented and compared two methods: tidal-estimation and basin-ratio methods, for estimating discharge and nutrient loads from tidally affected reaches of the Myakka and Peace Rivers. The two methods resulted in similar discharge and nutrient load estimates during high-flow periods. However, during low-flow periods, there were substantial differences of the results computed by the two methods. The study recommended that short-term tidal measurement results should be used with caution, because antecedent conditions could influence the discharge and nutrient loads.

More information on streamflow in the Myakka River watershed can be found in the following documents.

Flippo, H. N. Jr., and B. F. Joyner, 1968. *Low streamflow in the Myakka River basin area in Florida.* Florida Division of Geology Report of Investigations 53.

Hammett, K. M., 1985. *Low-flow frequency analyses for streams in west-central Florida. Water-Resources Investigation Report 84-4299, U. S. Geological Survey.*

Deuver, M. J. and J. M. McCollum, 1990. *Hydrological study within Myakka River State Park.* Report to U. S. Department of Commerce/NOM. Washington D.C. 20235

4.2.1.2 Flood Studies

Hammett, K. M., J. F. Turner, Jr. and W. R. Murphy, Jr., 1978. *Magnitude and Frequency of Flooding in the Myakka River, Southwest Florida.* Water Resources Investigation Report 78-65, U. S. Geological Survey.

> The report presents the results of a flood elevation study of the Myakka River basin including analysis of the effects of diking in the lower Tatum Sawgrass area. The difference between natural and diked condition flood peak discharges and flood heights was presented to illustrate the effects of the dikes that reduce storage and increase downstream flooding. Flood peak discharges, water level elevations and flood profiles were also provided for diked conditions. The study area included the Myakka River main stem upstream from U. S. Highway 41 near Myakka Shores in Sarasota County to State Road 70 near Myakka City in Manatee County. The study area also included Tatum Sawgrass, Clay Gully and the Blackburn Canal from the Venice By-Way to the Myakka River.

Federal Emergency Management Agency, 1998. *Flood Insurance Study, City of North Port, Sarasota County, Florida*.

> This study was to investigate the existence and severity of flood hazards in the City of North Port and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. The analysis included the effects of hurricane surge in the tidal areas of the City. The major flooding sources studied in detail were the Myakka River, Big Slough Canal/Myakkahatchee Creek, and the Gulf of Mexico. Based on this analysis, the FEMA produced the Flood Insurance Rate Map (FIRM) for the City. This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood.

Sarasota County Soil Conservation District et al. 1965. *Work Plan for Big Slough Watershed, Sarasota, Manatee, DeSoto and Charlotte counties, Florida.* United States Department of Agriculture, Soil Conservation Service, Gainesville, Florida.

> The report was published prior to the development of the City of North Port but it indicates that approximately 31,600 acres of the lower portion of the watershed would be developed as an urban area. The work plan was developed primarily to benefit agricultural operations in the watershed from flood damage. The report provides a description of the Big Slough Canal/Myakkahatchee Creek watershed,

discusses the types and severity of problems in the watershed, describes the benefits to landowners within the project area, and describes the drainage improvements to be undertaken. The main problem in the area was determined to be floodwater damage to improved pasture and inability to raise crops due to frequent inundations lasting from one to four weeks. Some areas were inundated for even longer periods and water depths in flooded areas generally ranged from one to four feet. The proposed solutions were the improvement or construction of 57 miles of channels and the installation of 21 grade stabilization structures as structural measures, as well as various land management efforts to be undertaken by individual landowners.

4.2.1.3 Stormwater Master Plan Studies

Information on Stormwater Master Plans can be found in the following literature, as well as other local government stormwater master plans:

Camp, Dresser and McKee, 1992. *City of North Port, Big Slough Watershed Study and Stormwater Management Master Plan (Phase 1: Interim Report),* prepared for the City of North Port, 1992.

Camp, Dresser and McKee, 1993. *City of North Port, Big Slough Watershed Study: Phase II, Task* 2 *Final Report: Stormwater Management Master Plan,* prepared for the City of North Port, 1993.

Camp, Dresser and McKee, 1993. *City of North Port, Big Slough Watershed Study, Phase II, Task* 3 *Preliminary Design Report,* prepared for the City of North Port, 1993.

Carter and Burgess, 1996. *Charlotte County Phase I Stormwater Master Plan*, prepared for Charlotte County Government for the Port Charlotte area between the Myakka and Peace rivers.

4.2.2 Information and Additional Data

4.2.2.1 Flood Control Structures in the Watershed

The District does not either operate or maintain structures for flood management in the watershed. Along Big Slough Canal/Myakkahatchee Creek, the City of North Port has three structures for local flood control and to maintain water levels at a water treatment plant. There are no flood control structures on the Myakka River. There are two dams, however, intended to maintain minimum water levels under low flow conditions. One of the dams is located immediately south of Upper Myakka Lake within the state park and was constructed by the Civilian Conservation Corps (CCC) around 1941. The other dam is privately owned and constructed and is known as Downs' Dam. Located south of river mile 28, it is capable of retaining approximately four feet of water behind the structure (Hunter 1990, 2001). Some other structures in the watershed include the Tatum Sawgrass dikes, a dike below the C.R. 780 bridge in the Hidden River area, an earthen

weir across the southern end of the Lower Myakka Lake, a salinity barrier in Deer Prairie Slough, and various canals and drainage ditches.

4.2.2.2 Flow Measuring Stations Within the Watershed

The USGS maintains several stage and flow measuring gages within the watershed. The Water Quality chapter of this report lists these stations and their locations. Periods of record (PORs) and frequency of measurement vary among the stations. The station site at Myakka City has a POR starting in 1963 and the site near Sarasota has a POR starting in 1936. The remainder of the stations have PORs generally beginning in the 1980s.

4.2.2.3 Land Use Within FEMA's 100-Year Floodplain

The District's Geographic Information System (GIS) has delineations of the FEMA's flood zones A, B, C, D, X and velocity zones (Figure 4-1). The zone designations are explained generally below:

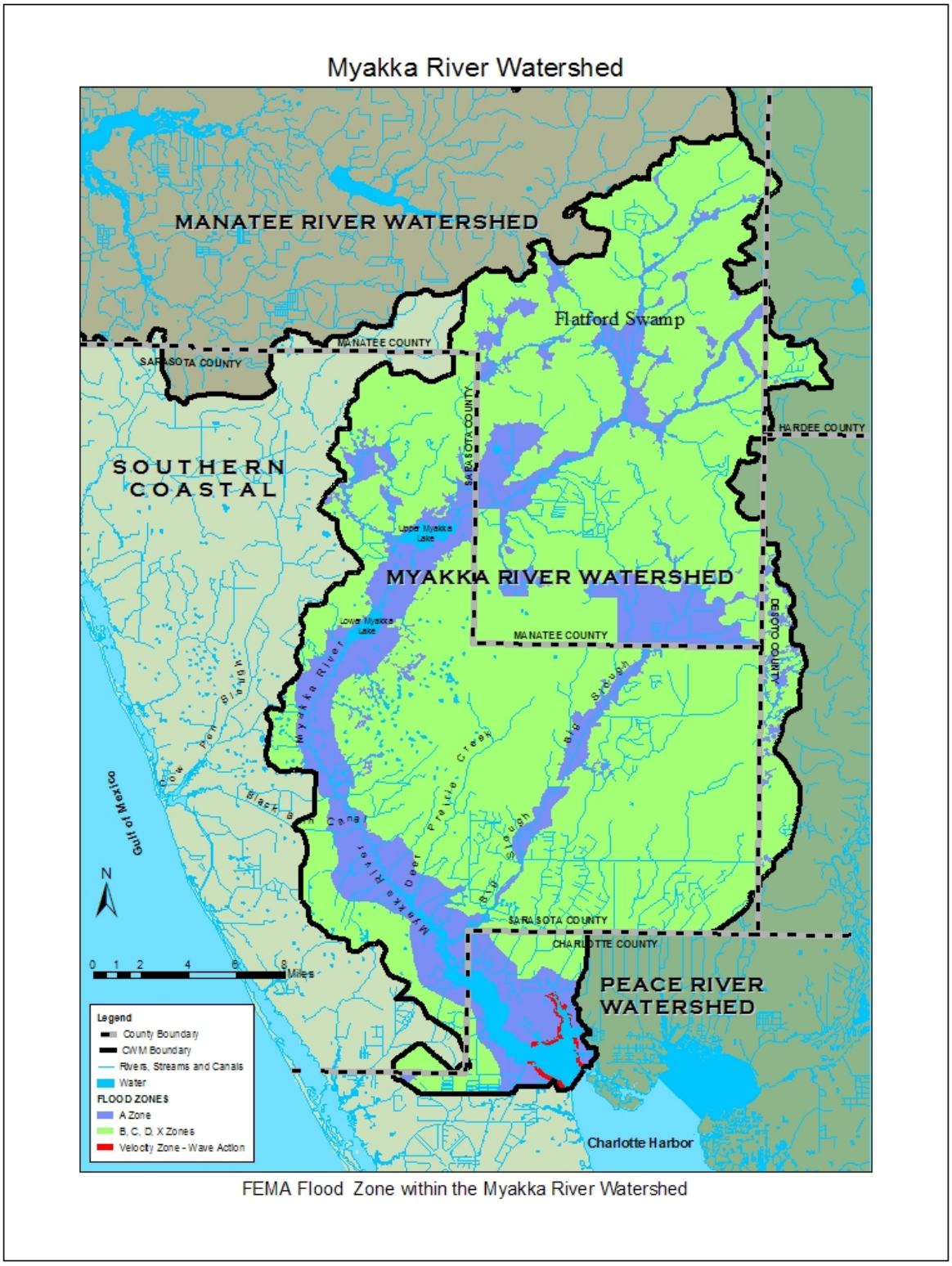
A	Various zones subject to 100-year floods. Areas that have an annual probability of flooding of 1% or greater.
B	Areas between the limits of 100-year and 500-year flood elevations Areas subject to 100-year floods with average depths less than 1 foot or where the contributing drainage basin is less than 1 square mile. Areas having an annual flood probability from 0.2% to 1%.
C, X	Areas outside the 500-year flood zone. Areas that have less than 0.2% probability of flooding.
D	Flood hazards are undetermined.

It should be noted that FEMA floodplain maps may contain inaccuracies in some cases due to topographical and hydrologic changes caused by development and natural processes. The District, along with local governments, is a cooperating technical partner with FEMA. This partnership will result in the standardization of data and the updating and digitalization of FEMA flood zone maps within the watershed. Additionally, the District is cooperatively funding the City of North Port's efforts in developing a stormwater master plan for the Big Slough Canal/Myakkahatchee Creek sub-basin.

As discussed in Chapter 2 the Myakka River watershed reflects a wide variety of land uses and conversions of natural lands as a result of residential, commercial, and agricultural development. As shown previously in Figure 2-2, roughly 40 percent of the watershed is either urban, platted or agricultural land. FEMA flood zones are shown in Figure 4-1.

4.2.2.4 District Information and Resources

The District has been involved in floodplain and flood prone area management since its establishment in 1961 as a flood control agency. Since then, the District has developed



FEMA Flood Zone within the Myakka River Watershed

Figure 4-1. FEMA Flood Zones in the Myakka River Watershed

continually stressed as the most appropriate methods to prevent or limit flood impacts. To achieve effective floodplain management, the District has undertaken a number of programs and initiatives to assist local governments and property owners in flood-prone area management.

The District cooperatively funds local government stormwater management programs. These programs consist of five components focused on collecting data, characterizing floodplains and implementing measures to help regulate development in flood prone areas. The five components are: topographic information, watershed evaluations, watershed management plans, implementation of best management practices, and database maintenance and model updates.

The District, along with several local governments in the region, is a "cooperating technical partner" with FEMA. This partnership ensures consistent data standards and has been the basis for federal cost sharing of floodplain map updates in many areas, including Sarasota County.

Data Collection

Since its establishment in 1961, the District has maintained an ongoing program for the collection and dissemination of rainfall, water level and stream flow data. The District maintains a comprehensive hydrologic conditions monitoring program and database. Conditions monitored include rainfall, evaporation, lake levels, groundwater levels, springflow, various water quality parameters, and river discharge and stage elevation. This data can be very useful for flood protection and flood forecasting activities, including the development of watershed management plans.

Floodplain Information

A number of flood profiles and floodplain delineations were completed during early 1970s. Many of these studies were used by the FEMA in the development of their Flood Insurance Rate Maps (FIRMs). These profiles and delineations provide information on river stage elevations and flood prone areas and are beneficial to local governments in regulating development adjacent to or within these areas. This effort is currently undergoing updating and revision with FEMA and the District cooperating to produce new maps.

Aerial Mapping

The District's aerial mapping program, initiated in the early 1970s, maintains an extensive inventory of aerial photography and aerial contour maps for use by local governments. These projects are funded by the Basin Boards on a cost-share basis with local governments. Aerial contour mapping has been completed for approximately 7,800 square miles of the SWFWMD. Also recently available is a complete set of digital orthophotographic quadrangles on CD-ROM. The District is currently updating its aerial photography and contour maps. Within the Myakka River watershed, in the upper Myakka River watershed (Flatford Swamp area), the District is currently conducting detailed aerial mapping and topographic analysis as part of the efforts to address hydrologic issues in this basin as indicated by abnormal tree mortality (see the discussion in Chapter 6 - Natural Systems).

Planning Assistance

The District's Planning Assistance Program was established in 1986 to provide assistance to local governments in the preparation of comprehensive plans. The District assisted each of its 98 local governments with the development of their initial plans and is currently assisting with their required periodic Evaluation and Appraisal Report (EARs) and plan updates. In addition, the District produced and distributed a technical information package to all of its local governments 1991. This information included a variety of District publications, such as the *Model Flood Management Ordinance* and a map atlas with county-scale GIS maps of wetlands, drainage basins and FEMA 100-year floodplains.

GIS Data

Since the mid-1980s, the District's Mapping and GIS Section has developed a significant database of data layers for use by District staff and local governments. Many of the District's data layers are useful for flood protection activities and have been provided to a number of local governments for use on their GIS. Such layers include drainage basin boundaries, land use/land cover, topography, and soils. Most local governments within the District have incorporated District maps or GIS data into their Comprehensive Plans.

Technical and Financial Assistance

The District and its Basin Boards have provided considerable financial and technical assistance to a number of local governments for the development and implementation of watershed analyses, watershed management plans and/or stormwater utilities. The five components used in the District's watershed management programs are explained later in this chapter. The watershed management plans produced by these programs identify existing and potential flood problem areas, recommend preventive and remedial actions and provide detailed floodplain delineations suitable for use by local governments in regulating development within these areas.

Public Education and Technical Information

The District produced and distributed its *Floodplain Facts* brochure in 1997. The brochure is part of a District-wide education effort to provide property and homebuyers with factual floodplain information and where to find such information before purchasing property. Local partners distributing these materials include municipal and county staff, Chambers of Commerce and Builders Associations. The District's *Model Flood Management Ordinance* was produced in 1982 and distributed to all local governments within the District. The document contains valuable floodplain management information for local government planners, engineers and administrators.

While the above District programs, initiatives and technical data represent a wealth of information, implementation of appropriate regulations to preclude or limit development in flood prone areas is the responsibility of local governments. Thus, the District continues to work with its local governments on flood protection related efforts and encourages local governments to incorporate appropriate measures to prevent or reduce flood hazard risks within their jurisdictions.

4.2.2.5 Flood Complaint Records

All of the counties which comprise the Myakka River basin have some system for tracking flooding complaints. Flood complaints in counties are located on a "flood-prone areas" map. The problem areas receive a priority ranking, as well as a description of the cause and extent of flooding. The District tracks and records flood complaints by section, township and range. Complaints are assessed to determine if there is a violation of District rules, and if so, actions are taken to correct the situation. Cities and local residents are also good sources of information. The Florida Department of Transportation (FDOT) keeps records of high water marks related to road design.

4.3 Regulatory Framework

Surface water management is governed by numerous rules and regulations, at various levels of government. The following discussion briefly identifies the major laws and rules governing Florida's surface water, regarding both water quantity and water quality. The District, county and city governments have standards and regulations controlling the discharge of runoff. Both the District and the Florida Department of Environmental Protection regulate dredging and filling in wetlands in accordance with Chapters 373 and 403, Florida Statutes.

4.3.1 District Regulations

Chapter 40D-4 Basis of Review, Environmental Resource Permitting (ERP), requires that post-development peak discharge rates for new development not exceed pre-development peak discharge rates for the 25-year, 24-hour event. In closed watersheds, i.e., those that do not have a surface outfall up to and including the 100-year, 24-hour event, post-development discharge volumes shall not exceed pre-development discharge volumes for the 100-year, 24-hour event. Additionally, the District also restricts floodplain encroachment. District regulations require compensating storage be provided for fill placed within the 100-year floodplain. Rules also stipulate that activities affecting floodplains and floodways will not cause adverse impacts, i.e., increase flooding. Technical guidelines further clarify how to analyze and minimize impacts from activities in the floodplain.

4.3.2 Florida Department of Environmental Protection (FDEP) Regulations

FDEP regulates dredging and placement of fill in wetlands and floodplains, for those projects that have an indirect influence on streamflow rates and flood levels, under its Environmental Resources Permitting program. FDEP has delegated this authority to SWFWMD for commercial, residential (new single family) and borrow pit projects.

4.3.3 Local Government Regulations

The watershed is primarily within the jurisdictions of Manatee, Sarasota and Charlotte counties, and the City of North Port. All have standards for stormwater management.

4.3.3.1 Manatee County

The County's adopted stormwater discharge levels of service require the rate of stormwater discharge from new development to be equal to, or less than, the rate of discharge that existed prior to development, based upon a 25-year frequency, 24-hour duration storm event. Trunk storm sewers and major drainage channels must accommodate the 25-year, 24-hour storm and internal or on-site drainage facilities on any project must accommodate the runoff from a design storm of a 10-year frequency, critical duration.

At this time, Manatee County does not have plans to develop stormwater management master plans for areas within the Myakka River watershed as residential development is limited with most land use in agriculture. The District's efforts within the upper Myakka River watershed (Flatford Swamp - see discussion in Chapter 6) will provide detailed aerial mapping and watershed analysis for most of the watershed within Manatee County.

Manatee County's comprehensive plan stipulates that conveyance structures within development shall provide a level of service based on a 10-year critical duration storm. Critical durations for small basins are typically equal to the time of concentration of the basin. The plan also prescribes design considerations for the construction of retention/detention facilities. They are to be safe, aesthetically pleasing, and provide for wildlife habitat.

In addition to the Manatee County Comprehensive Plan, the "Stormwater Management Design Manual," essentially sets forth the guidelines and methodologies to be used for the design of water conveyance systems in more detail than the comprehensive plan. The 25-year, 24-hour storm design criteria is to be followed unless the proposed system is located within a known flooding area or in a restrictive outfall setting. If these conditions exist, then the system design criteria are more stringent. For designs located in the Evers and the Lake Manatee watersheds, an additional 50 percent increase in water quality treatment is required. Also, facility ownership and maintenance guidelines are provided within the manual.

4.3.3.2 Sarasota County

The County adopted a tiered stormwater level of service in its Comprehensive Plan with buildings above or at the 100-year flood level; evacuation routes and major arterial roads above or at the 100-year flood; collector and neighborhood roads at the 25-year and ten-year flood levels, respectively; and urban and rural sites at the five-year and two-year flood levels. Stormwater quality levels of service require the retention and treatment of (at a minimum) the runoff from the first inch to one and a half inches of rainfall, depending upon whether a project is located in an area where higher design criteria are in place, such as an area adjacent to an Outstanding Florida Water (Sarasota County 1997).

Sarasota County assembled an Integrated Water Resources Management Team of its staff to coordinate tasks associated with water resources. Watershed Management Programs and model development are primary tasks for this team. The team models and develops stormwater master plans for various watersheds in the County.

4.3.3.3 Charlotte County

The County's requirements for stormwater permits are based upon determined pre-development runoff rates from a 25-year frequency, 24-hour duration rainfall event. Post-development runoff rates are not allowed to exceed these except for discharge going to tidally influenced water bodies. The County is developing a Master Stormwater Management Plan to better understand its drainage basins and how it is affected by rainfall, especially the greater Port Charlotte area between the Myakka and Peace rivers and areas south of the Peace River.

County Ordinance requires retention and treatment of the "first flush" of runoff from rainfall, varying from the first ½-inch to the first 1 ½ inches of runoff depending upon the type of treatment system, and other project specific characteristics. It is calculated separately from water quantity.

