Peace River
Comprehensive Watershed Management Plan


Lake Hancock Structure


Citrus


Pine Flatwoods


Pine lily


Peace River Estuary

2001
Volume I
DRAFT

Southwest Florida
Water Management District

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ACRONYMS

ACI	Areas of Conservation Interest
AGSWM	Agricultural Ground and Surface Water Management
AOR	Area of Responsibility
ASR	Aquifer Storage and Recovery
AUP	Agricultural Use Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CARL	Conservation and Recreation Lands
CCMP	Comprehensive Conservation and Management Plan
cfs	cubic feet per second
CGWQMN	Coastal Groundwater Quality Monitoring Network
CHNEP	Charlotte Harbor National Estuary Program
CWM	Comprehensive Watershed Management
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphate
DOH	Department of Health
DSP	Dedicated Site Plan
DWMP	District Water Management Plan
EMA	Ecosystem Management Area
EQL	Environmental Quality Laboratory
ERP	Environmental Resource Permit
ESA	Endangered Species Act of 1973
ETBWUCA	Eastern Tampa Bay Water Use Caution Area
FAC	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FEMA	Federal Emergency Management Agency
FFWCC	Florida Fish and Wildlife Conservation Commission
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Studies
FNAI	Florida Natural Areas Inventory
FPAQ	Flood-Prone Area Quadrangle
ft	feet
FY	Fiscal Year
FYI-5	Fifth Year Inspections
GCHEMA	Greater Charlotte Harbor Ecosystem Management Area
GIS	Geographic Information System
IHN	Integrated Habitat Network
IWRM	Integrated Water Resource Monitoring
LOS	Level of Service
MFL	Minimum Flows and Levels
mgd	million gallons per day
mg/l	milligrams per liter
mg N/l	milligrams of nitrogen per liter
mg P/l	milligrams of phosphorous per liter
mi^2	square miles
MIA	Most Impacted Area

ml	milliliters
MOU	Memorandum of Understanding
MSSW	Management and Storage of Surface Waters
NAWQA	National Water-Quality Assessment
NEP	National Estuary Program
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWSI	New Water Sources Initiative
OFW	Outstanding Florida Water
P2000	Preservation 2000
PLRG	Pollutant Load Reduction Goal
PNA	Potential Natural Area
ppt	parts per thousand
PR/MRWSA	Peace River/Manasota Regional Water Supply Authority
QWIP	Quality of Water Improvement Program
RAMP	Regional Ambient Monitoring Program
ROMP	Regional Observation Monitoring Program
RWSP	Regional Water Supply Plan
SGWB	Southern Groundwater Basin
SOR	Save Our Rivers
SR	State Road
SWFWMD	Southwest Florida Water Management District or District
SWIM	Surface Water Improvement and Management
SWUCA	Southern Water Use Caution Area
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
μg/l	micrograms per liter
μS/cm	microsiemens per centimeter
UPREPC	Upper Peace River Ecosystem Planning Committee
USACOE	Army Corps of Engineers
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WAR	Water and Air Research, Inc.
WMP	Watershed Management Program
WQMP	Water Quality Monitoring Program
WQMN	Water Quality Monitoring Network
WRAP	Water Resource Assessment Project
WUCA	Water Use Caution Area
WUP	Water Use Permit
WUPNET	Water Use Permit Network

EXECUTIVE SUMMARY

The Peace River Comprehensive Watershed Management Plan (Plan) has been developed to promote the effective integration and coordination of land and water planning, and thereby achieve a superior level of resource management and protection. During the past century, a variety of human activities including citrus and row crop production, the mining and processing of phosphate ore, cattle production, food processing, and urban and suburban land development activities have produced increased loadings of nutrients and other pollutants to many water bodies within the Peace River watershed.

This degradation of water quality and aggressive land development have also adversely affected the wildlife habitat values and functional integrity of a large proportion of the watershed. In many developed areas, the threat of recurrent flooding is a major concern. In terms of water supply, traditional groundwater sources derived from the Floridan Aquifer are now severely limited due to stressed environmental conditions found within the Southern Water Use Caution Area (SWUCA), which encompasses the majority of the Peace River watershed. Rededication of these long-term impacts presents a difficult challenge for future watershed management efforts.

The Governing Board of the Southwest Florida Water Management District (SWFWMD or District) declared Comprehensive Watershed Management (CWM) to be a Fiscal Year (FY) 94 Strategic Initiative and directed that appropriate staffing and funding resources be dedicated to support the establishment and perpetuation of an interdisciplinary CWM team for each of the 11 major watersheds within the District. The watershed assessments and management recommendations produced through the CWM initiative are intended to assist the District's Basin boards and senior staff in the establishment of watershed-specific priorities, the identification of important water management projects and the disbursement of funds made available through the District's Cooperative Funding Program.

1. BENEFITS

The CWM initiative is anticipated to produce several benefits. By encouraging staff to focus on existing and potential resource management problems within localized areas of the District, it is expected to produce more effective and efficient solutions to problems within the constraints of limited funds. Also, its multi-departmental and multi-disciplinary approach is necessary for the successful long-term management of complex natural systems. Multi-departmental evaluation of relationships between District activities and environmental systems will provide more effective watershed assessments. Also, links between human activities and related impacts to water supply, flood protection, water quality, and natural systems function can be more clearly assessed on a watershed basis. Finally, by clearly defining long-term resource management goals, the CWM plans will promote greater consistency in management, planning, and implementation.

2. PRIMARY AREAS OF RESPONSIBILITY AND AGENCY GOALS

The District's mission has been subdivided into four areas of responsibility (AOR) which have been agreed upon by each of the state's five water management districts and Florida Department of Environmental Protection (FDEP) to summarize the State's coordinated approach to water management. The AOR were developed as one component of the five districts' comprehensive District Water Management Plans (DWMP). Goals were also identified to provide statewide consistency in the districts' programs and activities that address water resource issues. The four AOR and their respective goals are as follows:

Water Supply	*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.*
Flood Protection	*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.*
Water Quality	*to protect water quality by preventing further degradation of the water resource and enhancing water quality where appropriate.*
Natural Systems	*to protect, preserve and restore natural Florida ecosystems and to establish minimum water levels and flows necessary to maintain these natural systems.*

In addition to providing statewide consistency among the water management districts and FDEP, these water management goals are intended to bridge the frequently divergent functions of the districts and other local, regional, state, and federal agencies. This bridge is intended to create common ground for consistent and coordinated action by government agencies, in the best interest of Florida citizens. ***A predominant theme of the CWM initiative is the effective integration of land use and water management planning to achieve sound resource protection.***

3. THE PEACE RIVER - A PRIORITY WATERSHED

The Peace River watershed was designated a priority watershed for evaluation using the CWM approach. It was given priority status due, in part, to impacts to surface waters resulting from land development activities including urbanization, phosphate mining, and agriculture. These land uses have produced severe water quality and natural system problems. This watershed is also one of six Ecosystem Management Areas (EMA) recently designated by the FDEP, lending additional emphasis to the need for a timely evaluation. The District and FDEP are working cooperatively on CWM and EMA working groups to ensure that the collection, analysis and interpretation of information, as well as the implementation of remedies, is effectively and efficiently coordinated among both efforts.

4. SPECIFIC PEACE RIVER WATERSHED GOALS

Water Supply	*Maximize water conservation and ensure an adequate supply of water from the Peace River for appropriate reasonable and beneficial uses, now and in the future, while protecting and maintaining water quality and river and estuaries flows.*
Flood Protection	*Coordinate with local governments to minimize the potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood-prone areas and the river channel.*

Water Quality	*Monitor, protect and restore water quality of lakes, the Peace River, and coastal and recharge areas through implementation of Surface Water Improvement and Management (SWIM) and other management plans; by working with local governments and the public; and through regulatory enforcement.*
Natural Systems	*Protect, preserve and restore important upland, wetland and estuaries systems, including areas of the Green Swamp and scrub ecosystems where feasible. Establish and maintain minimum flows for the Peace River to ensure the long-term health of the entire Charlotte Harbor system.*

5. GROWTH MANAGEMENT AND LAND DEVELOPMENT ACTIVITY

Florida's growth management process helps protect and preserve water resources from land development activities such as phosphate mining, new highways, major urban developments, and the growth of cities, and is accomplished through a variety of state, regional and local planning and regulatory initiatives. This section describes Florida's comprehensive growth management program and how it is being used by state and regional agencies and local governments to help protect and preserve the Peace River watershed and its associated natural resources.

The majority of the watershed is subject to relatively little urbanization over the next twenty years considering the total population growth projected for the area, the rural-agricultural nature of the upper and central counties (Polk, Hardee, and DeSoto) that make up the majority of the watershed, and the less intensive land uses from anticipated economic activities that will mainly consist of eco-tourism and storage type facilities to support the Tampa and Orlando markets. Existing development restrictions from local government comprehensive plans and associated land development regulations described in this section, should help alleviate or mitigate environmental impacts associated with irresponsible land development activities. Refer to Atlas Maps 3 and 4, which show 1995 land use/cover and generalized future land use for the Peace River watershed.

Water resource impacts from urbanization may not be a major factor on the watershed. However, degradation from past and anticipated future phosphate mining activities, industrial and domestic point source pollution from existing developments, and uncontrolled non-point source runoff from agricultural activities on the Peace River is of major concern. Adverse impacts associated from these land uses generally include changes in natural surface water hydrology, degradation of regional surface water quality, decreased wildlife habitat, and loss of natural vegetation. Atlas Map 10 depicts Floridan Aquifer pollution potential in the Peace River watershed.

6. CONDITIONS AND RECOMMENDED ACTIONS BY AREAS OF RESPONSIBILITY

6-1. Water Supply Conditions

With a total surface area of 2,400 square miles (mi^2), the Peace River watershed comprises the largest watershed in the District. There has been extensive agricultural and industrial development in the watershed for many years with a heavy reliance on groundwater resources. Although domestic water use has been comparatively small, population growth is occurring, and the Lower Peace River is projected to serve as an important source of water to meet increased demand for domestic water supply by those counties in the southern part of the District.

Because of the importance of the Upper Peace River as both a natural resource and a source of surface water supplies, flows in the upper river require more intensive assessment and management. Coordinated and multi-faceted studies to evaluate hydrologic factors affecting flows in the upper river need to be conducted. These studies should also assess how the ecology of the Upper Peace River has been affected by flow reductions and how the ecosystem might respond to various degrees of flow restoration. Pending the findings of these studies, a management plan to maintain and possibly restore flows in the upper river should be pursued.

A major water supply concern is that regional water level declines in the Upper Floridan Aquifer have resulted from increases in groundwater withdrawals throughout the Peace River watershed and the southern groundwater basin (SGWB) of the District. These declines have resulted in the landward movement of the freshwater/saltwater interface, impacts to lakes along the Lake Wales Ridge, and potential impacts to flows in the Upper Peace River.

The water quality and management implications of a Class I designation for the Peace River should also be assessed. If possible, a modified Class I designation could be investigated to differentiate between existing and proposed sources of pollution in the watershed.

There may be potential to increase available water supplies from Shell Creek through use of Aquifer Storage and Recovery (ASR) facilities in association with the existing reservoir. If necessary, ASR facilities could relieve demand on direct stream withdrawals in the dry season. Studies investigating the feasibility of ASR at Shell Creek should continue and facilities developed if they are necessary for water supply needs or environmental management purposes.

<u>Recommended Actions</u>

1. Evaluate hydrologic factors affecting stream flow reductions in Upper Peace River and develop plans to restore flow where it is feasible.

2. Improve understanding of the interrelationships between groundwater levels, groundwater usage, and stream flow in the Upper Peace River.

3. Determine the extent to which historic phosphate mining has altered flows in the Peace River, identify old mined lands where flow contributions can be restored, and implement plans to restore stream flow in sub-basins where such restoration is feasible.

4. Identify and evaluate other drainage modifications in the Upper Peace River watershed that may have affected flows in the Peace River, e.g., the Peace Creek Canal and the Lake Hancock structure.

5. Assess the ecological status of the Peace River and establish minimum flow regulations that are based on the ecological requirements of the river and associated natural systems.

6. Investigate the necessity and practicality of a Class I designation for the main channel of the Peace River below Highway 60.

7. Investigate the feasibility of developing ASR facilities in association with the Shell Creek reservoir.

8. Pursue the construction of an emergency interconnection between the Shell Creek reservoir and the Peace River/Magnesite Regional Water Supply Authority (PR/MRWSA) water storage and treatment facilities near Ft. Ogden.

6-2. Flood Protection Conditions

It has become apparent that flood protection has become a complex process in that a holistic approach to water management is now being pursued from a state and federal level. Natural system preservation, water supply, water quality, and flood protection considerations are being integrated in order to construct a comprehensive surface water management system. 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 purpose of the following sections is to identify issues associated with flood protection so that action plan strategies can be developed.

A review of the stormwater management master plans prepared for the various tributary watersheds revealed that restrictions (bridges and culverts) placed in natural streams are a significant factor in increasing the flood potential within a basin. Typically, the stormwater management plans recommend that the size of conveyance structures within streams be increased to reduce water surface elevations upstream. In other situations, increasing the conveyance capacity of a channel or outright purchase of homes was recommended. These last two situations suggest that residential structures were probably located within a floodplain.

Recommended Actions

1. Standardize hydrologic/hydraulic and flood protection data collection and management.

2. Develop a Geographic Information System (GIS) database of current floodplain information for the Peace River watershed.

3. Standardize methods and level of detail required for flood-prone area analysis.

4. Develop analysis protocol that contributes to the minimization of impacts beyond peak flows.

5. Perform watershed analysis using more detailed modeling protocols. This strategy will provide the development of the conveyance system inventory and proper identification of floodplains.

6. Establish better linkage between watershed management and land use planning.

7. Determine ownership and responsibility for flood management systems.

8. Plan future flood protection programs through multiple efforts and local government coordination.

9. Develop consistent source(s) of funding for the construction and maintenance of flood management systems.

10. Develop public education programs that inform the citizens about floodplains and their importance in protecting residences from flooding and damage.

6-3. Water Quality Conditions

Elevated loadings of nitrogen and phosphorus, which stimulate excessive growth of aquatic plants and drive the process of cultural eutrophication of surface water bodies, have severely degraded water quality in several portions of the Peace River watershed. In general, phosphorus is the nutrient that has the greatest impact on freshwater systems, while nitrogen is of primary concern in estuaries and marine waters. Natural environmental factors and human activities have combined to produce extremely large phosphorus loadings to surface waters in the Peace River watershed, and a number of fresh water bodies in the region have become severely degraded and exhibit hypereutrophic water quality conditions on a year-round basis in response to these loadings. Nutrient-driven phytoplankton blooms occur seasonally in the tidal reaches of the river and in Upper Charlotte Harbor, and periodically cause chlorophyll concentrations to reach levels that would be characterized as hypereutrophic in some estuaries classification systems.

Recommended Actions

In order to address the resource management issues outlined in this plan, the following projects, studies, and other initiatives are proposed as priorities for implementation as part of the District's Peace River CWM program. It is anticipated that these projects will be carried out cooperatively with appropriate federal and state agencies and local governments as funding and staff resources permit.

1. Develop and implement a cost-effective water quality restoration plan for Lake Hancock.

2. Prepare a priority list and time line for the development and implementation of resource-based water quality targets and pollutant loading goals for other significant water bodies, tributary streams, and river reaches within the Peace River watershed.

3. Develop and implement resource-based targets for groundwater discharge and river flow per unit rainfall for all major hydrologic sub-basins within the watershed.

4. Develop and implement hydrologically sound watershed-based reclamation plans for mined sub-basins in the northern watershed.

5. Coordinate with FDEP and US Environmental Protection Agency (USEPA) to develop and implement consistent monitoring and reporting requirements for permitted industrial and domestic point sources.

6. Perform a comprehensive assessment of the water quality impacts of existing point source loadings.

7. If shown to be appropriate, develop and implement pollutant load reduction strategies for existing point source loadings.

8. Develop and implement a coordinated, watershed-wide water quality monitoring program.

9. Pursue strategies directed toward the improvement of water quality in the Winter Haven Chain of Lakes, with emphasis on stormwater treatment and reduction of phosphorous loads.

6-4. Natural Systems Conditions

The Peace River watershed may be one of the most highly-altered watersheds in Florida. Over 63 percent of the total land area of the watershed has been converted from its pre-alteration land cover (Atlas Maps 5 and 6). Agricultural development and phosphate mining account for the direct physical conversion of over 50 percent of the total watershed land area. The nature and extent of land alteration varies somewhat from sub-basin to sub-basin. Some of the larger sub-basins, situated at the southern end of the watershed, still support substantial areas of natural land cover (Atlas Map 16). Sub-basins in the north are generally more highly altered as a result of phosphate mining and retain as little as 4 percent of their historic natural land cover.

The result of the high rate of land conversion taking place in the watershed is a correspondingly high rate of degradation to natural systems and widespread habitat destruction and fragmentation. Extensive modifications to surface hydrology, including the channelization or severance of natural drainage features that historically discharged to the Peace River, have resulted in severe impacts to aquatic communities. The impacts are attributable to declines in both the quantity and quality of water reaching these aquatic communities. Impacts to terrestrial systems have been equally severe. Much of the remaining natural land cover occurs as small, disjunct fragments scattered across a highly modified landscape or as narrow threads of floodplain forest lining the creeks and other small drainages that discharge to the Peace River.

The difficult challenge of maintaining a network of representative, sustainable natural areas within the watershed is exacerbated by a relative absence of protected conservation lands. In the upper watershed, which has borne the brunt of the impacts associated with phosphate mining, a piecemeal approach to mining and reclamation has produced a landscape consisting of a patchwork of reclaimed, unreclaimed, and actively mined lands. The absence of a holistic vision for the final disposition of these lands, including the identification of those that could be dedicated to conservation and fit into a linked network of protected lands, makes the outlook for future natural systems protection in the upper watershed especially problematic. A team permitting approach is being implemented in the review of several new mining proposals and may represent an important advancement in the review of such projects.

The outlook for protection of natural areas in the lower watershed is considerably better. There are a number of protected tracts of natural land that can potentially serve as core habitat areas and retain long-term viability if additional lands are protected to increase the size and preserve the connectivity of these sites. Atlas Map 17 shows the distribution of conservation lands in the Peace River watershed.

A variety of ongoing projects and programs will be employed in efforts to protect and restore the natural systems of the Peace River watershed. The District's SWIM Program, the Charlotte Harbor National Estuary Program (CHNEP), and FDEP's Ecosystem Management Initiative are several of the overlapping efforts with which the CWM effort will be coordinated.

Recommended Actions

1. Promote a comprehensive approach to the restoration of water quality and hydrologic function in the Upper Peace River watershed for the benefit of fish,

invertebrate, and other wildlife populations dependent on the aquatic habitat provided by the river.

2. Establish minimum flow requirements for the middle and upper reaches of the Peace River that meet the water quantity needs of natural systems associated with the Peace River.

3. Through a coordinated approach to land protection, and utilizing a combination of fee-simple and less-than-fee acquisition approaches, ensure the protection of a viable network of linked conservation lands.

4. Include the phosphate mining industry in efforts to preserve a viable network of conservation lands, particularly in the upper watershed, and to promote “whole mine” permitting through a team permitting approach to ensure that future reclaimed lands will retain their hydrologic function.

Chapter 1
Introduction

Peace River – “Old Rattling Bridge” Near Fort Meade
1889
From the Florida State Photographic Collection: Reference Collection

CHAPTER 1. INTRODUCTION

The CWM initiative has been established to improve the management of water and related natural resources within the SWFWMD. This initiative employs a watershed-based approach to resource management, which follows the four AOR defined in the DWMP (2000*b*). The four AOR are water supply, flood protection, natural systems and water quality.

1. WATERSHED TEAMS

Staff from a variety of disciplines and departments make up "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. Team goals include:

1. Collect, integrate and analyze existing information pertinent to each watershed and create a database for analytical purposes.

2. Identify and prioritize existing and future water resource management issues within the District's four AOR.

3. Develop preventative or remedial management actions to address these resource management issues.

4. Identify funding sources and partnerships to support action plan projects.

5. Implement and monitor the effectiveness of selected actions and the overall process, and recommend potential revisions.

CWM represents an evolution in direction for the District, providing the opportunity to enhance coordinated action between the District, local governments and others. It is a science-based approach that utilizes GIS technology and other modeling tools to plan for 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 breadth and variety of issues, but they are simple in intent and design. The plans 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 AOR. Specific and realistic actions to address each issue are presented within chapters associated with each AOR. Completed CWM plans become a part of the DWMP through incorporation by reference. These plans reflect a "snapshot-in-time" for the watershed and will be updated periodically.

The Peace River CWM plan is comprised of two volumes. Volume I is a detailed evaluation of each primary AOR within the watershed. It identifies water resource problems and recommends short and long-term solutions. Volume II will be updated every year and includes strategic action plans for each primary AOR. These plans identify more immediate water management concerns and recommend strategies and programs to alleviate or reduce water resource degradation. Water resource projects are prioritized to guide distribution of funds through the District's cooperative funding program. Each strategic action includes tentative implementation schedules, cost estimates, involved parties, benefits and environmental response monitoring.

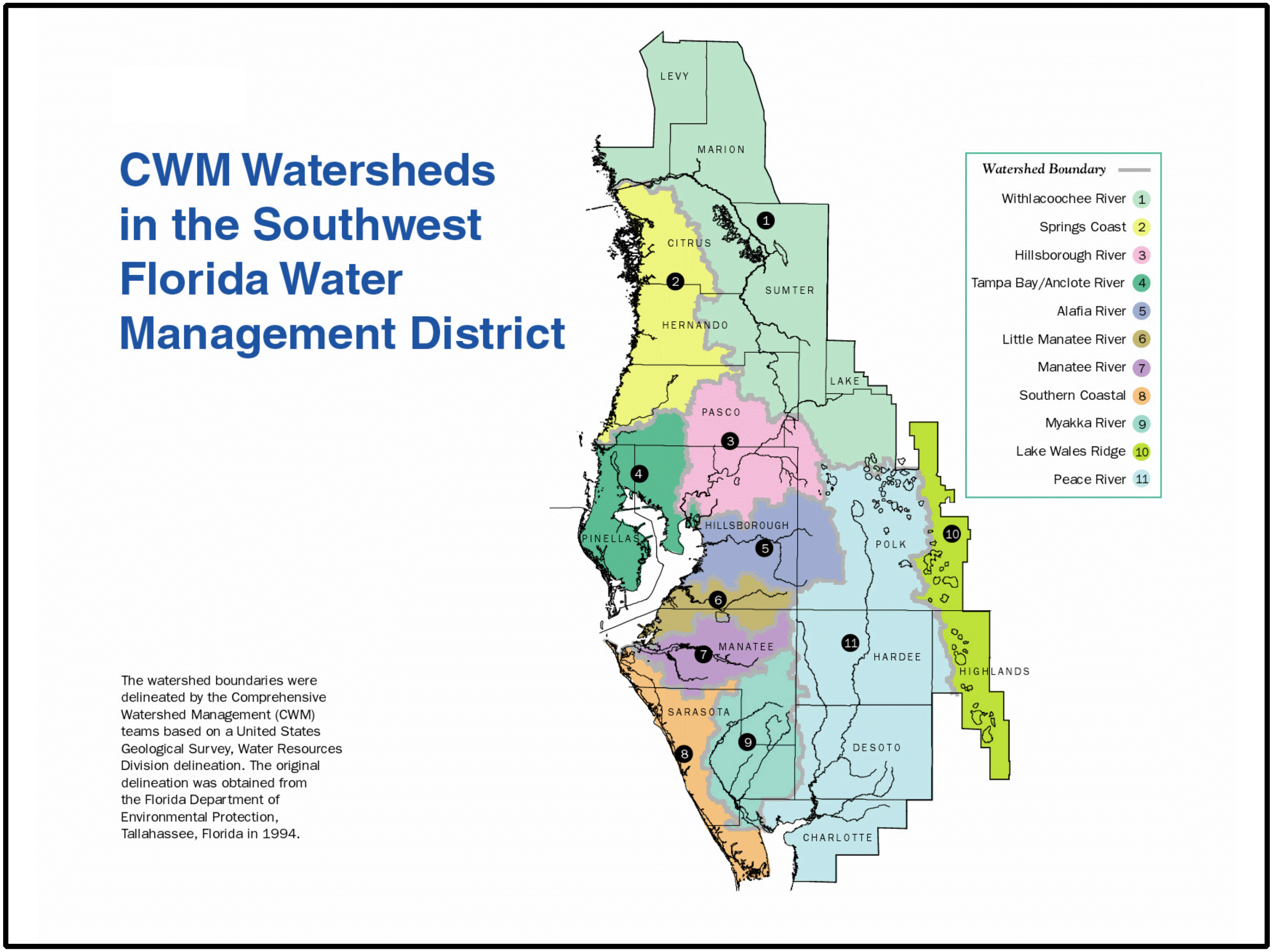


Figure 1-1. Southwest Florida Water Management District CWM Watersheds

2. PEACE RIVER WATERSHED MANAGEMENT GOALS

Goal statements have been developed to focus the District's efforts to enhance, restore and preserve the water resources and natural systems of the Peace River watershed. These goals help provide a sense of direction in making water management decisions in light of evolving and often conflicting priorities.

State Water Policy defines a watershed management goal as "an overall goal which provides the general strategies for the management of water resources within a watershed." It also states that all water management districts shall develop such goals for all watersheds within their boundaries that are consistent with the SWIM program and the USEPA's National Pollutant Discharge Elimination System (NPDES) program.

2-1. Water Supply

The Peace River is a source of potable water. Near its confluence with the river, Shell Creek has been impounded for drinking water, however, withdrawals are relatively small. The Peace River will be used increasingly as a potable water supply source. Since recent information has shown a long-term trend in decreased river flows, it is imperative that this source be protected from overdraft and degradation to ensure its viability into the future.

GOAL: *Maximize water conservation and ensure an adequate supply of water from the Peace River for appropriate reasonable and beneficial uses, now and in the future, while protecting and maintaining water quality and river and estuaries flows.*

2-2. Flood Protection

The headwaters of the Peace River are formed by large marshes or lakes and the river itself has wide floodplains and a meandering main channel. The system is rainfall driven with little influence from groundwater springs. There is tidal flooding along the coast and in the lower reaches of the river. Additionally, the Peace River is crossed by numerous bridges which become potential dams if vegetation jams on pilings impede or halt water flow. Localized upstream flooding can result, as well as damage to the bridge itself.

Flood damage occurs where there is development in flood-prone areas. Retaining natural flood attenuation properties of flood-prone areas and channel conveyance must be the focus of flood protection in this watershed. Significant urban development has already occurred in portions of Polk and Charlotte counties. Local governments authorize land uses so they must, therefore, be the first line of defense in prevention.

GOAL: *Assist local governments to minimize the potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood-prone areas and the river channel.*

2-3. Water Quality

Many surface water bodies within the watershed exhibit fair to poor water quality and are impacted by a variety of point and non-point source discharges associated with development. Others (e.g., Shell Creek, Horse Creek, Joshua Creek and Prairie Creek) currently possess good water quality and are crucial to the maintenance of current and future potable water supplies. The worst water quality problems originate in the upper portion of the watershed.

Lake Parker, Lake Hancock and their tributaries have some of the poorest water quality in the State. In addition, there are identified contaminant plumes in the area's groundwater which may pose a future surface water threat.

GOAL: *Protect and restore water quality of lakes in developed areas, the Peace River, and coastal and recharge areas through implementation of SWIM and other management plans, by working with local governments and the public, and enforcement of regulations.*

2-4. Natural Systems

This watershed begins in the Green Swamp, which has been officially designated an Area of Critical State Concern in response to the area's importance to water management and the threat posed to it by encroaching urbanization. Some of the finest remaining examples of scrub habitat exist in the Peace River watershed, along with significant riverine floodplains, expanses of dry prairie and a variety of other natural community types. In addition to providing habitat to numerous species of wildlife, these areas provide important groundwater recharge; flood protection through the natural storage and detention of flood waters; maintenance and enhancement of water quality; and potable water supplies used to meet the public's water needs. Much of the river corridor itself has been spared the effects of development and continues to support natural stands of floodplain forest.

Major urban areas in the upper watershed include Lakeland, Winter Haven and Bartow. Land use is predominantly agricultural. A large percentage of barren land (about 25 percent) is a remnant of extensive phosphate mining activities. Shell and Prairie creeks, along with the Shell Creek Reservoir, support excessive growths of water hyacinth and water lettuce. These species are also prevalent in the river channel.

The Charlotte Harbor estuary lies at the downstream end of the Peace River and is heavily dependent on freshwater inflow from the Peace and Myakka rivers. Mangroves and salt marsh grow along shorelines in the lower reaches of the watershed and reflect the estuaries conditions that occur due to the saltwater-freshwater interface. These estuaries communities, together with extensive seagrass meadows, make the watershed an extremely productive nursery for marine life. Most of Charlotte Harbor (Pine Island Sound, Matlacha Pass, Gasparilla Sound and Cape Haze) is a designated aquatic preserve in recognition of their outstanding natural values.

GOAL: *Protect, preserve and restore important upland, wetland and estuaries systems, including areas of the Green Swamp and scrub ecosystems where feasible. Establish and maintain minimum flows in the Peace River to ensure the health of Charlotte Harbor.*

3. COORDINATION WITH LOCAL GOVERNMENTS AND OTHER AGENCIES

Teamwork is a significant element of the CWM initiative. This is achieved through coordination between local governments and the District. The District and local governments share the premise that resource management incorporates the desire for sustainability. Scientific knowledge serves as the backbone to this process and allows us to achieve the desired watershed condition (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 CWM team will have active participation by the local governments within their watershed. This will include 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 FDEP, Florida Department of Agriculture and Consumer Services (FDACS), the Florida Fish and Wildlife Conservation Commission (FFWCC), regional planning councils, US Army Corps of Engineers (USACOE), National Estuary Programs (NEPs), 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 continues. It allows rational and logical resolution of problems based on science. Integrated plans are developed with actual implementation of strategies involving multiple parties.

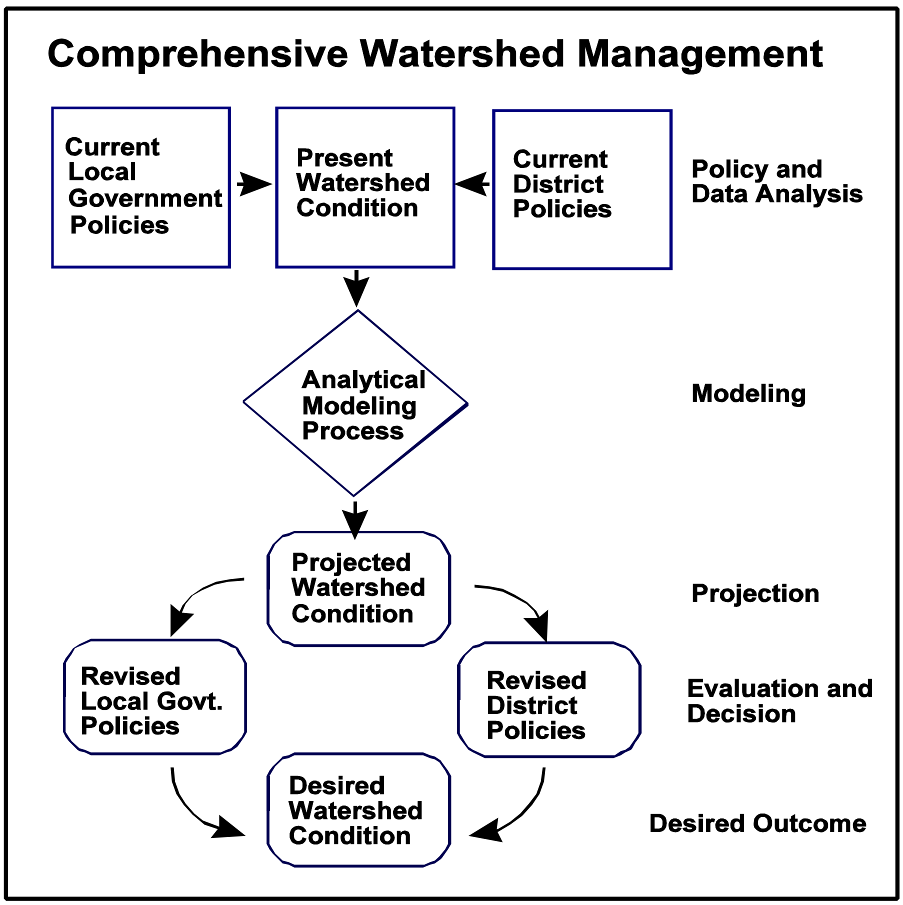


Figure 1-2. Sustainability Through Science

4. FUNDING COMMITMENTS

The District, in partnership with local, State and Federal governments, currently supports many significant water and related natural resource management projects and initiatives within each watershed. These efforts currently contribute to effective management of water and related natural resources. Figure 1-3 summarizes the District's current efforts for the eleven primary watersheds as of FY 2000. This figure shows the types of projects and initiatives being funded, and the estimated sources of revenues. A total of approximately $896 million in water and related natural resource management projects, wholly or partially funded by the District, are currently underway within these watersheds. Of this amount, approximately $61 million is designated for Peace River watershed projects (Figure 1-4). This does not include the many other resource management activities undertaken by local governments, the FDEP and others.

5. IMPLEMENTATION

Each watershed management team has suggested specific and realistic actions and tasks. Recommendations that the District is responsible for implementing are prioritized by a District senior management team (Steering Committee). 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 programs. Projects are reviewed and ranked by the CWM team, and funding recommendations are generated.

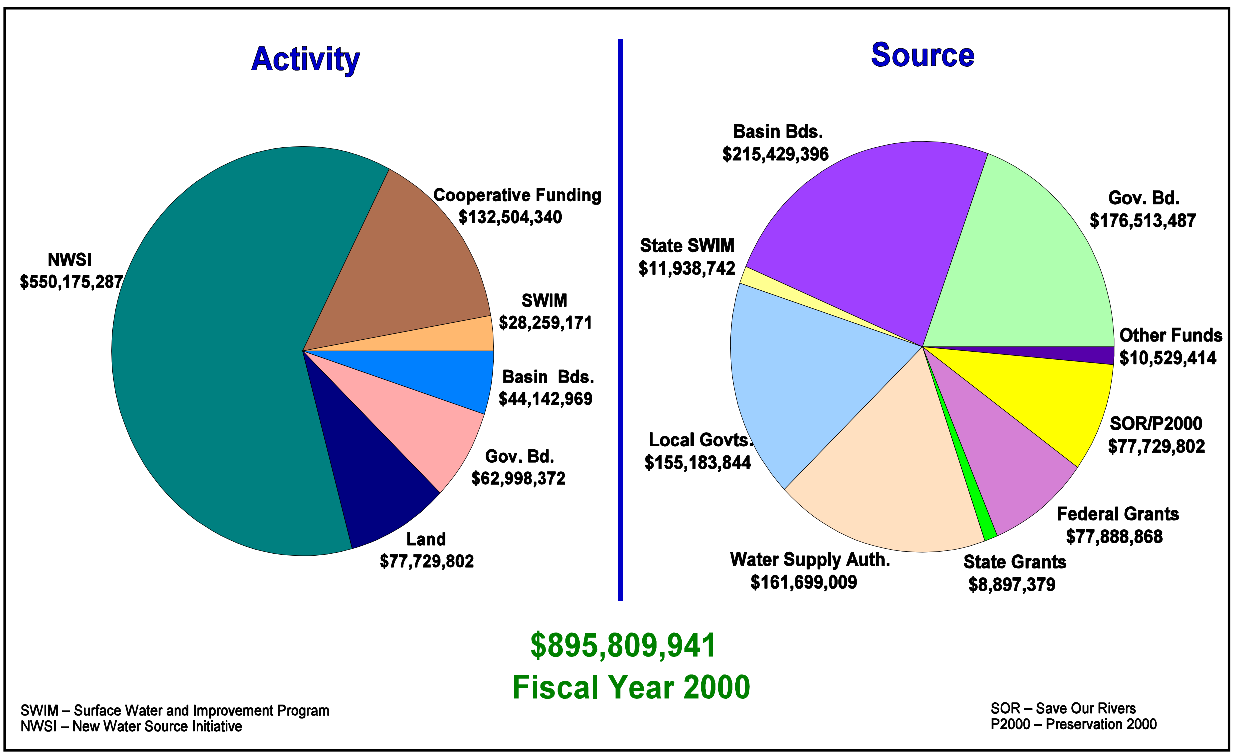


Figure 1-3. Fiscal Year 2000 Estimated Water Resources Funding by Activity and Funding Source

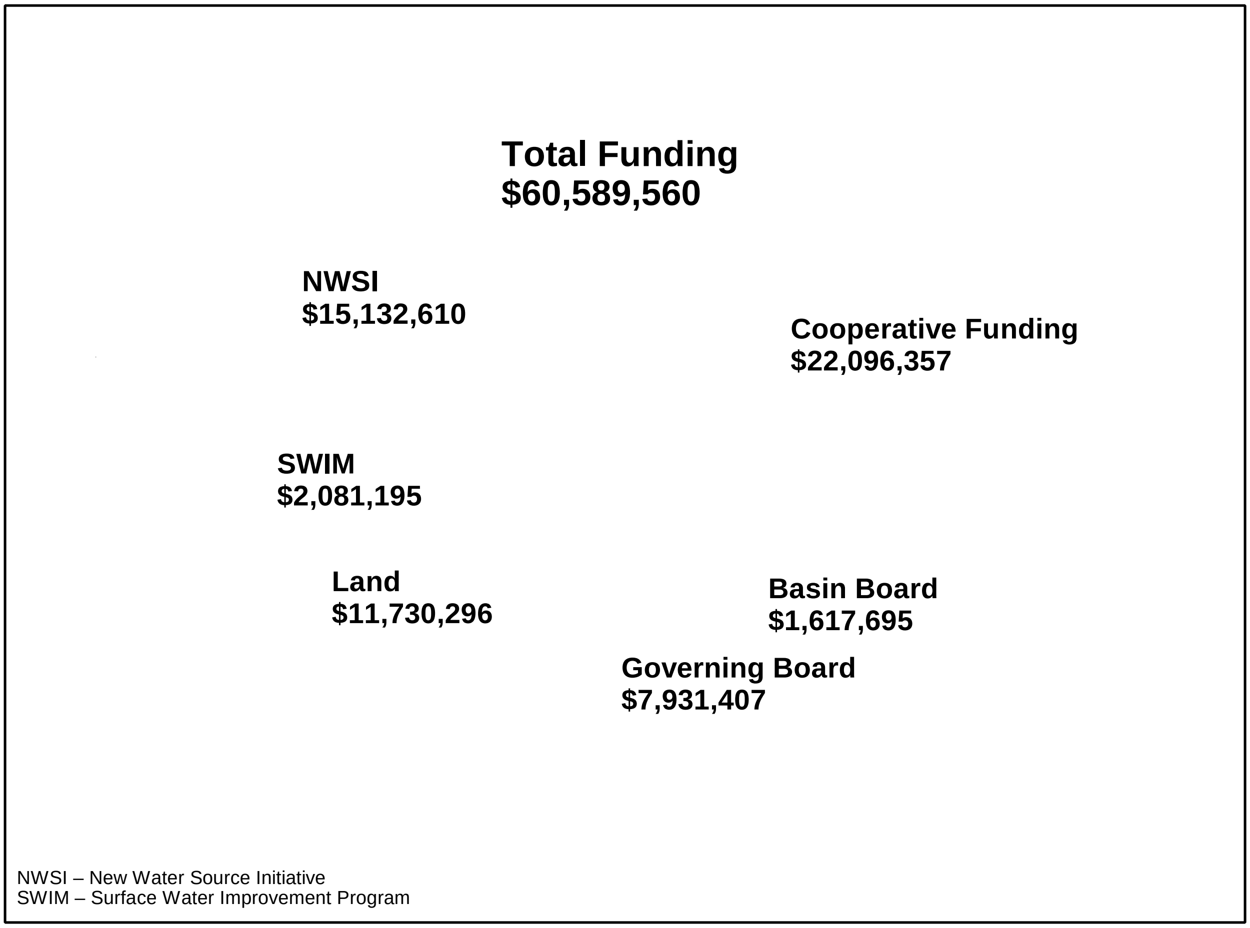


Figure 1-4. Peace River CWM Estimated Water Resources Funding by Activity for Fiscal Year 2000

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 these collaborative CWM planning efforts.

CWM teams will review the implementation of recommended actions on a regular basis. These teams will report on implementation status for the Annual Report on the DWMP and provide a brief summary for each watershed. This information will be used within the Basin Board Five-Year Plans and in District accountability and performance reporting.

6. FUTURE OF CWM - A WATERSHED-BASED PARTNERSHIP APPROACH

One of the most significant tools available to watershed teams is the District's GIS. 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 groundwater 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 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 CWM initiative represents an evolution in direction for the District. It provides 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 plan will reflect progress made in further developing this GIS-based partnership approach.

7. WATERSHED MANAGEMENT STRATEGIES

This section lists some water resource management tools currently used by the District to monitor, regulate and manage water resources. It is by no means exhaustive or complete. It does, however, represent a majority of the options currently available and feasible for the District. Of the strategies described in this section, the watershed management teams will give special attention to the Five-Year Basin Plan. The Five-Year Plan is particularly well suited for implementing watershed management recommendations. The Basin boards are responsible for many of the programs and projects needed to address watershed management issues. The Five-Year Basin Plan is action oriented, and it details specific projects and funding recommendations. CWM Plan recommendations will be given high priority and will be integrated into the Five-Year Basin Plans as they are updated.

8. DISTRICT RULES

Rule improvements and implementation methods may be suggested in the watershed management plans. Recommendations for rule revisions, however, will likely be a lower priority than other potential strategies to implement the plans.

8-1. Environmental Resource Permit

Environmental Resource Permits (ERPs) combine wetland resource permitting and Management and Storage of Surface Waters (MSSW) permitting into a single process in an effort to streamline permit procedures. It provides for management of water and related environmental resources by promoting the conservation, development and proper use of surface and groundwater (including water storage for beneficial purposes). The ERP process also helps prevent damage from floods, soil erosion and excessive drainage; protects wetlands, fish and wildlife and other natural resources; and promotes recreational development. The District has implemented the ERP program by adopting Chapter 40D-4, Florida Administrative Code (FAC).

8-2. Water Use Permit

The primary existing regulatory program at the District for water supply management is the water use permit (WUP) program contained in Chapter 40D-2, FAC. The District's WUP program was initiated in the 1970's in response to passage of the Water Resources Act, which gave the water management districts exclusive authority to regulate water uses within the State. All significant water uses within the District are now regulated by this rule. The rule was modified in 1989 to address cumulative and on-site impacts, minimum flows and levels (MFLs), impacts to known sources of groundwater contamination, and monitoring of agricultural water use.

8-3. Well Construction Permit

Well construction permitting is one of the primary regulatory means by which the District protects ground (and surface) water sources from degradation while protecting the quality of water for potable uses. District rules relating to well construction practices and water well contractor licensing are contained in Chapter 40D-3, FAC and include FDEP rules incorporated into 40D-3, FAC by reference. These rules were created to ensure water wells and test or foundation holes within the District are located, constructed, maintained, used and abandoned in a manner that protects the water resource.

9. WATER RESOURCE ASSESSMENTS AND WATER USE CAUTION AREAS

Intensive data collection and analysis was initiated in the mid to late 1980s to respond to observed long-term declines in hydrologic conditions in three geographic regions of the District. These resource studies are referred to as Water Resource Assessment Projects (WRAPs). The three study areas are the Highlands Ridge, Eastern Tampa Bay and Northwest Hillsborough WRAPs. In addition, a WRAP was initiated to address the entire SGWB of the District. This analysis was designed to ascertain the extent of the problem and identify probable causes. This information is used to develop modifications to existing resource management programs or to develop new programs to properly manage resources.

These studies provide the technical data and analysis that must be considered to determine safe yield for each area. Safe yield is defined by the DWMP as the amount of water that can be withdrawn without producing unacceptable impacts (SWFWMD 2000*b*). Once determined, the existing management programs established within each area will be modified as necessary.

Groundwater levels have been heavily impacted due to increased groundwater withdrawals (SWFWMD 1993). These declines have contributed to declines in lake levels on the Lake Wales Ridge and the landward movement of the saltwater interface in the Eastern Tampa Bay Water Use Caution Area (ETBWUCA).

Given these conditions, the District established the SWUCA in October 1992 in response to the regional declines in the potentiometric surface[1]. The Peace River watershed accounts for about 46 percent of the land area of the SWUCA, which encompasses approximately 5,100 mi^2. Additionally, in 1996, groundwater use in the Peace River watershed comprised about 48 percent of the total groundwater use (627 million gallons per day (mgd)) and 24 percent of the total used (99 mgd) in the SWUCA. A much more detailed explanation of the SWUCA and current management strategies are provided in the Water Supply chapter of this plan.

[1]The potentiometric surface that represents the level to which water will rise in tightly-cased wells (Fetter 1988).

10. LAND ACQUISITION AND MANAGEMENT

It is widely recognized that public ownership is one of the most effective means of preserving Florida's remaining natural systems and their associated water resource benefits. 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 two major statewide initiatives: The Water Management Lands Trust Fund (Save Our Rivers or SOR) and Preservation 2000 (P2000). These programs target 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. According to the District's Five-Year Land Acquisition Plan, the District has acquired over 292,000 acres for fee and 66,000 acres for less-than-fee (SWFWMD 2001). The majority of these lands were purchased through the SOR and P2000 programs.

10-1. Land Use and Management Assessments

To ensure that the natural values of District-owned lands are preserved, the District conducts more definitive 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.

10-2. Land Use and Management Planning and Implementation

The SOR statute (s. 373.59, *Fla. Stat.*) requires that lands acquired through the program be managed in an environmentally acceptable manner that serves to preserve and/or restore their natural condition. Public land uses that are compatible with the preservation and restoration and that are consistent with the water management purposes for which the lands were acquired are permitted. These land uses consist largely of resource-based recreation. The District prepares 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. All plans are ultimately accepted by the Governing Board.

The District prefers to coordinate with the appropriate government agencies to develop public recreational use on District lands. The District enters into agreements (primarily with local governments) to provide recreational opportunities, provided that those entities fund, develop, operate and maintain the facilities in a manner compatible with the purposes for which the lands were acquired.

Public awareness of the critical need to protect, conserve and preserve water resources within the State is of primary concern to the District. For this reason, the District has promoted the use of its lands for environmental education programs to raise awareness. Agreements for scientific study with various research organizations have also been negotiated to assess natural resources on District lands.

The District has entered into wildlife management area agreements with the FFWCC on four of its land holdings. The wildlife management areas cover approximately 68,000 total acres and provide significant sport hunting and fishing opportunities to the public while providing the

District with wildlife management and law enforcement assistance. The District also enters into agreements with law enforcement officers to provide security patrol on these lands. Other important management activities on District lands include control of exotic plants and animals, prescribed burning of fire-dependent ecosystems, fencing, road and bridge maintenance and restoration of altered ecosystems.

11. DATA COLLECTION AND ANALYSIS

The District has many data collection, research and analysis programs that support water supply, water quality, flood management and natural systems protection responsibilities. These programs include wellfield monitoring, stormwater research and the Supervisory Control and Data Acquisition system. The programs will be assessed through the CWM initiative. The CWM plans will identify databases, relationships between data collection initiatives, information redundancies or deficiencies. Recommendations will be made, as applicable, to improve data collection and analysis.

12. LOCAL GOVERNMENT PLANNING ASSISTANCE

The Local Government Comprehensive Planning and Land Development Regulation Act (the Act) requires local governments to prepare and adopt comprehensive plans that address specific public services. Future protection and use of water resources is a service for which long-range comprehensive planning is mandatory. The Act requires local governments to protect potable water wellfields (Atlas Map 12) and environmentally sensitive lands, regulate flood-prone areas and provide drainage and stormwater management. District staff provides input to the preparation of local government comprehensive plans. The District also subsequently reviews and comments on plan amendments in an advisory capacity for the Department of Community Affairs, which conducts a compliance review for consistency with the Act and with the State Comprehensive Plan.

The District provides technical assistance services (e.g., Technical Information Planning Series, local water atlases, etc.) and maintains regular communication with the 98 local governments through its Planning and Community Affairs staff, Regional Service Offices, advisory committees and other devices. The District also assists local governments through review and technical assistance on local issue papers, draft ordinances and land development regulations.

These multiple outreach efforts frame the context within which the Action Plans associated with each AOR will be developed. The projects under each AOR reflect the District's coordination with specific local governments and others to meet their water resource management needs. Projects considered for inclusion in the plan range from large-scale, regional projects (e.g., New Water Sources Initiative (NWSI)) to mid-scale projects (e.g., water conservation initiatives through local utilities). Public and in-school education are the continuing, underlying support elements that ensure the continued success of these partnerships.

13. NEW WATER SOURCES INITIATIVE AND ENVIRONMENTAL PARTNERSHIP

The NWSI is an innovative financial assistance and water supply planning program established in 1993 by the District to promote increased use of alternative sources. New sources of water are needed to ease demand, particularly on stressed groundwater resources. District studies indicate lowered groundwater levels have impacted lakes on the Highlands Ridge and contributed to saltwater intrusion on the coast, posing serious long-term water supply and resource concerns.

To reduce reliance on groundwater, the NWSI funding program focuses on regional alternative water sources. Examples of alternative sources include reclaimed wastewater, stormwater reuse, surface water, ASR and seawater desalination.

Beginning in FY 1994, the District's Governing Board allocated $10 million per year for eligible NWSI projects. The Basin boards have also contributed to a combined total of approximately $10 million per year since FY 1995. Local governments and other cooperators will collectively provide a match to District and Basin funds. Typically, eligible NWSI projects receive 25 percent of their funding from the District Governing Board, 25 percent from the appropriate Basin boards and the remaining 50 percent from the local cooperators. The Basin Board contribution may be split among one or more basins, depending on the geographical area and population served by the project. Individual Basin Board contributions may vary, but they are proportional to the share of benefits received in the basin.

Each year local cooperators submit project proposals to the District through the Basin's Cooperative Funding program. These project proposals are reviewed for possible NWSI funding consideration. This review includes input from the statutorily required Alternative Water Supplies Grants Advisory Committee, established by the District in 1995. Proposed projects are evaluated and compared using a set of criteria that reflect District priorities for NWSI projects. The NWSI criteria are grouped into qualification criteria and prioritization criteria. Projects are assigned scores for each of the criteria and are ranked based on their comparative scores. All projects must meet the qualification criteria to be eligible for NWSI funding. The qualification criteria are: (1) positive environmental results; (2) cooperator history; (3) consistency with the DWMP and local comprehensive plans; (4) project permittability; and (5) project schedule.

The prioritization criteria are: (1) degree to which the stress on the water resource will be relieved or avoided by the project; (2) location of the project relative to designated Water Use Caution Areas (WUCAs); (3) cost-effectiveness; (4) degree to which the project addresses District initiatives other than water supply (i.e., flood control, water quality and natural systems); (5) degree of local/regional support and participation; and (6) additional efforts by the cooperator which would enhance the long-term impact of the project.

New alternative water sources will help reduce groundwater pumping impacts in the District. These alternative sources will also help reduce the need for further groundwater development in the southern part of the District.

To offset the reductions in groundwater pumpage, the District's Governing and Basin boards are contributing $100 million to a trust fund for alternative source projects that will generate an additional 85 mgd annual average by December 31, 2007. In addition to funding those alternative source projects, the District's Basin boards will be contributing an additional $90 million over ten years to co-fund, on a 50/50 basis, demand management conservation projects.

14. BASIN BOARD INITIATIVES

The Basin Board's planning priorities and funding allocations provide the guidelines for District staff and local cooperators to develop specific water resource management projects. District staff works with local cooperators to link their local planning and project needs with the Board's traditional annual funding process. These traditional funding categories have included Basin initiatives that are usually recommended by District staff or by individual Basin Board members.

Such initiatives include, in part, SWIM, Regional Observation Monitoring Program (ROMP), Quality of Water Improvement Program (QWIP), Water Quality Monitoring Program (WQMP), and the NEP.

15. BASIN BOARD COOPERATIVE FUNDING PROGRAM

The Cooperative Funding program encourages local cooperators, primarily local governments, to submit requests for the joint funding of projects that are mutually beneficial to both the cooperator and the District. District staff implements the Cooperative Funding Program on the basis of Governing Board Policy 130-4 and District Procedure 13-4. These Policies and Procedures formalize the responsibilities and requirements that District staff, local governments and other entities must adhere to if they wish to participate in the funding program. Local government project requests are evaluated using the following six criteria:

1. consistency with the DWMP, including the District's Needs and Sources Plan;
2. consistency with the appropriate Basin Plan;
3. regional or multi-governmental in scope;
4. inclusion of the project in the local government comprehensive plan;
5. affect on current and future District programs and manpower allocations; and
6. applicant's past performance on similar cooperative projects, or ability to carry out the project.

This approach ensures fairness in project selection and that the best possible projects are recommended for funding. District staff conducts annual workshops in each county for potential Basin funding applicants. Deadlines for submittal, review and final action have been established by a Basin Plan Cooperative Funding Schedule.

16. FIVE - YEAR BASIN PLANS

The Basin boards fund projects that help implement the District's mission, goals and strategic objectives. The Board also advises the Governing Board on local water management concerns. Thus, it is the Basin Board's responsibility to apply their awareness of local water management needs to the District's regional goals and objectives. It is in the art of integrating these two perspectives that Basin Board priorities are established.

The Basin Plans address the Boards' water resource management needs and priorities and recommend work programs to address those priorities over five fiscal years. District staff has worked closely with the boards, local governments and the public to identify water resource projects for inclusion in the Basin Plan. This multi-year planning approach provides a degree of certainty for the boards and local governments as they prepare their local comprehensive (and related) plans. The plans are not self-executing. Implementation requires annual budgetary and contractual approvals by the boards and the plan is subject to annual revision by the boards. The Basin boards' five-year Basin planning approach reflects the following cyclical stages:

1. The Basin Board considers and endorses water resource management issues and priorities through an annual planning workshop that includes updating of the

Basin Board's Five-Year Plan to reflect current budget decisions and emerging issues.

2. Based on those annually established priorities, the Board targets funding allocations for each of the five program categories or "Action Plans" that address the Board's priorities.

3. District staff develops Basin Initiatives and works with local cooperators to identify Cooperative Funding and NWSI project proposals for the Action Plans.

4. The Basin Board annually budgets the specific program and project proposals within the Action Plan that best address its management priorities.

The Five-Year Basin plans seek to better coordinate and link the Basin Board's water resource planning with local comprehensive land use and infrastructure planning. This land and water linkage effort is one of several that the District is pursuing to better assist local governments in meeting their water resource planning needs, while assuring the District is playing an appropriate, supportive role in growth management.

Chapter 2
Watershed Overview

Peace River Between Gardiner and Zolfo Springs – 1929
From the Florida State Archives Florida Photographic Collection: Florida Geological Survey Collection

CHAPTER 2. WATERSHED OVERVIEW

1. INTRODUCTION

This chapter highlights major features of the watershed including its physical and climatic conditions, demographic and economic characteristics, land use effects and growth management regulations. It also identifies potential water resource concerns with respect to the region's potential future land development activities. The human impacts described in this and subsequent chapters demonstrate the importance of water management initiatives detailed in Volume II.

2. LOCATION

The Peace River watershed (Atlas Map 1) includes portions of the cities of Lakeland, Auburndale and Haines City to the north and stretches south near the city of Cape Coral in Lee County. Its western boundary includes portions of Hillsborough, Manatee and Sarasota Counties and incorporates portions of Highlands and Glades Counties to the east. The watershed encompasses major portions of Polk, Hardee, DeSoto and Charlotte counties and covers an area of approximately 2,400 mi^2.

3. CLIMATE

The climate of the area is subtropical and humid, with an average annual temperature of approximately 72°F and average annual rainfall of approximately 52 inches. More than 50% of the total annual rainfall typically occurs during the summer rainy season that extends from June through September. November is typically the month of lowest rainfall, although stream flows, lake stages and groundwater levels tend to reach annual lows in April and May due to a combination of low rainfall and high evapotranspiration rates (Hammett 1990). Freezing temperatures occur occasionally but are not common. Temperatures in coastal areas are moderated by the influence of the Gulf of Mexico and Charlotte Harbor. Temperature extremes tend to occur in inland portions of the watershed.

Tropical storms and hurricanes produce the most severe weather in the area. High tides and heavy rains cause flooding in low-lying areas adjacent to the coast and the tributary streams. Weather is the fundamental factor influencing coastal environments. For example, barrier islands have been completely overtopped by the tide, and passes have opened and closed as the result of severe storms. During the period 1871-1973, tropical storms and hurricanes made an average of two landfalls per 100 years per 10 nautical miles of coast in the Charlotte Harbor area (Hammett 1990).

4. PHYSIOGRAPHY

The three major physiographic provinces present in the Peace River watershed are the Polk Upland, the DeSoto Plain and the Gulf Coast Lowlands (White 1970). These general regions have been subdivided into the Bone Valley Uplands, DeSoto Slope and Barrier Island Coastal Strip (see Figure 2-1) (Brooks 1981). The physiographic boundaries generally correspond to paleoshorelines (ancient shorelines). A paleoshoreline at the 100-foot elevation separates the upland regions from the plain, and the 30-foot elevation separates the plain from the low coastal region (Lewelling and others 1998).