For stormwater quantity level of service (LOS), the county adopted a tiered level of service with arterial and collector roadways designed for a 25-year, 24-hour rainfall; new parking facilities design with a maximum temporary detention depth of nine inches; new development on existing platted lots (except for single-family, duplex and triplex dwelling units) is to provide for a 25-year, 24-hour rainfall; and new local residential streets designed at or above the design high water elevation resulting from a five-year, 24-hour rainfall event (Charlotte County 1997).

4.3.3.4 City of North Port

The City of North Port adopted LOS standards in its Comprehensive Plan governing stormwater management. For existing surface water management systems, a ten-year frequency, five-day duration is used. For new stormwater management systems, a 25-year, 24-hour design standard is required.

4.4 Other Resource Protection Initiatives

In addition to administering water quantity and floodplain regulations, governmental entities also contribute to flood protection through other activities. Some of these activities involve information collection, such as cataloging flood complaints by residents. Other activities that affect flood protection include stormwater management master plans, land acquisition and restoration programs, land use regulation, emergency management, and road and highway construction and maintenance.

4.4.1 Land Acquisition Programs

Several agencies have land-buying programs that operate within the watershed. These programs include the Department of Environmental Protection's Conservation and Recreational Lands (CARL) program, the Florida Forever program, as well as Florida Communities Trust and county programs. Also, the District's Save Our Rivers Program was formerly a land acquisition program that funded the protection of land in the watershed. Examples of lands acquired and/or protected via other legal means include riverine swamps and flood conveyance corridors, particularly those downstream of flood detention areas, those in areas of heavy development pressure, or those adjacent to other District or public land holdings. Usually, these land acquisition programs emphasize preservation of natural systems and the enhancement and preservation of water quality. However, since the lands purchased often include riverine areas and associated floodplains and other flood-prone wetland areas, acquisition also serves to prevent development in these natural flood storage areas. For a more detailed discussion of land acquisition within the watershed, please refer to Chapter 6 Natural Systems.

In addition to the purchase of lands for conservation and preservation of natural areas, occasionally, lands are acquired within floodplains to address repetitive losses due to flooding and to reduce future losses. Sarasota County has purchased homes in several areas of the County subject to regular flooding although no such properties are within the Myakka River watershed at this time. Most such properties were developed prior to current regulations and building practices and have always been prone to some flooding. However, some properties that did not historically flood on a regular basis are now subject to flooding, due to the increase in development and runoff within the basin. In the future, the purchase and demolition of homes within floodplains may increase in importance as few opportunities exist within urbanized areas to increase conveyance, storage and attenuation facilities.

4.4.2 Land Use Regulation

Each of the counties and municipalities in the watershed regulates land use within their boundaries in accordance with a state-approved Comprehensive Plan. These plans specify the type and amount of development allowed in any given area. As a result, the plans influence where and to what extent development will be allowed in floodplains. To participate in the National Flood Insurance Program, FEMA requires the local governments to adopt floodplain management ordinances meeting their specifications. All counties and municipalities within the watershed participate in the program.

4.4.3 Emergency Management

Many agencies and organizations are involved in emergency management and flood protection. On the Federal level they include the FEMA, the ACOE, and the National Weather Service (NWS). State agencies are the Florida Department of Community Affairs (DCA), Division of Emergency Management, the Southwest Florida Water

Management District (SWFWMD), their counterparts throughout the state, and various regional planning councils. Others include county and city governments, and the Red Cross.

Flooding requires actions such as evacuation planning and implementation (including operation of evacuation shelters and delivery of food and water), rescue operations, medical mobilization, flood control system operations, damage control and assessment, flood insurance compensation, delivery of federal aid, and repairs/replacement of damaged/destroyed infrastructure and buildings. Adequate building codes, inspections and code enforcement, along with appropriate land development regulations and comprehensive land use planning, can minimize these requirements.

Coordination with other agencies during disaster events, and also non-disaster periods, is an important component of the District's Flood Protection AOR. Coordination efforts depend on the program's pre-disaster, disaster event, and post-disaster requirements. Some flood protection efforts and projects can be acted upon with an immediate response (short-term); some projects require simple design, and permitting (mid-term); and other projects require an extensive data collection and evaluation phase, a lengthy implementation program, and process updates (Iong-term). The primary focus of the mid and long-term recovery programs is on hazard mitigation to break the cycle of recurring damages.

4.5 Flood Protection Issues

It has become increasingly apparent that flood protection is a complex process, therefore more holistic approaches to water management are being pursued at the local, state and federal levels. Natural system preservation, water supply, water quality, and flood protection considerations are being integrated in order to develop comprehensive frameworks for managing surface water systems. As a result, more information and sophisticated modeling are required to make good projections of flood levels based on the probabilistic variation of rainfall. The following sections identify issues associated with flood protection within the watershed and associated strategies and actions to address these issues.

Analysis of existing studies, available data and current governmental activities reveals several flood protection issues of concern in the Myakka River watershed. In general, impacts to floodplains as a result of development fall into two categories, including changes in storage volumes and changes in conveyance systems. Changes in storage volumes usually occur as losses of storage, generally the most common impact caused by development in the floodplain as roads and structures are built up. Changes in conveyance systems involve both increasing conveyance through the once ubiquitous practice of ditching and draining, and decreasing conveyance by encroaching into floodplains and blocking historic sheetflow, creeks, sloughs and other flow ways. Either of these types of impacts can result in increased flood levels upstream or downstream as a result of changes in the peak, timing and volume of runoff from the affected areas. To make knowledgeable decisions about what constitutes current and future water

quantity concerns and what to do about them, information must be available on the flooding characteristics of the watershed. As such, one of the primary issues concerning flood protection in the Myakka River watershed involves generation of flood estimates in those areas of the watershed with little or no flood information. In order to properly address the impacts discussed above and minimize potential future problems, stormwater management and flood protection activities need to be based on better and more accurate analysis than in the past.

4.5.1 Issue: Data Management

Background: Data management includes the collection, maintenance, update/revision and retrieval of the information required to understand the systems that influence the water resources of a watershed. Data can be used in a variety of ways to produce information that defines flood prone areas. Watershed characteristics are constantly changing, therefore, data must be updated frequently to accurately represent the current state of the watershed. The ability of the District, private consultants, Federal, State, or local governments to complete accurate flood prone area analyses is dependent upon the quality of the data available. Limitations on the collection of quality data include the cost of data acquisition, physical constraints, and lack of knowledge concerning what data is available and where it is located. Thus, a database standard should be developed so that a central repository of watershed information can be developed and updated.

Strategy: Enhance and standardize flood protection data collection and management.

Actions:

- Develop a standardized data management system that provides information regarding flood prone areas.

- Develop the data (where insufficient data exists) in formats to allow transfer and formulation of input/output data of numerical models (i.e., water quantity, water quality, ground water, natural systems).

- Update floodplain maps, including standardization and digitization.

Strategy: Collate/organize existing watershed information.

Actions:

- Update GIS database of current floodplain information for Myakka River watershed.

- Delineate boundaries of existing flood prone area studies.

- Identify the methods used, level of detail and goals of each study area and areas that were not addressed in existing studies.

- Identify areas that were not adequately addressed in existing studies.

- Check the accuracy of completed studies with the actual physical conditions of the study area.

- Identify areas of flooding impacted by storm surge.

Strategy: Perform analyses of data from rainfall stations located within the vicinity of the Myakka River watershed.

Actions:

- Perform statistical analyses of rainfall station data within the area to determine intensities, durations, and return frequencies for large events.

- Rainfall events should be matched with periods of known flooding to better define the causal factors. Once rainfall and flooding conditions has been established, a revised rainfall distribution and volume should be developed that better suits the hydrologic setting of the watershed.

4.5.2 Issue: Ownership, Responsibility, Maintenance and Operation of Flood Management Systems

Background: The existing flood management system in the watershed is a melange of natural and manmade systems. A major factor in ensuring that an acceptable level of service is provided, is to keep channels and conveyance ways clear of sediment, debris, and excessive aquatic growth. Siltation of channels decreases the cross sectional flow area while debris and aquatic growth create resistance to flow. Erosion from agricultural areas is of particular concern due to the removal of stabilizing vegetation. Under these conditions, intense storm events can generate sufficient velocities to erode the soil surface, transporting huge volumes of sediment to receiving streams and water bodies. Construction projects can create the same situation.

Strategy: Determine ownership and responsibility for flood management systems.

Actions:

- Determine who owns and is responsible for maintenance of various flood management systems.

- Develop operation and maintenance plans for the flood management systems within the Myakka River watershed. Obtain easements or ingress/egress agreements with property owners.

- Develop and implement Memoranda of Understanding (MOUs) that will define the roles of local governments and the District in terms of flood protection; that will document the local, intermediate, and regional systems within the local governments' boundaries; and that will detail the efforts required to update the existing floodplain information.

- Devise a program of training and monitoring/inspections to assist private entities or associations that have responsibility for private stormwater systems to operate and manage them in a manner which ensures that the systems function properly and meet all water quantity and quality criteria.

- Continue to support land acquisition programs within the watershed that acquire, fee simple and less-than-fee, flood prone areas for floodwater storage and attenuation.

4.5.3 Issue: Watershed Management Programs and Flood Prone Area Analysis

Background: Watershed management planning should address existing flooding problems with a focus on solutions that minimize environmental impacts, improve water quality, and prevent increased flooding. The planning process involves five major components: topographic information, watershed evaluations, watershed management plans, implementation of BMPs and database maintenance and model updates.

The methods used in flood prone area analysis vary from statistical analysis of measured physical data of past conditions to the use of mathematical algorithms in computer programs (models). Models predict a simulated response by the watershed, based upon physical data and assumptions of the watershed characteristics. The amount and quality of data used for input determines the level of detail provided for the analysis. The simulation results should represent the response of the watershed to a particular rainfall event and hydrologic setting when a sufficient level of detail is applied.

Strategy: Assist local governments in developing county-wide watershed management plans. Watershed analysis should be performed using detailed modeling protocols. This strategy will provide the development of the conveyance system inventory and proper identification of floodplains.

Actions:

- Coordinate with local governments to examine entire watersheds using flood prone area analyses.

- Encourage local governments to inventory existing drainage systems and maintain/update the inventory.

- Encourage local governments to set goals for flood protection based on an appropriate LOS policy.

- Pursue special development codes for building construction in floodplains (i.e., Fill for house pads in floodplains. Signage required for depth of flood in specific areas, etc.).

- Assist and coordinate with FEMA in updating floodplain maps for flood prone area analysis and stormwater management programs.

4.5.4 Issue: Infrastructure Management Policies, Regulation and Programs

Background: Urban development in a pristine watershed changes its runoff characteristics. Increases in peak discharge rates and runoff volumes typically occur as a watershed is developed. To counter these effects, state and county regulations dictate that the post development peak runoff rates can be no greater than the pre-development runoff rates. This is accomplished by creating attenuation basins that temporary store runoff excesses and regulate discharge from the site. However, total volumetric increases from a development site still may occur. If enough of these independent development sites exist, a cumulative impact of sufficient magnitude could be generated that increases flood levels. This is especially true if the time of concentration for the watershed is greater than 24 hours.

Use of several different strategies can help address the problem of increased runoff volumes. Analysis of various duration rainfall events for a specific return period can identify which event results in the greatest amount of flooding. Florida Department of Transportation (FDOT) regulations require a similar analysis, known as the "critical event" analysis. In addition, modification of current regulations can require more or less detention for slower or quicker release of runoff to avoid peak flows and stages in the receiving water. Reuse of storm water for irrigation purposes is potentially another method for reducing runoff volumes. If built on an appropriately large scale, the volume available in storm water reuse holding ponds could also provide flood protection.

Strategy: Reduce the impact of new land development in terms of flood protection.

Actions:

- Coordinate modeling efforts with local governments, possibly to include tailwater and upstream volume impact conditions and critical event analysis for proposed stormwater management systems.

- Promote the reuse of stormwater for non-potable water uses.

Strategy: Strengthen regulations and enforcement where necessary.

Actions:

- Ensure that design regulations are enforced. A major component of the stormwater regulation is compensation for development in flood prone areas. Efforts should be made to ensure that lands used for compensating storage are available when needed, (i.e., concurrent uses of the storage areas should not interfere with the designed flooding of the site, should be designed for flooding during extreme events, and should not increase levels of flood waters either up or down stream of the site).

- Identify basins where the establishment of basin specific criteria is appropriate and necessary. Basin specific criteria should be developed for these basins to address a variety of watershed issues.

- Encourage alternatives to impervious surfaces such as porous pavement. Benefits should be presented and incentives provided.

- Coordinate with local governments to alleviate problems associated with multiple layers of regulation, as well as duplication of effort.

- Continue to implement cooperative programs with local governments and the agricultural community to resolve water use and runoff problems in the upper Myakka watershed (Flatford Swamp).

- Develop/implement programs to measure the effectiveness of regulatory goals and performance criteria.

Strategy: Link watershed management and land use planning to minimize flood damages and the loss of natural flood storage areas.

Actions:

- Encourage local governments to establish levels of service for current (present) and targeted (build-out) conditions for the watershed's stormwater management infrastructure facilities for flood protection.

- Coordinate with FDOT and local governments on the design of roads to ensure their consistency with stormwater management master plans. Roads and associated drainage should be designed to help meet established areawide LOS standards. Signage programs, including flood elevation levels, could be developed to warn drivers of flooding conditions.

- Investigate methods to require legal disclosure of flood history and/or potential in deeds and other real estate documents.

- Determine and establish appropriate setbacks from riparian systems for structures.

- Encourage local governments to change land use plans to limit development in flood prone areas.

- Encourage conservation easements, greenways, and the efficient use of the required stormwater management storage, and placement of mitigation areas within existing flood prone areas.

4.5.5 Issue: Funding Sources For Flood Management Programs

Background: Funding mechanisms are available for surface water conveyance systems at the federal, state, regional, county and city government levels. Cooperative funding programs are available that provide assistance on projects that meet predetermined expectations. Flood hazard mitigation and special projects fall into this

category. Local governments fund stormwater projects through a variety of funding mechanisms. The primary mechanism has been through their capital improvement program for highway construction or a stormwater utility allocation program. However, a source that is typically overlooked in the watershed planning process is private entities (e.g., developers, home owners associations, etc.). Master plans typically address drainage system improvements without consideration of participation from the private sector that develops and uses the system.

New development or land alteration projects require stormwater management systems. These systems are under the jurisdiction of the local governments but are not necessarily funded, owned, maintained, or operated by the local government. As a result, conveyance systems and storage areas are constructed by a variety of entities with minimal guidance as to their interconnect function with the complete infrastructure. Therefore, well directed watershed planning and funding programs should help provide a coordinated stormwater management system that meets the expected level of service.

Strategy: Develop consistent sources of funding for the construction and maintenance of flood management systems, as well as for flood prone area acquisition for flood water storage and attenuation.

Actions:

- Alternatives to general revenue sources should be considered for funding of stormwater projects.

- Encourage the establishment of stormwater management utility fees payable by the entities that are beneficiaries of the system.

- Regional stormwater systems should be planned and funded as the upstream contributing areas develop or change.

- Encourage cooperative projects where many agencies contribute to a project developed through a watershed-wide study. Assistance could be provided for roadway improvements (FDOT, counties, cities) that tie into regional projects providing efficient stormwater quality and quantity storage, wetland mitigation, and protection of the floodplain and its function.

- Encourage and assist in the development of maintenance and operation funding programs.

- The District should participate in the local mitigation strategy to prioritize projects and programs that prevent flooding that are funded with disaster mitigation funds.

- Continue to support land acquisition programs within the watershed that acquire, fee simple and less-than-fee, flood prone areas for floodwater storage and attenuation.

4.5.6 Issue: Flood Management Awareness

Background: Public understanding of flood protection is necessary to build support for stormwater management projects or programs to protect the natural floodplain and its function. Many of the natural amenities provided in Florida are wetlands, lakes, rivers, and estuaries. The public must be made aware of the water level fluctuations of these systems along with their biological functions, and why it is important to protect them.

Strategy: Develop public education programs to inform citizens about flooding and the natural functions of floodplains and flood prone areas.

Actions:

- Educate the public on the hydrologic cycle and the watershed's response to rainfall events.
- Educate public and elected officials on the multiple benefits of protecting the natural storage and conveyance functions of floodplains.
- Clarify the roles of FEMA, the District and local governments, their responsibilities and their contributions to flood protection.
- Promote coordination and cooperation between the responsible jurisdictions on flood protection issues.

4.5.7 Issue: City of North Port Stormwater Management

Background:
The City of North Port faces singular challenges in managing its stormwater runoff, as the City is almost entirely platted, though sparsely developed. In previous decades, the City and adjacent areas in unincorporated Sarasota and Charlotte counties were subdivided by the General Development Corporation (GDC). The digging of ditches for drainage and fill to create building lots was common practice since the area was too low and wet for development otherwise. This development practice resulted in more than 55,000 lots, many of them still vacant, served by a drainage system designed to lower water tables and increase runoff rates, rather than accommodate the stormwater runoff of a particular design capacity like modern, engineered systems. This pattern of development provides little opportunity for the City to utilize modern development practices in site planning and subdivision regulation. This is compounded by the fact that these lots have vested development rights that pre-date current regulations.

In the early 1990s the District cooperatively funded a watershed evaluation to properly delineate floodplains and develop recommendations to address flooding in the Big Slough Canal/Myakkahatchee Creek watershed. In 1992 and 1993, Camp, Dresser and McKee published the *Big Slough Watershed Study* report, Phase I and Phase II respectively, to help address the issue of flooding of existing properties and future development. Some of the recommendations of the study have been or will be

implemented, others will not. For example, an updated delineation of the 100-year floodplain to correct FEMA floodplain maps has not been adopted into the City's Comprehensive Plan or Land Development Regulations.

The CDM study indicated that two thirds of the City lies within the 100-year floodplain, based upon actual flood elevations recorded during the June 1992 flood, and this area is considerably greater than the designated FEMA 100-year floodplain. The City feels that an expansion of the designated 100-year floodplain would make development financially unfeasible due to the limitations and restrictions placed upon such construction within the FEMA floodplain. A large majority of new homes built in North Port are built with funding guaranteed by Federal Housing Authority (FHA), and these federal loan programs will not lend money for construction within a FEMA floodplain. Therefore, the City decided that other alternatives to accurately delineating floodplains should be explored to allow owners to utilize their properties "while also maintaining, or enhancing, the effectiveness of the natural floodplain," (North Port 1997).

The District is currently cooperatively funding the City of North Port Watershed Plan update. This study will update model data with recent field observations, will collect streamflow data for model calibration and obtain up-to-date growth projections. Future phases of the project will include model redevelopment, evaluation of existing conditions, model calibration, LOS determination, alternatives analysis and priority project identification. In addition to this multiphased project, and using the information derived from it, FEMA will generate current digital Flood Insurance Rate Maps for the City, using a portion of the federally appropriated two million dollars for Sarasota County floodplain mapping.

The City has been involved in an acquisition program to acquire, fee simple, first tier (directly adjacent) and second tier (adjacent to first tier; one lot away from) lots adjacent to the Big Slough Canal/Myakkahatchee Creek within the City limits. This program has been successful in acquiring and eliminating development potential of the majority of the first tier lots adjacent to the creek. Efforts are on going to acquire the second tier of lots, though none have been acquired as of the time of this publishing. Also, lands along both shores of the creek have been acquired by the City using money available through the Florida Communities Trust. These lands are located within the City's Myakkahatchee Creek Environmental Park (Frank 2004).

Strategy: Work toward mitigation of the flooding problem of existing properties and implement preventive strategies to address flooding and potential of future development.

Actions:

- Continue to assist the City in its efforts to evaluate the Big Slough Canal/Myakkahatchee Creek watershed and implement priority projects to resolve the flooding situation within the watershed.

- Assist and coordinate with FEMA in updating floodplain maps for the City.

- Support the City's efforts to acquire flood prone lots adjacent to Big Slough Canal/Myakkahatchee Creek within the City limits.

- Continue to support land acquisition programs within the watershed that acquire, fee simple and less-than-fee, flood prone areas for floodwater storage and attenuation.