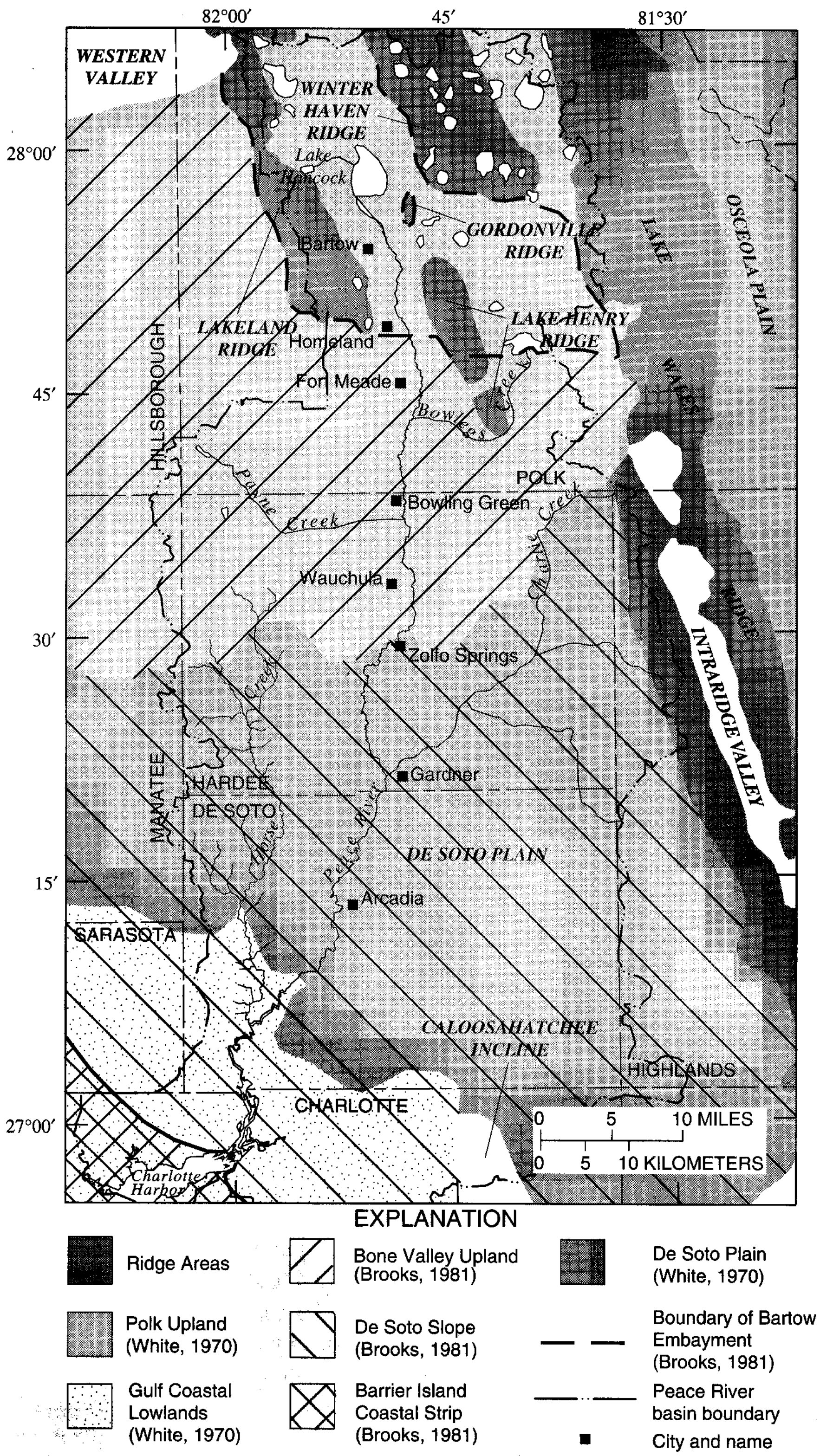


Figure 2-1. Regional Physographic Features of the Peace River Watershed (Modified from White 1970 and Brooks 1981.)

The physiography of the Peace River watershed ranges from an internally drained lake district with highland ridges in Polk County, to a poorly-drained upland that extends into the northern half of Hardee County, to a broad, gently-sloping plain with well-developed surface drainage in southern Hardee and most of DeSoto Counties. The Bartow Embayment, which extends from above Lake Hancock to directly north of Homeland, is an internally drained, local, erosional basin that has been partially infilled with phosphate-rich siliclastic deposits (Brooks 1981). The Polk Upland (White 1970) extends south from Homeland to Zolfo Springs, and it corresponds to the Bone Valley Uplands defined by Brooks (1981). Polk Upland land surface elevations are generally greater than 130 feet above sea level. The area contains flatwoods, wetlands and lakes that occupy a poorly-drained plateau underlain by deeply weathered sand and clayey sand of the Bone Valley Member of the Peace River Formation. Natural drainage upstream of Bowling Green has been altered by area phosphate mining activity. The DeSoto Slope (Brooks 1981), or the DeSoto Plain (White 1970), consists of wet prairie, swamp, and flatwoods with a well-developed surface drainage system. The Gulf Coastal Lowlands (White 1970) and the Barrier Islands Coastal Strip (Brooks 1981) are located where the Peace River discharges into the Charlotte Harbor Estuary.

Portions of the watershed contain abundant phosphate deposits in the surficial and intermediate aquifer systems (primarily in the Bone Valley Member). Mining and processing of phosphate deposits have taken place in the Upper Peace River watershed since the late 1800s.

5. HYDROLOGY

The Peace River watershed covers an area of approximately 2,400 mi^2, of which 2,020 mi^2 is monitored by US Geological Survey (USGS) stream gages located at Arcadia, Horse Creek, Joshua Creek and Shell Creek. The headwater tributary streams occur in northern Polk County, with the river itself beginning at the junction of Saddle Creek and the Peace Creek Drainage Canal near Bartow.

The river flows generally southward for about 75 miles (through Polk, Hardee, DeSoto and Charlotte Counties) and discharges into the northeastern portion of Charlotte Harbor near the city of Punta Gorda. Land surface elevations range from more than 200 feet above mean sea level near the headwaters to sea level at the river mouth. Upstream of Arcadia, the channel of the Peace River is generally well defined. Below Arcadia, however, the channel becomes braided, and the width of the floodplain increases substantially, exceeding a mile in some places. Tidal influences have been observed during periods of low flow as far as five miles upstream from Fort Ogden. During periods of low river flow the system is tidally influenced from Fort Ogden to the mouth (Hammett 1990). However, tidal influences may have occurred further upstream in 2000 and 2001 due to extreme drought conditions.

The mined lands encompass about 130 mi^2 or approximately 5.5% of the total watershed area. These areas tend to retain initial rainfall volumes and provide surface discharge only after internal storage areas are filled. Additionally, many of these areas have controlled and permitted point source discharge outfalls. Subsequently, freshwater flows from many of these internally-drained sub-basins consist of significant quantities of industrial point source discharges (Coastal Environmental, Inc. 1995*a*).

Flows in the Peace River have been impacted by a variety of factors including long-term variations in rainfall; land-use activities that have altered surface hydrology patterns; and groundwater withdrawals that supply industrial, agricultural and municipal water use needs. The river flows freely over its entire reach. Two tributaries have regulated flows, however, including a control structure (P-11) located on Saddle Creek south of Lake Hancock and a dam at the city of Punta Gorda's water supply reservoir on Shell Creek. The primary water withdrawals are made from the river at the PR/MRWSA water plant located south of Arcadia.

6. HYDROGEOLOGY

Three distinct hydrogeologic units occur in the Peace River watershed. They are the (1) unconfined surficial aquifer, (2) confined intermediate aquifer system and (3) confined Upper Floridan Aquifer (see Figure 2-2). The intermediate aquifer is bound by an upper and lower confining unit. In central Polk County, the intermediate aquifer system is thinner, less permeable and is referred to as the intermediate confining unit (Lewelling and others 1998).

6-1. Surficial Aquifer

The surficial aquifer, the unconfined and uppermost aquifer, ranges in thickness from a thin veneer of sand to greater than 50 feet. It is composed of undifferentiated sands, clay and shell. The quartz sand, which is generally uniform throughout the unit, grades to clay with depth as the surficial aquifer system approaches the intermediate aquifer system's upper confining unit.

The surficial aquifer is mainly recharged by rainfall, and the depth to water averages five to ten feet below land surface. However, the water table is exposed along river cut banks or is at land surface within the swampy floodplain and adjacent lowlands. The head gradient of the surficial aquifer is generally toward the river and the confinement between the surficial and intermediate aquifer is well established.

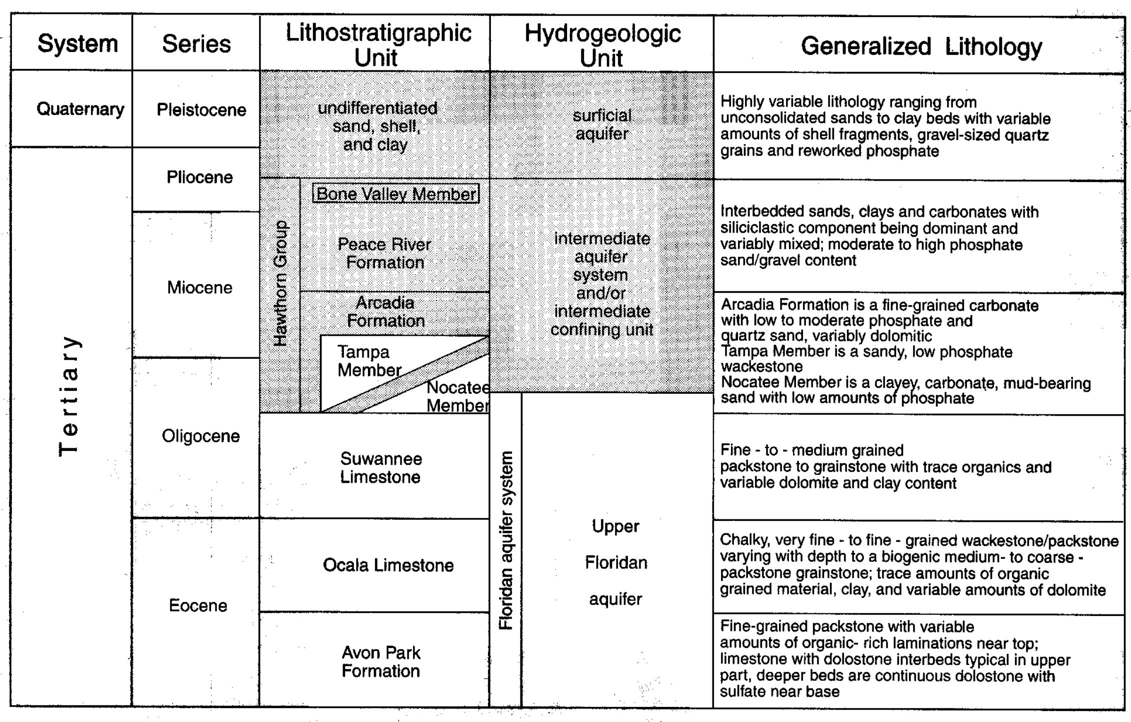


Figure 2-2. General Hydrogeologic Column for Units in the Peace River Watershed (From Covington 1993; Missimer and others 1994; Scott and others 1994; and Wingard and others 1994.) Shaded area corresponds to units that may be exposed within the Peace River Watershed. (Modified from Tihansky and others 1996.)

6-2. Intermediate Aquifer

The intermediate aquifer and its confining units occur within the Hawthorne Group (see Figure 2-2), which ranges in thickness from 50 to greater than 250 feet. The dominant geologic formations within the Hawthorn Group are the Peace River and Arcadia Formations. The lithology of the Hawthorn Group is variable and generally consists of gray to green to brown phosphate clay, minor sand, with occasional thin layers of residual limestone and dolostone.

The Peace River Formation forms rock ledges or outcrops within the floodplain and streambed. The Bone Valley Member is the upper unit of the Peace River Formation. It is the clayey and phosphate-rich object of mining activities (Lewelling and others 1998).

The confining units present in the intermediate aquifer system retard the movement of water between aquifers. Generally, the upper and lower confining units are thinner near the Peace River (Metz 1995). The intermediate aquifer is generally thicker and more confined toward the southwest.

Groundwater has the potential to move upward in areas where the potentiometric surface in the underlying aquifer is above the water table of the surficial aquifer. It has the potential to move downward where the potentiometric surface of the underlying aquifer is lower than the water table. September 1988 data (Metz 1995) show the potential for upward leakage through the upper confining unit in areas near Peace River, Charlie Creek, Prairie Creek, Shell Creek, the southern reach of Horse Creek and the southwestern reach of Joshua Creek (see Figure 2-3). The potential for downward leakage occurred through the upper confining unit in the remainder of the areas shown on Figure 2-3. Yobbi (1996) determined the head potential in September 1989 was downward from upstream of Bartow to the Polk-Hardee County line (see Figure 2-4). From the Polk-Hardee County line to south of Arcadia, leakage was upward. Location and aquifer response depends on annual and seasonal variations in water use, rainfall and recharge.

6-3. Upper Floridan Aquifer

Carbonate units that make up the Upper Floridan Aquifer are the permeable Lower Hawthorn Group, Suwannee Limestone, Ocala Limestone and Avon Park Formation. The total thickness ranges from 1,200 to 1,400 feet in the Peace River watershed. Dissolution of the limestone and dolomite enlarged preferential flow zones and structural features such as joints and fractures. Hydraulic characteristics of the Upper Floridan Aquifer vary widely due to the heterogeneity of the aquifer (Lewelling and others 1998).

According to Lewelling and others (1988) groundwater movement in the Upper Floridan Aquifer is generally from the northeast to southwest through Polk, Hardee and DeSoto counties. In 1995, the general flow direction in DeSoto County shifted to a more northwesterly direction. It was influenced by large depressions in the Upper Floridan potentiometric surface caused by groundwater withdrawals in Sarasota and Manatee counties. Atlas Map 11 shows areas of Floridan Aquifer recharge and discharge.

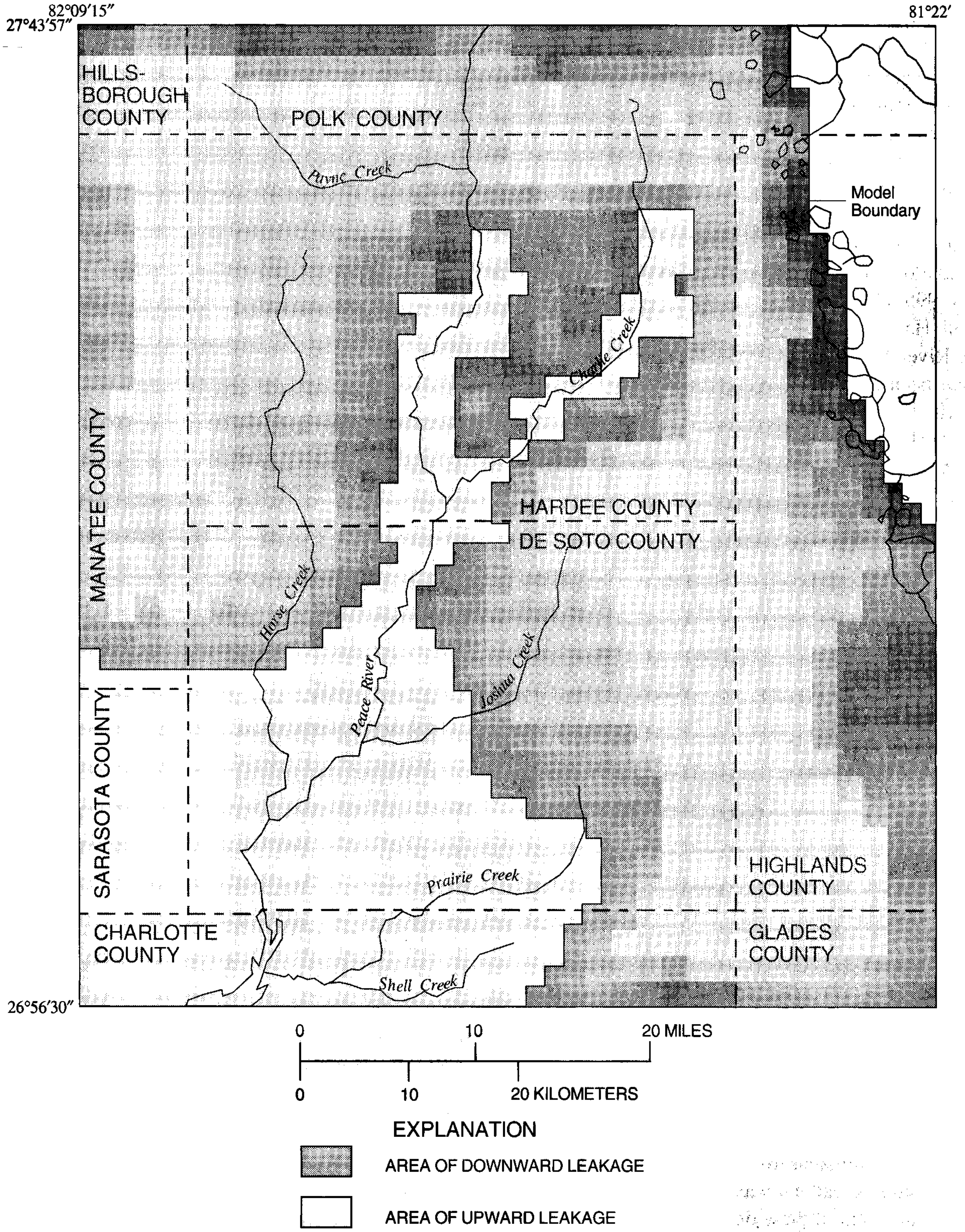


Figure 2-3. Areas of Upward and Downward Leakage through the Upper Confining Unit of the Intermediate Aquifer System, September 1998 (Modified from Metz 1995.)

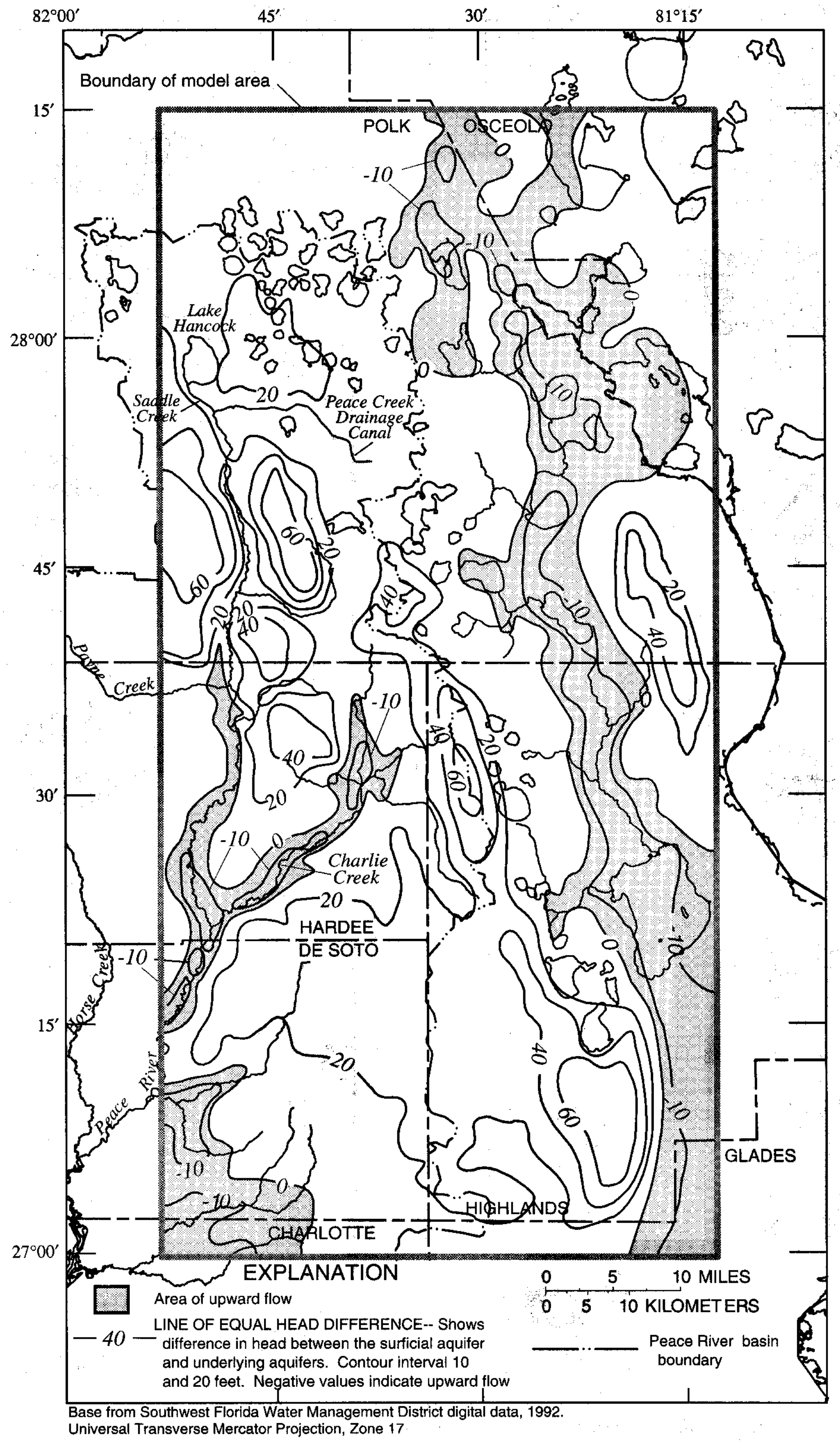


Figure 2-4. Head Difference between the Surficial Aquifer and Underlying Aquifers and Areas of Upward Flow, September 1989 (Modified from Yobbi 1996.)

7. GROUNDWATER-SURFACE WATER INTERACTION

Lewelling and others (1998) described hydrologic characteristics indicative of three segments of the Peace River. Those segments were from Bartow south to Fort Meade, Fort Meade south to Zolfo Springs and Zolfo Springs south to Arcadia.

Currently, the Peace River from Bartow to Fort Meade is characterized as a groundwater recharge area. Groundwater moves from the Peace River and the surficial aquifer into the intermediate aquifer system and into the Upper Floridan Aquifer in response to downward head gradients (Lewelling and others 1998). During wetter periods the intermediate aquifer system head may rise above river stage and create a potential for groundwater to flow into the river. Groundwater recharge in this area appears to be primarily a function of hydrologic conditions, as well as the existence of sinkholes and enlarged solution features within the Peace River channel and floodplain.

Lewelling and others (1998) stated historical groundwater heads from the 1950's show that the area from Bartow to Fort Meade was not always a recharge area. One effect of a lowered potentiometric surface has been cessation of spring flow in this portion of the watershed. Several springs in the vicinity of Bartow previously discharged significant amounts of groundwater into the Peace River; however, these springs ceased to flow by 1960. The USGS' earliest records indicate flow at Kissengen Spring (the largest spring to stop flowing) had a documented flow rate of 20 mgd in 1898 and 1917. Monthly measurements from 1932 to 1936 averaged 19 mgd. Discharge declined progressively until spring flow ceased in February 1950. Intermittent recoveries occurred in 1955 and 1959 due to high groundwater level conditions in the Upper Floridan Aquifer. Spring flow ceased permanently in 1960 (Lewelling and others 1998).

Groundwater recharge of water from the Bartow to Fort Meade has been observed through sinkholes. Because the intermediate upper confining unit is breached in this area, the Peace River and surficial aquifer interact directly with the intermediate aquifer and the Upper Floridan Aquifer. In local areas where groundwater seepages once augmented stream flow, water now flows from the river to underlying aquifers (Lewelling and others 1998).

Downstream, the physiography changes from an internally-drained basin to a poorly-drained upland. The area from Fort Meade to Zolfo Springs is characterized by seasonal reversal of head gradients that affect recharge and discharge potential between hydrologic units. That is, it is a seasonal transition area where changing head gradients create alternating groundwater recharge and discharge conditions.

The Peace River from below Zolfo Springs to Arcadia is characterized by upward groundwater head gradients that cause groundwater to discharge to the river. Banks in this stretch of the river are generally more than ten feet above the mean or average river stage. In places, sands of the surficial aquifer as well as clays and more indurated deposits of the upper Hawthorne Group units are exposed along the river banks. Water has been observed seeping into the river from surficial aquifer sands, which are above the more lithified, clayey units of the Peace River Formation.

8. NATURAL SYSTEMS

Extensive land cover alterations have occurred throughout the Peace River watershed. Over half of the northern one-third of the watershed (Polk County) has been significantly and permanently changed by phosphate mining along both sides of the Peace River. Mining has resulted in a permanent loss of natural lands (uplands and wetlands) and has altered the near-surface geology. Numerous creeks and small tributaries no longer exist or have been significantly changed, which altered the natural drainage patterns along this portion of the river. Landscape changes within the remainder of this upper region have been the result of agriculture and urban development. Landscape changes within the lower two-thirds of the watershed within Hardee and DeSoto Counties are predominantly the result of agriculture. Along the lower portion of the river in Charlotte County, urban development has significantly altered the landscape. Only a relatively small proportion of the watershed remains in natural land cover.

Since the majority of the watershed has been altered, the remaining natural lands are important. Natural lands protect and preserve water resources of the Peace River and provide habitat areas for wildlife. Several land acquisition projects are underway in the Peace River watershed, and they include natural upland and wetland areas along the river, major tributaries and tributary headwaters.

9. POPULATION, ECONOMY AND TRANSPORTATION

9-1. Population

Figure 2-5 shows population census data from the Florida Statistical Abstract for the period 1960-1990 (University of Florida 2000) and projected population trends from Projections of Florida Population Studies (University of Florida 2000) for 2000-2030. Data shown are for Charlotte, DeSoto, Hardee and Polk counties, which occupy 90% of the Peace River watershed's land area. In 1960, the population of Charlotte (12,590), DeSoto (11,680) and Hardee (12,370) counties was similar in size. Polk County's population was larger than the other three counties in 1960, and it is projected to have the highest population of the four counties in 2030. Population between 1960 and 1990 increased steadily in all but Hardee County, which experienced a slight decrease in 1990.

9-2. Economic Trends

Figure 2-6 summarizes the employment profile of Charlotte, DeSoto, Hardee and Polk counties, which occupy 90% of the Peace River watershed's land area. The 2001 projected employment totals for these four counties are as follows:

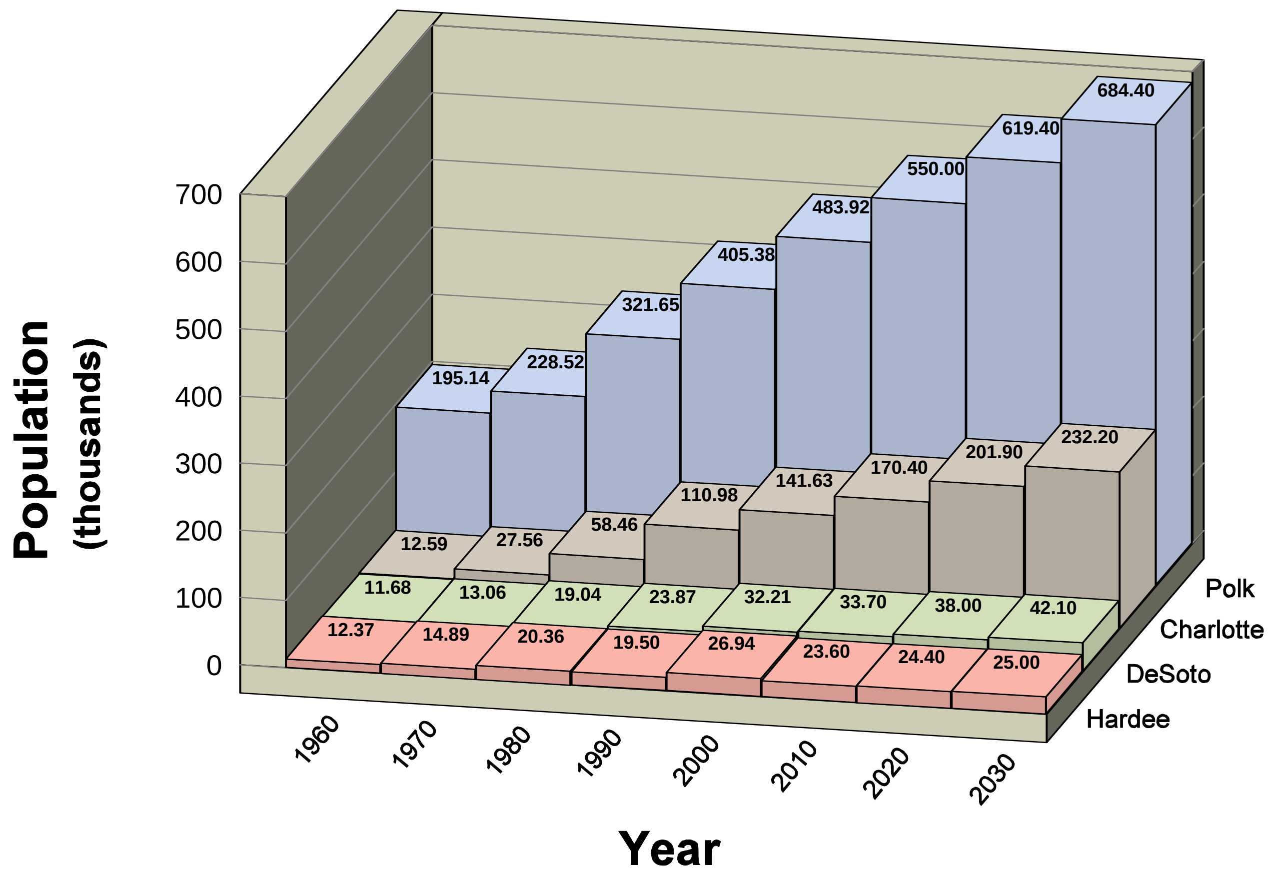
1. Polk County – 240,760 persons;

2. Charlotte County – 56,740 persons;

3. DeSoto County – 15,920 persons; and

4. Hardee County – 12,810 persons (Woods and Poole Economics 2001).

Figure 2-6 shows that dominant employment sectors in Polk County are services, wholesale/retail trade and government. The largest employment sectors in Charlotte County are services and wholesale/retail trade. Agriculture, government, services and wholesale/retail trade are the dominant employment sectors in DeSoto and Hardee counties.



Census data (1960-1990) source: Florida Statistical Abstract 2000, Bureau of Economic and Business Research, University of Florida, 2000.
Census data (2000) source: http://factfinder.census.gov/home/en/pldata.html. [Accessed May 4, 2001].
Projected data (2010-2030) source: Projections of Florida Population by County, Florida Population Studies. Vol. 33 No. 2, Bul.126. Bureau of Economic and Business Research, University of Florida, February 2000.

Figure 2-5. Population

The Peace River CWM area is comprised of 1,532,973 acres. Land uses in the Peace River CWM are dominated by agriculture (648,543 acres or 42.3 percent), upland forests (285,707 acres or 18.6 percent), and wetlands (245,520 acres 16.0 percent). The remaining land uses are barren land (27,711 acres or 1.8 percent), mining (131,283 acres or 8.6 percent), utilities (9,447 acres or 0.6 percent), urban/built-up (124,903 acres or 8.1 percent, and water (59,860 acres or 3.9 percent). The Peace River watershed land uses are graphically shown in Figure 2-7.

9-3. Transportation

Several main Interstates, US Highways, state roads and railroads transect the Peace River watershed. US Highway 17 is a north-south oriented road that connects Polk, DeSoto, Hardee and Charlotte counties. US Highway 27 is a north-south oriented road that transects Polk and Highlands counties. From north to south, US Highway 98 enters the northern portion of the watershed near Lakeland. It traverses south to Zolfo Springs in southern Polk County, then east where it exists the watershed and merges with US Highway 27 and turns south. State Road (SR) 60 crosses the middle of Polk County in an east-west direction. Interstate 4 and US Highway 92 are present in northern Polk County. Interstate 75 and US Highway 41 traverse Charlotte County in a north-south direction.

Several railroad lines are present in the Peace River watershed. Outbound destinations include Miami, Jacksonville, Tampa, Sarasota and Naples. Most railroad lines in the watershed are owned by CSX Transportation, Inc.

10. CONCLUSION

Aquifers in the Peace River watershed consist of the surficial, intermediate, and Floridan aquifers. The intermediate aquifer contains the Bone Valley Member, which is mined for phosphate in the watershed. The Peace River is hydraulically connected to groundwater, and river impacts are reflected in the underlying aquifers. The Peace River from below Zolfo Springs to Arcadia is an area of upward groundwater leakage and the Peace River from Bartow to Fort Meade is characterized as a groundwater recharge area. The Peace River between Fort Meade and Zolfo Springs is a transition area where changing head gradients create seasonal, alternating groundwater recharge and discharge conditions. Historical groundwater levels indicate the area from Bartow to Fort Meade was previously an area of upward groundwater leakage; however, the direction of vertical leakage has reversed in recent years.

Impacts associated with past, present and expected future land uses generally include changes in natural surface water hydrology, degradation of regional surface water quality, decreased wildlife habitat and loss of natural vegetation. The following chapters of this volume will discuss impacts and existing conditions associated with the District’s four AOR: water supply, flood protection, water quality and natural systems. Volume II offers issues and strategic actions specifically designed to improve and/or protect the natural function of the Peace River watershed.

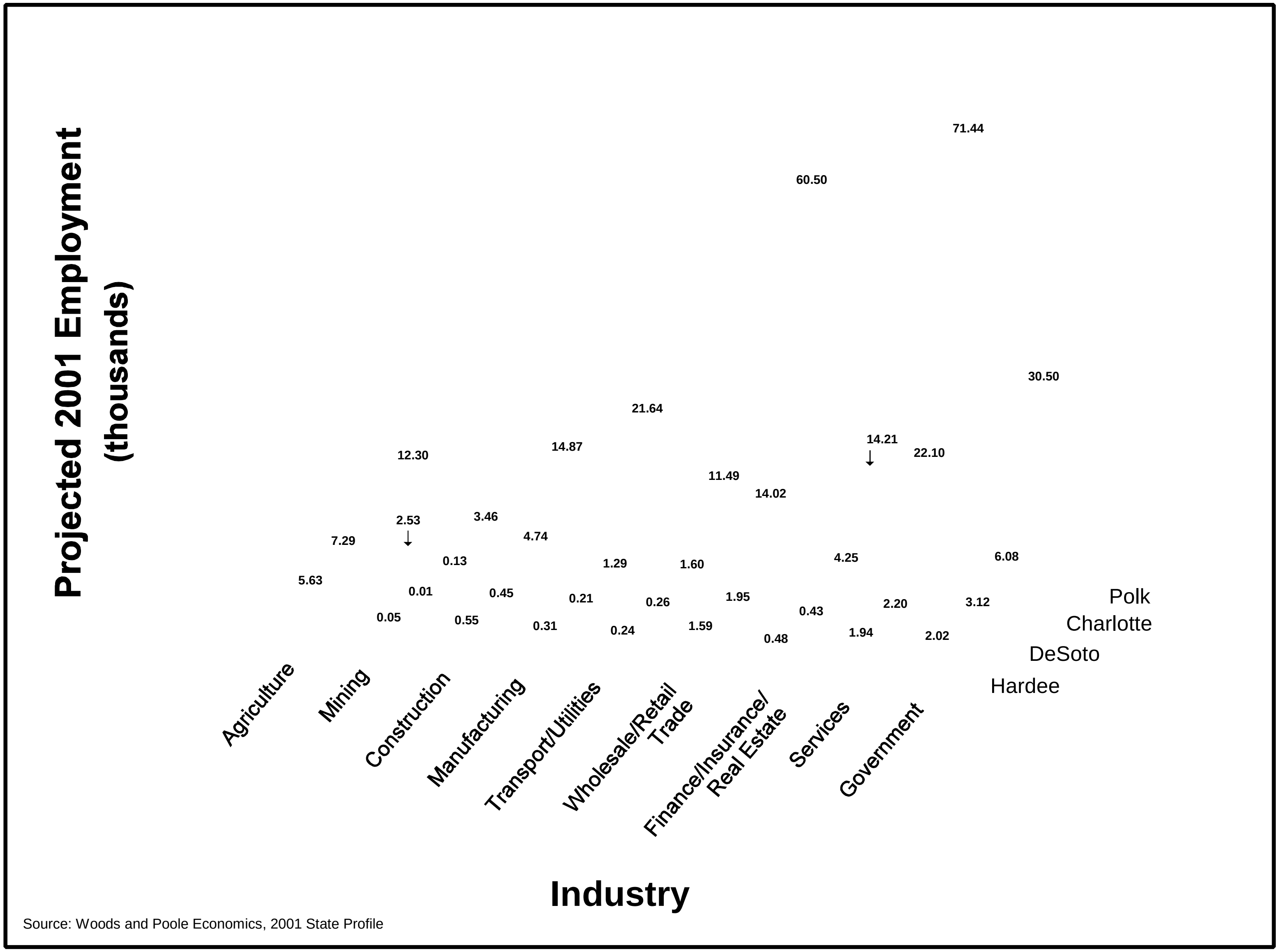


Figure 2-6. Employment Profile by County

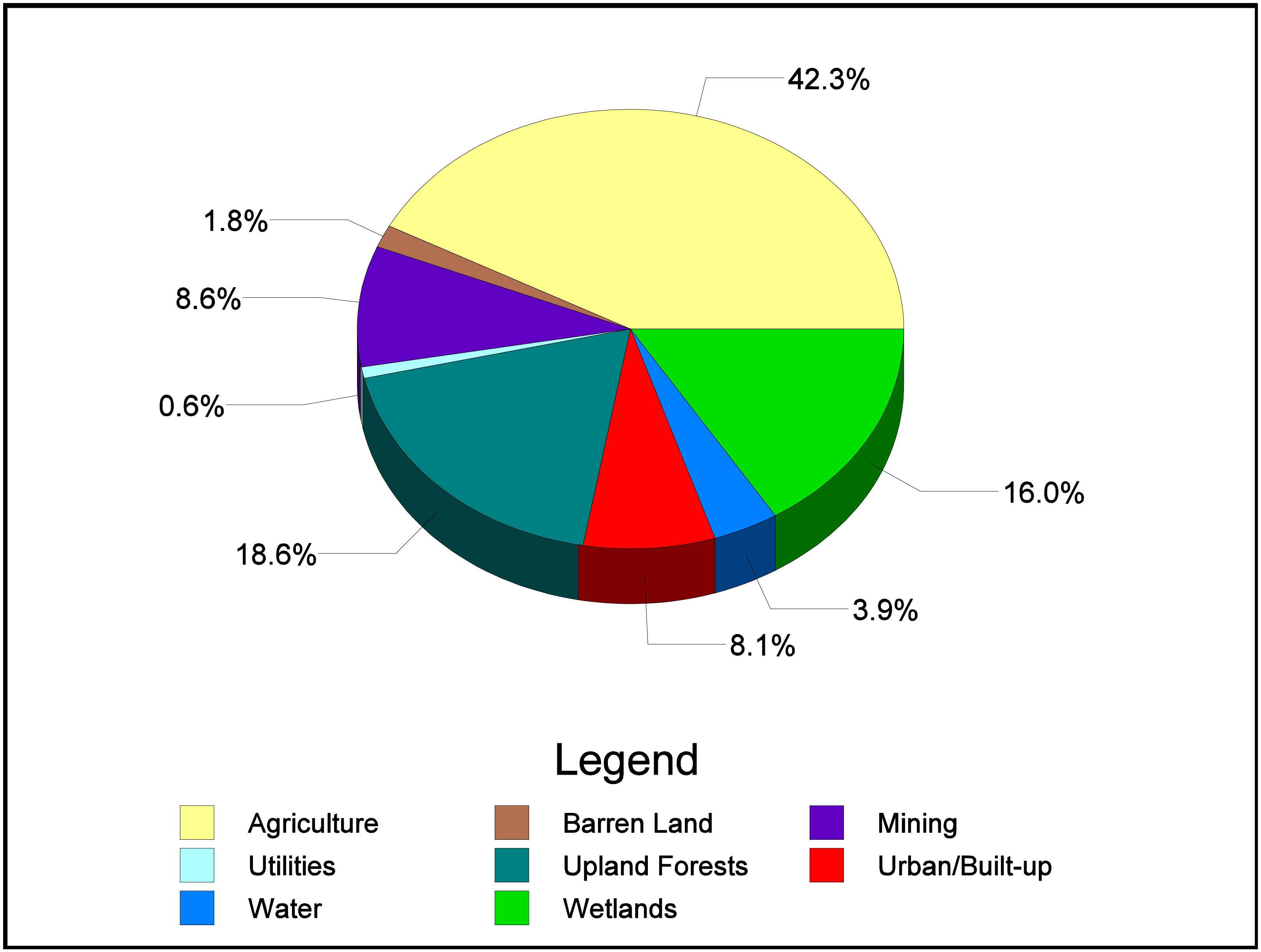


Figure 2-7. Peace River Watershed 1995 Land Use

Chapter 3
Water Supply

Peace River – Zolfo Springs Region – 1918
From the Florida State Archives of Florida Photographic Collection: J.K. Small Collection

CHAPTER 3. WATER SUPPLY

The following four chapters identify pertinent water resource issues for each of the District's four primary AOR; including Water Supply, Flood Protection, Water Quality, and Natural Systems. Together these chapters describe the detailed analyses needed to ultimately justify new projects, actions, policy or program recommendations, alternative approaches to resource management, or any other initiatives that may be proposed. Many projects and water management strategies recommended here are included in Volume II, the Strategic Action Plan. That volume includes short-range action steps and strategies that identify and potentially abate critical water resource problems.

1. INTRODUCTION

With a total surface area of 2,400 mi^2, the Peace River watershed comprises the largest drainage watershed in the District. There has been extensive agriculture and industry in the watershed for many years, with heavy reliance on groundwater resources. Although public water use has been comparatively small, population growth is occurring within the watershed and the Lower Peace River is projected to serve as a source of increased public water supplies for three counties in the southern part of the District.

2. GROUNDWATER

The Peace River watershed is contained within the SGWB of the District. Groundwater throughout the watershed occurs in the surficial, intermediate and Upper Floridan aquifers. The principal source of water supply in the watershed is the Upper Floridan Aquifer. In the southern portion of the watershed the intermediate aquifer becomes significant in terms of water supply production due to the poor water quality in the Upper Floridan Aquifer. The direction of regional groundwater flow in the watershed is generally west/southwest from the Green Swamp potentiometric high located in the northeast part of the watershed to the Gulf of Mexico. Groundwater in the Upper Floridan Aquifer originates as rainfall over the watershed that percolates to the water table in the surficial aquifer then moves vertically downward across a confining unit into the intermediate aquifer and then across a second confining unit into the Upper Floridan Aquifer.

2-1. Groundwater Use

The major use of water in the watershed has historically been for agricultural irrigation and activities associated with the mining and processing of phosphate ore. Estimates of water use produced by the District indicate that in 1996 there was a total of about 298 mgd of water used throughout the watershed. Approximately 92 percent (274 mgd) of this was obtained from groundwater sources and 8 percent (24 mgd) was obtained from surface water sources. The largest use of water in 1996 was for agricultural irrigation (194.7 mgd; 65 percent) and the second largest use of water was for public supply (53.8 mgd; 18 percent). Recent efforts to conserve groundwater use in the mining and related industries is reflected by the fact that the combined water use for mining/dewatering and industrial/commercial users was 40.8 mgd or 14 percent of the total water use in the watershed. In part this reflects the efforts of the industry to recycle and reuse water.

2-2. Water Resource Assessments and Water Use Caution Areas

In response to observed long-term declines in hydrologic conditions in three specific geographic regions of the District, more intensive data collection and analysis was initiated in each area in the mid to late 1980s. This analysis was designed to ascertain the extent of the problem, the probable causes, and to develop modifications to existing resource management programs, or new programs, to properly manage the resource within each area. These resource studies are referred to as WRAPs. The three study areas include the Highlands Ridge, Eastern Tampa Bay and Northwest Hillsborough WRAPs. In addition, a fourth WRAP was initiated to address the entire SGWB of the District.

These studies provide the technical data and analysis that must be considered to determine safe yield for each area. Safe yield is defined as the amount of water that can be withdrawn without producing unacceptable impacts on water and related natural resources. Once determined, the existing management programs established within each area will be modified as necessary.

2-3. Highlands Ridge, Eastern Tampa Bay and Northern Tampa Bay Water Use Caution Areas

The District realized that certain interim resource management initiatives could be implemented to help prevent existing problems from getting worse prior to the completion of these multi-year WRAPs. Therefore, in 1989 the District declared Highlands Ridge, Eastern Tampa Bay and Northern Tampa Bay as WUCAs. For each of these initial three WUCAs, a three-phased approach was implemented, including (1) short-term actions that could be put in place immediately, (2) mid-term or intermediate actions that could be implemented concurrent with the on-going WRAPs, and (3) long-term actions that would be based upon the results of the WRAPs.

One of the primary means of implementing the WUCA management plans was through modifications to the District's WUP rules for each specific WUCA. These modifications primarily addressed additional conservation requirements and the investigation of alternative water sources, including reuse, for water use permittees. One significant additional change was the designation of the Most Impacted Area (MIA) within the ETBWUCA, within which no net increase in permitted water use was allowed by significantly limiting the issuance of new permitted quantities. In addition, each WUCA was designated a "Critical Water Supply Problem Area" as stipulated in Chapter 62-40, FAC (also known as State Water Policy). State Water Policy now refers to these areas as Water Resource Caution Areas.

2-4. The Southern Water Use Caution Area

The Peace River watershed is contained within the SWUCA. The SWUCA encompasses about 5,100 mi^2 in the southern portion of the District and was designated a WUCA (an area where water resources are or will become critical in the next twenty years) in 1992. This was in response to long-term declines in groundwater levels resulting from increases in historical groundwater withdrawals throughout the region. Effects of these declines include increased landward movement of the saltwater/freshwater interface in coastal areas and lowering of lakes in Highlands and Polk counties. The SWUCA comprises all of Manatee, Sarasota, Hardee and DeSoto counties and portions of Hillsborough, Charlotte, Polk and Highlands counties. The Peace River watershed comprises a significant portion of the SUWCA, encompassing 46 percent of the land area and 48 percent (627 mgd) of the total 1996 groundwater withdrawals in the SWUCA.

In 1994 the District Governing Board approved the SWUCA rule which was intended to implement the regulatory portions of a previously developed SWUCA management plan. Objectives of the 1994 rule were to: (1) halt saltwater intrusion into the Upper Floridan Aquifer along the coast; (2) stabilize lake levels in Highlands and Polk counties; and (3) limit regulatory impacts on the region's economy and existing legal users. Long-term management and allocation of groundwater in the region were tied to a "minimum aquifer level." New groundwater withdrawals would not be permitted unless the minimum aquifer level criteria were met. A number of parties filed objections to this rule and an administrative hearing was convened. In 1997, the administrative law judge ruled to uphold the minimum aquifer level but ruled against provisions for reallocation and preferential treatment of existing users.

In October 1997 the District Governing Board moved to appeal specific components of the Final Order to the Second District Court of Appeals. Two major parts of the appeal involved requiring permit applicants to investigate the feasibility of reuse and desalination water resources, and a third involved a requirement that wholesale public supply customers obtain separate WUPs to implement conservation measures.

In September 2000, the Second District Court of Appeals ruled on the challenges presented to the original SWUCA rules. The Court found in favor of the District on all points on appeal. These findings support the District's Conceptual Management Strategy for managing the water resources in the SWUCA and District wide. Examples of issues that the Appeals Court sided with the District on were:

1. that all applicants must meet the "three prong test" where they must show that; the proposed use of water must be reasonable-beneficial, does not interfere with an existing legal use of water and is consistent with the public interest;

2. verified the District's criteria for issuance of a permit;

3. confirmed the District's Basis of Review for permit issuance;

4. confirmed District's authority to require an investigation into the availability and use of reclaimed water for certain applicants for new quantities of groundwater; and

5. confirmed District's authority to require an investigation into the availability and use of desalinated water.

While waiting for the Appeals Court ruling the District Governing Board approved a Conceptual Management Strategy in 1998 that outlined a process for developing a water resource management plan for the SWUCA. Development of the strategy was based on recognition by the Governing Board of the continued resource concerns in the region and the administrative law judge's ruling on the 1994 SWUCA rule. The proposed goal of the SWUCA management plan is, "To meet the water supply needs of the region while protecting the water resource and related natural systems." Specific objectives that were developed as parts of the strategy were: (a) "To minimize saltwater intrusion to protect the groundwater system as a water supply source" and (b) "To minimize the influence of groundwater and surface water withdrawals on lake levels to protect lake functions." Additionally, there were several legislative items that had been implemented since the development of the 1994 SWUCA rule that affected water resource management in the region. Some of these items were:

1. the requirement for water management districts to develop District-wide water supply assessments and to initiate water supply plans in areas where reasonably anticipated sources of water are insufficient to meet demands out to the year 2020;

2. revisions to the MFLs provisions of the statutes including development of a priority schedule of water bodies, establishing MFLs, that account for "...changes and structural alterations..." that affect the hydrology of the priority water bodies, and development of a recovery plan in areas where actual levels are below the adopted MFLs; and

3. the legislative requirement that water management districts should play a key role in "water resources development' and clarification of the intent of the legislature that "... sufficient water be available for all existing and future reasonable beneficial uses and natural systems, and that adverse effects of competition for water supplies be avoided."

As part of the SWUCA Conceptual Management Strategy the District convened a work group, comprised of stakeholders throughout the watershed, to provide input on the management plan. Included in this group were representatives of agriculture, industry, mining, power generation, development, public supply, and environmental groups from throughout the region. Their purpose is to assist the District in developing a water resource management plan for the SWUCA. The work group first began meeting in the fall of 1998 and established two focus groups to address specific water resource issues. The two groups are Resource Regulation and Resource Development. The Resource Regulation group will address demand management issues and the Resource Development group will address resource development projects that enhance the regional water supply. The work group meets once every two months and is expected to continue at least through the development and adoption of the SWUCA Management Plan (e.g., water supply plan).

As previously mentioned, during its 1997 session, the Florida Legislature amended the Water Resources Act (s. 373.036, *Fla. Stat.*) 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. This assessment functions similarly to the previous Needs and Sources Report, in that it evaluates water demand projections to the year 2020 and compares these demands to the availability of known water sources. In those areas where existing or reasonably-anticipated sources of water and conservation efforts will not be adequate to meet current or future water supply needs, a Regional Water Supply Plan (RWSP) must be prepared which further investigates water resource and supply development opportunities. The District-wide assessment was completed in 1998 and concluded that a RWSP had to be prepared for a ten county region of the central and southern portions of the District, including all of the SWUCA. The RWSP has become the vehicle by which water resource and supply development opportunities which can contribute to resolving the SWUCA resource management problems are being identified.

The District is currently in the process of preparing this RWSP and has turned to the SWUCA Work Group and a similar group representing the Northern Tampa Bay area as a means of obtaining input. The RWSP is being developed in an open public process, in coordination and cooperation with local governments and utilities, regional water supply agencies, the agricultural community, business and industry representatives, environmental organizations and other affected and interested parties. This has proven quite useful in identifying data gaps or other ways to improve the RWSP process and results. For example, how the District calculates water use in areas like Sarasota County where many publically supplied users also have separate irrigation wells is being reexamined in the development of the RWSP. This will allow the District to avoid underestimating actual demands while clearly delineating whether this is a localized or regional situation. Estimation of future agricultural water needs has similarly benefitted from the involvement of the District's Agricultural Advisory Committee and specific trade organizations.

Once completed, the RWSP will also contain a five-year work program for the implementation of water resource development projects.

The District collected public comments on the Draft RWSP until December 2000. It will be considered for approval by the District's Governing Board by July 2001.

The SWUCA management approach includes not only completion and implementation of the RWSP, but the establishment of MFLs and any accompanying recovery and prevention strategy. With respect to MFLs in the Peace River watershed, minimum flows for the Upper Peace River are scheduled for adoption by December 2001, Middle Peace River by 2002, and the for Lower Peace River by December 2003[1]. The District continues to monitor the effects of lowered groundwater levels throughout the region on movement of the freshwater/saltwater interface and declining lake levels. Minimum levels for the Upper Floridan Aquifer in the SWUCA are scheduled for adoption by December 2001 and for the intermediate aquifer by December 2005.

2-5. Groundwater Levels

The District's development of minimum groundwater levels is intricately tied to the ongoing WRAPs. The focus of these efforts is to identify and implement safe yield through a comprehensive approach that includes planning, technical analyses and effective regulation. This is intended to result in an integrated, comprehensive strategy for establishment of minimum groundwater levels.

3. SURFACE WATER

3-1. Lakes

The major surface water features in the watershed include the Peace River and its tributaries and a large number of lakes, most of which are located in Polk County. Many of these lakes drain to the Peace River system via tributaries to Saddle Creek (Lakes Hancock, Parker and Banana) or the Peace Creek Canal (Winter Haven Chain of Lakes). With the exception of Lake Parker, which is used for recirculating power plant cooling water, withdrawals from these lakes are for agricultural or private uses of relatively small water quantities. Accordingly, the issues discussed in this chapter emphasize the hydrologic characteristics of the Peace River and its tributaries as they pertain to surface water use and supply within the watershed.

3-2. Stream flow Trends in the Peace River Watershed

Both existing and future surface water use within the Peace River watershed are dependent upon the hydrologic characteristics of the streams in the region. Due to declining stream flow trends reported for gages on the Peace River, factors affecting flows in the river and its tributaries have received increasing attention in recent years. The following sections describe factors potentially affecting stream flow in the Peace River watershed and how these factors may be related to the future management of stream flow and water use in the watershed.

[1]Note: For purposes of setting minimum flows, the SWFWMD defines the Upper Peace River as the area generally north of Zolfo Springs; the Middle Peace River as the area generally between Zolfo Springs and Arcadia; and the Lower Peace River as the area below Arcadia.

Upper Peace River

Significant declines in stream flow have been documented for stations on the main stem of the Peace River, with the greatest rates of decline observed in the upper reaches of the river near Bartow and Zolfo Springs. Kissengen Springs, which contributed approximately 20 mgd of baseflow to the Upper Peace River, ceased flowing during the early 1950's. Sinkholes have formed in the channel and floodplain of the Upper Peace River, and during much of the dry season the river loses flow to sinkholes between Bartow and Ft. Meade.

The reasons for flow declines in the Peace River are varied. Reductions in rainfall have clearly played a major role, but human factors have also been important. Drawdown of the potentiometric surface of the Floridan Aquifer in the Upper Peace River watershed due to groundwater use has been identified as a major factor contributing to reduced stream flow. Although the potentiometric surface of the aquifer remains below pre-development levels throughout much of the upper watershed, there has been significant recovery of groundwater levels in much of the watershed due to reduced groundwater use by the phosphate industry. Flows in the upper river have not substantially recovered, however, and it appears other factors contribute to flow reductions.

Phosphate Mining in the Upper Peace River Watershed

Extensive phosphate mining has substantially modified the hydrology of the Upper Peace River watershed. Although most of the mining has occurred since the 1940's, mining in the region has occurred since the turn of the century as phosphate pebble was mined from the channel of the Peace River during the late 1800's. In many areas of the upper watershed phosphate mining has substantially altered surface drainage patterns and the surface water/groundwater relationships of the river and its tributaries. Many lands, termed nonmandatory lands, were mined before land reclamation was first required by the State of Florida in 1975. Furthermore, reclamation philosophies and techniques have evolved considerably during the last two decades so that a complex mosaic of reclaimed lands with different hydrologic characteristics now occur in the watershed. To date, there has been no comprehensive assessment of the effect of historic mining on the hydrology of the Peace River.

Potentially, the reclamation of certain phosphate lands could help restore some flows and wildlife habitats in various tributaries and reaches of the Upper Peace River. A hydrologic study of the Upper Saddle Creek sub-basin is underway to examine how that area may be managed to restore hydrologic and ecological functions in the drainage system above Lake Hancock. Additional studies should also be conducted on the extensive mined area below Lake Hancock in order to restore hydrologic and ecological functions in that area to the some feasible extent. Management strategies that could be investigated include restoring some former tributaries south of Bartow that were lost to mining. In other areas, the effects of old clay settling ponds on surface water relationships near the river should be assessed, and if necessary, stream flow restoration strategies evaluated.

Other Drainage Modifications

In addition to mining, there have been other substantial modifications to the drainage network of the Upper Peace River. The Peace Creek Canal was dug during the early 1900s, and it is uncertain how this canal affected flows of the Peace River. The canal was in place during the high flow years prior to 1961, and it is unlikely the canal has contributed to flow reductions since that time. Flooding problems are present on the Peace Creek Canal, however, and the potential may exist to improve flows to the Upper Peace River by drainage improvements to the canal. Habitat restoration by creating marshes or stream habitats could be included in any drainage improvements plans for the canal. Such habitat restoration, however, should not be designed as to result in further reductions in flows to the Upper Peace River.

Another modification to the Upper Peace River drainage system has been the construction and operation of water control structures on headwater lakes. Most notable is Lake Hancock, a large hypereutrophic lake that contributes an average flow of 62 cubic feet per second (cfs) to the Upper Peace River. A water control structure on Lake Hancock was constructed in the early 1960's and flows from the lake during the dry season have been regulated ever since. At present, outflows from the lake degrade water quality in the Peace River because of its hypereutrophic characteristics and high oxygen demand. The restoration of Lake Hancock has been suggested by various entities, and is discussed in more detail in the water quality chapter of this report. Restoration of Lake Hancock could have substantial benefits for the Upper Peace River if it allows for the more frequent release of higher quality waters to the river. The mining of Lake Hancock for phosphate ore which underlies the lake had been evaluated in the past and was recently determined to be economically infeasible. In any case, restoration of the lake would significantly improve the quality of outflow to the upper river, and might allow for improved management of the quantity of outflow as well.

Water control structures are also present on other headwater lakes of the Peace River. Water control structures on Lakes Lulu and Hamilton affect flows to the Peace Creek Canal and hence the Upper Peace River. These structures are managed largely to maintain the environmental and recreational qualities of the headwater lakes, and operation of these structures to benefit flows in the Peace River would have to consider and balance the management of the resources associated with the lakes.

Upper Peace River Cumulative Stream Flow Assessment

Because of the importance of the Peace River as both a natural resource and a source of surface water supplies, flows in the upper river require more intensive assessment and management. Coordinated and multi-faceted studies to evaluate hydrologic factors affecting flows in the upper river need to be conducted. These studies should also assess how the ecology of the Upper Peace River has been affected by flow reductions and how the ecosystem might respond to various degrees of flow restoration. Pending the findings of these studies, a management plan to maintain and possibly restore flows in the upper river should be pursued.

Lower Peace River and Southern Tributaries

Stream flow in tributaries within the southern portions of the Peace River watershed have not exhibited the flow reductions observed in the Upper Peace River watershed. Although a declining trend has been documented for the Peace River at Arcadia for the period of record, this trend has not been nearly as steep as trends observed in the upper river. Also, the trend at Arcadia has abated in recent decades, as flows have not continued to decline since the mid-1970s. Significant trends of increasing flows have been observed in Joshua Creek, including substantial increases in low flow levels. Increasing low flows also appears to be occurring in Horse Creek and Shell Creek. These differences in flows between the upper and lower portions of the Peace River watershed are largely due to differences in hydrogeologic characteristics, watershed alterations, and water use.