Chapter 5 ~ Water Quality

(Photo from National Park Service website)

Mangroves and Seagrasses

~ Estuaries are important nursery areas for many species.~

Chapter 5
Water Quality

5.1 Introduction

As one component of its Comprehensive Watershed Management (CWM) initiative, the Southwest Florida Water Management District (District), in conjunction with the Florida Department of Environmental Protection (FDEP), local governments and other interested parties, has identified and prioritized water quality issues within the Myakka River watershed, developed cost-effective strategies for addressing priority issues, and identified appropriate projects to implement those strategies.

5.1.1 Water Quality Overview

During the past century, a variety of human activities, including phosphate mining, citrus and row crop production, cattle production, and urban and suburban development, have produced increased loadings of nutrients and other pollutants to surface water bodies within the watershed. These impacts have been less severe in the Myakka River watershed than those occurring in some other regional river systems (such as the Peace River), and water quality in the Myakka River watershed is generally good overall with most tributary streams classified by FDEP as fair to good. Three areas are classified as having "fair" water quality, including Big Slough Canal/Myakkahatchee Creek, which is a Class I water body and a potable water source for the City of North Port.

Future increases in loadings of the nutrients nitrogen and phosphorus, which stimulate the growth of aquatic plants and drive the process of cultural eutrophication in surface water bodies, appear to represent the greatest potential threat to water quality in the Myakka River system, including the estuarine portion of the lower river. Cultural eutrophication refers to man-induced, versus natural, processes of nutrient enrichment leading to low dissolved oxygen in a water body causing it to be unable to support healthy populations of animal and plant life. In general, phosphorus is the nutrient that has the greatest impact in fresh water bodies (WetzeI 1983), while nitrogen is of primary concern in estuarine waters (Day et al. 1989).

Northern and eastern portions of the Myakka River watershed fall within the west central Florida phosphate mining area, where natural geologic conditions can cause phosphate concentrations in surface waters to be somewhat elevated relative to streams in other portions of the state (Odum 1953). Annual minimum phosphorus and ammonium concentrations are showing increasing trends at a long-term monitoring site located immediately south of Upper Myakka Lake in Myakka River State Park (CHEC 1999). The average total phosphorus concentration measured at the site during the period 1970-1998 was 0.39 mg/l, a value that is near the 75th percentile of Florida streams.

5.2 Studies, Reports and Data

5.2.1 Previous Studies

Extensive analyses of water quality data and summaries of water quality conditions and trends in the Myakka River watershed have been provided by Hammett (1985 and 1988), Hart (1993), Hand et al. (1996), Coastal Environmental, Inc. (1995a, 1995b), and Charlotte Harbor Environmental Center (CHEC), (December 1999). Long-term water quality monitoring has also been conducted at a number of sites in the watershed by the U.S. Geological Survey. Water quality trends at these gage sites are discussed in the following section.

The District's Surface Water Improvement and Management (SWIM) Section has implemented an estuarine water quality monitoring program for the Charlotte Harbor system, which includes monthly monitoring at four sites in the lower Myakka River and ten sites in other portions of the Harbor since January 1993. SWIM has also funded a diagnostic assessment of the Charlotte Harbor watershed, which provided estimates of average annual loadings of three pollutants (total nitrogen, total phosphorus, and total suspended solids) to major river segments for the period 1985-1991 and identification of hydrologic sub-basins and land uses contributing to those loadings (Coastal Environmental, Inc. 1995a). An additional SWIM project has provided a summary and synthesis of water quality data collected during the years 1976-1994 by the USGS, Environmental Quality Laboratory, and SWIM monitoring efforts (Coastal Environmental, Inc. 1995b). Finally, SWIM and the CHNEP have funded the collection of water quality data at numerous sites throughout the Peace River and Myakka River watersheds, starting in 1998. These data were recently analyzed by CHEC (1999).

The Charlotte Harbor SWIM Plan, prepared by the District in 1993 and updated in 2000, with input from many agencies, local governments, and citizens, covers the portion of the Charlotte Harbor watershed within the District consisting of the Myakka and Peace River watersheds and some coastal watersheds. It excludes the tidal Caloosahatchee River and areas within the South Florida Water Management District and thus does not include all of the Charlotte Harbor National Estuary Program (CHNEP) area, although the two efforts coordinate closely.

The SWIM plan describes land use in the watershed, water quality, habitat and other pertinent issues. The report goes on to discuss previous resource management activities, SWIM goals and tasks, and a list of priority projects for the preservation and restoration of Florida's second largest estuarine system. Water quality in the estuary is considered fair to good and the system is one of the most productive for recreational and commercial fishing despite significant urbanization in coastal areas and the presence of phosphate mining, chemical processing and other industrial operations in its watershed. General initiatives for the Charlotte Harbor SWIM Plan are: plan management and intergovernmental coordination; water quality protection; watershed management; habitat protection and restoration; and public education and involvement. See section 5.4.3 for further information on the Charlotte Harbor SWIM Plan.

5.2.2 Information and Additional Data

5.2.2.1 Sub-Basin Characterlzations

Myakka River at Myakka City (USGS gage 02298608)
During the period 1990-1995 the average annual total phosphorus (TP) concentration measured at this gage site exceeded 0.3 milligrams phosphorous per liter (mg P/l), greater than the 70th percentile value for Florida streams. More than 90 percent of the TP was in the form of dissolved inorganic phosphorus (DIP), which is readily available for uptake by algae and other aquatic plants (Hand et al. 1996, FDEP 2003a).

During 1990-1995 the average total nitrogen (TN) concentration was less than 1 mg nitrogen per liter (N/l) at this gage site, a value that is below the median concentration observed in Florida streams. TN concentrations have shown a decreasing trend at the site during the period 1976-1995, although annual average dissolved inorganic nitrogen (DIN) concentrations remain above levels that would limit algal growth. Conductivity has increased at the site during the 1976-1995 period, indicating increased off-site seepage of irrigation waters in the surrounding watershed (Hand et al. 1996, FDEP 2003a). U.S.G.S. gage locations are shown in Figure 5-1.

Myakka River at Sarasota (USGS gage 02298830)
During the period 1970-1998 the average annual TP concentration measured at this gage site was 0.39 mg P/l, greater than the 70th percentile value for Florida streams (Hand et al. 1996). More than 90 percent of the TP was in the form of DIP. During 1970-1998 the average Total Kjeldahl Nitrogen (TKN) concentration was 1.31 mg N/l at this gage site, a value that is just above the median concentration observed in Florida streams. TKN concentrations have shown no trend at the site during the period 1970-1998. Conductivity has increased at the site during the 1970-1998 period, indicating increased off-site seepage or irrigation waters in the surrounding watershed (Hand et al. 1996, FDEP 2003a).

Myakka River near Laurel (USGS gage 022988900)
During the period 1990-1992 the average annual TP concentration measured at this gage site was 0.34 mg P/l, exceeding the 70th percentile value among Florida streams. More than 90 percent of the total phosphorus was in the form of DIP. The average TN concentration was 1.27 mg N/l, a value that is slightly above the median concentration observed in Florida streams (Hand et al. 1996, FDEP 2003a).

Nutrient concentrations have shown no clear increasing or decreasing trends at this site during the period 1988-1992. DIP concentrations are well above levels that would be expected to limit algal growth, DIN concentrations are relatively low, and the average DIN:DIP ratio is <1, suggesting that primary production in the water column may be nitrogen-limited in this river reach. Conductivity showed a possible increasing trend (simple regression, p=0.06) at the site during the period 1988-1992, perhaps reflecting increasing discharges of groundwater to surface waters in the contributing drainage basin (Hand et al. 1996, FDEP 2003a).

Deer Prairie Slough near North Port Charlotte (USGS gage 02299160)
During the period 1997-1999 the average annual TP concentration measured at this gage site was 0.25 mg P/l (CHEC 1999), which is above the median value for Florida streams. Fifty-six percent of the total phosphorus was in the form of DIP (Hand et al. 1996, FDEP 2003a).

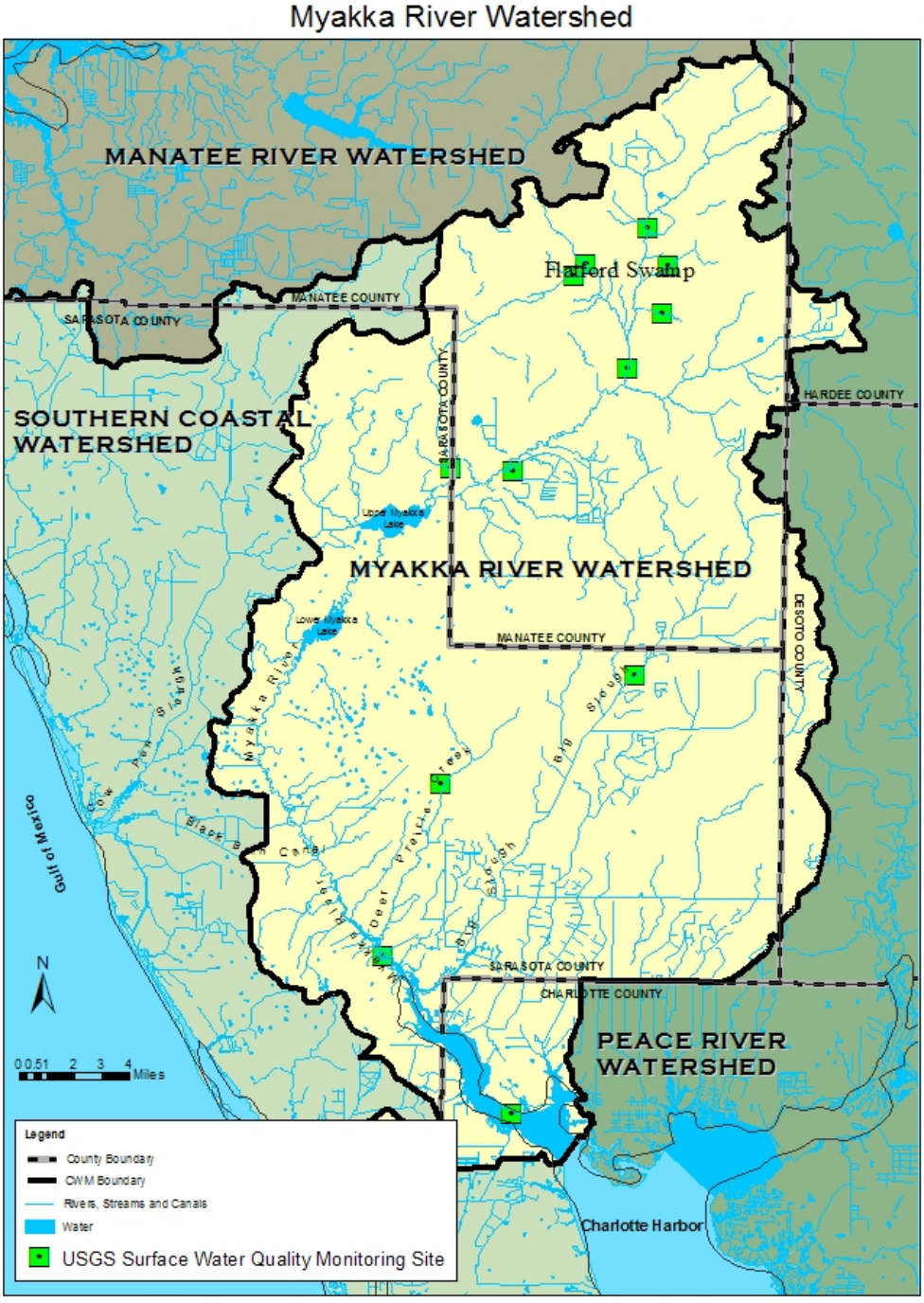
Big Slough Canal near Myakka City (USGS gage 02299410)
During the period 1997 -1999 the average annual TP concentration measured at this site was 0.36 mg P/l ,exceeding the 70th percentile value for Florida streams. On average, seventy-eight percent of the total phosphorus was in the form of DIP (Hand et al. 1996, FDEP 2003a).

Tidal Myakka River and Charlotte Harbor
The District's SWIM Section, with assistance from FDEP and Environmental Quality Laboratory, Inc., has conducted monthly monitoring of water quality conditions at three sites in the tidal Myakka River and 11 sites in other portions of Charlotte Harbor since January, 1993. Salinity conditions during the years 1993-1996 ranged from oligohaline (<5 parts per thousand (ppt)) at the most upstream Myakka River sampling site (CH-1), which is located near the mouth of Rock Creek in the river's main channel. Mesohaline conditions (ca. 10-20 ppt) prevailed at the remaining Myakka River sites, which are located at the CR-776 bridge (CH-2) and at the mouth of Tippecanoe Bay (CH-2B). Mesohaline conditions also predominated in upper Charlotte Harbor (CH-6) and along the western shoreline (CH-9B), where salinity levels are heavily influenced by freshwater inputs from the Peace and Myakka Rivers. Somewhat higher salinities (20-25 ppt) were observed along the eastern shoreline (CH-7) and in the middle Harbor (CH-9), indicating that Gulf waters are less diluted by riverine inputs in these areas. The Myakka River is a much smaller source than the Peace River of TN, TP, and TSS loadings to upper Charlotte Harbor (Coastal Environmental, Inc. 1995a, FDEP 2003a).

Average chlorophyll-a concentrations observed in the lower Myakka River during 1993-1996 ranged from <10 micrograms per liter (ug/l) at stations MY-1 and MY-3 to >12.5 ug/l at station MY-2. Maximum chlorophyll-a concentrations from 1993-1996 were greater than 10 ug/l at MY-1 (FDEP 2003a).

Minimum dissolved oxygen (DO) levels occasionally fell below 4 mg/l at the lower Myakka River monitoring sites (MY-1 and MY-2), and below 2 mg/l at the third site at the lower Myakka River, MY-3 during 1993-1996. DO concentrations below 4 mg/l are considered stressful, and concentrations below 2 mg/l are potentially lethal, to many estuarine animals (FDEP 2003a).

The above water quality data indicate that Upper Myakka Lake experiences water quality problems, primarily from high nutrient levels, seasonally low DO, and a seasonal infestation of exotic aquatic vegetation. Large numbers of migratory waterfowl also contribute to nutrients in the upper and lower lake during the winter months, corresponding to the dry season and times of little or no flow through the river. The northern and eastern portions of the Myakka watershed lie in the west-central Florida



USGS Monitoring Sites within the Myakka River Watershed

Figure 5-1. U. S. Geological Survey Gage Locations

phosphate mining area, where natural geologic conditions can cause phosphate concentrations in surface waters to be elevated compared with streams in other portions of the state. Annual minimum phosphorus and ammonium concentrations show increasing trends at a long-term monitoring site immediately south of Upper Myakka Lake in Myakka River State Park. Three permitted domestic and industrial facilities are present in the upper Myakka River watershed. However, none of these facilities discharges to surface waters. Agriculture, the major land use in the upper watershed, can be associated with nonpoint source pollutants and erosion (FDEP 2003a).

In the lower reaches of the Myakka River, generally phytoplankton production appears to vary seasonally between light limitation (due to elevated water color and low light penetration during periods of high river flow) and nitrogen limitation (due to reduced availability of DIN) in the lower Myakka River and upper Charlotte Harbor (Montgomery et al. 1991, FDEP 2003a). Long-term studies indicate that seasonal hypoxia (operationally defined as DO< 4 mg/l) has occurred in northern Charlotte Harbor since regular monitoring was initiated in 1976. The lower Myakka River watershed contains 18 permitted domestic and industrial facilities. Two of these facilities discharge less than 0.1 mgd through surface water discharges or land application of effluent. Five of the WWTPs produce reclaimed water for reuse. Urban and agricultural land uses comprise the majority of land uses in the lower watershed and can be associated with nonpoint source pollutants and erosion. (FDEP 2003a).

5.3 Regulatory Framework

The U.S. Environmental Protection Agency (EPA) and FDEP have primary responsibility for the enforcement of federal and state water quality standards within the Myakka River watershed. Under the National Pollutant Discharge Elimination System (NPDES), a federal program established by the Clean Water Act, EPA and FDEP are responsible for the issuance and enforcement of permits for pollutant discharges from regulated point and nonpoint sources. FDEP has delegated portions of the Environmental Resource Permitting Program to the Southwest Florida Water Management District.

5.3.1 Surface Water Classifications

All surface waters in the State have been classified by FDEP to define their designated uses (Chapter 62-302, Florida Administrative Code (F.A.C.)) from a legal and regulatory perspective. These designated uses include:

Class I Potable Water Supplies
Class II Shellfish Propagation or Harvesting
Class III Recreation, Propagation, and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife
Class IV Agricultural Water Supplies
Class V Navigation, Utility, and Industrial Use

Florida's administrative code provides class-specific standards for a wide variety of chemical constituents (e.g., metals, insecticides) and physical parameters (e.g., dissolved oxygen, pH) that affect water quality.

Most reaches of the Myakka River and its tributaries are designated as Class III water bodies. Exceptions include the river reach that extends south from the Manatee County line through Upper and Lower Myakka Lakes to Manhattan Farms (north line of Section 6, T39S, R20E; Class I) and Big Slough Canal/Myakkahatchee Creek (headwaters to U.S. 41; Class I). The southernmost reaches of the river, extending south from the western line of S35, T39S, R20E in Sarasota County and all of the river in Charlotte County are designated as Class II waters. The Charlotte County segment of the river falls within the Gasparilla Sound-Charlotte Harbor Aquatic Preserve and, along with the Sarasota County portion of the river, is an Outstanding Florida Water (OFW; see section 5.3.4 below). There are no Class IV or V waters present in the watershed.

5.3.2 State Water Quality Goals and Criteria

The Florida Legislature has expressed the State's water quality goals as follows:

> "It is declared to be the public policy of this State to conserve the waters of the State and to protect, maintain, and improve the quality thereof for public water supplies, for the propagation of wildlife and fish and other aquatic life, and for domestic, agricultural, industrial, recreational, and other beneficial uses and to provide that no wastes be discharged into any waters of the State without first being given the degree of treatment necessary to protect the beneficial uses of such water." (s.403.021(2), Florida Statutes (F.S.))

State water quality criteria (Chapter 62-302, F.A.C.) define minimum conditions that are legally required to be met in surface water bodies that fall within the classes. Some relevant standards for water quality in Florida include the following:

- Nutrients - in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna;

- Biological lntegrity - the Shannon-Weaver diversity index of benthic macroinvertebrates shall not be reduced to less than 75 percent of established background levels;

- Bacteriological Quality - fecal coliform bacteria shall not exceed a monthly average of 200 per 100 milliliters (ml) of sample, nor exceed 400 per 100 ml of sample in 10 percent of the samples, nor exceed 800 per 100 ml on anyone day;

- pH - shall not vary more than one unit above or below natural background of predominantly fresh waters and coastal waters; in no case shall pH be lowered to values less than 6 units (in fresh waters) or 6.5 units (in marine waters) or raised to values greater than 8.5 units;

- Dissolved Oxygen - in predominantly fresh waters, the concentration shall not be less than 5 milligrams per liter (mg/l). In predominantly marine waters, the concentration shall not average less than 5 mg/l in a 24-hour period and shall never be less than 4 mg/l;

- Biochemical Oxygen Demand - shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case shall it be great enough to produce nuisance conditions;

- Water Column Transparency - the depth of the compensation point for photosynthetic activity shall not be reduced by more than 10 percent compared to the natural background value.

In addition to these legal criteria, FDEP has also developed Chapter 62-40, F.A.C., that provides guidance to the Department, water management districts, local governments, and the private sector in the protection and improvement of water quality. These goals, policies, and criteria provide the legal and regulatory framework within which the CWM initiative's water quality restoration and protection efforts are developed.

5.3.3 Total Maximum Daily Loads (TMDLs)

The United States Environmental Protection Agency (EPA), through Section 303(d) of the Clean Water Act, requires that the state develop comprehensive lists of all polluted water bodies so that the public will have a clear picture of which waters are polluted and when they will be cleaned up. The FDEP was given the responsibility to develop procedures for listing impaired water bodies, determine the water bodies that will require a TMDL and to set TMDLs for those water bodies.

Pursuant to and compliant with the Consent Decree and settlement agreement in the Florida TMDL lawsuit, in 2001 the EPA proposed TMDLs for several segments of the Myakka River for various parameters. This information can be reviewed in detail by accessing the *Proposed Total Maximum Daily Load* report on the EPA's Region 4 website. The proposed TMDL's, along with the water quality and source assessments and continued monitoring plans for each parameter for each segment can be reviewed on the website (http://www.epa.gov/region4/water/tmdl/florida/myakka/Myakka_TMDL.pdf).

FDEP is involved in its own efforts in establishing TMDLs for those segments of the Myakka River that will remain on the Section 303(d) list of impaired waters. In the FDEP's efforts, Phase II – strategic monitoring for Group 3 basins (including the Myakka River basin) was completed in 2003. The data collected in Phase II monitoring, along with data collected through other programs, is being compiled and evaluated to develop a verified list of impaired waters for Group 3 basins (Petrus 2004). The current schedule lists completion of the development and adoption of TMDLs for the Myakka River in 2005. The basin action plan is scheduled for completion in 2006 and

implementation of the plan is scheduled for 2007 (FDEP 2004). The methodology used in developing and verifying the list of impaired waters is explained in section 5.4.7 of this Plan.

5.3.4 Outstanding Florida Water (OFW) Designations

In addition to the surface water classifications discussed above, the entire portion of the Myakka River which flows through Sarasota County and the estuarine portions of the Myakka River are designated as OFWs due to locations within the Wild and Scenic River segment and the Gasparilla Sound-Charlotte Harbor Aquatic Preserve, respectively. With OFW designation certain rules that regulate activities potentially impacting water quality become effective, including:

62-4.242(2), F.A.C., Antidegradation Permitting Requirements: Standards applying to OFW, states that no Department permit or water quality certification shall be issued within an OFW, which causes significant degradation.

62-640.770(4)(f), F.A.C., Domestic Wastewater Residuals: increases the setback distance for land application of residuals from 200 feet to 3000 feet, and requires that the setback area be vegetated.

62-312.080(3), F.A.C., Standards for Issuance or Denial of a Permit: states that no permit shall be issued for dredging or filling which significantly degrades an OFW.

Responsibility for Management and Storage of Surface Waters (MSSW) (Chapter 373, F.S.), which provides for the permitting of stormwater pretreatment ponds, has been delegated to the water management districts. The Southwest Florida Water Management District's rules (Chapter 40D-4, F.A.C.) require that developments which discharge to OFWs provide treatment of a 50 percent greater volume of stormwater runoff than is otherwise required.

5.3.5 Domestic and Industrial Point Source Discharges

As noted above, discharges from domestic and industrial point sources are regulated by EPA and FDEP under the National Pollutant Discharge Elimination System (NPDES). Point sources are defined as facilities that discharge pollutants from a discrete location (typically a pipe) or a small land area (e.g., a site used for land application of treated effluent). Domestic point sources, which may be privately or publicly owned, treat human waste and must discharge or otherwise dispose of treated effluent and sewage sludge. Industrial point sources are privately-owned facilities (e.g., phosphate mines, fertilizer production plants, food processing plants) that discharge process water and a wide variety of pollutants.

A recent search of FDEP files indicated that two major point sources (defined as discharge points whose permitted discharges exceed 0.1 million gallons of effluent per day) discharge to surface waters in the Myakka River watershed (Coastal

Environmental, Inc. 1995a). Those sources, both of which are associated with a phosphate mining facility located in Manatee County, are apparently not active at present (Tomasko 2004). In addition, a number of smaller domestic point sources that discharge effluent to the surficial aquifer via percolation ponds, spray irrigation, or land application are present in the watershed. TN, TP, and total suspended solids (TSS) contributions from these smaller sources were incorporated in the non-point source component of the estimated loadings developed by Coastal Environmental, Inc. (1995a).

5.3.6 Disposal of Domestic Wastewater Residuals, Septage and Food Establishment Sludge

Domestic residuals, septage, and food establishment sludge are land applied in the Myakka River watershed. Land application of these materials, which may contain nutrients, heavy metals and other pollutants, is regulated by U.S. EPA under 40 CFR Part 503, by FDEP under Chapter 62-640, F.A.C. and the Florida Department of Health (FDOH) under 64E-6, F.A.C. Residuals, septage and sludge are usually spread on the land in a liquid state, allowed to dry, and used as a soil supplement for certain agricultural activities. Domestic residuals disposal sites are regulated by FDEP, while disposal sites for septage and food establishment sludge are regulated by FDOH. Land application rates are based on the nitrogen content of the material. Maximum rates are typically set at 500 pounds N per acre per year. Domestic residuals disposal sites where application rates are anticipated to exceed the agricultural requirements of vegetation are required to develop dedicated site plans (DSPs), which are reviewed and approved by FDEP. DSPs and agricultural use plans (AUPs) provide records of application sites, application rates, and annual application volumes. These plans are updated annually and are filed at regional offices of FDEP and FDOH. Septage haulers are required to maintain logs providing information on the date of septage or sludge collection, collection address, and nature of the activity (e.g., residential, commercial) generating the collected material (Ayres and Associates 1994).

5.4 Other Resource Protection Initiatives

The Myakka River watershed, covering approximately 600 square miles, falls primarily within three counties (Manatee, Sarasota, and Charlotte) and includes portions of two rapidly growing metropolitan areas (North Port and Port Charlotte) that have jurisdiction over zoning and land use issues. Small portions of the watershed also fall within Hardee and DeSoto counties. A number of federal, state and regional agencies share regulatory responsibilities with local governments for activities that potentially affect the quality of surface and ground water.

5.4.1 Myakka River State Park

The State Park covers an area of 28,875 acres and includes a 12-mile reach of the Myakka River. The park has established a 7,500 acre wilderness preserve in the vicinity of Lower Myakka Lake. This area is closed to motorized vehicles and the number of

human visitors is managed to prevent over-use. Outside the wilderness preserve, FDEP's Division of State Parks provides visitor-use and service areas with facilities for camping, hiking, boating and related recreational activities.

5.4.2 Gasparilla Sound-Charlotte Harbor Aquatic Preserve

Gasparilla Sound and Charlotte Harbor Aquatic Preserve is one of 42 Aquatic Preserves statewide and one of six Aquatic Preserves in the Charlotte Harbor estuary complex. Aquatic Preserves are submerged areas of high quality that have been set aside by the State Legislature for the purpose of "being preserved in essentially natural conditions so their aesthetic, biological, & scientific values may endure for the enjoyment of future generations" (Chapter 18-20.001, F.A.C.). Gasparilla Sound-Charlotte Harbor was designated an Aquatic Preserve in 1979 and encompasses 79,168 acres. The boundary of this Preserve is the mean or ordinary high water line (high tide line) of the main water body, plus the lower reaches of the tributary streams, generally up-stream to where tidal influence stops.

Seagrass, mangroves, and salt marshes are biologically productive natural habitats that benefit from the Aquatic Preserve designation. This Aquatic Preserve supports a tremendous diversity of animal life including fish, shellfish, birds, reptiles and marine mammals such as dolphins and manatees. The Charlotte Harbor-Gasparilla Sound Aquatic Preserve provides many types of recreational and commercial uses for permanent and part-time residents and visiting tourists including recreational and commercial boating and fishing, canoeing, swimming, birding, and shelling. Aquatic Preserve management for Gasparilla Sound-Charlotte Harbor includes resource management, research, and education aimed at maintaining and enhancing existing resources. The Charlotte Harbor-Gasparilla Sound Aquatic Preserve is managed by the FDEP, Charlotte Harbor Aquatic and State Buffer Preserves field office located in Punta Gorda. A Citizen Support Organization (CSO), the Friends of the Charlotte Harbor Aquatic Preserves, assists the office in achieving Aquatic Preserve management goals. Only through wise management and active citizen participation can these exceptional resources be preserved for the enjoyment of future generations and continued fishing, boating, bird watching, and other recreational and commercial activities.

5.4.3 SWIM Program - Charlotte Harbor

The Florida Legislature, through the SWIM Act of 1987 (Chapter 87-97, Section 1-6, Laws of Florida), directed the state's water management districts to design and implement plans and programs for the improvement and management of surface waters. The SWIM legislation expressed concern for the ecological, aesthetic, recreational, and economic value of the state's water bodies, noting that degradation of surface waters is typically caused by a combination of point and non-point source pollution and by the alteration or destruction of natural systems that provide enhanced water quality as well as important wildlife habitat.

District staff, working in conjunction with the Charlotte Harbor SWIM Advisory Committee, updated the SWIM plan for the estuary and its drainage basin (including the Myakka River watershed), which was approved by FDEP and the District Governing Board in 2000. The 2000 plan focuses on four primary issues:

- Protection of water quality in the estuary and its tributaries, with emphasis on prevention of excessive nutrient enrichment;
- Protection of optimum freshwater flows to the estuary;
- Habitat protection and restoration, with emphasis on acquisition of select parcels; and
- Development of public education and public involvement programs, to inform citizens of problems affecting the water body and their potential solutions.

The SWIM plan is structured around five major themes (initiatives): program coordination; water quality protection; assurance of optimal freshwater inputs; habitat protection and restoration; and public education and involvement. A series of projects addressing those themes have been implemented, including:

- A diagnostic assessment of pollution sources in the Charlotte Harbor watershed, including the Myakka and Peace River basins (Coastal Environmental, Inc. 1995a).
- The development of resource-based freshwater inflow and salinity targets for the tidal Peace River (Coastal Environmental, Inc. 1995c).
- The design of a long-term monitoring program for the estuary and tidal portions of the Myakka and Peace Rivers (Coastal Environmental, Inc. 1995d).
- An assessment of the causes of hypoxia (DO<2 mg/l) in Charlotte Harbor (CDM, 1998).
- The mapping of seagrass status and trends in Charlotte Harbor (CHNEP 2000).
- An assessment of the causes of light attenuation in Charlotte Harbor (Dixon and Kirkpatrick 1999).

Additionally, the SWIM Program has completed several habitat restoration projects, including the Deer Prairie Slough Restoration Project to restore natural wetland hydrology to approximately 680 acres of herbaceous marsh and at least 500 acres of hydric and mesic hammock. Benefits of this project include improving and increasing wetland wildlife habitat, reducing exotic plant coverage, improving water quality to on-site and downstream locations including estuarine habitats, as well as reducing floods by increasing water storage and water retention times of on-site wetlands. A number of

additional projects, addressing the development of resource-based water quality and pollutant loading targets for the tidal Myakka and Peace Rivers and other priority issues, are currently underway.

5.4.4 Upper Myakka River Watershed (Flatford Swamp)

The Myakka River watershed encompasses almost 600 square miles. The Myakka River is the second largest source of freshwater inflow for Charlotte Harbor, which is generally viewed as one of the most productive estuaries in Southwest Florida. Because Flatford Swamp is a major surface water feature in the upper region of the Myakka River, its importance extends to the Harbor itself. Because of the many benefits provided by Flatford Swamp, such as its ability to moderate flood conditions, the cleansing properties associated with wetlands, and the habitat value of its natural systems, the Manasota Basin and Governing Boards approved the acquisition of 21,123 acres (18,512 acres fee simple; 2,611 acres less-than-fee) within the upper watershed. To date, approximately 2,357 acres of this system have been acquired by the District using state land acquisition funds (SWFWMD 2003a).

The Flatford Swamp Tree Mortality project was initiated by the District in 1997 to investigate widespread mortality of trees in Flatford Swamp and adjacent areas. In response to citizens' reports and the District's concern and responsibility, the project was launched to determine the extent, cause, and possible remediation of Flatford Swamp tree mortality. It has been concluded by forest pathology experts from the University of Florida that the pattern of tree mortality in the Flatford Swamp is not typical of insect infestation or disease, but that widespread tree mortality appeared to have resulted from hydrologic stress associated with elevated water levels and soil saturation conditions and/or extended hydroperiods.

District staff have been measuring field parameters at sixteen sites in and around the swamp on a monthly basis since December, 1997. In December 1998, water quality monitoring began on a quarterly basis, due to the tree mortality discussed above. The results from the water quality monitoring showed elevated specific conductance and major ion (sulfate and calcium) values within the major tributaries to the swamp when compared to ambient surface water systems. Elevated values for these constituents within a surface water system are traditional markers of irrigation water from deeper, more mineralized aquifers (Flannery et al. 1991). District staff continues to monitor seven surface water sites for major ions on a quarterly basis.

A few samples collected at the start of the monitoring program showed elevated levels of certain pesticide and herbicide compounds. The locations of these samples suggested that the source might have been attributed to runoff from the irrigation of agricultural areas that surround the Flatford Swamp watershed. However, as of December 2003, monitoring for pesticide/herbicide parameters ceased due to the detection of only trace amounts (well below State water quality criteria) and/or below detection levels of these compounds in the downstream-most portions of the swamp (Starks 2004).

5.4.5 Facilitating Agricultural Resource Management Systems (FARMS)

The FARMS Program is a private/public partnership between members of the agricultural community, the District and the Florida Department of Agriculture and Consumer Services (FDACS). Agricultural best management practices projects are developed and implemented on a cost-share reimbursement basis. In order to be eligible for the program, projects must provide one or more of the following: 1. water quality improvement; 2. reduction of Florida aquifer withdrawals; and/or, 3. conservation, restoration or augmentation of the area's water resources and ecology. Projects must also be consistent with the Southern Water Use Caution Area (SWUCA) Recovery Strategy, the District's Regional Water Supply Plan and furthering the District's mission in protecting water resource availability and sustainability.

The FARMS Program was originally implemented in 2002 to address agricultural irrigation runoff problems in the Shell, Prairie, and Joshua creeks watersheds and expanded to include problems in the upper Myakka River (Flatford Swamp) watershed. The program has since been implemented SWUCA-wide (8 counties), with emphasis remaining in the original target areas. In late 2003/early 2004, the Cameron Dakin Dairy, a water quality improvement project, and the McClure Property Project, which has a water quality component, were approved for FARMS funding in the upper Myakka River watershed. The FARMS Program is discussed in more detail in Chapter 6 – Natural Systems.

5.4.6 North Port Public Works Department

The City of North Port, through its Public Works Department's stormwater division, has conducted an ongoing water quality monitoring program since 1980. The program was revised in 1995 to be in compliance with NPDES requirements. The program's original objective was to sample water quality in the City's canals and Big Slough Canal/Myakkahatchee Creek.

The present program monitors water quality in Big Slough Canal/Myakkahatchee Creek, Snover Waterway and Cocoplum Waterway in order to detect non-point source discharges associated with upstream agricultural activity. The program presently includes six sampling sites at three stations selected to represent inflow and outflow points from the City. The three sites representing inflow are sampled monthly and all six sites are sampled quarterly. Physical parameters monitored include temperature, pH, alkalinity, conductivity, turbidity, salinity, and dissolved oxygen. Water quality parameters include chloride, copper, iron, sodium, nitrate, total Kjeldahl nitrogen, lead, total phosphorus, ortho-phosphate, and un-ionized ammonia. In addition, herbicide and pesticide scans are performed semi-annually at all sampling sites (Fraser et. al. 1997).

5.4.7 Manatee County Environmental Management Department Regional Ambient Monitoring Program (RAMP)

Manatee County has operated an on-going monitoring program since the late 1980s to observe ambient water quality status and trends in the freshwater reaches of the

county, including tidal freshwater areas. The program consists of fixed stations where a variety of in-situ water quality measurements are made as well as samples collected for laboratory analysis. Among the parameters measured are turbidity, color, nutrients, and similar constituents. This is a county-wide program and only two sampling stations are located within the Myakka River watershed, one at the Myakka River and Clay Gully Road which has been sampled since 1988 and another at the Myakka River and State Road 70 which was added in early 1997 (Fraser, et al. 1997).

5.4.8 Florida Department of Environmental Protection Watershed Management Program

The Watershed Management Program (WMP) is based on a five-phase cycle that rotates through Florida's basins every five years. Objectives in each phase of the cycle are outlined below:

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

The objectives of the Phase 1, Initial Basin Assessment, are to establish the general ecological health of the basin, identify waterbodies requiring restoration, protection, and/or TMDL development, identify sources of pollution, develop a coordinated monitoring plan, and develop consensus-based water resource protection and restoration goals (FDEP 2004).

The objectives of Phase 2, Coordinated Monitoring, in the basin are to supplement existing data to further characterize basin conditions, investigate areas with identified or potential water quality problems, evaluate the effectiveness of management actions, and collect data for TMDL development (FDEP 2004).

The objectives of Data Analysis and TMDL Development (Phase 3) are to document the water quality data collected in Phase 2, noting any changes in the conclusions of the initial basin assessment; provide a more detailed assessment of major pollutant sources, including the quantification of nonpoint source loadings; and conduct and document TMDLs, as needed (FDEP 2004).

The objective of Phase 4 is to work with local stakeholders to develop a Basin Management Plan to specify how established goals will be achieved by recommending management activities. The plan will establish who is responsible for implementation, developing a schedule for implementation, and note how the effectiveness of the plan will be assessed. While the plan will focus on implementation of TMDLs developed in the basin, it will also address more general watershed goals (FDEP 2004).

In Phase 5, the objective is to begin implementation of the Basin Management Plan and associated water resource protection and restoration efforts, including development and

implementation of Best Management Practices (BMPs), habitat protection and restoration activities, environmental infrastructure improvements, and issuance of permits (FDEP 2004).

The development cycle outlined above will take place within the context of Chapter 99-223, Laws of Florida, which details a specific process for listing impaired waters, determining which waters will be subjected to Total Maximum Daily Loads calculations, adopting by rule those TMDL calculations and associated allocations of pollutant loadings, and implementing the management strategies designed to reduce the loadings and enable the water body to meet water quality standards (FDEP 2004). Total Maximum Daily Loads are key components of the Watershed Management Program. The five-year cycle provides the structure for focusing resources on specific basins, identifying impaired waters, conducting targeted monitoring that will provide the data needed for model calibration and verification, and developing TMDLs for impaired waters. Basin Management Plans are a critical product of the Watershed Management Program because they provide the roadmap for implementation of the TMDLs, and will serve as basin-specific, consensus driven implementation plans. (FDEP 2004)

5.4.8.1 Status of Myakka River in TMDL Establishment

As noted in Section 5.3.3 of this document, FDEP's efforts in establishing TMDLs for those segments of the Myakka River that will remain on the Section 303(d) list of impaired waters are progressing into Phase III. Phase II – strategic monitoring for Group 3 basins (including the Myakka River basin) was completed in 2003. The data collected in Phase II monitoring, along with data collected through other programs, is being compiled and evaluated to develop a verified list of impaired waters for Group 3 basins (Petrus 2004). The current schedule lists completion of the development and adoption of TMDLs for the Myakka River in 2005. The basin action plan is scheduled for completion in 2006 and implementation of the plan is scheduled for 2007 (FDEP 2004).

5.5 Water Quality Issues

5.5.1 Issue: Cultural Eutrophication

Background: Although water quality in the Myakka River watershed generally ranges from fair to good, some water bodies (e.g., portions of Wingate Creek, Owen Creek and the Myakka River below Big Slough Canal/Myakkahatchee Creek) do not currently meet their designated uses (Hand et al. 1996). Elevated (and increasing) nutrient concentrations in the river reach within Myakka River State Park, and the periodic occurrence of algal blooms in the estuarine portion of the river above Charlotte Harbor, are also items of concern.

Because some northern and eastern portions of the watershed drain phosphate-rich lands, phosphate concentrations in surface waters are naturally somewhat elevated in these areas. Additional phosphate loadings caused by human activities, if sufficiently

large, have the potential to cause undesirable increases (e.g., from eutrophic to hypereutrophic) in the trophic state of these water bodies.

The trophic state of the estuarine portion of the Myakka River system is more strongly influenced by nitrogen than phosphorus inputs. Primary production in this area appears to vary seasonally between nitrogen-limitation (during period of low river flow) and light-limitation (during periods of high river flow and high water color). Although productivity is naturally high, the occurrence of periodic algal blooms in the lower river and near anoxia in upper Charlotte Harbor may reflect increasing anthropogenic loadings of nutrients and Biochemical Oxygen Demand (BOD).

Strategy: Develop and implement numerical water quality targets, pollutant load reduction goals (PLRGs) and site-specific restoration/management plans for water bodies and/or river segments, which currently violate State water quality standards or fail to meet designated uses. Priority was given to SWIM water bodies, of which all in the District have been established. PLRGs, where established, will provide a basis for the development of TMDLs.

Actions:

- Develop and implement a cost-effective management plan for Upper and Lower Myakka Lakes, eutrophic water bodies which exhibit elevated (and increasing) nutrient concentrations. As initial steps in this process, develop water and nutrient budgets for both lakes, conduct paleolimnological assessments to identify the lakes' historic trophic state, and perform algal bioassays to identify appropriate nutrient concentration targets.

- Develop prioritized list of other water bodies and stream reaches within the watershed that currently violate State water quality standards or fail to meet designated uses, or appear likely to do so in the future based on current water quality trends. Develop and implement resource-based water quality targets and pollutant loading goals for those water bodies and stream reaches.