In the southern part of the watershed the top of the Floridan Aquifer is separated from the surficial aquifer by relatively thick confining units, thus diminishing the effects of groundwater drawdown on stream flow. In this part of the watershed it also appears that considerable agricultural irrigation water is finding its way to the streams and supplementing flow in the dry season. This finding is supported by increasing mineralization and nutrient content of streams in the region. With regard to flows to the Lower Peace River estuary, increases in flow in the southern part of the watershed may be acting to partially offset the effect of reduced flows in the Upper Peace River. Increased nutrient loading and other effects of changing land use may be factors for concern.

3-3. Surface Water Supplies

Surface water supplies taken directly from the Peace River and its tributaries are restricted to three small agricultural withdrawals and two separate municipal water supplies obtained from the Lower Peace River and Shell Creek. Withdrawals from the Lower Peace River are permitted to the PR/MRWSA. This facility has been in service since 1980, with recent use averaging about 10 mgd serving citizens in Charlotte and DeSoto Counties and the city of North Port. This facility is scheduled for major expansions over the next fifteen years to serve as a larger regional water supply source, eventually providing an average of 32.6 mgd to citizens in Charlotte, Sarasota and DeSoto counties. This projected increase in use has been supported by extensive environmental studies, and future increases in supply will be subject to the findings of an ongoing environmental monitoring program. One issue that has been raised is the FDEP Class III designation for the Peace River, which denotes recreational use. The designation of the Peace River as a Class I water body (potable use) could be considered, although it may have implications for the regulation of existing point source discharges to the river.

Shell Creek has been used for potable water supplies by the city of Punta Gorda since 1965. Water use from the creek has averaged about 4 mgd in recent years. Withdrawals are taken from an in-stream impoundment, created by a low head structure located about six miles upstream from the confluence of Shell Creek with the Lower Peace River. Although the dam has truncated the system and restricted the migration of fish in Shell Creek, recent environmental monitoring data indicate that Shell Creek is in good ecological condition. The feasibility of developing ASR facilities on Shell Creek to increase available water supplies is presently being evaluated. Another management option that warrants consideration is an interconnection between the Shell Creek Reservoir and the Peace River Water Treatment Facility near Ft. Ogden. Such an interconnection could be used to transfer water between these two water supply systems in time of emergency or drought.

3-4. Minimum Flows and Levels

The management of future water use from surface waters in the Peace River watershed will involve the determination of MFLs. The water management districts are directed by Florida Statutes to establish MFLs. Minimum flows are defined as "the limit at which withdrawals are significantly harmful to the water resources or ecology of the area" (s. 373.042, *Fla. Stat.*). The District has established withdrawal limits from the Lower Peace River through permit conditions, but minimum flow regulations for the upper and middle reaches of the Peace River have not been established. With regard to surface water withdrawals, this has not yet posed a problem as surface water withdrawals from the Upper Peace River have been small and insignificant. Flows in the Upper Peace River have been impacted by other factors, however, which may have implications for future water use.

The District has committed to establishing minimum flows for the Upper Peace River in 2001 (generally north of Zolfo Springs), for the Middle Peace River (generally between Zolfo Springs and Arcadia) in 2002, and the Lower Peace River (south of Arcadia) in 2003. This will determine what quantities of surface water are available at various rates of stream flow. As part of this process, the hydrologic requirements of natural systems in the river will be assessed and the impacts of previous flow reductions in the river should be accounted for. Minimum flow studies should also evaluate how the river would respond to various degrees of flow restoration or mitigation. The relationships of flow to groundwater levels should be assessed and the possible regulatory strategies relating stream flow to groundwater use should be evaluated. These results could help provide realistic quantifiable goals for management plans to maintain or restore flows in the Upper Peace River.

Chapter 4
Flood Protection

Peace River
From the Florida State Photographic Archives Collection: Louise Frisbie Collection
(date unknown)

CHAPTER 4. FLOOD PROTECTION

1. INTRODUCTION

A natural fluctuation of surface water elevations occurs in the landscape of uplands and water features within the watershed boundaries of the Peace River. The watershed response to the water fluctuation has played a role in shaping the natural systems, their characteristics, function, and interaction with one another. Through time, conditions occur within the watershed where the surface water elevations are higher than normal and water overflows onto areas of dry land. This flooding of dry land occurs as a response to the dynamics of the hydrologic cycle. The areas subject to flooding are considered floodplain. It is important to understand the function of the floodplain and provide for protection when flood conditions occur within the watershed. As such, the District's water management goal for flood protection is to minimize the potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of the flood-prone areas.

The District shall give preference, wherever possible, to non-structural surface water management methods. A “non-structural” method is to avoid incompatible land uses within flood-prone areas and to ensure that land development does not alter natural patterns of water movement and storage. A “structural” method involves the intentional alteration of natural surface water systems through construction of facilities such as ditches, canals, dams, and control structures to ensure that formerly flood-prone areas are reasonably safe from future inundation. The current management of the floodplain incorporates both structural and non-structural methods. The flood management within the watershed is the responsibility of federal, state, regional, and local agencies; and specialized districts who are tasked to manage surface water conveyance and storage systems.

The challenge in addressing flood protection issues is to understand surface water management events in which magnitude and duration of the occurrence depends on ever-changing watershed characteristics. To gain an understanding of the flood protection for the watershed, a review of the watershed characteristics, historical records, existing studies, available data, and current governmental management practices should be conducted.

2. GAGING RECORD AND HISTORIC FLOODS

2-1. Stream Gaging Data and Yearly Peak Discharges

Locations of stream gaging stations within the Peace River watershed are shown on Atlas Map 9. Several large-magnitude floods have been recorded at the following long-term gages: Bartow, Zolfo Springs, and Arcadia. Drainage areas for these gages are as follows: Bartow 390mi^2, Ft. Meade 480 mi^2, Zolfo Springs 826 mi^2, and Arcadia 1367 mi^2. Major flood events were recorded at these sites in 1933, 1947, 1949, and 1960. Higher annual peak flows are more prevalent before 1961 than after. In more recent years, one of the higher peak discharges occurred at the Arcadia gage in 1982; however, at Bartow, Ft. Meade, and Zolfo Springs the peaks were not notable.

Predominantly, peak discharges are much higher at Zolfo Springs and Arcadia compared to Ft. Meade and Bartow. The majority of runoff contribution to flood events along the Zolfo Springs-Arcadia reach originates in that portion of the watershed downstream of the Ft. Meade gage. The peak flows reflect the much larger drainage areas at Zolfo Springs and Arcadia compared to Bartow and Ft. Meade. Also, there tends to be greater storage capacities in the lakes and surficial aquifer in the sandhills found in the upper watershed than the flatwoods further downstream.

The USGS is maintaining long-term tributary gaging sites in the central to lower regions of the Peace River watershed. Drainage areas for these gages are as follows: Charlie Creek (near Gardener) 330 mi^2, Joshua Creek (at Nocatee) 132 mi^2, and Horse Creek (near Arcadia) 218 mi^2. There is a wide variation in the peak discharge patterns among tributaries, that reflects the affects of other factors unrelated to the differences in drainage areas. These differences are also apparent between tributaries and the mainstream.

For example, a descending order of peak discharges in 1992 was Horse Creek, Joshua Creek, and Charlie Creek. Whereas in 1960, the order differs, being Horse Creek, Charlie Creek, and Joshua Creek. The peak flow recorded in 1992 at Horse Creek was higher than that of the Peace River at Arcadia. These shifting peak flow patterns show that temporal and spatial rainfall variations within the watershed can easily override drainage basin hydrology as factors controlling the peak discharge rate, especially at the tributary scale.

2-2. Lake Level Gaging Data and Yearly Peak Levels

Extending from an appreciable period prior to 1960 to present, long-term records of lake levels within the Peace River watershed show the highest annual peak elevations occurred in 1960 or pre-1960, except for Lake Parker. This lake differs from the others because the outlet structure was modified to hold the lake at higher lake levels to accommodate a power plant built on the lake in the mid-1970's. Hydrographs also show after 1960, peak annual levels of many lakes are lowest in the mid-1970's, and recover in more recent years, especially since 1990.

Fluctuation patterns of these lakes vary with their hydrologic setting and long-term rainfall patterns. Lakes Howard (Winter Haven Chain of Lakes), Mariana, and Parker fluctuated less than the others during the same period of record, because they had a sufficient water supply to remain near the discharge elevation of the outfall structure. Excess water was often discharged through their outlets, preventing the lakes from rising higher. Whereas the other lakes water supply was such that they dropped to levels far below the outlet level, and could rise many feet in response to rainfall without incurring a water loss through the outlet.

Typically, lakes that remain near the outlet level flood as a result of short duration rainfall events where runoff and rainfall enter them at a much faster rate than it can leave. Since antecedent rainfall in previous months influences the amount of runoff, and pre-storm lake levels, flooding is most prevalent near the end of wet summers. However, flooding can be exacerbated when annual rainfalls are sufficient to keep water bodies and surficial groundwater levels from recovering during the dry season, resulting in little remaining basin storage at the beginning of the wet season. This was the case during the 1997-1998 El Niño event. Lake levels throughout the District were already elevated above normal levels after the rainfall events. These lake levels continued to raise for several months after the December and January rainfall events while the surficial groundwater system continued to drain into them. In many areas, emergency actions had to be taken to drain lakes via pumps and emergency ditch and pipe systems to allow lake levels to recede.

For lakes that fall well below outlet levels during dryer periods, short duration rainfall events typically will not cause flooding. Long-term rainfall runoff and associated surficial groundwater supplies, must be sufficient for the lakes to sustain a rise in water level before they can reach the higher “flood” levels. This can require a period of years. Therefore, flooding can be dependent on rainfall fluctuation patterns over multiple years, or even decades. Once these lakes are at high levels, and surface water/surficial aquifer storage is full, flood conditions can be exacerbated by short duration rainfall events, which was also experienced during El Niño.

2-3. Floods of Record for Streams

Maximum published stages and discharges at USGS long-term stream gaging sites within the watershed for the period of record prior to 1961 are shown in Table 4-1. These maximum stages and discharges are instantaneous values, which were compiled from USGS annual water resource records and the USGS publication, summarizing maximum annual floods (USGS 1961). Also shown in Table 4-1 are approximate return intervals, given for both the maximum stages and discharges.

Notable flood years since 1960 within the watershed are shown in Table 4-2. This table is based on average daily values in SWFWMD’s database. It should be noted that stage and discharge values in Table 4-2 apply to maximum daily values for a given year. For the floods in Table 4-2, a return interval is based on stage, the element most critical to flooding. To be consistent with flood studies, return intervals were based on stages. In both tables, where recorded values fall between published values, return intervals published for each end of the range are given.

It is evident from the Peace River gaging sites that the extreme flooding events on the mainstream of the river that occurred after 1960 has consistently been much smaller in magnitude compared to the pre-1960 maximum events. This same pattern is evident for at least one tributary. A Peace Creek gage site near Alturas has some data records coincident with the earlier records at the Peace River gages. This high water level information, and information gathered from conversations with long-term residents of the Peace Creek sub-basin, confirms that the pre-1960 flooding events were larger in magnitude. However, this information also indicates that flooding in 1960 was the greatest within this tributary sub-basin in recent years.

The flooding pattern for the other tributaries with longer periods of record (Horse, Joshua, and Charlie Creeks) differs from the above, in that return intervals of floods since 1960 for the most part are greater (flooding probability is lesser). Taken as a whole, the return intervals in Table 4-2 seem high for 6 events occurring over a 32 year time span (1960-1992). It is thought that the differing patterns result from: (1) the shorter period of record used in the tributary flood studies compared to the mainstream studies; (2) it is likely that floods having a magnitude greater than the highest recorded floods occurred prior to the establishment of the gages, in a pattern similar to the earlier mainstream gaging record; and (3) areal and temporal rainfall variations in rainfall patterns tend to have a greater influence on flows at the tributary scale.

The above comparison is made possible by the additional records available since the mid- to late-1970's, when the tributary studies were done. Incorporation of these additional records could increase accuracy of studies done during the 1970's and likely would result in higher estimates of flood frequency elevations along the tributaries. Additional statistical and/or data analysis could also be incorporated to better relate tributary flooding to the large magnitude floods that occurred prior to establishment of tributary gages. More accurate information would provide floodplain management and regulation benefits, especially in cases where greater accuracy produces higher flood frequency elevations.

Table 4-1. Floods of Record in the Peace River Watershed (Large Magnitude Floods)[a] (USGS 1961)

Gage Station	Maximum Discharge (cfs)	Date	Approx. Frequency (years)	Maximum Stage (ft NGVD)[b]	Date	Approx. Frequency (years)
Gages with a long-term record (most reliable flood frequency relationships).						
Peace River @ Bartow	4,140	Sept 24, 1947	25-50	98.6	Sept 13,14, 1960	50
Peace River @ Zolfo Springs	26,300	Sept 6, 1933	100-200	55.3	Sept 6, 1933	100-200
Peace River @ Arcadia	36,200 43,000[c]	Sept 9, 1933 1912	50-100 100	25.9 26.6[c]	Sept 9, 1933 1912	50 100
Charlie Creek near Gardener	8,160	Aug 1, 1960	50	40.4 45.9[c]	Aug 1, 1960 1928	50 >500
Joshua Creek near Nocatee	8,670	Oct 10, 1953	25	23.0	Sept 22,1962	25-50
Horse Creek near Arcadia	11,700	Aug 1, 1960	50	28.9	Aug 1, 1960	50
Gages with a shorter-term record (flood frequency relationships are less reliable than those with a long-term record). Discharge is based on regional analysis or rainfall/runoff methods.						
Peace Creek near Alturas	1,740 2,540[c]	Aug 28, 1949 1928	2550	110.5 111.0[c]	Sept 12, 1960 1928	25 25-50
Gages where flood frequency relationships have not been not determined.						
Lake LuLu Outlet @ Eloise	218	Jun 21, 1959	N/A	131.2[c]	Aug 25, 1948	N/A
Little Charlie Bowlegs Creek near Sebring	874	Sept 27, 1960	N/A	79.9	Sept 27, 1960	N/A

NOTES:

[a]Frequencies for maximum discharge are based on flow. For stage, frequencies are based on elevation above NGVD. Frequencies were determined from stage-discharge-frequency relationships published in flood studies. Because channel roughness and/or geometry can change with time, the stage-discharge relationship for a certain flood can vary from the published relationship. Therefore, listed stage and discharge frequencies may not coincide for a certain flood.

[b] Feet National Geodetic Vertical Datum

[c]This information was derived from eyewitness accounts, or high water marks.

Table 4-2. Notable Peak Flows and Stages in the Peace River Watershed 1960-Present				
Gage Station	**Date**	**Peak Discharge (cfs)**	**Peak Stage (ft. NGVD)**	**Approx. Frequency (years)[a]**
Gages with a long-term record (most reliable flood frequency relationships).				
Peace River @ Bartow	Sept 13, 1960 Sept 23, 1962 July 30, 1974 Sept 29, 1982 Sept 14, 1988 Aug 19, 1992	3,470 598 784 1,640 1,150 872	98.6 94.9 95.2 95.8 96.0 95.5	50 <2 <2 2 2 <2
Peace River @ Zolfo Springs	Sept 12, 1960 Sept 23, 1962 July 7, 1974 June 20, 1982 Sept 9, 1988 Aug 12, 1992	17,000 6,270 4,870 6,370 6,490 3,020	53.8 48.3 47.3 49.6 49.7 45.2	50 2.33-5 2.33 5 5 <2
Peace River @ Arcadia	Sept 15, 1960 Sept 24, 1962 July 8, 1974 June 23, 1982 Sept 12, 1988 June 29, 1992	21,000 11,200 11,800 17,000 11,700 5,440	24.1 21.1 21.9 23.8 22.0 18.7	10-25 2.33-5 5 10 5 <2
Charlie Creek near Gardner	Aug 1, 1960 Sept 22, 1962 July 7, 1974 June 21, 1982 Sept 10, 1988 June 30, 1992	8,160 5,900 5,770 7,910 3,960 1,280	40.4 38.8 39.1 39.4 37.6 32.8	50 10 10-25 10-25 5 <2
Joshua Creek @ Nocatee	Sept 11, 1960 Sept 22, 1962 July 7, 1974 June 19, 1982 Sept 8, 1988 June 27, 1992	4,160 8,220 3,100 4,340 3,540 3,630	20.4 23.0 20.5 21.9 21.3 21.5	10 25-50 10 10-25 10-25 10-25
Horse Creek near Arcadia	Aug 1, 1960 Sept 21, 1962 July 7, 1974 June 18, 1982 Sept 9, 1988 June 27, 1992	11,700 6,690 3,910 6,260 5,430 8,960	28.9 27.7 26.3 28.3 27.6 28.7	50 10 5 25 10 50
Gages with a shorter-term record (flood frequency relationships are less reliable than those with a long-term record). Discharge is based on regional analysis or rainfall/runoff methods.				
Peace Creek near Alturas	Sept 12, 1960 Sept 21, 1962 Sept 11, 1974	1,620 328 N/A	110.5 104.8 106.0	25 <2 2
Peace Creek near Wahneta (new gage approximately 1.2 miles downstream)	Aug 16, 1992	475	105.1	2.33-5

Table 4-2. Notable Peak Flows and Stages in the Peace River Watershed 1960-Present				
Gage Station	**Date**	**Peak Discharge (cfs)**	**Peak Stage (ft. NGVD)**	**Approx. Frequency (years)[a]**
Gages where flood frequency relationships have not been not determined.				
Lake LuLu Outlet @ Eloise	Sept 11, 1960 July 11, 1962	215 20	130.3 126.2	
Little Charlie Bowlegs Creek near Sebring	Sept 27, 1960 Sept 22, 1962 June 27, 1974 June 21, 1982	874 351 828 843	79.9 78.8 79.4 79.4	

NOTES:

[a]All frequencies are based on stage.

2-4. Floods of Record for Lakes

Unfortunately, few lakes within the watershed have records that cover an appreciable time span prior to 1960. For the lakes whose outlet structures were not changed (Lakes Howard, Mariana, Otis, and Mountain), flood information indicates that the 1960 flood varied from a 10 to 50-year return interval. For all these lakes, 1960 is the highest recorded level. Although Lake Hamilton outlet structure was modified in the mid-1960's, records prior to 1961 show that its elevation in 1948 exceeded 1960. Additionally, based on interviews with long-term local residents, lake flooding of magnitude equal to or greater than 1960 occurred in previous years and flooding has occurred less frequently since then.

2-5. Historic Rainfall Patterns and the Relationship to Floods

Annual total rainfall within the Peace River watershed at long-term stations having concurrent periods of record shows that rainfall is highly variable from station to station. Difference in annual totals varies by up to about 20 inches. It should be noted that departures of 10 inches or greater magnitude remain evident at gages nearest each other. Further, wet and dry periods are apparent across all stations, including a low rainfall trend between about 1961 and 1978.

Prior to 1961, the overall trend was average to above average rainfall, except Lakeland which exhibits a slightly below average trend during this period. Following 1960, the trend was average to below average until at least 1978, or in some cases 1990. Based on all stations, annual rainfall averaged about 2-3 inches above the long-term average for the 25 years prior to 1961, whereas for the next 25 years, the annual average was about 2-3 inches below the long-term average. In all stations excluding Mountain Lake, there was an above average trend until the current drought cycle began in the 1990's.

In addition, a smaller amount of rainfall was recorded at stations north of Bartow, compared to those south of Bartow, particularly following 1960. Overall, rainfall at the stations north of Bartow averaged about 2-3 inches less per year than the stations to the south. Whether it has produced a long-term difference in flooding is difficult to determine because of differing hydrology in the north and south portions of the watershed. The rainfall difference could also be a perpetual phenomena.

Rainfall frequency distributions further illustrate pre/post 1960 rainfall trends. Distributions for two 25-year periods were based on annual totals, averaged across all stations and grouped by volume ranges as follows: 20-30, 30-40, 40-50, 50-60, 60-70, 70-80, and 80-90 inches. Results demonstrate that the two distributions are particularly informative when annual evaporation and transpiration demand is considered, averaging about 40 inches from land areas and 50 inches from water bodies. For the first 25-year period, it is 35% of the time that rainfall was 50 inches or less, whereas for the second 25-year period it is 60% of the time. Under these conditions, lake level, surficial aquifer, and stream flow declines are expected from the earlier to later periods. Storage capacity increases within water bodies and the surficial aquifer result in less frequent flooding during the later 25-year period.

3. SUMMARY OF AVAILABLE FLOOD INFORMATION

3-1. Flood Studies

Studies of flood-prone areas within the Peace River watershed became available beginning in the early 1970s and have been improved in detail and coverage since then. The USGS published Flood-Prone Area Quadrangle maps in 1973. Although limited in detail, these maps, based on USGS quadrangle maps, showed the approximate extent of flood-prone areas throughout Florida. Flood profiles for rivers and most of their tributaries were originally published by the USGS, USACOE, and District during the mid to late 1970's.

Flood elevations for a series of lakes in the upper watershed were also published by the District in 1976. Later, when the Flood Insurance Program was instituted in the early 1980's, further flood information and floodplain mapping was published by the FEMA for counties and municipalities within the watershed. In addition, FEMA continued conducting Flood Insurance Studies (FIS). These FIS, to a varying extent, relied on information from the earlier publications. Future FIS will expand the aerial extent and update or improve the level of detail of the information used to evaluate the study area. Meanwhile, the District is continuing to develop flood frequency elevations for lakes as part of the District's MFLs program.

Table 4-3 summarizes flood studies that have been completed for the Peace River watershed. All the FEMA studies for counties and municipalities within the watershed are listed, but not necessarily all the study updates. Also, the FEMA information cited is only for the portion of counties and municipalities within the Peace River watershed. Flood information may also be included in stormwater management plans that are discussed in a later Section.

3-2. Floodplain Mapping

Available floodplain mapping can be divided into two categories: (1) those areas mapped by detailed methods, and (2) those areas mapped by approximate methods. For detailed methods, the depth, elevation, and areal extent of the floodplain for studied areas are known, based on calculation of flood frequency elevations and the surrounding topography. Whereas for approximate methods, only the approximate, floodplain areal extent of studied areas is known, based on knowledge of past flooding, topography, and land form (no flood frequency elevations are calculated).

Table 4-3. Flood Studies Within the Peace River Watershed

Date	Study	Source	Description
1973	Flood Prone Area Quadrangle Maps	USGS	Approximate delineation of flood-prone areas in Florida
Aug 1974	Floodplain Information, Saddle Creek - Peace River	USACOE	Aug 1974 flooded area mapping, flood profiles for 100-year and SPF*, hazard assessment
Jun 1976	Flood-Stage Frequency Relations for Selected Lakes in Polk County	SWFWMD	2-, 10-, 25-, 50-, 100-, and 500-year flood frequency elevations for lakes in central Polk County
Mar 1976	Floodplain Information of the Peace River From Punta Gorda to Arcadia	SWFWMD	Floodplain mapping; 2.33-, 25-, and 100-year flood frequency profiles for this reach
Oct 1976	Floodplain Information on the Payne and Little Payne Creeks From Mouth to Hickey Branch and District Line Road	SWFWMD	2.33-, 10-, 25-, 50-, 100-, and 500-year flood frequency profiles for these reaches
Feb 1977	Floodplain Information on Horse Creek From the Mouth to SR 62	SWFWMD	2.33-, 10-, 25-, 50-, 100-, 500-year flood frequency profiles for this reach
Feb 1977	Floodplain Information on Joshua Creek From the Mouth to SR 70	SWFWMD	2.33-, 10-, 25-, 50-, 100-, 500-year flood frequency profiles for this reach
Sep 1977	Floodplain Information on Charlie Creek From the Mouth to H. Kelly Road	SWFWMD	2.33-, 10-, 25-, 50-, 100-, 500-year flood frequency profiles for this reach
Jan 1978	Flood Profiles on Shell Creek From Peace River to Shell Creek Reservoir and on Prairie Creek From Shell Creek Reservoir to SR 31	SWFWMD	2.33-, 10-, 25-, 50-, 100-, 500-year flood frequency profiles for these reaches
1978	Flood Profiles for Peace River, South-Central Florida	USGS	2-, 2.33-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year flood frequency profiles for the reach between Arcadia and Bartow
Nov 1979	Floodplain Information on Bowlegs Creek From Peace River to S. Buffum Rd.	SWFWMD	2.33-, 10-, 25-, 50-, 100-, and 500-year flood frequency profiles for this reach
Apr 1981	Floodplain Information on Shell Creek From Shell Creek Reservoir to SR 31 And On Myrtle Slough From Shell Creek to SR 31	SWFWMD	2.33-, 10-, 25-, 50-, 100-, and 500-year flood frequency profiles for these reaches

Table 4-3. Flood Studies Within the Peace River Watershed

Date	Study	Source	Description
May 1980	Flood Insurance Study City of Fort Meade, Florida, Polk County	FEMA	Floodplain mapping; flood elevations for various lakes and ponds; flood frequency profiles for Peace River
May 1980	Flood Insurance Study Town of Lake Hamilton, Polk County	FEMA	Floodplain mapping; flood elevations for lakes and depressions
Jun 1980	Flood Insurance Study City of Bartow, Florida, Polk County	FEMA	Floodplain mapping; flood profiles for the Peace River
Jun 1980	Flood Insurance Study Town of Davenport, Florida, Polk County	FEMA	Floodplain mapping; flood elevations for lakes and depressions; flood frequency profiles for Horse Creek
N/A	Flood Insurance Study Town of Dundee, Florida, Polk County	FEMA	Floodplain mapping; flood elevations for lakes and depressions; flood frequency profiles for Peace Creek Drainage Canal and Lake Dell Outlet Ditch
Mar 1981	Flood Insurance Study City of Haines City, Florida, Polk County	FEMA	Floodplain mapping; flood elevations for lakes; flood profiles for Haines City Drainage Canal, Lake Brown Outlet Ditch, and Lake Eva Outlet Ditch
Mar 1981	Flood Insurance Study City of Lakeland, Florida, Polk County	FEMA	Floodplain mapping; flood elevations for lakes and depressions; flood profiles for Lake Parker Tributary, Lake Hollingsworth Drain, Lake Bentley Drain, and Lake John Drain
Mar 1981	Flood Insurance Study City of Winter Haven, Florida, Polk County	FEMA	Floodplain mapping; flood elevations for lakes
Aug 1982 revised Oct 1988	Flood Insurance Study Polk County, Florida	FEMA	Floodplain mapping; flood elevations for various lakes and flood frequency profiles for Haines City Drainage Canal, Lake Gibson Drain, Lake John Drain, Lake Lena Drain, Lake Parker Drain, Lake Parker Tributary, Peace River, Peace Creek Drainage Canal, and Saddle Creek
May 1984	Flood Insurance Study Charlotte County Florida	FEMA	Floodplain mapping; flood profiles for Shell Creek, Prairie Creek, and Myrtle Slough

Table 4-3. Flood Studies Within the Peace River Watershed			
Date	**Study**	**Source**	**Description**
May 1988	Flood Insurance Study Hardee County Florida and Incorporated Areas	FEMA	Floodplain mapping; flood profiles for Peace River, Troublesome Creek, Thompson Branch, Hog Branch, Payne Creek, Little Payne Creek, and Lee Branch
Jun 1988	Flood Insurance Study DeSoto County Florida and Incorporated Areas	FEMA	Floodplain mapping; flood profiles for the Peace River, Horse Creek, Joshua Creek, Durrance Branch, Whidden Branch, and McBride Branch

Flood Insurance Rate Maps (FIRMs) published by the FEMA are produced by means of either detailed studies, approximate information derived from the Flood-Prone Areas Quadrangle maps, or combinations of both information. In addition, flood studies are often performed by state and local governments for use in designing system improvements, or for use in growth management and planning. These studies usually include an analysis of storm events ranging from the mean annual to the 500-year 24-hour event, and may use a higher level of detail, with respect to basin parameters and survey information, than the FEMA analysis.

Atlas Maps 13, 14, and15 show the FEMA 100-year flood zones, the 1990 urban land uses, and 2010 future land uses within the floodplain, respectively. Most of the floodplain that is not associated with the lakes and streams cited in Table 4-3 has not been studied in detail. As such, areas studied by approximate methods can be recognized by noting the distant between the designated floodplain, and contributing lakes, wetlands and streams. These contributing areas make up a large proportion of the FEMA 100-year floodplain, but may not be identified on the FIRM map as being within the floodplain.

In addition, the influence of phosphate mining on floodplain boundaries is not accounted for in the FEMA mapping. For upper portions of the watershed, phosphate mining and reclamation activities are largely complete. The mine plans prepared for lands regulated under the mandatory reclamation rules include a 100-year storm analysis, and a determination of limits of the 100-year and 25-year event related floodplains. This valuable information should be reviewed, updated and submitted to FEMA for their use in updating FIRM panels. In areas where phosphate mining is not involved, the FEMA 100-year floodplain study may be the best available information for establishment of existing floodplain conditions.

4. STORMWATER MANAGEMENT AND HYDROLOGIC STUDIES

The term “stormwater” has been coined to define water produced in the hydrologic cycle during storm events, while a storm is defined as an atmospheric disturbance manifested in strong winds accompanied by rain, snow or other precipitation and often by thunder and lightning. Stormwater management involves dealing with the water resource during and after storm events. Decisions are made by those responsible to perform management practices, based on users’ constraints of the water resource.