5.5.2 Issue: Potential Impacts of Pesticide Use in Watershed

Background: Surface water quality in some portions of the watershed may be at risk due to pesticide application practices in the watershed. Although pesticide (insecticide and herbicide) concentrations are not intensively monitored in the Myakka River basin, a recent National Oceanic and Atmospheric Administration (NOAA) study suggested that surface water quality in the region may be at risk due to high per acre application rates of several relatively hazardous compounds (Pait et al. 1992). Among herbicides, the Charlotte Harbor watershed (including the Peace and Myakka River basins) had the highest estimated 2,4-D use (more than 330,000 pounds/year) of Gulf of Mexico estuaries, with the majority of the material applied to pasture and range lands (Pait et al. 1992). Among insecticides, endosulfan (applied to tomatoes) and chlorpyrifos (applied to citrus) made the largest contributions to the elevated risk ranking calculated for Charlotte Harbor (Pait et al. 1992). A portion of this agricultural chemical use

presumably occurred in the Myakka River drainage basin, which contains an appreciable proportion (about 15 percent) of the non-rangeland agricultural acreage that currently exists in the Charlotte Harbor watershed.

Strategy: Identify lakes and stream reaches in which pesticide concentrations in the water column or sediments currently reach levels sufficient to cause toxicological impacts in humans or wildlife. Implement best management practices to reduce pesticide concentrations in (identified or anticipated) problem areas.

Actions:

- Coordinate with the FDACS to design and implement a monitoring program to assess pesticide concentrations in surface waters and their environmental impacts in the portions of the watershed that have been identified as potentially at risk.

- Promote the use of BMPs, such as those developed by the University of Florida, Institute of Food and Agricultural Services, to reduce pesticide discharges to surface waters in impacted areas.

5.5.3 Issue: Coordination of Water Quality and Point Source Discharge Monitoring Programs

Background: Until recently, water quality monitoring has not been coordinated among the numerous federal, state, and local government agencies which conduct monitoring in the watershed.

Strategy: Develop a coordinated, watershed-wide water quality monitoring program for the Myakka River, involving all federal, state, regional, and local government agencies with monitoring responsibilities. Perform comprehensive assessment of the water quality impacts and sources of impacts. Develop and implement pollutant load reduction strategies for those sources as needed.

Actions:

- Identify historical water quality conditions, and develop appropriate water quality targets and pollutant loading goals, for Upper and Lower Myakka Lakes and identify the cause(s) of increasing DIP and DIN concentrations in this portion of the watershed.

- Ensure that reporting data from all facilities are available in a standardized electronic format to support the development of nutrient budgets and pollutant load reduction goals.

- Prepare a priority list and timeline for the development and implementation of resource based water quality targets and pollutant loading goals for significant river reaches, tributary streams, and surface water bodies within the watershed.

5.5.4 Issue: Potential Water Quality Impacts Resulting from Lands Platted Prior to Stormwater Regulations

Background: Much of the Myakka River watershed, particularly the lower watershed in the City of North Port and unincorporated areas of Charlotte County, was subdivided in previous decades. The City of North Port is almost entirely platted, though sparsely developed. Common practice was to install ditches to provide fill for building lots, lower the water table and promote stormwater runoff. This practice resulted in tens of thousands of lots with vested development rights that pre-date current stormwater treatment regulations. The increased runoff rates and lack of stormwater quality treatment requirements will likely result in water quality impacts to receiving streams once development of these lots occurs.

Strategy: Seek to implement water quality improvement components in local government Watershed Management Programs.

Actions:

- Work with local governments to develop BMPs for water quality treatment within developing areas of individual homes (i.e., swales, etc.).

- Seek opportunities to retrofit existing stormwater management systems, adding water quality treatment components.

Strategy: Continue outreach efforts regarding stormwater education and treatment options.

Actions:

- Provide materials to builders and individual homeowners exhibiting options they can implement to protect water quality of receiving streams (i.e., Florida Friendly Landscaping, proper usage of irrigation and fertilizers, etc.).

- Continue funding and assistance to local governments for programs such as Florida Yards and Neighborhoods.

Chapter 6 ~ Natural Systems

(Photo by: Brunosmi; from Community Webshots Florida Scenery webpage)

West Indian Manatees

~ The lower Myakka River and tributaries are important Manatee habitat.~

Chapter 6
Natural Systems

6.1 Introduction

Most environmental issues related to the watershed result from human impacts within the area. Portions of the Myakka River watershed have undergone conversion from forested uplands, wetlands and sloughs to a mixture of urban, agricultural, mining, and relict biological communities. This pattern of land conversion and its infrastructure elements (e.g., roads, utility systems, landfills, etc.) continue to shape conditions within natural systems in the Myakka River watershed.

As land is developed to serve human needs, the size, condition, distribution, and abundance of biological communities are altered. Declines in water quality and wildlife populations are often in direct correlation to the amount of land and type of development. As these changes and losses continue, ecosystem conditions, functions, and values are diminished. These changes are typically slow due to the incremental nature of alteration of the watershed, thus changes may go unnoticed for decades.

Past and projected land conversion throughout the watershed will continue to produce adverse impacts to natural systems as more natural lands are altered. Without prudent management of the resource, the watershed will continue to experience reductions in biological diversity, habitat quality, and the abundance and distribution of most native species. In addition, improper management will continue to fragment habitats and shrink and/or block wildlife corridors for wildlife movements. Low intensity agricultural lands that retain portions of natural areas and forest cover are valuable as buffers or wildlife corridors.

In a watershed characterized by increasing population growth and development, even areas already under the protective status of public conservation lands are at risk. Public conservation lands are often threatened by adjoining land uses and development, requests for high intensity and consumptive uses of natural resources, recreational uses, and proposals to construct infrastructure features such as utility lines, roads, etc.

An extensive tree die-off has spread from the Flatford Swamp into the Myakka River State Park and is an example of how conservation lands may be impacted by activities nearby. Without limitations and prohibitions on uses incompatible with natural resource protection, and renewed support and actions to protect their conservation status and value, natural resources within public lands may be threatened.

In the Myakka River watershed, water supply development and management can have pronounced impacts on natural systems. Surface water and groundwater supply development within the Southern Water Use Caution Area have the potential to adversely affect surface water and ground water systems. Water diversions,

impoundments, aquifer and water table withdrawals, and otherwise removing significantly large volumes of water from the same hydrologic system that supports all water-dependent natural systems and their associated living resources (flora and fauna) can have pronounced effects on natural systems.

6.1.1 Overview of the River Area

The Myakka River originates in marshes near Myakka Head and flows approximately 66 miles in a southerly direction, through Manatee, Sarasota, and Charlotte counties to empty into Charlotte Harbor and the Gulf of Mexico. The approximately 34-mile segment of the river within Sarasota County, from County Road 780 to the Sarasota-Charlotte County line, is designated as a Florida Wild and Scenic River and Outstanding Florida Water (OFW).

In the upper reaches of the river near Myakka Head in Manatee County, the river consists of a very narrow channel during the dry season and an undefined channel during the wet season. Mesic flatwoods, a habitat type that is typically used for native range is dominant in the watershed. The wetlands adjacent to the river are mixed hardwoods dominated by bays, oaks and pop ash with a fern understory.

Wingate Creek joins the Myakka River at river mile 60 and the Flatford Swamp located below river mile 59 and north of State Road 70. The first of four large topographic, depressional areas within the watershed, Flatford Swamp is formed from the confluence of seven different tributaries: the Myakka River, Wingate Creek, Ogleby Creek, Long Creek, Maple Creek, Young's Creek, and Taylor Creek. Immediately below Flatford Swamp, the river runs through pop ash swamp and marsh habitats.

At Myakka City, some channelization and alteration of the river has occurred. Below Myakka City, at river mile 52, there is a transition from marsh and hardwood swamp to cabbage palm, live oak and laurel oak hammock. This vegetation remains the dominant association for the remainder of the river to the estuarine portions where salt marsh habitat is associated with Charlotte Harbor. Adjacent land uses in the segment of the river south of Myakka City are primarily agricultural and rural residential.

At river mile 43, just above Myakka River State Park, the river channel splits into Clay Gully and the Myakka River. Both watercourses run into Upper Myakka Lake. Before entering the state park, about one-half mile of the Myakka River flows through the southeastern part of Tatum Sawgrass marsh. This 4,300-acre marsh is the second of the four natural depressions within the Myakka River watershed. A series of dikes were constructed around 1974 to divert water away from the marsh to allow its conversion to agricultural land. These dikes have reduced the water storage capacity of the marsh and increased flood stages downstream.

Twelve miles of the river are within the boundaries of the state park. However, much of the river lies within public conservation lands and is therefore protected from development. The dominant water features of the river in the park are Upper Myakka

and Lower Myakka Lakes, the remaining two of the four major topographic depressions along the river. Upper Myakka Lake experiences water quality problems, primarily from high nutrient levels, seasonally low dissolved oxygen, and a seasonal infestation of exotic aquatic vegetation. Large numbers of migratory waterfowl also contribute to nutrients in the lakes as they typically are in the area during the winter months, corresponding to the dry season and times of little or no flow through the river. At the southern end of Upper Myakka Lake there is a weir that was built by the Civilian Conservation Corps to maintain the water level in the lake. However, in the 1970s, culverts were installed to bypass this weir and allow flow to the river.

Down river from Upper Myakka Lake, the river flows through a large marsh area known as Big Flats. Originally a secondary watercourse from Upper Myakka Lake passed through Vanderipe Slough. However, this was blocked by a dike constructed near the lake in the 1930s and 1940s. Below State Road 72, the river enters the Myakka River State Park Wilderness Preserve. At this point the hammock closes in on the river channel for a short reach before again opening into marshes at the northern end of Lower Myakka Lake. Down river from Lower Myakka Lake, the hammock again closes in on the river channel. At river mile 28, a private dam known locally as Downs' Dam, has been constructed across the river. The river channel is undisturbed from this point to approximately river mile 23.

Down river of Downs' Dam, the river channel is deeply incised, meandering and bordered by hardwood hammock. At several locations, the river flows through higher and drier land, with pine-palmetto flatwoods extending to the river's edge, creating a number of bluffs along this river segment. The outside edges of many meanders display evidence of erosion (cutbanks), with sand bars (point bars) accreting on the inner edges of the meanders. These are natural physical processes. Much of the river bottom below Downs' Dam consists of hard limestone, and limestone outcroppings along the river banks occur in many places. The bottom and banks in many places also are covered by relict marine shells.

The first residential development along the river is located at river mile 23. From this point to 1-75, at river mile 19.5, there are a number of homes along the banks. Below I-75 there are only a few homes, the Snook Haven Fish Camp, and Ramblers' Rest Resort. From Ramblers' Rest Resort south to U.S. 41, along the west shore of the river, a large lot subdivision (Myakka River Trails) has been developed. Boat docks and single family homes are visible along this stretch of the river. Downstream of U.S. 41, both shorelines of the river have been partially developed. In this river area to the Sarasota-Charlotte County line, the river widens and is relatively shallow with a sandy bottom. Two small mangrove islands in this area are the sites of bird rookeries. Limited development exists along the western bank of the river down to the county line. This contrasts with the eastern bank, which contains several large, fully-developed subdivisions. Between the county line and the El Jobean Bridge (County Road 771), most of the native vegetation has been replaced with bulkheads and finger canals associated with residential development.

Beginning just downstream from Snook Haven, the brackish water influence on riverbank vegetation is evidenced by the growth of leather fern and other halophytic plants. Mangroves are found growing as far upstream as the mouth of Deer Prairie Creek (Slough). Tidal marshes and mangroves gradually become more extensive from this point down river towards Charlotte Harbor. Down river from El Jobean, the riverbanks are relatively natural as they widen into Charlotte Harbor (Hunter 1990, 2001). Three unique features in the watershed include Deep Hole, a deep karst feature in the Lower Myakka Lake, Warm Mineral Springs and Little Salt Springs, both important archaeological sites. Also, the warm waters issuing from Warm Mineral Springs make up critical West Indian Manatee habitat.

The downstream reaches of the Myakka River are experiencing habitat alterations and eutrophication pressures. The Myakka River is typically regarded as pristine. However, natural shoreline has been converted to hardened shoreline fairly extensively in the watershed. The cumulative length of tidal shoreline that has been converted to seawall is equivalent to the length of one river bank, from the Harbor to the furthest upstream reaches that are tidally influenced. Alterations also include invasion by exotic plant species such as Brazilian pepper (Schinus terebinthifolius). These changes in shoreline and wetland quality reduce riverine primary production, reduce wetland area/edge ratios, and reduce the natural filtration properties of wetlands.

6.2 Studies, Reports and Data

6.2.1 Previous Studies

The Myakka River and the associated natural systems within its watershed have been described in a variety of publications including agency project assessments, land acquisition reports, general references, government planning reports, ecological assessments and private consultant reports. Many of these publications cover only select areas of the watershed and limited sections of the River or its tributaries. Conditions, problems and issues raised in many of these reports are similar and are often applicable to most areas within the watershed. However, few reports treat the entire watershed and natural systems issues in an integrated or comprehensive manner. Information is often project specific and limited in scope, time frame and locality.

As part of the District's evaluation and selection process for lands considered for acquisition, resource evaluation reports for lands within portions of the watershed have been prepared to assess water resources and environmental conditions in light of acquisition criteria. There have been numerous resource evaluations performed on properties within the Myakka River watershed. It should be noted that many properties undergo changes in boundaries and size between initial evaluations and final acquisition, but the ecological characterizations generally remain consistent.

Also, land use and management plans are required to be developed for properties acquired by public agencies. The District prepares these plans for lands that it acquires and manages. For lands acquired by the District but managed by another agency, management plans typically are prepared by the managing agency. Land use and management plans contain extensive information regarding the acquired property and the watershed in general.

In addition to the resource evaluations and management plans mentioned above, a variety of agencies, local governments, and private groups have generated reports regarding the natural resources of the Myakka River and the Charlotte Harbor area. A few of these reports are described below.

SWFWMD, 2000. *Charlotte Harbor SWIM Plan Update*.

> This report was prepared by District staff in 1993 and updated in 2000, with input from many agencies, local governments, and citizens. The report covers the portion of the Charlotte Harbor watershed within the District consisting of the Myakka and Peace River watersheds and some coastal watersheds. It excludes the tidal Caloosahatchee River and areas within the South Florida Water Management District and thus does not include all of the Charlotte Harbor National Estuary Program (NEP) area, although the two efforts coordinate closely.
>
> The SWIM plan describes land use in the watershed, water quality, habitat and other pertinent issues. The report goes on to discuss previous resource management activities, SWIM goals and tasks, and a list of priority projects for the preservation and restoration of Florida's second largest estuarine system. Water quality in the estuary is considered fair to good and the system is one of the most productive for recreational and commercial fishing despite significant urbanization in coastal areas and the presence of phosphate mining, chemical processing and other industrial operations in its watershed. General initiatives for the Charlotte Harbor SWIM Plan are: plan management and intergovernmental coordination; water quality protection; watershed management; habitat protection and restoration; and public education and involvement.

CH2M Hill, February 1988. *Technical Report No.2, Hydroecology* of *Wetlands on the Ringling-MacArthur Reserve, Volume I: Technical Report,* Sarasota County, Sarasota, Florida.

CH2M Hill, December 1988. *Technical Report No.1, Floral Composition* of *Major Vegetation Zones* of *Wetlands on the Ringling-MacArthur Reserve,* Sarasota County, Sarasota, Florida.

> These two reports were published as part of the assessment of the Ringling-MacArthur Reserve (now known as the T. Mabry Carlton, Jr. Memorial Reserve) for Sarasota County's water supply development. They examine and describe onsite

wetlands, their vegetation, their hydrologic regimes, impacts of well field development on wetlands and the surface water table, and monitoring and management strategies.

Coastal Environmental, 1998. *Tree Mortality Assessment of the Upper Myakka River Watershed*, Coastal Environmental for the Southwest Florida Water Management District.

The resulting report from the investigation into the extent, cause(s), and possible remediation of the tree die-off in the upper Myakka River watershed. The study found that there has been an increasing trend in flow from the Flatford Swamp area upstream of S.R. 70; annual low flows at the S.R. 70 gauge have almost tripled since the period 1985-88; historical rainfall data for 1957 to 1996 do not show any trends; and there has been an overall increasing trend in the ratio of flow to rain from 1978 to 1996.

Evidence indicates that the primary cause of the tree die-off and other changes in the upper Myakka River watershed are due to hydrologic stress related to either higher seasonal high water elevations, longer seasonal hydroperiods, or both. Increased baseflow contributions from groundwater used for agricultural irrigation are indicated by water quality analysis. Since elevated groundwater levels seem to prevent or reduce the natural dry season water levels, upland trees and the swamp have remained too wet for too long and the system is changing.

Post, Buckley, Schuh & Jernigan (PBS&J) 1999. *Trend Analysis of Tree Mortality in the Upper Myakka River Watershed*, PBS&J for the Southwest Florida Water Management District.

An analysis performed to provide a more accurate and contemporary assessment of tree mortality in an expanded study area than that of the 1998 Coastal Environmental report. The assessment utilized more consistent sources of aerial photography and more proficient and controlled methodology for aerial photo-interpretation and digital mapping. The original study area was also expanded to areas downstream of Flatford Swamp, including the Crowley Nature Center and portions of the Myakka River State Park.

The Myakka River watershed comprises a large portion of the Charlotte Harbor National Estuary Program (CHNEP) study area. The CHNEP prepared several technical documents, as well as publications targeting the general public, that address the Myakka River watershed, either generally with regard to the harbor's watershed or as an individual component watershed itself. Publications concerning the CHNEP study area and the Myakka River watershed include the following.

Daltry, W. E. and Burr, D. Y., 1998. *Charlotte Harbor National Estuary Program Base Programs Analysis Volume 1*, Southwest Florida Regional Planning Council for the Charlotte Harbor NEP.

This document provides a description of the existing laws, policies, and resource management structures in the greater Charlotte Harbor watershed. The document provides a brief overview of the watershed's setting, describes the various relevant governance structures from the federal to the local level, and describes priority problems in the watershed regarding hydrologic alterations, water quality degradation, fish and wildlife habitat loss, and land use and land management.

CHNEP, 1998. *The Story of the Greater Charlotte Harbor Watershed*.

This document served as the "State of the Harbor" report for the CHNEP Management Conference and the public. It describes the historic and current condition of the Harbor and the activities both supported by and affecting the Harbor and its watershed.

CHNEP, 1998. *Framework for Action*.

This document was developed by the Management Conference as a conveyance of the Program's Quantifiable Objectives and Actions Plans that would be the framework of the Conservation and Management Plan.

CHNEP, 1999. *Synthesis of Existing Information*.

This is a technical publication characterizing the water quality, hydrologic alteration and fish and wildlife habitat in the greater Charlotte Harbor watershed.

CHNEP, 2000. *Committing to Our Future, Volume 1, Comprehensive Conservation and Management Plan for the Greater Charlotte Harbor Watershed*.

This publication is the volume of the Comprehensive Conservation and Management Plan that describes the management conference, the watershed and its economics, land uses and its priority problems. It explains the region and its organizational network with regard to watershed management. It describes the CHNEP's early action projects, its quantifiable objectives, priority actions and related projects and its public education and outreach. It also describes the Program's governance, implementation, and finances.

CHNEP, 2000. *Committing to Our Future, Volume 2, Preliminary Action Plans for the Greater Charlotte Harbor Watershed*.

This publication is the volume of the Comprehensive Conservation and Management Plan that describes the preliminary action plans that will address the quantifiable objectives, and ultimately the three priority problems embraced by the Program. Action plans are presented on a component watershed-by-component watershed basis. Therefore, problems, objectives and action plans regarding the Myakka River watershed are considered as such. The document also assigns responsibility of the action plans to the appropriate entities.

The CHNEP priority problems and goals are discussed in more detail later in this document.

Florida Department of Natural Resources, 1989. *Florida Rivers Assessment.*

> Prepared as a cooperative, multi-jurisdictional process involving a wide range of public agencies and private organizations, the Florida Rivers Assessment is an objective, systematic inventory of the existing information on natural, cultural, and recreational values along major Florida rivers. Additionally, in each of the individual river assessments (50 in total), the report identifies needs and opportunities for conserving and managing the resources of Florida's river ecosystems. Map and data files were incorporated into a geographic information system (GIS) for data analysis, data maintenance and update. For the Myakka River, the report includes general descriptive information on the river system, as well as inventory findings on water quality, biological resources, general land use, and archaeological and historical resources. Management needs identified include additional water quality monitoring, evaluation of areas for designation as manatee zones, control of feral animal populations and exotic (aquatic) weeds, and protection of wildlife, especially birds.