To manage stormwater effectively, one must first understand the interrelated surface water and groundwater systems. Antecedent moisture conditions, lake levels, base flows, and potentiometric levels affect each have an affect on the flow rates and water levels experienced after a rainfall event. A stormwater management system is typically made up of both natural and constructed components, owned and operated by a variety of entities, both public and private. The purpose of these systems is to convey water from one location to another for purposes ranging from providing wildlife habitat, to providing adequate drainage for agricultural purposes. These components react with the stormwater based on their storage and conveyance characteristics, and may be designed to afford a specified level of service (LOS) for flood protection purposes. Therefore, the management of stormwater systems is based on the goals and objectives of those who use the system. Seeking to accommodate this variation in users with possibly differing management goals and objectives has made the management of stormwater on a regional basis a even more complex issue.

4-1. Stormwater Management Studies

Stormwater management studies are developed in support of a variety of activities: mining, residential, commercial, industrial development, stormwater system capital improvements for both water quantity and quality purposes, control of pollutant sources, and evaluation for flood mitigation. This section focuses on stormwater management studies conducted for the purpose of evaluating rates, quantity, and quality of the stormwater runoff that discharges into the areas major lakes and regional and intermediate conveyance systems. The studies reviewed herein are those of a regional scale, primarily done for state, county and city governments.

Studies of the broadest scale are usually done in conjunction with development of county stormwater management master plans for their jurisdiction. These studies are parts of their comprehensive planning efforts, and can also be linked to NPDES permitting and objectives. Of the four counties that contain most of the Peace River watershed, Polk County has completed a stormwater management master plan study, Charlotte county has a stormwater management master plan in progress, and Hardee and DeSoto Counties are planning to complete stormwater management master plans in the future.

Polk County's Surface Water Management Plan was completed in 1987, prior to implementation of the NPDES program. Through a cooperative funding agreement with the District, the County commissioned Envisors, Inc. to conduct a study of their surface management systems and make recommendations for improvement (Envisors 1987). Of the areas studied in detail, potential drainage and/or stability problems were identified at 94 stream crossings, including recommendations for improvements of 54 county structures. Conceptual plans were also developed to improve stormwater management in 67 areas identified as having chronic flooding problems. The study also included recommendations concerning maintenance, legal access, staffing, and county stormwater management regulations. Many of the problems are in areas within in the Peace River watershed. This study did not include water quality, and there are plans to address this issue in future studies.

Polk County has also entered into cooperative funding agreements with the District to cooperatively fund the development of Watershed Management Programs (WMP) for the Peace Creek/Wahneta drainage system, and for Saddle Creek and its tributaries, including those discharging into Lake Hancock such as the Lake Lena Run, and Eagle and Millsite lakes. These WMPs are multi-year funded, multi-phase projects that include three major elements: Watershed Evaluation, WMP, and Implementation of Best Management Practices (BMPs).

The Watershed Evaluation element of the program is the first step in understanding a watershed. The evaluation provides an opportunity to explore the sub-basins, and conveyance and storage features within a watershed. Topographic maps are used to establish the study area and the boundary of the watershed, to determine the flow direction, the ridges on the watershed's land form and to properly delineate its sub-basins. An inventory of the resources of the area and stormwater management infrastructure identify the watershed's natural and manmade conveyance and storage features which is accomplished through mapping and field verification. A photo and geographic positioning system inventory of the features is developed and documented in a report. The resources of the area (wetlands, lakes, rivers, tributaries, creeks, and streams) and stormwater management infrastructure are identified and categorized by system scale (local, intermediate, regional). The watershed is evaluated to determine which areas require immediate maintenance and determine the property status for legal access to maintain and control the conveyance and storage features in the watershed.

The information gathered along with recommendations from the Watershed Evaluation determines the level of detail required to analyze the identified watershed parameters for the floodplain analysis portion of the WMP. During the watershed evaluation GIS coverages are developed to document the watershed parameters. This information is entered into the GIS according to the District's Data Standards. The watershed sub-basins are delineated based on storage (flood-prone areas) and conveyance features. A Preliminary Link-Node Watershed Connectivity coverage of the storage and conveyance features is developed in the GIS that includes the photos of the features from the inventory. District land use and soils coverages are also included.

The Watershed Evaluation provides information used for management decisions and regulatory review. The information gathered is used to define the cost for future elements of the water management program.

The WMP builds upon the information developed in the Watershed Evaluation to conduct a floodplain analysis, establish LOS, identify system deficiencies, and provide an alternative analysis. The plan addresses the status of water quality within the watershed and conveyance system, and includes an overview of the status of wetland systems within the watershed, particularly in the vicinity of the intermediate conveyance system. The alternative analysis includes the development of a BMPs Implementation Plan with prioritized recommendations and associated cost estimates for implementation.

The Watershed Evaluation and the WMP for Peace Creek/Wahneta system have been completed. To date, several stormwater management options have been reviewed. Storage areas were analyzed and it was found that they would reduce the outflow to the Peace River by about 10-20%, depending on the amount of storage. Storage benefits were considered small compared to costs and loss of flow to the river. Currently, a final plan has not been adopted, but a preferred plan is a modest one consisting of maintenance dredging of Wahneta Canal and Peace Creek downstream from the confluence with the canal. The objectives are to allow more rapid releases from the Lake LuLu structure downstream to the Wahneta Canal, to increase flexibility in managing the Winter Haven Chain of Lakes, and possibly to adjoin the Lake Hamilton Chain so that water storage benefits can be achieved.

The Watershed Evaluation and WMP has also been completed for the Eagle/Millsite Lake project, and the WMP is under development for the rest of the Saddle Creek system, including Lake Lena Run.

Charlotte County's Master Stormwater Management Study is currently underway. This study includes both the water quantity and quality aspects. Watersheds have been prioritized based on problem areas, and recommendations are being developed. Development of plans for DeSoto and Hardee counties will be dependent on funding availability and their priorities. However, DeSoto County has recently completed a study of the Deep Creek Gully watershed that was cooperatively funded by the District. Funding for infrastructure improvements based on the study recommendations was also approved for FY 2001. Additional funding for implementation has also been requested for FY 2002.

In addition, DeSoto County, and the District conducted a study for the Durrance Branch watershed, east of Arcadia, which is a tributary of Joshua Creek (SWFWMD 1990). Detailed flood information was developed for existing conditions, and three options were reviewed: (1) maintaining existing conditions which required preservation of basin storage; (2) clearing sediments and vegetation from drainage channels; and (3) a full upgrade of the stormwater management system, including increasing structure capacities and channel excavation. It was noted that the last option might introduce water quality problems, downstream flooding, and permitting concerns.

In Hardee County, sections of Horse Creek. Brushey Creek, and Oak Creek will be evaluated as part of the IMC Ona and Farmland Hydro Mine plans. The permit review process for these mines will include an analysis of the Mean Annual, 25-year, and 100-year 24-hour rainfall events for the existing and post reclamation conditions. In addition, Hardee County has expressed a desire for the creation of recreational lakes within the County, especially on reclaimed mine land. How these lakes will impact flood protection, as well as MFLs, will need to be addressed during the permitting process.

Similar to the counties, but on a smaller scale, cities have also commissioned stormwater management master plans of their jurisdictions. In the upper watershed, the Cities of Winter Haven and Lakeland engaged Dames and Moore, Inc. to do stormwater studies (Dames and Moore, Inc. 1992 and 1990). Both these studies included water quality and flooding assessments of lakes within the cities, based on the Stormwater Management model. Loading rates to lakes were determined based on existing conditions, developed conditions, and developed conditions with institution of BMPs. It was found that lake water quality would be degraded without implementation of BMPs. Also included was the development of a GIS database, so the cities could assess the influence of land use and other changes.

In addition, the city of Wauchula engaged Kimley-Horn and Associates, Inc. to perform a similar analysis for runoff from the City that discharges directly into the Peace River. The study, which was cooperatively funded by the District, included a alternatives analysis and the design of recommended infrastructure improvements to enhance flood protection within the City. The City has also requested cooperative funding in FY 2002 for the implementation of these recommendations.

Likewise, the city of Lake Alfred is currently developing plans to prepare a Stormwater Master Plan to improve flood protection within the City, and to improve the quality of the water discharged into area lakes that outfall to the Winter Haven Chain of Lakes. The City is currently conducting a study to evaluate areas near Lake Swoope and Lake Haines, and to develop a plan to improve flood protection and provide additional water quality treatment for these areas. This project is also being cooperatively funded by the District.

4-2. Local Drainage Districts

Seven independent special districts, formed pursuant to Chapter 298, *Fla. Stat.*, for water control purposes, are located within the Peace River watershed. The majority of these districts were developed for agricultural purposes, as a way to undertake projects to drain water from lands or provide for basic drainage control to increase usable acreage. The two oldest districts, Peace Creek and Haines City Drainage Districts, were formed in the 1920s with the balance

(Bermont, Central Charlotte and East Charlotte Drainage Districts and Joshua and West Lakeland Water Control Districts) formed in the 1960s and 1970s. Legislative changes in 1997 moved oversight for all of the state's water control districts from the FDEP to the water management districts. This legislation also required that each of the water control districts develop water control plans, for review by the water management districts, detailing their current and proposed activities.

Watershed planning within tributary sub-basins was done in conjunction with watershed programs instituted primarily in the 1960's. Programs were established for tributaries such as Peace Creek, Joshua Creek, Payne Creek, Thompson's Branch, and Prairie Creek. Studies within the watersheds generally consisted of assessments of the sub-basin's surface water resources, and planning to utilize and conserve water resources. Plans generally consisted of methods to control surface water levels, remove standing water from sub-basins more quickly, and/or control water table levels. Plans were implemented through the local drainage districts established for sub-basins within the Peace River watershed. According to local needs, watershed plans varied between the districts and were implemented to varying degrees. Some districts were formed and dissolved before significant work was done. Whereas other districts, most notably the Lakes Region Lakes Management District in Polk County, remain active in managing water resources within their jurisdictions.

Land development activity within Prairie Creek watershed, with attendant local drainage improvement, resulted in exacerbation of flooding problems of a sub-watershed, known as Tippen Bay. Problems arose because of a lack of coordinated watershed/land development planning. An attempt to develop a watershed plan was dropped because consensus was not formed concerning the extent of project improvements among the sponsors. The watershed district was subsequently dissolved in 1973.

As a result of continuing problems, Water and Air Research, Inc., (WAR) was later commissioned by SWFWMD to perform a cursory evaluation of problems and make recommendations concerning a course of action (WAR 1985). The study showed that the most significant problem was caused by a perimeter dike and by-pass drainage system surrounding a farming area developed in Long Island Marsh. WAR noted that system caused significantly higher headwater conditions in the eastern part of the marsh, and caused an increased diversion of water into an adjacent watershed. Because the problems involved multiple watersheds and land owners, WAR recommended that a multi-watershed Stormwater Management Master Plan be developed for the area. They also included interim recommendations, including restrictions on land development and changes to stormwater management systems, until a plan could be developed and implemented. To date, further progress has not been made toward solving the problems.

4-3. Other Sources of Stormwater Management Information

Other studies, such as development of regional impact applications, and information developed for Federal, State and Local regulatory programs provide additional sources of information regarding local stormwater management systems. Since this information is required for land development, such as phosphate mining operations, residential, infra-structure and industrial developments, these sources supply information on how existing stormwater management systems will be changed. They also provide information related to how proposed activities will satisfy the water quality and water quantity requirements of regulatory programs.

Wider scale studies have also been conducted to examine the influence of various types of land development on water resources. Of particular interest in this watershed is phosphate mining.

A study of interest was done by USGS to assess hydrology and water quality of reclaimed phosphate mining areas in Central Florida (Lewelling and Wylie 1993). The study stated that open-pit mining has affected the hydrology of a 2,000 mi ^{2} area in west-central Florida. In addition, the report states that at that time, the mining and chemical companies owned about 450,000 acres, or about 35 percent of the land within this area. The study went on to say that much of this land might be mined by the year 2000.

In 1975, the Florida legislature mandated that land mined for phosphate be reclaimed. Reclamation of these areas is intended to protect water quality and provide flood and erosion control. As can be seen from the land use map (Atlas Map 4), much of the Peace River watershed is designated mined lands. The USGS study concluded that peak runoff rates from reclaimed land generally were higher than those for unmined areas for short duration high intensity storms. However, for low intensity long duration storm events, peak rates were similar. Based on stream flow recordings, no flow occurred about 31% of the time in streams of unmined sub-basins and varied between 19% to 60% in mined sub-basin streams.

The influence of reclamation on surface water hydrology varied widely with the backfill material and resulting topography. In three sub-basins filled with clay, there was no sustained base flow and little runoff because of storage in depressions on the land surface. In sub-basins backfilled with overburden, stream flows were characterized by relatively low peak runoff rates but relatively high base flow.

Because of the 1975 state mandate, mined lands permitted after 1975 within the Peace River watershed will undergo reclamation. In the past, mine plans were reviewed in accordance with Chapters 40D-4 and 16C-16, FAC. Since the implementation of the ERP rules in 1994, new mines will be required to obtain an ERP from the FDEP. Historically however, each reclamation plan is reviewed for conformance with criteria related to quantifiable flows, levels and acreages without the benefit of an overall regional reclamation guide, or plan. In 1992, the FDEP Bureau of Mine Reclamation published a report on the Integrated Habitat Network (IHN). This report identified a plan for the restoration of habitat networks within the phosphate mining region that would extend beyond individual mine boundaries.

Lands that were disturbed prior to 1975 are not required to undergo reclamation; however, funds are available for reimbursement from the Old Lands Trust Fund. As a requirement for reimbursement, reclamation plans for these Old Lands must also receive an ERP. However, there are currently about 35,000 acres of eligible Old Lands, for which the property owners have not requested reimbursement for reclamation costs. These areas are assumed to be in an un-reclaimed condition, and may also be closed basins that do not contribute surface water to intermediate or regional conveyance systems, or have excessive storage due to lack of recontouring.

The above information points to the probability that watershed hydrology will not be properly restored unless careful planning and execution of reclamation is consistently pursued throughout the reclamation period. Planning methodologies must be improved to incorporate a holistic watershed approach to the reclamation process that addresses the contribution of both surface and groundwater. Information resources are available from the FDEP Bureau of Mine Reclamation, USGS, Florida Institute of Phosphate Research and FFWCC regarding methodologies for the reclamation of integrated surface water and habitat systems. A listing of some of these resources are included in the Reference Section.

5. LAND USE AND STORMWATER RUNOFF REGULATION

Prevention of flooding and other stormwater quantity problems historically has been through enactment of land use and stormwater runoff regulations. These regulatory responsibilities have been separated based on local, state, and federal jurisdictions. Local government has zoning authority, applies floodplain building ordinances in conjunction with the Federal Flood Insurance Program, and specifies stormwater regulations related to their stormwater management infrastructure.

State government, through the FDEP regulates water quality and quantity. This authority has been delegated to some water management Districts, including SWFWMD. Each of these Districts have their own variations of rules and thresholds of development size and density applicable to permitting exemptions.

At the Federal scale, the USACOE is responsible for the management of some major flood control systems. However, none of these systems are located within the Peace River watershed. The USEPA also regulates stormwater runoff through NPDES requirements.

5-1. District Regulations

Chapters 40D-4, 40D-40, 40D-400 and 40D-6, FAC, provide the basis of water quantity control within the District. Much of the Peace River watershed falls under the general requirements, which specify that the post development condition peak runoff rate shall not exceed the pre-development peak rate for a 25-year 24-hour duration design storm. There are also areas within the watershed that are specified as volume sensitive. Within these sub-basins, the post development runoff volume must not exceed the pre-development runoff volume for a 100-year 24-hour duration design storm. This provision generally applies to the upper watershed where there are many lakes with restricted outlets where flooding could be increased as a result of increased runoff volumes. It is important to note that these rules apply to releases of runoff to downstream receiving areas, and not to a development's internal drainage system.

Floodplain encroachment is also regulated by the District. Regulations require that compensating storage be provided for fill placed within the 100-year floodplain. Conveyance restrictions resulting from new facilities crossing the floodplain, such as roads, bridges, and pipelines are also required to have no adverse impacts to floodplain levels.

5-2. Local Government Activities

Each of the counties and municipalities within the watershed regulates land use and development within their boundaries in accordance with a state approved local comprehensive plan. Each local plan consists of eight basic elements including capital improvement, future land use, traffic circulation, public facilities and services, conservation, recreation and open space, housing, and intergovernmental coordination. These elements are designed to address areas of local government concern, and assist them with the planning process. The content within each of the plan elements includes data, analysis, goals, objectives, and policies.

The data and analysis section of each element defines particular problems the local government must address with regard to that element, while the goals, objectives and policies section establishes guidelines for solving these problems. The goals, objectives and policies section also describes how existing or proposed local government programs, activities, and Land Development Regulations will be utilized to implement the comprehensive plan.

Several elements addressed in the comprehensive plans forward the objectives in the CWM plan. The plans define a LOS standard for each public facility, describe problems and infrastructure needs, and identify capital improvements needed to support future demands. This is comparable to the WMPs described in the Flood Protection section of Volume II, Peace River CWM Strategic Action Plan.

The Growth Management Act (Chapter 163, *Fla. Stat.*), requires that all public facilities and services needed to support development must be available, concurrent with impacts of development. This is known as concurrency. The concept is that roads, sanitary sewer, potable water, parks and recreation, solid waste, public transportation, and drainage (stormwater management) must not be allowed to fall below the specific LOS standard set forth in the plan. The law also provides that a local government cannot issue permits or development orders if a project would reduce the LOS for the subject service or infrastructure facility below the level identified in the approved comprehensive plan.

The requirement of a concurrency management system was established in order to measure the progress of the comprehensive planning process and its impacts on managing growth consistent with service and infrastructure capacities. As part of this process, each local government prepares a concurrency report that reviews the adopted LOS for each development proposal and plan amendment. In addition, local governments generally establish their own concurrency management processes in which new land development proposals are evaluated to determine if the project will negatively impact the adopted LOS standard for each element.

5-3. County and Local Government Stormwater Regulations

Stormwater regulations used by Counties and other local governments generally specify that the requirements of State and Federal agencies, and other appropriate regulations will be satisfied by proposed developments. In addition, these entities may also establish more stringent regulations as may be required to address unique circumstances.

To participate in the National Flood Insurance Program, the FEMA specifies that participating local governments adopt floodplain management ordinances meeting FEMA's specifications. The local government then acts as FEMA's agent for floodplain information as it pertains to the flood insurance program. Where Flood Insurance Study information is lacking, FEMA specifies that local participators regulate floor slab levels based on the best available information. All counties and municipalities within the Peace River watershed participate in these federal programs.

The local governments have also specified LOS standards for stormwater management systems within their jurisdiction. As examples, Polk County specifies that existing stormwater systems be able to adequately control runoff from the 10-year 24-hour storm event, while the LOS standard for new and re-constructed systems is the 25-year design storm. Charlotte County regulations specify a 25-year 24-hour design storm for arterial and collector roadways, which is reduced to a 5-year event for residential streets. The designs for parking facilities within Charlotte County are based on a 5-year storm and 0.75 foot maximum inundation depth. As illustrated by these requirements, design standards may vary with their particular application and are concerned with preserving the capacity of existing infrastructure, as well as designing systems to meet the needs of future development.

6. DEVELOPMENT IN FLOODPLAINS

Although the above regulations apply to development within floodplains, they are not meant to prevent development in flood-prone areas. The potential exists for increased flood hazards as a result of land use changes and construction of residences and other buildings in flood-prone areas. For example, homes may be built at levels where they rarely flood, however, much of the infrastructure, yards, and common areas may be subjected to flooding on a more frequent basis.

6-1. Development Below Levels of Outfall Controls or Historic Flood Levels of Lakes

Hazards of developing in floodplains have been exemplified in recent years as a result of the recovery of lake levels from record or near record lows in the mid-1970's. In many cases, homes were built below elevations to which lakes have historically fluctuated. Examples in Polk County are Lakes Thomas, Grassy, and Deeson where house floor slabs have been placed well below the level these lakes attained in 1960. In some cases, homes were built below levels at which water discharges from the lake. Although many flooding problems have been experienced, it should be noted that most lakes had not yet recovered to their 1960 and pre-1960 levels until the 1997-1998 El Niño event. With the exception of El Niño, rainfall averages prior to 1960 were greater than has been experienced since that time. Lake levels would therefore be expected to rise if rainfall averages return to their historic values.

6-2. Development in Riverine Floodplains

Problems have also been experienced due to development in the floodplains of rivers and streams. In many cases, homes have been placed in flood-prone areas adjacent to riverine systems. Even when floor slabs have been elevated, or have been built outside of the floodplain, the obstruction of fill and ancillary facilities can impact the flow capacity and storage volume provided by floodplain features. In addition, debris form these facilities may be transported downstream, further restricting flow capacity and damaging facilities such as road and bridge crossings. Other problems can also occur for these home owners due to the flooding of out-buildings, septic tanks, potable water wells, driveways and access roads. Chronic, long-term flooding can occur as was experienced during the extremely wet fall and winter of 1997-1998. In many of these cases, chronic flooding occurred because floor slabs were constructed below historic high water elevations.

6-3. Preservation and Maintenance of Conveyance Systems

Lack of stormwater management system maintenance and inconsistent application of stormwater management policies have also influenced flooding potential. During dry years, there is little impetus to regularly maintain conveyance systems. As a result, the conveyance capacity of these systems can become shallower, or restricted due to erosion and sediment deposition, and they can become choked with vegetation.

In addition, when stormwater infrastructure improvements are not required in conjunction with development the capacity of existing conveyance systems can be exceeded, increasing the potential for flooding potential. In many areas, conveyance systems are inconsistently sized along their lengths. For example, in Polk County where a road was built across the Spirit Lake discharge system without adequate provisions for drainage; at Cypress Lake where a small culvert was placed in front of a much larger culvert in the lake outfall system; and at the Peace Creek Drainage Canal where, until recently, very little maintenance had been done since its construction in the early 1900's.

7. INTEGRATION OF LAND USE AND STORMWATER REGULATION WITH WATERSHED PLANNING

Historically, problems have occurred, due to a lack of integration between land development activities and regional surface water management. To address this issue, the District, through the cooperative funding program, assists local governments with the development of WMPs that include a study of the subject watershed, its characteristics and conveyance system capacity. Watershed studies can be used to identify important hydrologic features that are essential to the functions of a watershed and specify means to preserve them. Study recommendations may include the construction of system improvements, or the development of area specific regulations based upon the unique characteristics of individual watersheds and system capacity limitations. It is important that these studies identify critical drainage features and flood elevations so that homes and businesses are not placed in jeopardy. In addition, studies can be used to identify opportunities for wetland and water quality enhancements.

Land use planning can be integrated into watershed planning so that suitable land uses are encouraged for the type of land form involved. The integration of proposed land development into watershed databases could facilitate evaluation of the impacts of development on the entire receiving system. This type of database could also be used to evaluate land use planning scenarios to allow local governments to evaluate what effects planning decisions today will have on the surface and groundwater system, and our quality of life tomorrow. These processes facilitate consensus building among affected parities as to whether development proposals are advisable, and could be used to coordinate efforts between regulatory agencies and local governments to achieve mutual stormwater management goals and objectives.

8. 1997-1998 "EL NIÑO" FLOODING AND DISTRICT AND LOCAL GOVERNMENT INITIATIVES

8-1. The 1997-1998 Floods

Several cold fronts during the late fall and early winter of 1997-1998 brought record off-season rainfall to Florida and produced wide-spread flooding throughout west-central Florida. These events have been linked to a cyclic climatologic phenomenon in the western Pacific Ocean known as "El Niño." During an El Niño year, weather patterns are disrupted on a worldwide scale. As a result of the unusually intense 1997-1998 El Niño, many homes throughout the District were destroyed or severely damage and many communities were affected by septic tank failures, well contamination, and partial or total isolation due to flooding.

In addition to the effects of rainfall runoff, the prolonged period of soil saturation exacerbated flooding conditions as surficial groundwater drained into low areas increasing flood levels, and extending the period of inundation.

8-2. District and Local Government Initiatives

The District's Governing Board approved $125,000 from contingency funds for the completion of aerial photography for use in documenting flood conditions within the District. Special funding was also provided for aerial photography to document flooding produced by the 1997-1998 El Niño event so that this photography would be available for future identification and evaluation of flood-prone areas. The Board approved the expenditure of $75,000 for as-needed engineering services to assist the District in responding to flood related issues. In addition to aerial photography, the District is exploring options for the placement of flood elevation monuments within areas of recurrent flooding. These monuments would provide a physical reference of historic flood events, and potential future flood risks, for area residents and the general public.

In addition, the District is developing a Flood Protection Coordination Initiative whereby the District and local governments can execute MOUs that clearly define the respective roles of each in addressing flooding. The purpose of the MOUs is to help guide local governments, citizens, and the District in understanding the individual and mutual responsibilities of each entity through the identification of programs, services, and initiatives that address flood protection issues. This, and other District efforts, should reduce the potential for, and magnitude of adverse impacts related to future flooding events.

Chapter 5
Water Quality

Peace River – Bartow, Florida – 1959
From the Florida State Photographic Collection: Department of Commerce Collection

CHAPTER 5. WATER QUALITY

1. SURFACE WATER

1-1. Previous Studies and Available Data

Extensive analyses of water quality data and summaries of water quality conditions and trends in the Peace River watershed have been provided by Texas Instruments, Inc. (1978), Estevez et al. (1981), Stoker (1986, 1992), German and Shiffer (1988), Stoker et al. (1989), Hammett (1990), Fraser (1991), Montgomery et al. (1991), Hand et al. (1994), and Coastal Environmental, Inc. (1995*a*, 1995*b*).

Long-term water quality monitoring has been conducted at a number of surface water sites in the watershed by the USGS (e.g., Stoker 1986, 1992, German and Shiffer 1988, Hammett 1990), FDEP (e.g., Hand and Paulic 1992, Hand et al. 1994), the Environmental Quality Laboratory, Inc. (Montgomery et al. 1991, Environmental Quality Laboratory, Inc. 1994), and the PR/MRWSA. Polk County conducts water quality monitoring in a number of lakes, streams, and manmade canals within its jurisdiction (Polk County Natural Resources Division 1999). Since 1994, the District has conducted water quality monitoring at approximately 146 lake stations located within the Peace River watershed in Polk and Highlands counties (SWFWMD 2000*c*). Among the ongoing water quality monitoring programs, the USGS provides the longest period of record at a number of sites in the watershed (Table 5-1 and Figure 5-1). Refer to Atlas Map 8 for District monitoring sites.

The District's SWIM section has funded a diagnostic assessment of the Charlotte Harbor watershed, which provided estimates of average annual loadings of three pollutants (total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS)) to major river segments for the period 1985-1991 and identification of hydrologic sub-basins and land uses contributing those loadings (Coastal Environmental, Inc. 1995*a*). Additional SWIM projects have provided a summary and synthesis of water quality data collected during the years 1976-1994 by the USGS, Environmental Quality Laboratory (EQL), and SWIM monitoring efforts (Coastal Environmental, Inc. 1995*b*), and preliminary resource-based freshwater inflow and salinity targets for the tidal Peace River (Coastal Environmental, Inc. 1995*c*).

1-2. Current Projects

Charlotte Harbor

The District's SWIM Program conducted an estuaries WQMP for the Charlotte Harbor system, which included monthly monitoring at four sites in the Lower Peace River and ten sites in other portions of the Harbor from January 1993 through December 2000. This monitoring effort will continue with the initiation of a unified estuaries WQMP for the Charlotte Harbor region. This long-term monitoring effort (tentatively scheduled to begin April 2001) uses the stratified random statistical design developed by the USEPA Environmental Monitoring and Assessment Program for Estuaries. This design is probability-based and allows the status and trends of environmental quality indicators to be estimated with statistical confidence. Shared funding and active cooperation for this monitoring program includes numerous agencies; SWIM, Charlotte County, FDEP, CHNEP, and the FFWCC Florida Marine Research Institute.

Table 5-1. USGS Gage Sites in the Peace River Watershed (USGS)		
Site Name	**USGS Gage #**	**Period of Record**
Banana-Hancock Canal	02294405 [a]	7/86 - 6/92
Peace Creek Canal near Wahneta	02293987[a]	3/91 - present
Saddle Creek at Structure P-11	02294491 [b]	11/63 - present
Peace River at Bartow	02294650 [b]	10/39 - present
Peace River at Ft. Meade	02294898 [b]	6/74 - present
Bowlegs Creek near Ft. Meade	02295013 [a]	2/64 - 9/68 2/91 - present
Payne Creek near Bowling Green	02295420 [a]	10/63 - 9/68 10/79 - present
Peace River at Zolfo Springs	02295637 [b]	9/33 - present
Charlie Creek near Gardner	02296500 [b]	4/50 - present
Peace River at Arcadia	02296750 [b]	4/31 - present
Joshua Creek at Nocatee	02297100 [b]	4/50 - present
Horse Creek near Myakka Head	02297155 [a]	10/77 - present
Horse Creek near Arcadia	02297310 [b]	4/50 - present
Prairie Creek at Ft. Ogden	02298123 [b]	10/63 - 9/68 10/77 - present
Shell Creek near Punta Gorda	02298202 [b]	1/65 - 9/87 10/87 - 9/94 10/94 - present

NOTES:

[a] Discharge data only
[b] Discharge and water quality data

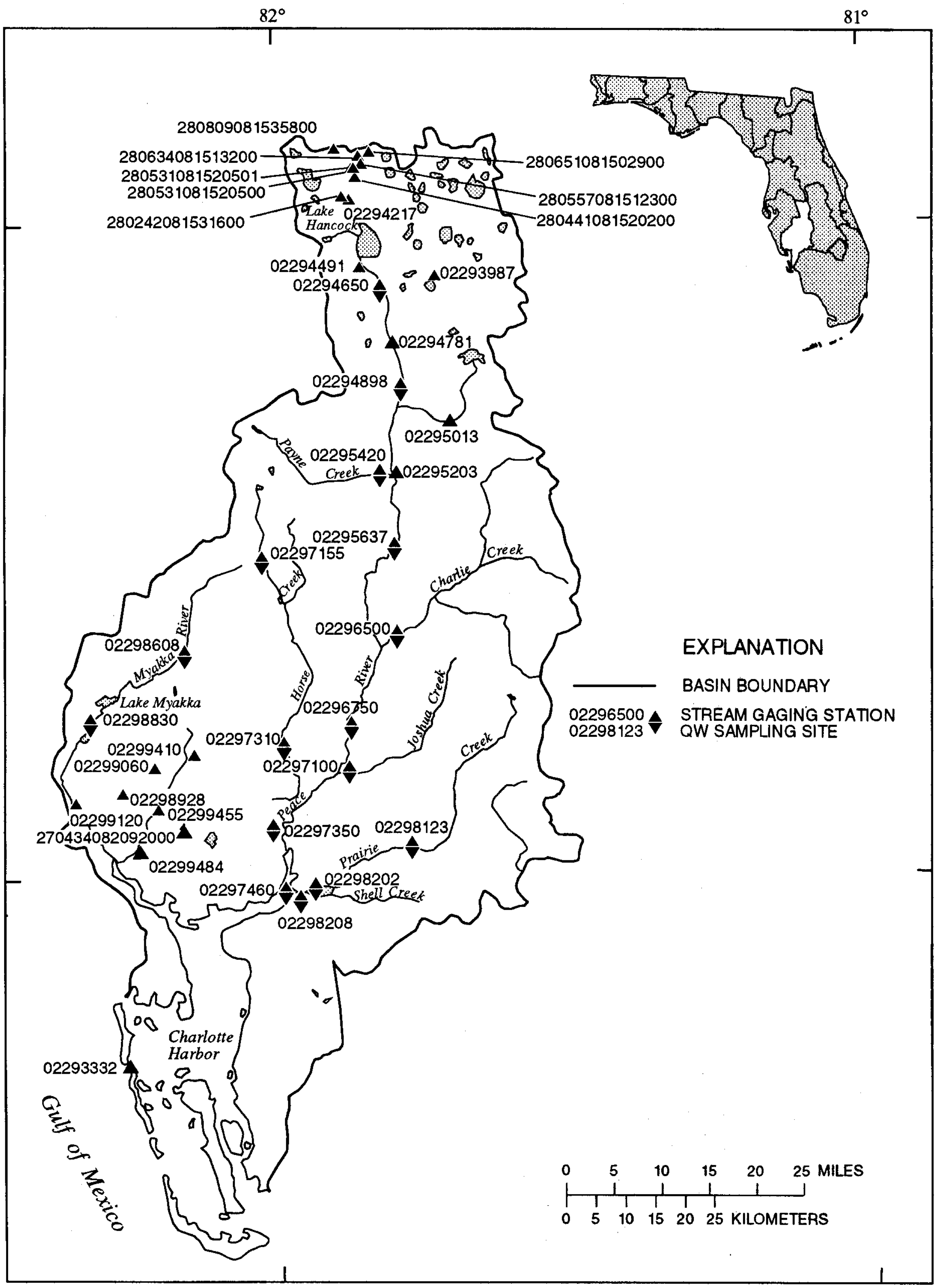


Figure 5-1. Locations of USGS gaging stations in the Peace River Watershed (USGS 1997)

Peace River Long-Term Water Quality Monitoring Study

More recently monthly water quality monitoring was initiated at ten long-term stream gaging stations in the Peace River watershed in September 1997 (Figure 5-1 and Table 5-2). The project, which is to serve as a long-term monitoring effort, is being carried out cooperatively by the Charlotte Harbor Environmental Center, Inc., the CHNEP, the District, FDEP, and the PR/MRWSA. Annual reports on water quality status and trends in the Peace River are generated from this monitoring effort (CHNEP March 1999 and December 1999).

Table 5-2. USGS Stream Gaging Stations Used as Monitoring Locations in the Peace River Long-Term Water Quality Monitoring Study (USGS)

Site Name	USGS Gage #	Location
Peace Creek Canal near Wahneta	2293987	Peace Creek Canal at County Road 665, Polk County
Saddle Creek at Structure P-11	2294491	Lack Hancock discharge point. Polk County
Peace River at Bartow	2294650	Peace River at SR 60, Polk County
Peace River at Ft. Meade	2294898	Peace River at US Highway 98, Polk County
Peace River at Zolfo Springs	2295637	Peace River at US Highway 17, Polk County
Peace River at Arcadia	2296750	Peace River at SR 70, DeSoto County
Charlie Creek near Gardner	2296500	Charlie Creek at US Highway 17, Hardee County
Horse Creek near Myakka Head	2297155	Horse Creek at SR 64, Hardee County
Horse Creek near Arcadia	2297310	Horse Creek at SR 72, DeSoto County
Shell Creek near Punta Gorda	2298202	Shell Creek upstream from Punta Gorda Dam, Charlotte County

CWM Water Quality Monitoring Network

During the development of the CWM plans for the District, all eleven teams identified the need for a District-wide long-term water quality monitoring network (WQMN) and/or additional water quality monitoring sites within their watersheds. Based on this well documented need the CWM WQMN was developed. This network will ultimately include surface and groundwater monitoring sites; however, at present, only surface water sites are included. The CWM WQMN strategy includes field sampling activities, laboratory activities, quality assurance, some additional sites and a centralized water quality database. All the elements of the strategy are either in-place or being actively pursued.

The primary goal of the CWM WQMN is to develop a reliable, temporally and spatially relevant ambient monitoring data collection, analysis and distribution system. Ambient water quality data are necessary to establish a long-term record of water quality and biological data for:

1. early detection of water bodies with declining water quality trends, which may benefit from District or local government intervention;

2. documentation of water quality improvements associated with the implementation of management strategies by the District or local governments;

3. determination of the extent to which statutory water quality criteria or state/regional water quality targets are met or violated (e.g., total maximum daily loads (TMDLs), pollutant load reduction goals (PLRGs));

4. identification of water bodies that may ultimately be included in the SWIM Priority Water Body List;

5. calibration of water quality models and the development of loading databases that support event mean concentration calculations;

6. establishing long-term databases for water bodies representative of identifiable geographical and ecological regions that can be used for comparative purposes in other water body studies; and

7. establish a basis for effective response to citizen requests for water quality information.

The CWM WQMN is designed to complement other monitoring efforts by local, state and federal agencies by using data currently being collected by those entities and only sampling sites not being monitored by other agencies. The primary agency programs from which data will be derived are: the District, the USEPA, the USGS, FDEP, the Tampa Bay Estuary Program, local government members of the Regional Ambient Monitoring Program (RAMP), and Florida Lake Watch.

The CWM WQMN structure is designed to establish a coordinated monitoring policy for the water resources within District boundaries, and as such will employ a single or linked database for all water quality data collected by agencies within District Boundaries. The current database strategy includes:

1. the development of database protocols to allow shared use of water quality databases;

2. the employment of the RAMP to ensure uniformity, standardization and regional use of water quality data;

3. the uploading of quality controlled data to the USEPA's Storage and Retrieval database; and

4. the web enabling of CWM and cooperator water quality data.

Currently (April 2001), twenty-two CWM water quality stations are monitored District-wide. The CWM water quality sites located in the Peace River watershed are provided in Table 5-3. Data from other water-quality projects which are currently monitored in the Peace River watershed (FDEP Surface Water Temporal Variability Network and Peace River Long-Term Study) are also utilized for the CWM water quality monitoring effort. Future phases of the network will incrementally increase the total number of monitoring station to approximately 100 sites District wide. The sites are carefully chosen to avoid duplication of efforts between sampling agencies.

Table 5-3. CWM Water Quality Sites in the Peace River Watershed (USGS)		
Site Name	**USGS Gage #**	**Location**
Whidden Creek above Bridge on US Highway 17-98	N/A	Approximately 3 miles south of Ft. Meade on US Highway 17
Payne Creek @ US Highway 17	2295420	Approximately 2 miles south of Bowling Green on US Highway 17
Bowlegs Creek near Ft. Meade	2295012	Approximately 4 miles east of US Highway 17 from Ft. Meade

The CWM monitoring network has adopted a standard set of parameters for all surface water quality sites. The CWM parameters mirror those which are collected by the FDEP in their statewide status and trends monitoring programs. The CHNEP and the RAMP member agencies and local governments have also recommended this parameter list. The sampling frequency for all CWM sites is monthly. Sampling frequency and site locations are reviewed annually by the CWM Water Quality AOR Team to ensure that data needs are met.

Additionally, the FDEP, along with the USEPA, has initiated a bio-assessment project that will create an extensive biological database on near-pristine water bodies within a state-wide, regional framework. The state has been divided into broad eco-regions and more specific sub-regions defined by climate, elevation, soils, geology, vegetation and land use. Water quality and biological data collected from near-pristine water bodies within these sub-regions will provide reference 'benchmarks', useful for establishing reasonable and attainable water quality and biological goals for water bodies within the same sub-region type. The bio-assessment approach addresses the shortcomings of simple water quality monitoring, because it will provide a tool for environmental agencies throughout the state to evaluate the impacts of deteriorating water quality on biological communities within a water body. District staff has coordinated with FDEP staff to select representative sites within the District, and will coordinate the collection of bio-assessment data from some sites.

Ultimately, the water quality and bio-assessment data will be used to group water bodies having similar characteristics (e.g., watershed development and land use, geology, soils, hydrology), and to thereby identify outliers – those water bodies that do not fit within the expected range of variability. An extensive database for water bodies throughout the District will provide the means to compare non-study water bodies to water bodies with similar characteristics and to determine the extent to which they are impacted by human activity. If such water bodies can be identified before they begin significant decline, then mitigation alternatives will more likely succeed, and will be less costly.

Another recent development is also well served by this sampling scheme. The FDEP has been directed by the USEPA under the authority of Section 303(d) of the Clean Water Act, to develop TMDLs for various pollutants in water bodies that do not meet the State of Florida water quality standards. Initially states must submit to the USEPA a list, known generally as the “303(d) List”, of water bodies that fail to meet state water quality standards, and provide a schedule for the development and implementation of TMDLs for each listed water body. The TMDL process identifies the sources and causes of pollution or stress, including point and non-point sources, and establishes allocations for each source of pollution as needed to attain water quality standards.

A closely related effort is the statutory provision for the development of PLRGs for impaired water bodies (Rule 60-40.210(18), FAC). PLRGs are specific numeric targets for load reduction of pollutants, typically nutrients that are often linked to ambient water quality goals necessary for sustaining aquatic life. However, unlike TMDLs, there is no formal regulatory process to ensure that water quality targets and PLRGs will be achieved. For both the TMDL and PLRG development efforts, water quality data are essential to identify impaired water bodies and to provide baseline water quality information about water bodies. The data collected for the ambient monitoring program will help identify impaired water bodies and provide baseline data for many water bodies that have no historical water quality data.

<u>FDEP Ambient Monitoring Programs</u>

The FDEP's Surface Water Assessment and Monitoring Program and Groundwater Quality Monitoring Program were merged in 1996 to create the Integrated Water Resources Monitoring (IWRM) Network. IWRM was developed to provide integrated, statewide information on the important chemical, physical, and pertinent biological characteristics of surface water, groundwater, and sediments and is designed to fulfill many monitoring, management and regulatory needs. The data generated will help evaluate the status and trends of surface and groundwater quality, meet FDEP 305(b) reporting requirements (which are used to rate the water quality of surface waters in Florida), and establish TMDLs.

IWRM employs a three-tiered approach to water quality monitoring. Each FDEP district is divided into four super-basins called Group A, Group B, Group C and Group D. Each group contains one or more hydrologic units. The Peace River and Charlotte Harbor basins fall within Group C (Charlotte Harbor, Myakka River and Manatee River watersheds) and Group D (Peace River watershed) of the Southwest District. Tier I monitoring in Groups C and D is conducted by the District under contract with FDEP.

There are two aspects to Tier I monitoring; fixed station monitoring and status monitoring. The purpose of fixed station monitoring is to document temporal variability in specific locations within watersheds (trend monitoring). Fixed station monitoring began in October 1998 and is conducted monthly at 80 stations statewide; thirteen of which are located within District boundaries and are monitored by the District. Two of these stations (Charlie Creek near Gardner and Peace River @ Arcadia) are located in the Peace River and Charlotte Harbor drainage basins (Table 5-2).

Status monitoring is conducted within groups on a five-year rotation (each group is monitored once in a four-year period, with the first group repeated in year five). Status monitoring in the Southwest District will begin in Group B in October 2000 and in Group C in October 2001. It will be conducted at 180 randomly-selected stations within each group; 30 stations each in the water resource classifications of low order streams (stream order 1-4), high order streams (stream order > 4) plus canals, small lakes (10 hectares or less), large lakes (> 10 hectares), confined aquifers, and unconfined aquifers including springs. Stations will be monitored during the most appropriate season of the year for the particular water resource being monitored. Data obtained through Tier I monitoring will also be used in the development of 305(b) reports and to delineate areas of the state which need further and more intensive study.

Tier II monitoring will address the same parameters and six categories of water resources as those of Tier I; however, it will focus upon specific waters requiring restoration, protection and/or TMDL development. Basin management plans and best management plans will be developed during the Tier II cycle. It is hoped that regulatory permits can be issued within basins at the end of each Tier II monitoring cycle. This will enable information from Tier II to be fed into Tier III. The monitoring efforts of Tier II will be conducted for the most part by FDEP, but other stakeholders will be brought into the process as well. Before monitoring commences, an evaluation of existing data and information, including those generated in Tier I, will be evaluated. Tier II monitoring and TMDL development will be conducted in Groups C and D from October 2002 through September 2004. In years 2005 and 2006, TMDLs and basin management plans will be developed and implemented, water resource protection and restoration efforts will get underway, and such legislative action as might be required to ensure these activities will be initiated. The long-term goal of Tier II is to synchronize the renewal or issuance of wastewater permits with the fifth year of the Tier II cycle so that information generated up to that point within the basin involved can be applied to the permitting process.

Tier III is the regulatory stage of IWRM and involves monitoring of permitted activities and the effectiveness of BMPs. FDEP will determine how monitoring is to be conducted, but the actual monitoring effort will be the responsibility of the permittee and/or their contractors.

1-3. Regulatory Authorities and Special Rules

The USEPA and FDEP have primary responsibility for the enforcement of federal and state water quality standards within the Peace River watershed. Under the NPDES, a federal program established pursuant to the Clean Water Act, USEPA and FDEP are also responsible for the issuance and enforcement of permits for pollutant discharges from regulated point and non-point sources. FDEP has delegated certain regulatory responsibilities (e.g., for stormwater management, water use permitting, and environmental resource permitting) to the District and some local governments.

<u>Surface Water Classifications</u>

All surface waters in the State have been classified by FDEP to define their designated uses (Chapter 62-302, FAC) 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 also 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 Peace River and its tributaries are designated as Class III water bodies. Exceptions include Shell Creek, Prairie Creek, portions of the Port Charlotte Canal System, and the southernmost portion of Horse Creek (downstream of SR 761), which are classified as Class I waters due to the roles they play in providing municipal water supplies. The lowermost reach of the river, extending from the Barron Collier (US Highway 41) Bridge to the river mouth, falls within the Charlotte Harbor Aquatic Preserve and is designated as a shellfish propagation and harvesting area (Class II) and an Outstanding Florida Water (OFW). There are no Class IV or V waters present in the watershed.

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), *Fla. Stat.*

State water quality criteria for Class I and Class III waters (Chapter 62-302, FAC) define minimum conditions which are legally required to be met in surface water bodies which fall within these classes. The criteria most frequently violated in surface water bodies within the Peace River watershed appear to include the following.

1. 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.

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

3. 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 ml on any one day.

4. 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.

5. 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.

6. Biochemical Oxygen Demand (BOD) - 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.

7. 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 regulatory criteria, FDEP has also developed the water resource implementation rule (Chapter 62-40, FAC) which provides guidance to the Department, water management districts, local governments, and the private sector in matters related to the protection and improvement of water quality. This combination of goals, policies, and criteria appears to provide the most appropriate legal and regulatory framework within which the CWM initiative's water quality restoration and protection efforts can be developed.

Outstanding Florida Water Designations

In addition to the surface water classifications discussed above, the estuaries portion of the Peace River (downstream of US Highway 41) is designated an OFW due to its location within the Charlotte Harbor Aquatic Preserve. A petition to extend OFW status to Horse Creek has been submitted to the State by the DeSoto Citizens Against Pollution, and is currently undergoing review by FDEP.

Additional rules that regulate activities potentially impacting water quality become effective with OFW designation, including:

1. Rule 62-640.770(4)(f), FAC – 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.

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

3. Responsibility for MSSW (Chapter 373, *Fla. Stat.*), which provides for the permitting of stormwater pretreatment ponds, has been delegated to the water management districts. The District's guidelines (Chapter 40D-4, FAC) require that developments which discharge to OFWs provide treatment of a 50 percent greater volume of stormwater runoff than is otherwise required.

Domestic and Industrial Point Source Discharges

As noted above, discharges from domestic and industrial point sources are regulated by USEPA and FDEP under the 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 46 major point sources (defined as facilities whose permitted discharges exceed 0.1 mgd of effluent) discharge to surface waters in the Peace River watershed (Coastal Environmental, Inc. 1995*a*). Those facilities, the majority of which are industrial point sources located in Polk County, are summarized in Table 5-4. In addition, a large number of domestic point sources that discharge effluent via percolation ponds, spray irrigation, or land application are present in the watershed. Pollutant loadings from these facilities were recently estimated by Coastal Environmental, Inc. (1995*a*).

Table 5-4. Domestic and Industrial Point Sources Permitted to Discharge Effluent Volumes >0.1 mgd to Surface Waters in the Peace River Watershed. (Coastal Environmental, Inc. 1995*a*)

FDEP ID #	Type	Facility Name/Outfall Number	Location	Discharge Point (Nearest USGS Gage Site)
PK218	D	Auburndale North	Polk County	Saddle Creek - P11
PK748	D	Auburndale North	Polk County	Saddle Creek - P11
PK041	I	Coca Cola #002	Polk County	Peace River - Bartow
PK023	I	Bordo Citrus #001	Polk County	Peace River - Bartow
PK0641	I	Florida Distiller Company #001	Polk County	Peace River - Bartow
PK0642	I	Florida Distiller Company #002	Polk County	Peace River - Bartow
PK063	I	Florida Distiller Company #003	Polk County	Peace River - Bartow
PK087	I	Florida Distiller, Jacquin #002	Polk County	Peace River - Bartow
PK0643	I	Florida Distiller #003	Polk County	Peace River - Bartow
PK064S	I	Florida Distiller #002	Polk County	Peace River - Bartow
PK0001	I	Adams Packing #001	Polk County	Peace River - Bartow
PK0222	I	Bordo Citrus #001	Polk County	Peace River - Bartow
PK0031	I	Agrico, Saddle Creek Mine #01	Polk County	Peace River - Bartow
PK0032	I	Agrico, Saddle Creek Mine #02	Polk County	Peace River - Bartow
PK049	I	Estech, Silver City Mine #004	Polk County	Peace River - Zolfo Spr.
PK2341	I	US Agrichemicals Rockland Mine #001	Polk County	Peace River - Zolfo Spr.
PK2347	I	US Agrichemicals Rockland Mine #007	Polk County	Peace River - Zolfo Spr.
PK1266	I	US Agrichemicals Rockland Mine #006	Polk County	Peace River - Zolfo Spr.
PK150	I	Mobil Mining #001	Polk County	Peace River - Zolfo Spr.
PK001	I	Mobil Mining, Ft. Meade #002	Polk County	Peace River - Zolfo Spr.
PK010	I	Mobil Mining, Ft. Meade #003	Polk County	Peace River - Zolfo Spr.
PK0150	I	Mobil Mining, Ft. Meade #PR	Polk County	Peace River - Zolfo Spr.
PK000	I	Adams Packing #002	Polk County	Peace River - Zolfo Spr.
PK299	I	IMC, Noralyn Mine #002	Polk County	Peace River - Zolfo Spr.
PK2991	I	IMC, Noralyn Mine #001	Polk County	Peace River - Zolfo Spr.
PK2993	I	IMC, Noralyn Mine #003	Polk County	Peace River - Zolfo Spr.

Table 5-4. Domestic and Industrial Point Sources Permitted to Discharge Effluent Volumes >0.1 mgd to Surface Waters in the Peace River Watershed. (Coastal Environmental, Inc. 1995*a*)

FDEP ID #	Type	Facility Name/Outfall Number	Location	Discharge Point (Nearest USGS Gage Site)
PK076	I	IMC, Clear Springs #002	Polk County	Peace River - Zolfo Spr.
PK0768	I	IMC, Clear Springs #004	Polk County	Peace River - Zolfo
PK0766	I	IMC, Clear Springs #003	Polk County	Peace River - Zolfo
PK0551	I	Estech, Watson Mine #001	Polk County	Peace River - Zolfo
PK0554	I	Estech, Watson Mine #004	Polk County	Peace River - Zolfo
PK0553	I	Estech, Watson Mine #003	Polk County	Peace River - Zolfo
PK2372	I	Gardinier #002	Polk County	Peace River - Zolfo
PK069	I	Cargill #001	Polk County	Peace River - Zolfo
PK032	D	City of Bowling Green	Polk County	Peace River - Zolfo
PK893	D	City of Wauchula	Polk County	Peace River - Zolfo
PK128	I	Cargill, Ft. Meade Mine #02	Polk County	Payne Creek/ Bowling Green
PK0261	I	CF Industries #001	Polk County	Payne Creek/ Bowling Green
PK0263	I	CF Industries #003	Polk County	Payne Creek/ Bowling G.
PK009	I	Agrico Chemical Ft. Green Mine #002	Polk County	Payne Creek/Bowling Green.
PK0091	I	Agrico Chemical Ft. Green Mine #001	Polk County	Payne Creek/ Bowling Green.
PK008	I	Agrico Chemical Payne Creek Mine #01	Polk County	Payne Creek/ Bowling Green.
PK237	I	Cargill, Ft. Meade #001	Polk County	Payne Creek /Bowling Green.
HD001	I	CF Industries - Hardee #003	Hardee County	Payne Creek/ Bowling Green.
HD007	I	Nu-Gulf Industries #01	Hardee County	Payne Creek/Bowling Green
DE340	D	City of Arcadia	DeSoto County	Peace River - Arcadia

FDEP has implemented an approach to monitoring point source discharges in order to estimate their impacts on receiving waters. These techniques, known collectively as Point Source Biology, include: fifth year inspections, ambient and baseline monitoring, and whole effluent toxicity testing. The data generated help determine if a given discharge is in violation of Florida Surface Water Quality Standards. Fifth year inspections (FYI-5) are used to determine whether or not a facility is in compliance with its permit in reference to surface water discharge. These inspections are conducted by FDEP on a five-year basis and evaluate the following: water quality; toxicity; biological diversity; and bacteriological criteria. The combination of these parameters can determine if the discharge is affecting the environmental integrity of the receiving water. The sampling sites usually monitored in an FYI-5 include the point source outfall as well as an upstream and downstream site.

Ambient monitoring is conducted by either the facility responsible for the point source discharge, or by a consultant. This monitoring is usually performed on a quarterly basis and is used to assess water quality, biological diversity, and bacteriological criteria. Sediment chemistry and benthic macroinvertebrate data collection can also be included in this evaluation. This information is also helpful in determining water quality trends that may be associated with non-point source pollution. Ambient monitoring is a useful instrument in the regulatory decision-making process. As in the FYI-5 monitoring, the sampling sites usually include the outfall, an upstream and downstream site, as well as a control site.

Whole Effluent Toxicity Testing evaluates the effect of an effluent sample on one or more test species, which in turn can help predict the potential toxicity of the receiving waters. A single test can test for either chronic or acute toxicity. Acute toxicity measures the lethality of the test organisms and chronic toxicity measures sub-lethal effects on growth and/or reproduction of the test organisms. The type and frequency of the testing is specified in each facility's permit. The test may be conducted onsite or by an approved laboratory.

Disposal of Domestic Wastewater Residuals, Septage and Food Establishment Sludge

Portions of the Peace River watershed are used for the land application of domestic residuals, septage, and food establishment sludge. These materials are defined as follows (Ayres Associates 1994):

1. domestic wastewater residuals - solid, semisolid, or liquid residue (excluding treated effluent or reclaimed water) removed from the treatment of municipal wastewater;

2. septage - mixture of sludge, fatty material, human feces and wastewater removed during the pumpage of domestic or commercial septic systems, not including the contents of portable toilets, holding tanks, or grease interceptors; and

3. food establishment sludge - oils, fats, greases, food scraps and other grease interceptor pumpings generated by a food operation or institutional food preparation facility.

Land application of these materials, which may contain nutrients, heavy metals and other pollutants, is regulated by USEPA under Code of Federal Regulations Title 40, Part 503 and by FDEP and Department of Health (DOH) under Chapter 62-640, FAC. Residuals, septage and sludge are usually spread on the land in a liquid state, allowed to dry, and used thereafter 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 DOH. Land application rates are typically based on the nitrogen content of the applied material, with maximum rates typically set at 500 pounds nitrogen per acre per year.

Domestic residuals disposal sites at which 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 DOH.

Domestic wastewater treatment plants which apply residuals to agricultural lands are required to develop AUPs and to maintain records of residuals application sites, application rates, and annual application volumes per site. 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 Associates, 1994).

<u>Other Governmental Activities</u>

The Peace River watershed falls primarily within four counties (Polk, Hardee, DeSoto and Charlotte) and includes a number of incorporated municipalities which share jurisdiction over zoning and land use issues. Small portions of the watershed also fall within Hillsborough, Manatee, Highlands, Glades, and Sarasota counties. In addition, a number of federal, state and regional agencies share regulatory responsibilities with local governments for activities that potentially affect the quality of surface and groundwater. Some of the major management and planning entities and programs concerned with the Peace River watershed are discussed in the following sub-sections.

Charlotte Harbor National Estuary Program

The federal NEP was created under the Clean Water Act and is administered by the USEPA. The CHNEP was established in 1995, with local sponsorship from the Southwest Florida Regional Planning Council, to provide a forum within which public and private-sector participants can develop a Comprehensive Conservation and Management Plan (CCMP) to provide long-term protection for Charlotte Harbor and its watershed. The Greater Charlotte Harbor Watershed encompasses an area of 4,400 mi^2 and includes all or part of eight counties. The CHNEP CCMP was completed in February 2000.

Charlotte Harbor SWIM Program

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, developed a SWIM plan for the estuary and its drainage basin (including the Peace River watershed) which was approved by FDEP and the District Governing Board in 1993. The 1993 plan focused on four primary issues:

1. protection of water quality in the estuary and its tributaries, with emphasis on prevention of excessive nutrient enrichment;

2. protection of optimum freshwater flows to the estuary;

3. habitat protection and restoration, with emphasis on acquisition of select parcels; and

4. 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:

1. a diagnostic assessment of the Charlotte Harbor watershed (Coastal Environmental, Inc. 1995*a*);

2. the development of resource-based freshwater inflow and salinity targets for the tidal Peace River (Coastal Environmental, Inc. 1995*c*); and

3. the design of a long-term monitoring program for the estuary and tidal portions of the Peace and Myakka rivers (Coastal Environmental, Inc. 1995*d*).

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

Winter Haven Chain of Lakes SWIM Program

The Winter Haven Chain of Lakes is composed of 19 interconnected lakes which discharge to the Peace Creek Canal in the northeastern corner of the Peace River watershed. A SWIM management plan was developed for the system in 1990 and is currently being updated by District staff and a Winter Haven Chain of Lakes SWIM advisory committee. Primary goals identified in the initial SWIM plan are the improvement of water quality and associated natural systems throughout the Chain of Lakes. Major issues affecting water quality and natural systems are thought to be (in priority order): stormwater runoff; point source discharges; excessive cattail growth; a need for additional public education; preservation of fish and wildlife; a comprehensive water and nutrient budget; reduction of septic system discharges; lake level management; management of nutrient releases from lake bottom sediments; and improved growth management.

USGS National Water-Quality Assessment Program

In 1991, the USGS began implementing a full-scale National Water-Quality Assessment (NAWQA) Program. The major objectives of the this program are to "provide a consistent description of current water-quality conditions for a large part of the Nation's water resources, define long-term trends (or lack of trends) in water quality, and identify, describe, and explain the major factors that effect observed water-quality conditions and trends." (USGS Fact Sheet, FS-061-98, July 1998).