Florida Game and Fresh Water Fish Commission, 1994. *Closing the Gaps in Florida's Wildlife Habitat Conservation System*.

> This landmark technical report presents results to identify lands in Florida that need to be conserved to protect long-term habitat needs for rare wildlife populations and other components of biological diversity. Maps and analyses provided in the report are intended for use by decision makers involved in public land acquisition, land-use planning and development regulation.
>
> In the southwest Florida region, and in particular for the Myakka River watershed, the report identifies several "hot spots" of biological resources and rare species occurrence records. Major concentrations of these spots occur in the Flatford Swamp, areas within the District's MacArthur Tract and Sarasota County's Carlton Tract, the area south of SR 776 along Charlotte Harbor, the estuarine portions of the river, and areas of southeastern Manatee and eastern Sarasota counties.

Hunter Services, Inc., 1990. *Myakka Wild and Scenic River Management Plan, Florida Department of Natural Resources and the Myakka River Management Coordinating Council.*

> This report is the result of a long effort that began in the mid to late 1970s which recognized that the Myakka River was Sarasota County's only river and that it possessed abundant natural resources. In 1978, the National Park Service began to study the Myakka for inclusion in the National Wild and Scenic Rivers System. The final study recommended that the 12 miles of the river within the state park be included as a state administered component of the National Wild and Scenic River

System, that additional segments of the river be designated as components of the national system if state and local efforts could provide permanent protection of the corridor, and that a Myakka River commission be formed to coordinate conservation efforts. In response to significant local support, the Florida Legislature designated the approximately 34-mile segment of the river in Sarasota County as a Florida Wild and Scenic River in Section 258.501, Florida Statutes. To date, however, the Myakka River is not a part of the national program.

The Myakka River Management Coordinating Council, an oversight advisory council, has produced this management plan, which provides an overall resource evaluation of the watershed, a river management program, and implementation strategies. The adoption of the Myakka River Protection Zone Agreement, which is an intergovernmental agreement among the Florida Department of Environmental Protection, the Florida Department of Community Affairs, and Sarasota County is the implementation tool based upon the recommendations of the management plan. Management efforts within a 220-foot buffer zone landward of wetlands bordering the Wild and Scenic portion of river include more stringent development review criteria and performance standards than required of development outside the protection area, removal of exotic plant species, prohibition of removal of wetland vegetation along the river (with minimal exemptions), and other actions. The *Myakka Wild and Scenic River Management Plan* has been updated. The draft of the revised plan is under state review at the time of this publishing.

Layne, James N., Jerre A. Stallcup, Glen E. Wolfman, Melinda N. McCauley, and David J. Worley, 1977. *Fish and Wildlife Inventory of the Seven County Region Included in the Central Florida Phosphate Industry Areawide Environmental Impact Study,* Archbold Biological Station for the U.S. Fish and Wildlife Service.

Prepared by members of the scientific staff at the Archbold Biological Research Station (Lake Placid, Florida), this two-volume report plus appendices, is a comprehensive inventory of fish and wildlife resources within a seven-county area including Charlotte, Manatee and Sarasota counties. The inventory compiles available data from a variety of sources including: primary literature (e.g., journals, books), agency reports, regional surveys, consultant and conservation organization reports, museum records and specimens, and interviews with local and regional researchers. The information is organized and analyzed to provide an accurate list of species known to occur in the region and the distribution, habitats, and population levels for each species. County-by-county wildlife occurrences are tabulated. Annotated species accounts give additional information on life-histories and living requirements.

Wang, J.C.S. and Edward C. Raney, 1971. *Charlotte Harbor Estuarine Studies - Distribution and Fluctuation in the Fish fauna* of *the Charlotte Harbor Estuary, Florida.* Mote Marine Laboratory, Sarasota, Florida.

This report describes the result of a survey that covered approximately 120,000 acres of Charlotte Harbor and adjacent waters. Primary sampling methods were by trawl net and occasionally by seine net and collections came from 38 sampling stations. The report provides a listing of the species collected, the number of individuals, the size (length) of individuals collected, monthly length-frequency distribution of major species, water conditions (temperature and salinity), and some other information. Results of the survey indicated that anchovies of several species were the dominant fish in the harbor along with pinfish, silver perch, silver jennies, and seatrout. The estuarine portions of the Myakka River were very productive for euryhaline species (those adapted to a wide range of salinities) and juveniles of many species.

Winchester, Brian H., CH2M Hill, 1986. *Recommendations for the Protection of Ecological Resources on the Ringling-MacArthur Reserve,* Sarasota County, Sarasota.

This report looked at the environmental impacts of groundwater development at Sarasota County's Ringling-MacArthur Reserve (T. Mabry Carlton, Jr. Memorial Reserve). The report looks at impacts of groundwater withdrawals and impacts associated with facility siting, fire management, forestry and cattle grazing. The report provides recommendations for environmental protection and minimization of impacts.

6.2.2 Additional Information and Data

In addition to the information available in the publications described in the Literature Review Section, other information in the form of maps, aerial photographs, GIS data bases, consultant reports, model analyses, monitoring records, and field observations is available from the following sources.

6.2.2.1 Southwest Florida Water Management District

The following data resources are maintained by the District and are available upon request:

- Geographic Information System, including regional land use and land cover, soils, hydrography, topography, groundwater recharge potential.
- Aerial photographs, maps with contours (land elevations).
- Surface water and groundwater levels (hydrologic data base), monthly values for lakes, select wetlands (e.g., marshes, swamps), rivers and streams (stage elevation and discharge values).
- Regional wetland monitoring system (select wetland stations: qualitative and quantitative vegetation data; general wildlife observations).

- Consultant reports submitted as part of permit conditions (e.g., wetlands monitoring for water levels, hydroperiods, vegetation composition and abundance, and wildlife use).

- Surface Water Improvement and Management (SWIM) Program: research studies, restoration sites progress reports and inventories, water quality monitoring and model analyses, consultant reports, etc.

6.2.2.2 Florida Department of Environmental Protection

Florida Natural Areas Inventory (FNAI)
Site-specific records of floral and faunal occurrences including listed species records, assessment of local and regional importance; part of the Natural Heritage Program; information regularly updated.

Division of Recreation and Parks
Myakka River Monitoring: the Myakka River Biologist makes regular field surveys along the river for bird and wildlife counts, river conditions, and general observations.

6.2.2.3 Florida Fish and Wildlife Conservation Commission (FFWCC)

Information maintained and provided by the FFWCC includes the following:

- Game species inventories, Fisheries Reports (population estimates).

- Wading Bird Atlas (inventory of rookeries).

- Non-Game Species Program (species inventories, listed species information, eagle nests).

- Florida Breeding Bird Atlas (all species): Extensive surveys to confirm breeding status in all counties of the state (at various levels). Data collected and compiled at the U.S. 7.5 Minute Quadrangle Map level.

6.2.2.4 U.S. Fish and Wildlife Service

National Wetlands Inventory (wetland map), classification and acreages.

6.2.2.5 Miscellaneous

Audubon Society Christmas Bird Counts (published in: American Birds).

6.3 Regulatory Framework

Section 258.501, F.S., "Myakka River Wild and Scenic Designation and Preservation Act," designates the 34-mile segment of the Myakka River within Sarasota County as a

Florida Wild and Scenic River and directs the Florida Department of Environmental Protection (FDEP) and the Florida Department of Community Affairs to develop performance standards and guidelines to review and monitor the regulation of activities in the protection zone by Sarasota County. The statute requires the development of a management plan (described above) and allows the FDEP to adopt rules to regulate activities within the river area that would have adverse impacts on resource values as adopted by the coordinating council within the river area. Chapter 62D-15, Florida Administrative Code (F.A.C.), "Myakka River Wild and Scenic River Rule," is the FDEP rule, based upon the authority provided by Section 258.501, F.S., which delineates regulatory responsibility and jurisdiction, provides for permits, prohibitions, exemptions and regulated activities, and provides for enforcement and penalties.

The "State-Local Agreement for Administering the Myakka River Wild and Scenic; River Protection Zone" is the implementation mechanism of the management activities developed for the Myakka Wild and Scenic River Management Plan described above. The intergovernmental agreement, adopted in December 1997, states that Sarasota County, having jurisdiction over land use regulation, will amend the Goals, Objectives, and Policies of its Comprehensive Plan, Apoxsee, and its Land Development Regulations to implement the management plan for the protection zone within one year of the adoption of the agreement. The agreement sets forth the respective responsibilities of the signatories. In December 1998, the Sarasota County Board of County Commissioners adopted the "Myakka River Protection Plan" to provide direction for the process of amending the zoning ordinance. Zoning ordinance amendments regarding the Myakka River Protection Zone were adopted in 2003.

6.4 Other Resource Protection Initiatives

In addition to the various federal, state and local regulatory programs that attempt to provide protection to the natural resources of the Myakka River watershed, several other initiatives (most of them of recent vintage) have emerged; and they are attempting to enhance protection and management of the watershed's natural resources by broadening, improving, developing and integrating restoration, management and protection options.

6.4.1 Land Acquisition

Natural, undeveloped, and open lands are acquired for a variety of public purposes by many different agencies, from the federal level to the local level. Within the Myakka River watershed, a large number of properties have been acquired in order to protect and preserve the river and its associated ecosystems, to provide for recreation, to provide for water supply and other public facilities, to protect and improve water quality, to prevent flooding, and to provide for habitat and wildlife protection. Although there are no federal lands within the watershed, Sarasota County, the District and the State have acquired major tracts of land for various conservation and other considerations.

Together, state and local governments have protected over 100,000 acres in the Myakka River watershed. Land acquisition may occur in fee simple where the property is purchased outright, or in some form of less-than-fee simple such as the purchase of development rights, conservation easements, or other land use restrictions which limit the "bundle" of property rights generally associated with ownership of property. This allows for continued private ownership and limited use of the property with agreement to maintain its resource values.

6.4.1.1 Florida Forever

The Florida Forever Act, passed in 1999, provides for the issuance of up to $3 billion in bonds over a ten-year period, to be used for land acquisition (including less-than-fee purchases), water resource development, stormwater management, water body restoration, recreational facility construction, public access improvements, invasive plant control, and related projects. The annual appropriation of up to $300 million is divided among programs administered by several state agencies and the five water management districts (WMDs). The five WMDs together annually receive up to $105 million (minus administrative costs). (See Section 6.4.1.4 below.)

6.4.1.2 Conservation and Recreation Lands Program (CARL)

FDEP's Conservation and Recreational Lands program has long been Florida's major public environmental land acquisition program for the protection and conservation of Florida's natural heritage. The CARL program was implemented in 1979 and originally funded solely by mineral extraction severance taxes and documentary stamp fees. The creation of Preservation 2000 (P2000), in 1990, provided financial stability for the CARL program. Since 1980, the Division of State Lands has acquired more than 680,000 acres under the CARL program with funding provided by P2000. The Division will continue land acquisitions under Florida Forever. From 1992 to the present, the Division of State Lands and the Florida Department of Agriculture Division of Forestry have acquired some 1,000,000 acres of public lands using CARL, P2000 and Florida Forever funds (FDEP 2003).

6.4.1.3 Florida Communities Trust

The Florida Communities Trust (FCT), established by the state legislature in 1989, assists local governments in meeting the natural resource protection requirements of Florida's Growth Management Act (Chapter 163, Part II, F.S). The trust operates within the Florida Department of Community Affairs (FDCA) as a non-regulatory agency. It provides monies through loans and grants (including matching funds) for land acquisitions that further the goals of the conservation, recreation, open space, and coastal elements of local governments' comprehensive plans. The FCT focuses on locally important land acquisition projects that don't fit into other state funded programs.

6.4.1.4 Southwest Florida Water Management District

The District, through the course of its local and regional water management activities, has undertaken the acquisition of lands for a broad spectrum of water resource protection and management benefits. These have included flood protection, water quality protection and improvement, water supply development, protection of recharge areas, protection of wetland systems (such as headwater swamps and floodplains) and restoration and management of uplands. Land acquisition at the District is guided and funded by the Florida Forever program.

The District is projected to receive over $26 million a year for project funding. Over the life of the program, at least 50 percent of the funds must be spent on land acquisition. As required by Section 373.199(7), Florida Statutes (F.S.), the District prepares an update of its Florida Forever Work Plan annually. Its purpose is to present projects eligible for funding under the Florida Forever Act (Section 259.105, F.S.), and to report on progress and changes since the initial April 2003 submission (SWFWMD 2003).

The District's land acquisition program targets the protection of natural resources at the local and regional level. Lands of importance to water resources and water management are acquired along with lands of unique environmental values endangered by development activities. Most lands currently owned were purchased through the SOR and P2000 (now Florida Forever) programs. The District has acquired more than 300,000 acres fee simple and more than 80,000 acres less-than-fee district-wide. Nearly 50,000 acres have been acquired, either by fee simple or less-than-fee methods, within the Myakka River watershed. District ownership of lands located within the Myakka River watershed is shown in Table 6-1 and in Figure 6-1. The totals under the "Acquired" headings represent acreage acquired by the District either fee simple or less-than-fee, and includes joint acquisitions with other purchasers. Much of the Myakka River acquisition project was purchased jointly with Sarasota County. The totals under the "Approved" and "Study Area" headings are either approved and/or proposed for purchase or are being studied to determine eligibility for purchase.

To ensure that the natural values of District-owned lands are preserved, the District conducts environmental assessments upon acquisition. These analyses identify the current status of natural resources, critical water management functions, significant ecological resources and potential threats to their preservation. SOR/P2000 and Florida Forever lands acquired must be managed in an environmentally acceptable manner that serves to preserve and/or restore their natural condition. All District lands are open to public use, generally passive recreation such as hiking and nature study, except for certain lands acquired under less-than-fee agreements. Uses of District lands that are compatible with the preservation and restoration directive, and that are not inconsistent with the water management purposes for which the lands were acquired, are to be permitted. These uses consist largely of passive, resource-based recreation but District-owned lands also may accommodate developed parks and other activities such as cattle grazing, hay and timber management where appropriate. The District or its

managing partners prepare site-specific land use and management plans for each District-owned property in order to formalize those uses and management regimes that are appropriate for the property.

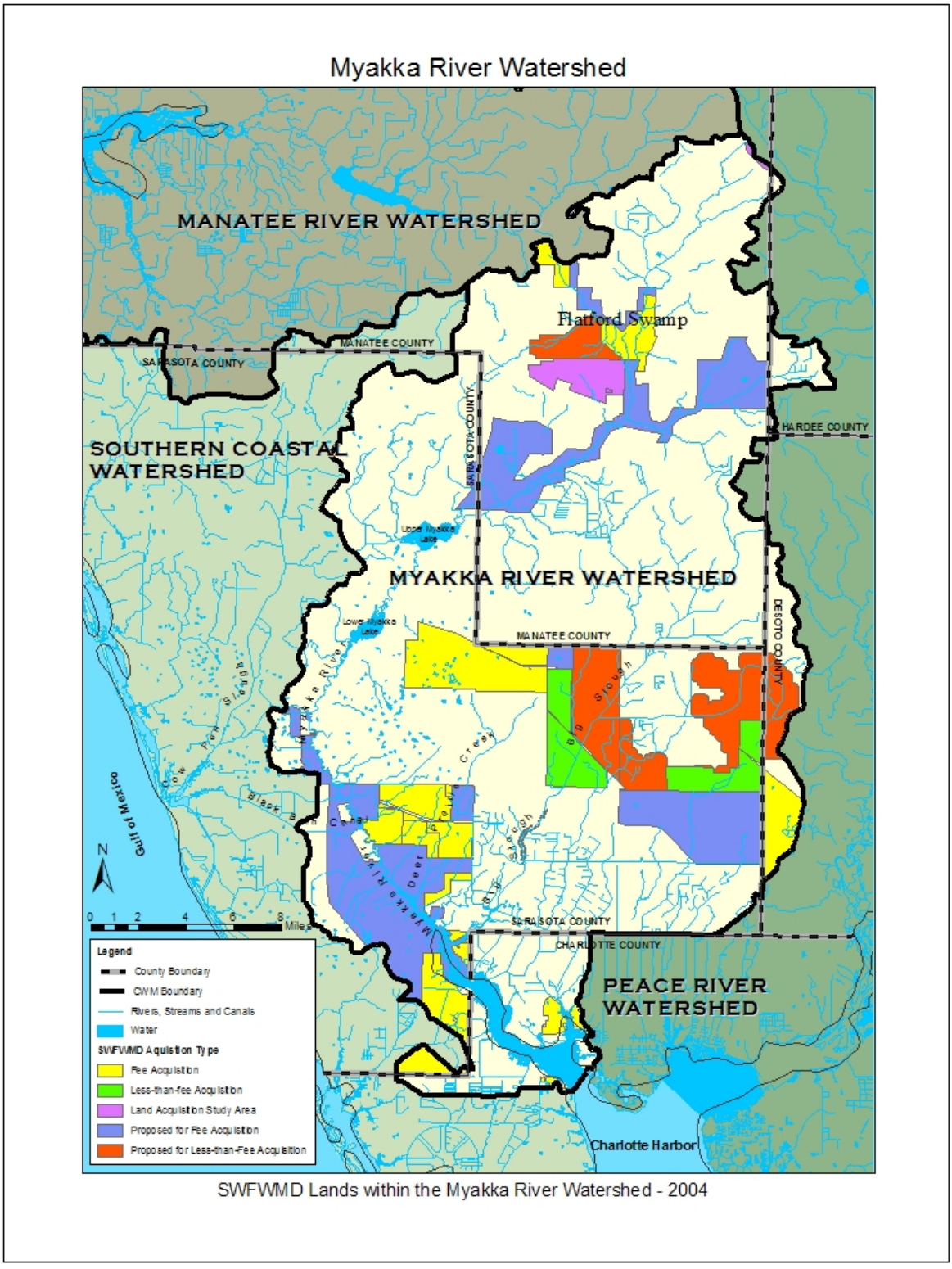
Table 6-1. District Land Acquisition Within the Myakka River Watershed

Project	Acquired Fee	Acquired LTF	Approved Fee	Approved LTF	Study Area	Total
***Charlotte Harbor State Buffer Preserve**	***7,529**	**0**	**0**	**0**	**0**	***7,529**
***Lake Manatee Lower Watershed**	***7,932**	**0**	***11,544**	**0**	**0**	***19,476**
Lewis Longino Preserve	**0**	**3,802**	**0**	**0**	**0**	**3,802**
Myakkahatchee Creek	**0**	**4,548**	**667**	**6,073**	**0**	**11,288**
Myakkahatchee Creek Preservation Corridor	**0**	**0**	**608**	**0**	**0**	**608**
Myakka Prairie	**8,249**	**0**	**0**	**0**	**0**	**8,249**
Myakka River	**10,359**	**0**	**17,807**	**0**	**0**	**28,166**
***Myakka State Forest**	***8,043**	***15**	**0**	**0**	**0**	***8,058**
***R.V. Griffin Reserve**	***5,839**	***3,895**	***9,191**	***12,165**	**0**	***31,090**
Upper Myakka Watershed	**2,357**	**0**	**16,155**	**2,611**	**3,230**	**24,353**
Total	*50,308	*12,260	*55,972	*20,849	3,230	*142,619

(SWFWMD 2003a)
All amounts in acres
Fee – Fee simple
LTF – Less-than-fee
*Projects are not located entirely within the Myakka River watershed; acreage is for total project.

Developed public recreational facilities on District lands are generally provided through coordination with other governmental agencies. The District has entered into agreements, primarily with local governments, to provide recreational opportunities, with the provision that those entities fund, develop, operate and maintain the facilities in a manner compatible with the purposes for which the lands were acquired. The District promotes the use of its lands for environmental education and scientific research. The District also has wildlife management area agreements with the Florida Fish and Wildlife Conservation Commission (FFWCC) on some of its land holdings. These wildlife management areas provide significant sport hunting and fishing opportunities to the public while providing the District with wildlife management and law enforcement assistance. The District has entered into land management agreements with the (FDEP) Myakka River State Park for management of the adjacent Myakka Prairie tract; with the Florida Department of Agriculture, Division of Forestry for management of the Myakka State Forest and with the FDEP Aquatic and State Buffer Preserves Program for the Charlotte Harbor State Buffer Preserve tract.

The protection and preservation of natural aquatic systems, especially the native plant communities they support, cannot be accomplished without effectively managing exotic aquatic plant species. Because of their rapid growth rates and competitiveness, introduced species, such as water hyacinth, water lettuce and hydrilla reduce the



SWFWMD Lands within the Myakka River Watershed - 2004

Figure 6-1. District Lands in the Myakka River Watershed (2004)

abundance and diversity of native plant populations, affecting fish and wildlife habitat and interfering with recreational utilization of surface waters. Unmanaged growth of these invasive species can degrade water quality, impede flows and increase sedimentation rates. Aquatic plant management operations on natural waters are funded and/or coordinated with the FDEP, the FFWCC, the U.S. Army Corps of Engineers and local government agencies, since this operation also provides recreational, water quality and habitat preservation benefits. The District's basin boards provide funding where appropriate.

The District currently conducts aquatic plant management activities in the Myakka River State Park. Other important management activities on District lands include control of exotic plants and animals, prescribed burning of fire dependent ecosystems to mimic the natural fire cycle, fencing, road and bridge maintenance and restoration of altered ecosystems to their natural state.

6.4.1.5 Manatee County

In 1992, the Manatee County Board of County Commissioners created the Environmental Lands Management and Acquisition Committee (ELMAC), which is responsible for identifying environmentally sensitive lands for acquisition and non-fee simple methods of protection. Prior to the formation of the ELMAC, Manatee County voters passed two referenda in 1984 and 1987 to fund acquisition of lands within the Lake Manatee watershed. Lands purchased by the County are evaluated for passive recreation consistent with the environmental sensitivity of the particular tract. The Duette Park property, purchased to protect the Manatee River watershed and the County's source of potable water, consists of about 21,149 acres in eastern Manatee County. Small portions of the property cross into the northern parts of the Myakka River watershed (Manatee County 1996). Prior to the end of the County's Fiscal Year 2002 – 2003, funds used to purchase environmentally sensitive lands were generated from property taxes in the amount of 25 cents for every $1,000 of assessed value. Beginning in Fiscal Year 2003 – 2004, the amount generated from property taxes to purchase environmentally sensitive lands dropped to just under 20 cents for every $1,000 of assessed value (Manatee County 2004).

Both the District and FDEP have also acquired and manage relatively large land holdings in the Manatee County portion of the Myakka River watershed, including a portion of the Lower Lake Manatee watershed, the upper Myakka River watershed property (Flatford Swamp), a large portion of Myakka River State Park and the Wingate Creek State Preserve.

6.4.1.6 Sarasota County

Sarasota County has been acquiring lands for the protection of water and other natural resources within the Myakka River watershed since the early 1980s. The 24,565 acre Carlton Reserve was acquired by the County in 1982 to protect public water supply. In

1988 the 2,900 acre Pinelands Reserve was acquired. Since its inception in 1999, the Sarasota County Environmentally Sensitive Lands Protection Program (ESLPP) continues to actively pursue acquisition of environmentally sensitive lands in the county.

Land acquisition efforts are frequently in cooperation with other public and private agencies. To date the County has acquired several tracts within the Myakka River watershed, totaling more than 32,300 acres. This includes several joint acquisitions (with the District) amounting to approximately 9,720 acres in the District's Myakka River (Deer Prairie Creek (Slough)) and R. V. Griffin (Longino) project areas. Sarasota County and the District share title to these lands. These joint purchases, as noted above, comprise a portion of the District's Myakka River acquisition project (Ryan 2004).

6.4.1.7 Charlotte County

Essentially all of the large, publicly owned tracts of natural lands in Charlotte County were purchased by state or federally funded programs. In 1991, the Board of County Commissioners established the Environmental Lands Acquisition Advisory Council (ELAAC) to aid county staff in identifying properties suitable for acquisition. The County also established a trust fund for the purchase of environmentally sensitive lands but has not acquired any land within the Myakka River watershed to date (Charlotte County 1997).

6.4.1.8 City of North Port

As of 1997, the City owns close to 500 acres within the Big Slough Canal/Myakkahatchee Creek flood plain called the Myakkahatchee Environmental Park. This includes lands along both shores of the creek and was acquired by the City using money available through the Florida Communities Trust (Frank 2004). The creek is one of the City's most important natural resources, serving as a potable water supply source, a natural drainage way, and a wildlife corridor. It is generally managed for its drainage function at this time.

The City continues to assign a high priority to the acquisition of properties along the creek that are in the 25-year flood plain and to develop and implement management practices which would limit development in these areas. The City has been involved in an acquisition program to acquire, fee simple, first and second tier lots adjacent to the Big Slough Canal/Myakkahatchee Creek within the City limits. This program has been successful in acquiring and eliminating development potential of the majority of the first tier lots adjacent to the creek. Efforts are on going to acquire the second tier of lots, though none have been acquired to date (Bellia 2004). Also, the City intends to continue utilizing innovative growth management techniques such as Transfers of Development Rights (TDRs) and develop partnerships with public and private parties in order to protect the creek and to complete its proposed acquisition program (North Port 1997).

6.4.2 Myakka Wild and Scenic River Designation

In November 1978, Congress authorized the National Park Service to study the Myakka River for potential inclusion in the National Wild and Scenic Rivers System. The study was completed in 1984 and proposed that the twelve miles of the river within the Myakka River State Park be included as a state administered component of the National Wild and Scenic Rivers System. It also recommended that a Myakka River Commission be established to coordinate conservation efforts for the river.

In 1985 the Florida legislature designated the 34 mile corridor of the river within Sarasota County a Florida Wild and Scenic River through the passage of the Myakka River Wild and Scenic Designation and Preservation Act (Chapter 258.501, F.S.). The statute provides for the permanent preservation, management and administration of the designated segment by development of management plan. The *Myakka Wild and Scenic River Management Plan* was developed, pursuant to the Act, by the Florida Department of Natural Resources (now FDEP) and the Myakka River Management Coordinating Council (Council). The Act established the Council to provide interagency and intergovernmental coordination in the management of the river. Regulatory protection of the designated segment is discussed earlier in this document.

6.4.3 Charlotte Harbor National Estuary Program (CHNEP)

The National Estuary Program (NEP) was created by Congress as Section 320 of the Water Quality Act of 1987. Congress established the NEP to develop innovative ways for citizens to protect estuaries. The U.S. EPA is authorized to form management conferences (coordinated committees) to develop plans called Comprehensive Conservation and Management Plans (CCMPs) for the restoration or preservation of a given estuary. Charlotte Harbor was designated an estuary of national significance in 1995 by its inclusion in the National Estuary Program (NEP). The Southwest Florida Regional Planning Council locally sponsors the CHNEP to provide a forum within which public and private-sector participants work to develop the means to provide long-term protection for Charlotte Harbor and its watershed. The general program goals of the CHNEP are to improve the environmental integrity of the study area, to preserve and restore critical habitats, to reduce pollution, to preserve natural salinity regimes, to increase public awareness and participation, to develop and implement a sound management plan for the estuary, and to serve as a primary information resource for the greater Charlotte Harbor watershed.

While Charlotte Harbor consists of 270 square miles of open water, its watershed extends over an area of 4,400 square miles and includes the Myakka River and its watershed. The following goals were developed for the Harbor through the Management Conference, by the Technical and Citizens' Advisory Committees:

1. Improve the environmental integrity of the Charlotte Harbor study area,
2. Preserve, restore, and enhance seagrass beds, coastal wetlands barrier beaches, and functionally related uplands,

3. Reduce point and non-point sources of pollution to attain desired uses of the estuary,
4. Provide the proper fresh water inflow to the estuary to ensure a balanced and productive ecosystem,
5. Develop and implement a strategy for public participation and education, and
6. Develop and implement a formal Charlotte Harbor management plan with a specified structure and process for achieving goals for the estuary.

Early activities included the identification of the region's *priority problems.* These are:
Hydrologic Alteration - Adverse changes to amounts, locations, and timing of freshwater flows, the hydrologic function of floodplain systems, and natural river flows.
Water Quality Degradation - Including, but not limited to, pollution from agricultural and urban runoff, point source discharges, septic tanks system loadings, atmospheric deposition, and groundwater.
Fish and Wildlife Habitat Loss - Degradation and elimination of headwater streams and other habitats caused by development, conversion of natural shorelines, cumulative impacts of docks and boats, invasion of exotic species, and cumulative and future impacts.

On February 11, 2000, the Charlotte Harbor NEP CCMP was finalized and approved by the program's Management Conference. The plan incorporates the above listed goals and priority problems and then details the actions needed to protect and improve the watershed. The CCMP lists specific objectives, called *quantifiable objectives,* for each of the priority problems. It then lists action strategies, called *priority actions,* to identify the specific activities needed to achieve the quantifiable objectives. The CCMP was signed by all participating agencies on April 13, 2000.

6.4.4 Surface Water Improvement and Management (SWIM) Program

The SWIM Act of 1987 was enacted in response to growing concerns of the legislature and others over continuing declines in water quality within the State's regional, significant surface water bodies and associated degradation of natural systems. The Act mandated that priority be given to Tampa Bay and its tributaries, as one of the eight water bodies identified in the enabling legislation. The District originally identified Charlotte Harbor as another priority water body.

Management plans for each priority water body have been prepared. SWIM plans are action-oriented documents intended to serve as a guide to District staff and local governments in restoration and protection efforts for the priority water bodies. The Charlotte Harbor SWIM Plan, which addresses the Myakka River, was prepared by District staff in 1993 and updated in 2000 with input from many agencies, local governments, and citizens. It describes land use in the watershed, water quality, habitat and other pertinent issues. It discusses previous resource management activities, SWIM goals and tasks and lists priority projects in the watershed. General initiatives for the Charlotte Harbor SWIM Plan are: plan management and intergovernmental coordination; water quality protection; watershed management; habitat protection and restoration; and public education and involvement.

The SWIM Program has undertaken a wide variety of activities, including environmental assessments, urban stormwater analyses, seagrass mapping and habitat restoration, model ordinance development, wildlife assessments and lake rehabilitation. As ranked water bodies are successfully addressed by the SWIM Program, additional surface water bodies will be added, as the District is required to periodically review SWIM priorities. The process to accomplish such additions will build on the previous participatory efforts that were undertaken to identify the most regionally significant surface water bodies.

6.4.5 Establishment of Minimum Flows and Levels and Approved Priority List and Schedule

The District, pursuant to Section 373.042 (2), F.S., annually updates and publishes its approved Priority List and Schedule for the Establishment of Minimum Flows and Levels. Currently, MFLs are scheduled to be established for the upper Myakka River in 2005 and the Lower Myakka River, including Myakkahatchee Creek, Deer Prairie Creek/Slough and Blackburn Canal, in 2006.

Aquifer levels in the region are also listed for MFL development. A minimum aquifer level to address saltwater intrusion in the Florida aquifer is expected to be established in 2004. An MFL for the intermediate aquifer in the SWUCA (where technically feasible) is scheduled to be established in 2005.

The Priority List is based on the importance of waters to the state or region and the existence of or potential for significant harm to the water resources or ecology of the region and waters that are experiencing or may reasonably be expected to experience adverse impacts. It is the District's intent to voluntarily undertake independent scientific peer review for all waterbodies on the Priority List.

6.4.6 Facilitating Agricultural Resource Management Systems (FARMS)

The FARMS Program is a private/public partnership between members of the agricultural community, the District and the Florida Department of Agriculture and Consumer Services (FDACS). Agricultural best management practices projects are developed and implemented on a cost-share reimbursement basis. In order to be eligible for the program, projects must provide one or more of the following: 1. water quality improvement; 2. reduction of Florida aquifer withdrawals; and/or, 3. conservation, restoration or augmentation of the area's water resources and ecology. Projects must also be consistent with the Southern Water Use Caution Area (SWUCA) Recovery Strategy, the District's Regional Water Supply Plan and furthering the District's mission in protecting water resource availability and sustainability.

The FARMS Program was originally implemented in 2002 to address agricultural irrigation runoff problems in the Shell, Prairie, and Joshua creeks watersheds and expanded to include problems in the upper Myakka River (Flatford Swamp) watershed.

The program has since been implemented SWUCA-wide (8 counties), with emphasis remaining in the original target areas. The FARMS Program in the upper Myakka River watershed funds tailwater recovery and other best management practices (BMPs) that will significantly reduce the amount of excess water entering the Flatford Swamp.

In 2001, the District funded two surface water exchange projects under the Agricultural Conservation Partnership (AgCP) Program. The Falkner Farms and Pacific Tomato Growers, Ltd. projects were implemented to reduce excess flow entering the Flatford Swamp. In late 2003/early 2004, two more projects (Cameron Dakin Dairy and McClure Farms) were approved for FARMS funding in the upper Myakka River watershed and additional projects are being considered.

6.4.7 Citizen and Private Support

In addition to the activities and efforts described above, the Myakka River has strong local support. There are several citizen and private organizations dedicated to protecting and preserving the Myakka River, the State Park, and surrounding areas through environmental education and volunteer activism. Some of these groups include: Friends of the Myakka, Charlotte Harbor Environmental Center, the Myakka Conservancy, the Crowley Museum and Nature Center, the Jelks Foundation, the Audubon Society (several local chapters exist: Manatee County, Sarasota County, Southwest Florida), the League of Women Voters, the Manatee-Sarasota Group of the Sierra Club Florida Chapter, the Environmental Confederation of Southwest Florida (ECOSWF), and Manasota 88.

6.5 Natural Systems Issues

While much of the Myakka River watershed is protected from development, historic and continuing potential for future impacts still exist. The threat of development and conversion of lands, the continuing threat of agricultural and other runoff impacts to water resources and habitat, and the extensive presence of invasive exotic plant species are a few of the factors that warrant consideration in the Myakka River watershed.

6.5.1 Issue: Habitat Loss, Alteration and Fragmentation

Background: Increased and continued land development (industrial, agricultural, suburban and urban) in the watershed has led to adverse environmental impacts and the loss, fragmentation, isolation and alteration of natural habitats. Additionally, lands in passive agriculture and silviculture which generally provide "green spaces" of secondary habitat value (e.g., wildlife corridors, buffer areas) are also at risk of conversion to more intensive uses and development.

Strategy: Identify and maximize habitat restoration opportunities within the watershed essential to ecosystem support and management and the maintenance of biodiversity.

Actions:

- Identify and prioritize key resource areas in need of protection and implement necessary resource protection measures (e.g., land acquisition, conservation easements, management agreements, conservation\stewardship tax incentives, etc.).

- Encourage local government agencies to make land use decisions that are compatible with adjacent protected land.

- Protect existing public conservation lands. Require mitigation, restoration and compensation for impacts to public lands as a result of infrastructure development (or other land development activity) on the affected lands.

- Prevent or reduce the number of crossings of key habitat areas or major watercourses by linear infrastructure facilities.

- Identify potential sites (i.e., those of least adverse environmental consequences if affected) and investigate feasibility of linear infrastructure corridors (e.g., transmission powerlines, roads, pipelines) where linear facilities can be co-located to reduce environmental impacts.

- Where feasible and appropriate (i.e., key resource areas), encourage regional mitigation banks (both public and private).

- Cooperate with local governments, agencies and private interests to seek and implement restoration opportunities.

- Provide incentives for landowners to maintain and protect natural habitats (e.g., tax relief, assistance in developing land management plans, etc.).

- Identify mining areas as potential priority areas for restoration activities.

Strategy: Continue land acquisition (fee simple) and other land conservation methods (e.g., conservation easements, less-than-fee) to protect natural systems within the watershed. Target high quality natural areas, particularly wildlife corridors and areas of high biodiversity and of importance to listed species.

Actions:

- Coordinate land acquisition and other conservation efforts among all available programs (local, regional, state, federal).

- Encourage, promote and facilitate conservation easements and other less-than-fee instruments to secure protection of natural lands and other resources.

- Educate and coordinate with private landowners about protection and management of listed species habitat.

Strategy: Incorporate, to the greatest extent possible, public and private lands in the creation of protected corridors essential for the long-term protection and preservation of the Myakka River and associated natural resources and ensure connection to future regional and statewide networks of greenways, conservation lands and wildlife corridors.

Actions:

- Coordinate with agencies and local governments to develop contacts, cooperation and participation with private landowners.

- Explore and implement additional opportunities for coordinated and integrated management of public lands within the watershed.

- Coordinate closely with FDEP Office of Greenways and Trails to develop recommendations.

- Seek cooperation of private landowners in developing recreational linkages (e.g., greenways, hiking trails, etc.).

Strategy: Identify, implement and promote compatible land uses and BMPs for the protection of buffer areas along the river floodplain and to protect wildlife corridors.

Actions:

- Identify sensitive or key ecosystem areas using the FFWCC's "Closing the Gaps" analysis and the CHNEP. These areas should be targeted for implementation of BMPs and compatible lands uses along with other conservation and protection measures.

- Assist Sarasota County and FDEP in implementing the Myakka River Rule (Chapter 62D-15 F.A.C.) and Sarasota County's River Protection Zone Ordinance.

- Coordinate administration and enforcement of regulations along the River and in the River Protection Zone among all responsible regulatory agencies.

Strategy: Effectively manage recreational pressures and other land uses to prevent adverse environmental impacts on public lands.

Actions:

- Identify amount and types of recreation needed in the watershed.

- Conduct, promote and fund research to ascertain the impacts of various recreational activities and to determine their suitability and compatibility within various habitat areas.

- Determine BMPs and carrying capacities for recreational activities. Implement management and enforcement measures.

- Educate the public about recreational impacts on sensitive ecosystems.

- Assist FDEP and local governments to educate the public, especially boaters, about aquatic systems management and protection, Manatee Protection Zones, wildlife and bird sanctuaries, and the environmental impacts of recreational activities.

6.5.2 Issue: Biodiversity and Wildlife Protection

Background: In spite of land development trends (and their consequences on the region's biota), the Myakka River watershed contains a variety of ecosystems and habitat types regionally and locally important to the support of wildlife populations. Some areas are in protective conservation status (i.e., public lands). Protection of viable examples of wetland and upland habitats (inland and coastal) is essential to maintain the watershed's biodiversity. Protection of Endangered, Threatened and Rare species and State Listed Species of Special Concern is a priority.

Strategy: Manage and control nuisance exotic species (plant and animal) to maintain natural systems' values and functions.

Actions:

- Develop integrated land management efforts among public lands for coordinated control of troublesome species.

- Continue District assistance to the Myakka River State Park for aquatic weed control.

- Educate the general public, local governments, plant nursery industry, and private landowners on the adverse impacts and long-term consequences of exotic species on natural systems and seek their cooperation in the control and eradication of those species.

- Encourage and fund further research on exotics (i.e., their mode of spreading and remedial control measures).

Strategy: Identify key elements of the greater Charlotte Harbor ecosystem that are dependent on features and functions of the Myakka River watershed. Maintain and protect ecosystem relationships essential to migratory waterfowl, wintering birds and other wildlife.

Actions:

- Using assessments prepared by the CHNEP identify key ecosystem relationships.

- Protect key wetland foraging areas for support of breeding colonies of seabirds and wading birds located in the river and estuary.

- Implement protection measures (conservation, land acquisition, etc.) to ensure long-term maintenance of ecosystems and wildlife, especially breeding areas for colonial birds; and ephemeral wetlands that are important for Woodstorks as well as amphibians.

- Identify key migratory stop-over and wintering areas and seek to implement protective status and management.

- Assist the FDEP and other agencies to educate public officials and citizens about the importance of migratory bird habitat protection and increase general public awareness of the issue and the role the region plays.

Strategy: Maintain ecosystem values and functions through water quality protection and improvement, both along the river's course and ultimately at the Charlotte Harbor estuary. Pollutant and nutrient reduction are priority issues.

Actions:

- Implement proper management and protection of natural lands by acquiring core area and buffer systems along the river and tributaries.

- Develop and implement setbacks and BMPs to protect watercourses from stormwater and agricultural runoff.

- Identify and promote compatible land uses along river course and buffer areas.

6.5.3 Issue: Hydrologic Stress and Tree Mortality in the Upper Myakka River Watershed

Background: The upper Myakka River watershed is defined as that portion of the basin that extends north of State Road 70 in Manatee County. Flatford Swamp is a major surface water feature in the upper Myakka River basin. Recognizing the importance of the various roles Flatford Swamp performs, 9,083 acres within this general area was approved for acquisition by the District. To date 2,357 acres of the Flatford Swamp system have been acquired through Save Our Rivers and Preservation 2000 land acquisition programs.

Starting in the mid-1990's, the District began receiving inquiries concerning potentially abnormal levels of tree mortality in the Flatford Swamp and adjacent areas. A relatively high degree of tree mortality was subsequently observed by District staff during

numerous site visits. In addition, similar tree mortality patterns were being simultaneously reported in other portions of the Myakka River basin south of S.R. 70. The Crowley Nature Preserve, located immediately north of S.R. 70 on the Myakka River in Sarasota County, and the Myakka River State Park also have been identified as areas of concern.

As indicated in the 1998 report entitled, *Tree Mortality Assessment of the Upper Myakka River Watershed,* the primary cause of the tree die-off and other changes in the upper Myakka River watershed are due to hydrologic stress related to either higher seasonal high water elevations, longer seasonal hydroperiods, or both. Increased baseflow contributions from groundwater used for agricultural irrigation are indicated by water quality analysis. Since elevated groundwater levels seem to prevent or reduce the natural dry season water levels, upland trees and the swamp have remained too wet for too long and the system is changing.

Strategy: Restore historic hydrologic patterns within the Flatford Swamp and other affected portions of the upper Myakka River watershed areas.

Actions:

- Continue to develop partnerships with private interests in the basin. Assist in the implementation of projects to decrease excess surface and/or groundwater contributions to streamflow and baseflow by reducing pumping and use of groundwater for irrigation.

- Continue funding and technical assistance in developing alternative irrigation sources, such as tailwater recovery and reservoir storage.

- Develop a water budget for the upper Myakka River watershed in order to develop and implement regulatory and/or non-regulatory controls.

- Investigate the designation of the upper Myakka River basin as a *volume sensitive* basin and initiate formal rule making, if appropriate.

- Investigate where historic flows can be restored.

- Examine reforestation and revegetation potential as hydroperiod is restored.

Strategy: Detect and quantify temporal trends in the annual water budget of the upper Myakka River basin and in the vegetation communities within the affected portion of the basin.

Actions:

- Develop partnerships with affected private interests in the basin; focus and expand monitoring and data analysis programs; install permanent water level recorders and/or piezometers at strategic upstream and downstream locations to monitor

- changes in the annual water budget and hydroperiod and to measure the effects of any subsequent remedial actions; and

- Conduct regular aerial photography and quantitative field sampling to quantify and detect temporal trends in the vegetation communities within the affected portion of the basin. Build upon the work conducted in the study and allow for statistically valid estimates of vegetation community changes over time.

Acronyms

(Myakka River State Park Staff Photo)

Myakka River State Park Canopy Walkway

~ Take a walk through the treetops.~

ACRONYMS

ACOE	Army Corp of Engineers
AgCP	Agricultural Conservation Partnership
AORs	Areas of Responsibility
ASR	Aquifer Storage and Recovery
AUP	Agricultural Use Plan
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
C.R.	County Road
CARL	Conservation and Recreational Lands
CCC	Civilian Conservation Corps
CCMP	Conservation and Management Plan
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHEC	Charlotte Harbor Environmental Center
CHNEP	Charlotte Harbor Natural Estuary Program
CSO	Citizens Support Organization
CWM	Comprehensive Watershed Management
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphorous
DO	Dissolved Oxygen
DSP	Dedicated Site Plan
DWMP	District Water Management Plan
EAR	Evaluation and Appraisal Report
ECOSWF	Environmental Confederation of Southwest Florida
ELAAC	Environmental Lands Acquisition Advisory Council (Charlotte County)
ELMAC	Environmental Lands Management & Advisory Committee (Manatee Co.)
ERP	Environmental Resource Permit
ESLPP	Environmentally Sensitive Lands Purchasing Program (Sarasota County)
ET	Evapotranspiration
F.A.C.	Florida Administrative Code
F.S.	Florida Statutes
FARMS	Facilitating Agricultural Resource Management Systems
FCT	Florida Communities Trust
FDACS	Florida Department of Agriculture and Consumer Services
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Authority
FIRM	Flood Insurance Rate Maps
FLUCCS	Florida Land Use, Cover and Forms Classification System
FMRI	Florida Marine Research Institute
FNAI	Florida Natural Areas Inventory

FWCC	Florida Fish and Wildlife Conservation Commission
GDC	General Development Corporation
GIS	Geographic Information System
HRWUCA	Highlands Ridge Water Use Caution Area
IAS	Intermediate aquifer system
LOS	Level of Service
LTF	Less-Than-Fee
MFL	Minimum Flows and Levels
mg/l	Milligrams per liter
mgd	million gallons per day
MIA	Most Impacted Area
ml	Milliliter
MOU	Memorandum of Understanding
MSSW	Management and Storage of Surface Waters
N/l	Nitrogen per liter
NEP	National Estuary Program
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTBWUCA	Northern Tampa Bay Water Use Caution Area
NWS	National Weather Service
OFW	Outstanding Florida Waters
OWTS	Onsite Wastewater Treatment System
P/l	Phosphorus per liter
P2000	Preservation 2000
PBS&J	Post, Buckley, Schuh & Jernigan
PLRG	Pollutant Load Reduction Goal
POR	Period of record
ppt	Parts per thousand
PR/MRWSA or Authority	Peace River/Manasota Regional Water Supply Authority
RDB	Regulatory Data Base
RWSP	Regional Water Supply Plan
S.R.	State Road
SAS	Surficial aquifer system
SOR	Save Our Rivers
SOR	Save Our Rivers
SWCFGWB	Southern West-Central Florida Ground-Water Basin
SWFRPC	Southwest Florida Regional Planning Council
SWFWMD or District	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
SWUCA	Southern Water Use Caution Area
TDR	Transfer of Development Rights
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDLs	Total Maximum Daily Loads
TN	Total Nitrogen
TP	Total Phosphorous
TSS .	Total Suspended Solids

UFA	Upper Floridan aquifer
USDA	U. S. Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WMD	Water Management District
WMDB	Water Management Data Base
WMP	Watershed Management Plan
WSRD	Water Supply Resource Development
WUCA	Water Use Caution Area
WWTP	Wastewater Treatment Plant

References

(Photo by: A. M Shehadah from Myakka River State Park website)

Alligator Lily in Myakka River State Park

~ One of many wildflowers in the park.~

References

Ayres and Associates, *1994. Wastewater residuals and OWTS source management in the Tampa Bay watershed. plan of study*. Prepared for the Surface Water Improvement and Management (SWIM) Department, Southwest Florida Water Management District, Tampa, Florida.

Ayres and Associates, 2003. *Estimates of 2000 census populations by political and geographic boundaries of the SWFWMD*.

BEBR, 2003. Projections of Florida population by county, 2002-2030, *Florida Population Studies, Volume 36, Number 1, Bulletin 134, January 2003*. Bureau of Economic and Business Research, University of Florida.

Bellia, J., 2004. Personal communication, Julia Bellia, City of North Port.

Bridges, W. C., 1982. *Technique for estimating magnitude and frequency of floods on, natural-flow streams in Florida. Water Resources Investigations Report 82-4012*, U. S. Geological Survey.

Camp, Dresser and McKee, 1992. *Big Slough/Myakkahatchee Creek watershed study and stormwater management master plan for the City of North Port*. Prepared for the City of North Port.

Camp, Dresser and McKee, 1993. *City of North Port, Big Slough Watershed Study: Final Report: Stormwater Management Master Plan*. Prepared for the City of North Port.

Camp, Dresser and McKee, 1993. *City of North Port, Big Slough Watershed Study: Preliminary Design Report*. Prepared for the City of North Port.

Carter and Burgess, 1996. *Charlotte County Phase I Stormwater Master Plan*. Prepared for Charlotte County Government for the Port Charlotte area between the Myakka and Peace rivers.

Charlotte County, 1997. *Charlotte County Comprehensive Plan.* Charlotte County Board of County Commissioners.

CHEC, 1999. *Peace River and Myakka River water quality trend analyses*. Charlotte Harbor Environmental Center.

CHNEP, 1998. *The story of the greater Charlotte Harbor watershed; the state of Charlotte Harbor and its inland waters and watersheds*.

CHNEP, 1998. *Framework for Action, Quantifiable Objectives and Proposed Action Plans for the Greater Charlotte Harbor Watershed*. *Technical Report No. 98-04*.

CHNEP, 1999. *Synthesis of Existing Information, A Characterization of Water Quality, Hydrologic Alterations, and Fish and Wildlife Habitat in the Greater Charlotte Harbor Watershed*. *Technical Report No. 99-02*.

CHNEP, 2000. *Committing to Our Future, Volume 1*, *Comprehensive Conservation and Management Plan for the Greater Charlotte Harbor Watershed*.

CHNEP, 2000. *Committing to Our Future, Volume 2, Preliminary Actions Plans for the Greater Charlotte Harbor Watershed.*

CH2M Hill, February 1988. *Technical Report No.2, Hydroecology of wetland on the Ringling-MacArthur Reserve, Volume I: Technical Report,* Sarasota County, Sarasota, Florida.

CH2M Hill, December 1988. *Technical Report No.1, Floral composition of major vegetation zones of wetlands on the Ringling-MacArthur Reserve,* Sarasota County, Sarasota, Florida.

Coastal Environmental, Inc. 1995a. *Estimates of Total Nitrogen, Total Phosphorus, and Total Suspended Solids Loadings to Charlotte Harbor, Florida*. Prepared for the Surface Water Improvement and Management (SWIM) Department, Southwest Florida Water Management District, Tampa, Florida.

Coastal Environmental, Inc. 1995b*. Review and Analysis of Meteorological, Tributary Flow, and Water Quality Data from the Charlotte Harbor Estuarine System*. Prepared for the Surface Water Improvement and Management (SWIM) Department, Southwest Florida Water Management District, Tampa, Florida.

Coastal Environmental, Inc. 1995c*. Living resource-based salinity targets for the tidal Peace River (Draft, November, 1995).* Prepared for the Surface Water Improvement and Management (SWIM) Department, Southwest Florida Water Management District, Tampa, Florida.

Coastal Environmental, Inc. 1995d*. A long-term water quality monitoring design for Charlotte Harbor, Florida (Draft, January, 1995).* Prepared for the Surface Water Improvement and Management (SWIM) Department, Southwest Florida Water Management District, Tampa, Florida.

Coastal Environmental/PBS&J, Inc., 1998. *Tree mortality assessment of the upper Myakka River watershed.* Southwest Florida Water Management District, Brooksville, Florida.

Day, J.W., Jr., C.A.S. Hall, W.M. Kemp, and A. yanez-Arancibia, 1989. *Estuarine Ecology*. Wiley-Interscience, New York, NY.

Daltry, W. E. and D. Y. Burr, 1998. *Charlotte Harbor National Estuary Program Base Programs Analysis, Volume 1*, Prepared for the Charlotte Harbor National Estuary Program, North Fort Myers, Florida.

Deuver, M. J. and J. M. McCollum, 1990. *Hydrologic study within the Myakka River State Park*. Report to the U. S. Department of Commerce/National Oceanic and Atmospheric Administration. Washington, D. C.

Dixon, L. K., and G. J. Kirkpatrick. 1999. *Causes of light attenuation with respect to seagrasses in the upper and lower Charlotte Harbor*. Mote Marine Laboratory Technical Report No. 650. Sarasota, FL.

Dohrenwend, R. R., 1977. Evapotranspiration patterns in Florida. *Florida Scientist*, Vol. 40.

FEMA, 1998. *Flood Insurance Study, City of North Port, Sarasota County, Florida*. Federal Emergency Management Agency.

Flannery, M.S., H.C. Downing, G.A. McSarry and M.O. Waiters, 1991. *Increased nutrient loading and baseflow supplementation in the Little Manatee River watershed*.

Flippo, H. N., Jr. and B. F. Joyner, 1968. *Low streamflow in the Myakka River basin area in Florida.* Florida Division of Geology Report of Investigations 53.

Florida Agricultural Statistics Service, 1996a. *Citrus Summary 1994-95*. Florida Department of Agriculture and Consumer Services, Division of Marketing and Development, Florida Agricultural Statistics Service, Orlando, Florida

Florida Agricultural Statistics Service, 1996b. *Livestock, Dairy and Poultry Summary 1995*. Florida Department of Agriculture and Consumer Services, Division of Marketing and Development, Florida Agricultural Statistics Service, Orlando, Florida

Florida Agricultural Statistics Service, 1996c. *Vegetable Summary 1994-95*. Florida Department of Agriculture and Consumer Services, Division of Marketing and Development, Florida Agricultural Statistics Service, Orlando, Florida

Florida Department of Environmental Protection, 2001. *Florida Water Plan; Implementing watershed management.*

Florida Department of Environmental Protection, 2003a. *2003 Group 3 basins status report; water quality status report: Sarasota Bay and the Peace and Myakka rivers.*

Florida Department of Environmental Protection, 2003b. *2003 Interim report of the Florida Forever Program*. Division of State Lands.

Florida Department of Environmental Protection, 2004. TMDL development schedule, FDEP website.

Florida Department of Natural Resources, 1989. *Florida Rivers Assessment*. Prepared by Florida Resources and Environmental Analysis Center at Florida State University (Dean K. Jue, Principal Investigator). Florida Department of Natural Resources, Tallahassee, Florida.

Florida Game and Freshwater Fish Commission, 1994. *Closing the Gaps in Florida's Wildlife Habitat Conservation System*.

Frank, S., 2004. Personal communication, Stan Frank, City of North Port.

Fraser T., Thomas H. and Ralph Montgomery, 1997. *Compendium of existing monitoring programs in the greater Charlotte Harbor watershed.* Prepared for the CHNEP, North Ft. Myers, Florida.

Greeley and Hansen, LLC, 2003. *Regional system planning and engineering study: phase I – assessment of existing supplies.* Prepared for the Peace River/Manasota Regional Water Supply Authority and the Water Planning Alliance.

Hammett, K. M., J. F. Turner, Jr. and W. R. Murphy, Jr., 1978. *Magnitude and frequency of flooding in the Myakka River, southwest Florida. U. S. Geological Survey Water Resources Investigation Report 78-65*.

Hammett, K. M. , 1992. *Physical processes, salinity characteristics, and potential salinity changes due to freshwater withdrawal in the tidal Myakka River, Florida. U. S. Geological Survey Water Resources Investigation Report 90-4054.*

Hammett, K. M., 1985. *Low-flow frequency analysis for streams in west-central Florida. U. S. Geological Survey Water Resources Investigations Report 84-4299.*

Hammett, K. M., 1988. *Land use, water use, streamflow and water quality characteristics of the Charlotte Harbor inflow area, Florida. U. S. Geological Survey Open-file report 87- 472*.

Hand, J., Jana Col and Linda Lord, 1996. *Water quality assessment for the State of Florida 305(b} technical appendix southwest Florida*. Bureau of Surface Water Management, Florida Department of Environmental Regulation. Tallahassee, Florida.

Hart, Robin L., Ph.D., ed., 1993. *Management guidelines and goals for the Myakka River basin,* Sarasota County Natural Resources Department, Sarasota, Florida.

Hunter Services, Inc., 1990. *Myakka wild and scenic river management plan.* Florida Department of Natural Resources, Division of Recreation and Parks/Myakka River Coordinating Council, Tallahassee/Sarasota, Florida.

Hunter Services, Inc., 2001. *Draft Myakka wild and scenic river management plan.* Florida Department of Natural Resources, Division of Recreation and Parks/Myakka River Management Coordinating Council, Tallahassee/Sarasota, Florida.

Layne, James N., Jerre A. Stallcup, Glen E. Wolfman, Melinda N. McCauley, and David, J. Worley, 1977. *Fish and wildlife inventory of the seven county region included in the central Florida phosphate industry areawide environmental impact study, 3 vols.* Prepared by the Archbold Biological Research Station for the U.S. Fish and Wildlife Service.

Levesque, V. A. and Hammett, K. M., 1997. *Comparison of two methods for estimating discharge and nutrient loads from tidally effected reaches of the Myakka and Peace rivers. U. S. Geological Survey West-Central Florida. Open-File Report 97-118*.

Manatee County, 1990. *Stormwater management design manual*, Manatee County Board of County Commissioners.

Manatee County. 1999. *Manatee County comprehensive plan.* Manatee County Board of County Commissioners.

Manatee County, 2004. Manatee County Government Website.

Montgomery, Ralph T., Benjamin F. McPherson, and Edward E. Simmons. 1991. *Effects of nitrogen and phosphorus additions on phytoplankton productivity and chlorophyll a in a subtropical estuary, Charlotte Har*bor, Florida. U.S. Geological Survey. Water-Resources Investigations Report No.91-4077. Tallahassee, Florida.

Myakka River State Park, 1998. Park staff, personal communication.

North Port City Commission. 1997. 1996 *Comprehensive Plan-Evaluation and Appraisal Report.* North Port, Florida.

Odum, H.T.,1953. *Dissolved phosphorus in Florida waters. Florida Geological Survey Report of Investigations, No.9.*

Pait, A.S., A. DeSouza, and D.R.G. Farrow, 1992. *Agricultural pesticide use in coastal areas: a national summary*. Rockville, MD: National Oceanic and Atmospheric Administration

Petrus, K., 2004. Personal communication, Kevin Petrus, Florida Department of Environmental Protection.

Post, Buckley, Schuh & Jernigan, 1999. *Trend analysis of tree mortality in the upper Myakka River watershed*. Prepared for the SWFWMD.

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, Florida

Ryan, J. S., 2004. Personal communication, Jennifer Steadman Ryan, Sarasota County.

Sarasota County, 2004. *Myakka River protection zone* ordinance, Sarasota County Board of County Commissioners.

Sarasota County, 1997. *Apoxsee -The revised and updated Sarasota County comprehensive plan.* Sarasota County Board of County Commissioners.

Sarasota County Soil Conservation District et al., 1965. *Work plan for Big Slough watershed, Sarasota, Manatee, DeSoto and Charlotte counties, Florida.* United States Department of Agriculture (USDA), Soil Conservation Service, Gainesville, Florida.

Southwest Florida Regional Planning Council, 1993. *Generalized Future Land use Map of the State of Florida*.

Southwest Florida Water Management District (SWFWMD), 1982. *Model flood management ordinance*.

SWFWMD. 1988a. *Ground-water resource availability inventory: Manatee County, Florida*.

SWFWMD. 1988b. *Ground-water resource availability inventory: Sarasota County, Florida.*

SWFWMD. 1988c. *Ground-water resource availability inventory: Charlotte County, Florida.*

SWFWMD, 1993a *Charlotte Harbor surface water improvement and management (SWIM) plan*.

SWFWMD, 1993b. *Eastern Tampa Bay water resource assessment project report*.

SWFWMD, 1995a. *District water management plan.*

SWFWMD, 1996. A *plan for the use and management of the RV Griffin Reserve.*

SWFWMD, 1997 *Floodplain facts*.

SWFWMD, 1998. *District water supply assessment* 1995-2020.

SWFWMD,1999. *Save Our Rivers/Preservation* 2000 *Five-Year Plan*.

SWFWMD, 2000. *Charlotte Harbor surface water improvement and management (SWIM) Plan Update.*

SWFWMD, 2001. *Regional water supply plan*.

SWFWMD, 2003a. *Florida Forever land acquisition plan*.

SWFWMD, 2003b. *2001 Estimated Water Use in the SWFWMD*.

SWFWMD, 2003c. *2000 Annual reuse report*.

SWFWMD, 2004a. Geographic Information System.

SWFWMD, 2004b. *Draft SWUCA recovery strategy*.

Starks, R., 2004. Personal communication, Roberta Starks, SWFWMD.

Tomasko, D., 2004. Personal communication, David Tomasko, Ph. D., SWFWMD.

U. S. Environmental Protection Agency, 2004. *Proposed total maximum daily load report*, USEPA Region 4 website.

Wang, J.C.S. and Edward C. Raney, 1971. *Charlotte Harbor estuarine studies - distribution and fluctuations in the fish fauna of the Charlotte Harbor estuary, Florida.* Mote Marine Laboratory, Sarasota, Florida.

Wetzel, R.G., 1983. *Limnology (2nd Edition)*. Saunders College Publishing Co. New York, New York.

White, W. H., 1970. *The geomorphology of the Florida peninsula. Geological Bulletin No. 51*. Bureau of Geology, Department of Natural Resources. Tallahassee, Florida

Winchester, Brian H., CH2M Hill, 1986. *Recommendations for the protection of ecological resources on the Ringling-MacArthur Reserve,* Sarasota County, Sarasota, FL.