In 1994, the USGS began a NAWQA Program in southern Florida which is scheduled to occur from 1996-98. The southern Florida NAWQA study area encompasses approximately 19,500 mi^2 which includes the Peace River and its tributaries as well as the coastal waters between Charlotte Harbor and the St. Lucie River on the Atlantic Ocean.

1-4. Watershed Characterization

Nutrient Concentrations and Trends

Unnaturally elevated 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, have caused negative impacts to water quality in several portions of the Peace River watershed. In general, phosphorus is the nutrient which has the greatest impact in fresh water bodies (Wetzel 1983), while nitrogen is of primary concern in estuaries and marine waters (Day et al. 1989). Because natural environmental factors and human activities have combined to produce large phosphorus loadings to surface waters in the Peace River watershed, a number of fresh water bodies in the region have become degraded and currently exhibit hypereutrophic water quality conditions on a year-round basis. Nitrogen loadings have not reached such elevated levels, and on a relative basis water quality conditions in estuaries segments of the river appear less impacted than those in many fresh water portions of the system (Hand et al. 1994). Nutrient-driven phytoplankton blooms occur seasonally in the tidal river and Upper Charlotte Harbor, however, and periodically cause chlorophyll concentrations to reach hypereutrophic levels in some estuaries classification systems (Table 5-5) (e.g., National Oceanic and Atmospheric Administration (NOAA) 1995).

In recent decades three water bodies in the Upper Peace River watershed (Lake Parker, Banana Lake and Lake Hancock), along with their tributaries (Stahl Canal, Banana-Hancock Canal, and Lake Lena Run), have consistently exhibited some of the poorest water quality found in the State of Florida (Hand and Paulic 1992, Hand et al. 1994). Reduced point source discharges and recent restoration efforts implemented by the District, FDEP, and local governments have produced water quality improvements in Lake Parker and Banana Lake.

Despite these improvements, however, both water bodies remain highly eutrophic. Lake Hancock is a hypereutrophic system that discharges water of extremely poor quality to Saddle Creek and the Upper Peace River. Discharges from the lake, which are characterized by high concentrations of phytoplankton cells and other sources of BOD, have been documented to cause faunal mortality and long-term water quality impacts extending many miles downstream along the river's main stem (Hand et al. 1994). Those discharges have also been implicated as a potential contributing factor in the water quality problems experienced periodically at the PR/MRWSA's drinking water facility located on the Lower Peace River (C. Dye, SWFWMD, personal communication 1998). Degradation of Lake Hancock has been attributed to its highly impacted tributaries, which have received elevated nutrient loadings over a period of several decades from a number of industrial and domestic point sources (Zellars-Williams 1987, Hand et al. 1994).

Although high phosphorus concentrations have shown improving trends in recent decades in some portions of the Peace River watershed, concentrations of dissolved inorganic phosphate (DIP) and TP have declined at several long-term monitoring sites maintained by the USGS (Table 5-5). These improvements appear due to increased oversight by regulatory agencies and increased compliance by regulated industries and local governments, leading to reduced phosphorus loadings from a number of phosphate mining and processing facilities, food processing facilities, and municipal wastewater treatment plants. Despite these trends, however, average annual TP concentrations measured at the Bartow, Homeland, Ft. Meade, Zolfo Springs, and Arcadia USGS gage sites during the period 1990-1995 exceeded 1.0 mg/l (Table 5-5) and thus fell within the range observed in the most degraded 10 percent of Florida streams (Hand and Paulic 1992). Refer to Atlas Map 7, which shows wastewater treatment plant locations in the Peace River watershed.

Elevated DIP concentrations and low dissolved inorganic nitrogen (DIN):DIP ratios are known to contribute to the development of nuisance cyanobacterial blooms in fresh water bodies (Schindler 1977, Smith 1983, Reckhow 1988, Paerl 1988). These blooms are most likely to occur in quiescent areas such as lakes and floodplain sloughs, where a combination of high nutrient concentrations and low current velocities allow dense phytoplankton populations to develop and persist. The frequent development of cyanobacterial blooms in many surface water bodies in the Peace River watershed, and episodic complaints from consumers regarding unpleasant tastes and odors caused by cyanobacterial metabolites in public water supplies provided by the PR/MRWSA, represent symptoms of the high phosphorus concentrations that continue to occur in the system.

Temporal trends in nitrogen (DIN and TN) concentrations at the long-term USGS monitoring sites are summarized in Table 5-6. In recent decades concentrations of DIN appear to have declined somewhat along the river's main stem at the Ft. Meade, Zolfo Springs, and Arcadia sites and fluctuated with no apparent trend at the Saddle Creek, Bartow and Homeland sites (Table 5-6). Increasing trends are evident at the Charlie Creek, Joshua Creek, Horse Creek and Shell Creek sites. TN concentrations show similar temporal changes. The increasing trends observed in several of the tributary creeks are cause for concern, and appear to signal increasing anthropogenic nutrient loadings to stream systems that have traditionally been among the least degraded in the Peace River system (e.g., Fraser 1991).

With the exception of the Shell Creek-Punta Gorda gage site, average TN concentrations at each of the USGS monitoring locations in the Peace River watershed exceeded 1.4 mg/l during the period 1990-1995 (Table 5-6), the 60th percentile value when compared to other Florida streams (Hand and Paulic 1992).

<u>Annual Nutrient and Total Suspended Solids Loadings</u>

Coastal Environmental, Inc. (1995*a*) estimated average annual loadings of TN, TP, and TSS to gaged and ungaged segments of Charlotte Harbor, the Peace and Myakka Rivers and their major tributaries for the period 1985-1991. Upper Charlotte Harbor received the bulk of its estimated annual TN, TP, and TSS loadings from the Peace River watershed, and in many ways can be considered an extension of the watershed for purposes of water quality analysis (e.g., Table 5-5).

Among hydrologic sub-basins in the Peace River watershed, those located upstream of the USGS gages at Bartow and Zolfo Springs were estimated to generate the largest annual loadings of TN, TP, and TSS. Industrial point source discharges contributed large proportions of the estimated TN, TP, and TSS loadings in these sub-basins. Periodic discharges of algal-rich water from Lake Hancock also degrade water quality in the Peace River and occasionally cause the degradation of river fauna some distance below the lake. Because this portion of the watershed has also experienced substantial anthropogenic impacts to surface and groundwater hydrology in recent decades (Hammett 1990, Coastal Environmental, Inc. 1995*c*), it represents an area in which focused management efforts appear needed to restore both water quality and surface water flow regimes.

Table 5-5. Water Quality Conditions in the Peace River Watershed and Charlotte Harbor (USGS 1990 - 1995)

Parameter	**Monitoring Sites**																	
	Saddle Creek, Structure P-11	Peace River, Bartow	Peace River, Homeland	Peace River, Fort Meade	Peace River, Zolfo Springs	Charlie Creek, Gardner	Peace River, Arcadia	Joshua Creek, Nocatee	Horse Creek, Arcadia	Prairie Creek, Fort Ogden	Shell Creek, Punta Gorda	Peace River, Mary Point	Peace River, US Hwy 41 Bridge	Peace River, Alligator Bay	Peace River, Mouth	Charlotte Harbor (Upper)	Charlotte Harbor (Lower)	Boca Grande Pass (outer)
Gage I.D.	USGS 02294491	USGS 02294650	USGS 02294781	USGS 02294898	USGS 02295637	USGS 02296500	USGS 02296750	USGS 02297100	USGS 02297310	USGS 02298123	USGS 02298202	SWFWMD/SWIM CH-029	SWFWMD/SWIM CH-004	SWFWMD/SWIM CH-05B	SWFWMD/SWIM CH-005	SWFWMD/SWIM CH-006	SWFWMD/SWIM CH-011	SWFWMD/SWIM CH-014
DIP (mg P/l)[a]	0.11± 0.09 (n=18)	1.21± 1.93 (n=34)	0.85± 0.29 (n=17)	0.95± 0.40 (n=35)	0.98± 0.26 (n=29)	0.52± 0.14 (n=21)	0.91± 0.28 (n=26)	0.19± 0.06 (n= 20)	0.41± 0.11 (n=33)	0.08± 0.06 (n=20)	0.15± 0.16 (n=15)	0.60± 0.17 (n= 35)	0.28± 0.16 (n= 35)	0.18± 0.12 (n=35)	0.18± 0.09 (n=35)	0.15± 0.12 (n=35)	0.07± 0.07 (n=34)	0.01± 0.01 (n=29)
TP (mg P/l)	0.45± 0.25 (n=18)	1.38± 1.91 (n=34)	1.03± 0.34 (n=17)	1.21± 0.65 (n=35)	1.13± 0.24 (n=29)	0.57± 0.15 (n=21)	1.07± 0.23 (n=26)	0.24± 0.09 (n= 20)	0.44± 0.11 (n=33)	0.10± 0.07 (n=20)	0.20± 0.21 (n=15)	0.73± 0.16 (n= 35)	0.39± 0.15 (n= 35)	0.25± 0.12 (n=35)	0.25± 0.09 (n=35)	0.19± 0.12 (n=35)	0.10± 0.09 (n=34)	0.04± 0.06 (n=29)
DIN (mg N/l)[b]	0.27± 0.24 (n=5)	0.27± 0.18 (n=27)	0.80± 1.50 (n=15)	0.61± 0.74 (n=33)	0.86± 0.34 (n=29)	0.36± 0.24 (n=21)	0.75± 0.36 (n=29)	1.05± 0.42 (n=20)	0.78± 0.72 (n=32)	0.36± 0.70 (n=18)	0.16± 0.06 (n=12)	0.43± 0.28 (n= 35)	0.15± 0.13 (n= 35)	0.10± 0.10 (n=35)	0.09± 0.11 (n=35)	0.07± 0.11 (n=35)	0.06± 0.08 (n=34)	0.02± 0.02 (n=29)
TN (mg N/l)	5.36± 2.61 (n=18)	2.26± 1.24 (n=33)	2.37± 1.42 (n=17)	1.95± 0.92 (n=35)	1.86± 0.29 (n=29)	1.54± 0.43 (n=21)	1.69± 0.30 (n=38)	2.05± 0.56 (n=20)	1.77± 0.69 (n=33)	1.48± 0.74 (n=20)	1.15± 0.33 (n=15)	1.59± 0.55 (n= 35)	1.25± 0.49 (n= 35)	1.05± 0.42 (n=35)	1.02± 0.41 (n=35)	1.02± 0.49 (n=35)	0.65± 0.49 (n=34)	0.60± 0.61 (n=29)
Conductivity (μS/cm)[c]	268± 48 (n=18)	268± 92 (n=33)	463± 236 (n=18)	425± 169 (n=34)	395± 112 (n=31)	243± 82 (n=20)	343± 121 (n=127)	609± 193 (n=20)	308± 192 (n=32)	548± 175 (n=29)	691± 269 (n=24)	2199± 4268 (n=36)	21592± 11368 (n=34)	30944± 9371 (n=72)	26525± 10003 (n=37)	31871± 9828 (n=71)	41675± 7794 (n=66)	50442± 2441 (n=58)
D.O. minimum (mg/l)	1.4 (n=15)	1.1 (n=28)	0.8 (n=14)	3.1 (n=30)	3.8 (n=24)	4.0 (n=18)	3.9 (n=125)	5.2 (n=13)	4.2 (n=25)	1.8 (n=25)	2.2 (n=24)	1.4 (n=35)	1.6 (n=35)	0.1 (n=70)	3.5 (n=34)	0.1 (n=68)	4.4 (n=64)	3.3 (n=56)
pH	7.8± 1.0 (n=16)	7.0± 0.5 (n=32)	7.2± 0.7 (n=18)	7.2± 0.4 (n=34)	7.3± 0.5 (n=31)	6.6± 0.7 (n=21)	7.1± 0.5 (n=126)	7.0± 0.6 (n=20)	6.8± 0.6 (n=32)	7.3± 0.5 (n=28)	7.3± 0.5 (n=23)	7.0± 0.5 (n=36)	7.5± 0.5 (n=36)	7.6± 0.3 (n=72)	7.5± 0.3 (n=36)	7.7± 0.3 (n=71)	7.8± 0.1 (n=66)	7.8± 0.1 (n=58)
Color (platinum-cobalt units)	—	178± 98 (n=12)	148± 118 (n=4)	131± 104 (n=5)	95± 79 (n=7)	270± 145 (n=5)	148± 84 (n=18)	157± 76 (n=9)	197± 101 (n=13)	200± 215 (n=5)	171± 149 (n=5)	160± 70 (n=36)	89± 66 (n=35)	63± 67 (n=35)	59± 54 (n=35)	52± 67 (n=36)	22± 38 (n=34)	5± 1 (n=28)
Chl-*a* (*ug*/l)[d]	—	—	—	—	—	—	—	—	—	—	—	8.2± 11.7 (n=34)	15.6± 24.2 (n=34)	7.8± 6.1 (n=35)	12.2± 16.5 (n=34)	7.9± 12.6 (n=34)	3.8± 4.9 (n=34)	2.0± 1.9 (n=29)
Chl-*a* maximum (*ug*/l)	—	—	—	—	—	—	—	—	—	—	—	40.9	126.3	27.8	81.1	70.2	22.3	9.3

NOTES:

Data are expressed as mean value ± standard deviation (unless otherwise noted). Values in parentheses indicate sample sizes.

[a]Milligrams of phosphorus per liter

[b]Milligrams of nitrogen per liter

[c]Micrograms per liter

[c]Micrograms per liter

Table 5-6. Water quality trends at long-term USGS monitoring sites in the Peace River watershed. Significance levels from simple (concentration vs. year) regression analysis (USGS 1990-1996)

Parameter	Monitoring Sites										
	Saddle Creek, Structure P-11	Peace River, Bartow	Peace River, Homeland	Peace River, Ft. Meade	Peace River, Zolfo Springs	Charlie Creek, Gardner	Peace River, Arcadia	Joshua Creek, Nocatee	Horse Creek, Arcadia	Prairie Creek, Ft. Ogden	Shell Creek, Punta Gorda
Gage I.D.	USGS 02294491	USGS 02294650	USGS 02294781	USGS 02294898	USGS 02295637	USGS 02296500	USGS 02296750	USGS 02297100	USGS 02297310	USGS 02298123	USGS 02298202
DIP (mg P/l)	Decreasing 1982-1994 (p<0.001)	Decreasing 1971-1995 (p<0.001)	Decreasing 1981-1994 (P<0.001)	Decreasing 1981-1995 (p<0.001)	Decreasing 1971-1995 (p<0.001)	No trend 1971-1995 (p>0.20)	Decreasing 1971-1995 (p<0.001)	Decreasing 1982-1995 (p<0.001)	Decreasing 1971-1995 (p<0.02)	Increasing? 1971-1995 (p<0.10)	No trend 1973-1995 (p>0.30)
TP (mg N/l)	Decreasing 1982-1994 (p<0.01)	Decreasing 1971-1995 (p<0.001)	Decreasing 1981-1994 (P<0.001)	Decreasing 1981-1995 (p<0.001)	Decreasing 1971-1995 (p<0.001)	No trend 1971-1995 (p>0.20)	Decreasing 1971-1995 (p<0.001)	Decreasing 1982-1995 (p<0.005)	Decreasing 1971-1995 (p<0.02)	Increasing 1971-1995 (p<0.05)	No trend 1973-1995 (p>0.30)
DIN (mg N/l)	No trend 1982-1992 (p>0.50)	No trend 1971-1995 (p>0.40)	No trend 1981-1994 (p>0.30)	Decreasing 1981-1995 (p<0.03)	Decreasing 1971-1995 (p<0.001)	Increasing 1979-1995 (p<0.01)	Decreasing 1971-1995 (p<0.005)	Increasing 1982-1995 (p<0.001)	Increasing 1971-1995 (p<0.001)	Insufficient data	Increasing 1982-1995 (p<0.05)
TN (mg N/l)	No trend 1982-1994 (p>0.50)	No trend 1971-1995 (p>0.15)	Decreasing 1981-1994 (p<0.01)	Decreasing 1981-1995 (p<0.001)	Decreasing 1973-1995 (p<0.01)	No trend 1979-1995 (p>0.50)	Decreasing? 1971-1995 (p=0.10)	Increasing 1982-1995 (p<0.001)	Increasing 1971-1995 (p<0.001)	Insufficient data	Increasing? 1982-1995 (p=0.10)
Conductivity (μS/cm)	Decreasing 1972-1995 (p=0.001)	Decreasing 1970-1995 (p<0.001)	Increasing 1982-1994 (p<0.10)	No Trend 1972-1995 (p>0.50)	Decreasing 1970-1995 (p=0.05)	Increasing 1970-1995 (p<0.01)	No trend 1970-1995 (p>0.50)	Increasing 1965-1995 (p<0.01)	Increasing 1970-1995 (p<0.05)	Increasing? 1970-1995 (p<0.20)	Increasing 1970-1995 (p<0.05)

NOTES:

Data are expressed as mean value ± standard deviation (unless otherwise noted). Values in parentheses indicate sample sizes.

Conductivity Patterns and Trends

Conductivity, a water quality indicator which normally varies in west central Florida surface waters as a function of groundwater or saltwater inputs, shows complex spatial and temporal variability in the Peace River watershed (Table 5-5). At monitoring sites in the predominantly freshwater portion of the system (e.g., the USGS gage sites extending from Saddle Creek-P11 to Shell Creek-Punta Gorda), variations in the conductivity of surface waters are primarily driven by fluctuations in groundwater discharge. In the predominantly estuaries portion of the system (e.g., the SWFWMD/SWIM monitoring sites extending from Peace River-Mary Point to Boca Grande Pass), variations are primarily caused by fluctuating inputs of freshwater and salt water from the Peace River and the Gulf of Mexico, respectively.

In freshwater portions of the watershed, temporal conductivity trends can be used as a surrogate to examine trends in groundwater discharge. During recent decades, conductivity has declined at the Saddle Creek-P11, Peace-Bartow and Peace-Zolfo gage sites (Table 5-5), presumably reflecting reduced groundwater discharges in these portions of the watershed. Increasing trends occurred at the Peace River-Homeland, Charlie Creek-Gardner, Joshua Creek-Nocatee, Horse Creek-Arcadia and Shell Creek-Punta Gorda gage sites (Table 5-5), presumably reflecting increased groundwater discharges in these areas. Temporal changes in groundwater discharge appear to be caused by a complex combination of natural (e.g., rainfall) and anthropogenic (e.g., domestic, industrial and agricultural groundwater use) factors (Hammett 1990). One potential factor contributing to increasing trends in specific conductance may be related to the build-up of solids and salts in the soil from irrigation practices. These constituents may then be leached out of the soil through rainfall and stormwater runoff events.

Dissolved Oxygen

During the period 1990-1995, minimum dissolved oxygen concentrations below 4.0 mg/l (considered biologically stressful) and below 2.0 mg/l (lethal to many organisms) were observed at many of the USGS and SWIM monitoring sites (Table 5-5). Depressed dissolved oxygen concentrations can occur naturally in productive subtropical aquatic systems, where elevated water temperatures cause reduced oxygen solubility and high biological productivity leads to increased BOD. Anthropogenic loadings of nutrients and BOD can exacerbate this situation, however, and appear to be doing so in many water bodies within the Peace River watershed.

Toxic Materials

Although pesticide (insecticide and herbicide) concentrations are not intensively monitored in the watershed, a recent 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 watersheds) 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). Much of this agricultural chemical use presumably occurred in the Peace River watershed, which contains a large proportion (about 85 percent) of the non-rangeland agricultural acreage that currently exists in the Charlotte Harbor watershed.

1-5. Sub-Basin Characterizations

Peace River above Bartow

During the period 1990-1995, the average annual TP concentration measured at the USGS monitoring site at Bartow has exceeded 1.2 milligrams of phosphorous per liter (mg P/l), placing water quality in this river reach among the poorest 10 percent when compared to other Florida streams (Hand and Paulic 1992). During the same period the average TN concentration exceeded 2.2 milligrams of nitrogen per liter (mg N/l) (Table 5-5), a value placing it among the poorest 20 percent when compared to other Florida streams. This reach of the river receives discharge from the Saddle Creek and Peace Creek sub-basins, whose water quality conditions are summarized below.

Loadings of TP, TN, and TSS to this river reach during the period 1985-1991 were estimated by Coastal Environmental, Inc. (1995*a*). Non-point source runoff and permitted industrial discharges appear to be the largest loading sources for the reach, contributing 56 percent and 40 percent of the estimated Nitrogen load, 91 percent and 6 percent of estimated phosphorous load, and 83 percent and 17 percent of the estimated TSS load, respectively. Urban and rangeland land-uses appear to contribute large proportions of the anthropogenic non-point source loadings, while a combination of phosphate mining and processing facilities, citrus-processing facilities, and distillers make up the bulk of the industrial point source discharges (Coastal Environmental, Inc. 1995*a*).

During the period 1940-1993, stream flow measured by the USGS at Bartow has exhibited a 42 percent reduction which cannot be explained on the basis of reduced rainfall alone (Coastal Environmental, Inc. 1995*c*). Although a portion of the unexplained flow reduction may be due to natural watershed characteristics (e.g., natural reductions in the level of the surficial aquifer during periods of extended drought), a portion also appears due to anthropogenic activities in the watershed (Hammett 1990). Those activities include substantial withdrawals of groundwater by industrial and agricultural facilities, and physical alteration of the landscape and its hydrologic characteristics by the phosphate mining industry.

Saddle Creek Sub-Basin

Eutrophication driven by excessive nutrient loadings is the most serious water quality problem in this sub-basin, which includes a number of hypereutrophic lakes (Lake Parker, Lake Hancock, Banana Lake) and streams (Saddle Creek, Banana-Hancock Canal, Lake Lena Run) (Hand and Paulic 1992, Hand et al. 1994). During the period 1990-1995, the average annual TP concentration measured at the USGS monitoring site on Saddle Creek at Structure P-11 (immediately south of Lake Hancock) has exceeded 0.4 mg P/l, placing water quality in this river reach among the poorest 25 percent when compared to other Florida streams (Hand and Paulic 1992). During the same period the average TN concentration exceeded 5.2 mg N/l, within the poorest 10 percent when compared to other Florida streams.

Effective long-term restoration of water quality in this portion of the watershed will require restoration of the large hypereutrophic lakes (e.g., Hancock, Parker) that currently discharge substantial loadings of nutrients and other pollutants to Saddle Creek and downstream reaches of the Peace River. It would be helpful if resource-based water quality targets and pollutant load reduction goals could be developed for these lakes and their tributaries as expeditiously as possible. Given the extent and magnitude of water quality degradation in this area, however, achievement of those targets and goals is anticipated to be a long-term task that will require coordinated action by agencies at the local, regional, state, and federal levels as well as local property owners and the private sector.

Several lakes in this sub-basin have received excessive nutrient loadings over periods of several decades and have developed extensive deposits of nutrient-enriched organic sediments in response to those long-term loadings. Successful restoration of water quality in these water bodies may therefore require a two-phase approach in which (1) existing nutrient loads to the lakes are reduced to levels consistent with selected water quality targets and (2) excessive nutrient releases from the sediments are prevented by removing or inactivating the sediment layer.

Reclamation of mined phosphate lands, including both the mandatory reclamation of recently-mined parcels and the voluntary, or "nonmandatory", reclamation of sites mined prior to 1976, offers a potentially important opportunity to restore water quality and aquatic habitats in the Saddle Creek sub-basin. FFWCC staff have emphasized the need for watershed-based mine reclamation plans in this area (T. King, FFWCC, personal communication 1998) and are currently working with FDEP staff to develop conceptual reclamation plans for upper portions of the Saddle Creek sub-basin.

Peace Creek Sub-Basin

The Peace Creek sub-basin contains a large number of small to medium-sized lakes (<50 acres to >1000 acres), with more than 50 lakes located in the Winter Haven area alone. As noted above, the Winter Haven Chain of Lakes, composed of 19 interconnected lakes and totaling more than 7000 acres, is a SWIM priority water body. A SWIM plan was developed for the Chain of Lakes by the District in 1990 and is currently being updated.

Cultural eutrophication is the most serious water quality problem in the Peace Creek sub-basin. The control of phosphorus loading appears to be key to attaining and maintaining desirable water quality and limiting algal production in surface water bodies in the area. Unlike the Saddle Creek sub-basin, where phosphate mining and processing contribute large proportions of the annual nutrient loadings to surface water bodies, nutrient loading to lakes in the Peace Creek sub-basin appears attributable to a combination of point source discharges of domestic wastewater (treated sewage effluent) and urban stormwater runoff.

Discharges from two significant domestic point sources (the city of Lake Alfred and city of Winter Haven wastewater treatment plants) have recently been removed from two lakes (Haines and Conine) in the northern Winter Haven Chain of Lakes. While no direct point source discharges remain on the Chain of Lakes, water quality degradation persists as a result of historic discharges. In addition, much of the urbanization that has occurred in the sub-basin preceded the institution of stormwater treatment regulations. As a result, much of the stormwater entering these lakes lacks adequate treatment. It appears likely that significant reductions in nutrient loadings in this sub-basin will require a mix of conventional and innovative stormwater treatment technologies.

Peace River - Bartow to Zolfo Springs

During the period 1990-1995, the average TP concentration measured at the USGS monitoring sites at Homeland, Ft. Meade and Zolfo Springs exceeded 1.0 mg P/l (Table 5-5), placing water quality in this river reach among the poorest 10 percent when compared to other Florida streams (Hand and Paulic 1992). During the same period the average TN concentrations exceeded 1.8 mg N/l, a value that falls among the poorest 30 percent when compared to other Florida streams (Hand and Paulic 1992).

As was the case for the river reach above Bartow, non-point source runoff and permitted industrial discharges appear to be the largest loading sources for this segment of the river, contributing 64 percent and 35 percent of the estimated Nitrogen load, 18 percent and 81 percent of estimated Phosphorous load, and 70 percent and 30 percent of the estimated TSS load, respectively, during the period 1985-1991 (Coastal Environmental, Inc. 1995*a*). Rangeland, mining, urban, and agricultural land-uses appear to contribute large proportions of the anthropogenic non-point source loadings in this portion of the watershed, while phosphate mining and processing facilities make up the bulk of the industrial point source discharges (Coastal Environmental, Inc. 1995*a*).

During the period 1934-1993, stream flow measured by the USGS at Zolfo Springs has exhibited a 26 percent reduction which cannot be explained on the basis of reduced rainfall alone (Coastal Environmental, Inc. 1995*c*). Although a portion of this unexplained flow reduction may be due to natural watershed characteristics, a portion also appears due to anthropogenic activities in the watershed (Hammett 1990).

<u>Peace River - Zolfo Springs to Arcadia</u>

During the period 1990-1995, the average TP concentration measured at the USGS monitoring site on the Peace River at Arcadia exceeded 1.0 mg P/l, placing water quality in this river reach among the poorest 10 percent of Florida streams (Hand and Paulic 1992). During the same period the average TN concentration exceeded 1.6 mg N/l (Table 5-5), a value that is among the poorest 30 percent of Florida streams.

Non-point source runoff appears to be the largest loading source for this segment of the river, contributing more than 99 percent of the estimated Nitrogen, Phosphorous, and TSS loads during the period 1985-1991 (Coastal Environmental, Inc. 1995*a*). The pasture/rangeland land use category was estimated to contribute more than 75 percent of the anthropogenic non-point source nitrogen and phosphorus loadings in this portion of the watershed during the 1985-1991 period, while the combination of pasture/rangeland and urban land uses contributed more than 75 percent of the estimated TSS load (Coastal Environmental, Inc. 1995*a*).

During the period 1933-1993, stream flow measured by the USGS at Arcadia has exhibited a 10 percent reduction which cannot be explained on the basis of reduced rainfall alone (Coastal Environmental, Inc. 1995*c*). Although a portion of this unexplained flow reduction may be due to natural watershed characteristics, a portion also appears due to anthropogenic activities in the watershed (Hammett 1990).

<u>Horse Creek</u>

During the period 1990-1995, the average phosphorus concentration measured at the USGS monitoring site on Horse Creek near Arcadia was 0.44 mg P/l (Table 5-5), placing water quality in this river reach near the poorest 20 percent when compared to other Florida streams (Hand and Paulic 1992). During the same period the average nitrogen concentration was 1.77 mg N/l (Table 5-5), placing the site among the poorest 30 percent when compared to other Florida streams.

Non-point source runoff appears to be the largest loading source in this portion of the watershed, contributing more than 99 percent of the estimated Nitrogen, Phosphorous, and TSS loads during the period 1985-1991 (Coastal Environmental, Inc. 1995*a*). The pasture/rangeland land use category was estimated to contribute more than 75 percent of the anthropogenic non-point source nitrogen and phosphorus loadings in this sub-basin during the 1985-1991 period, and more than 70 percent of the estimated TSS load (Coastal Environmental, Inc. 1995*a*).

Concentrations of DIN measured at the Horse Creek gage site in recent years are substantially higher than concentrations observed at the site in the early 1980's. Because Horse Creek has traditionally represented one of the least impacted tributaries in the Peace River watershed, increasing nutrient concentrations are a matter of considerable concern from a water quality management perspective.

Joshua Creek

During the period 1990-1995, the average phosphorus concentration measured at the USGS monitoring site on Joshua Creek at Nocatee was 0.24 mg P/l (Table 5-5), placing water quality in this river reach among the poorest 30 percent when compared to other Florida streams (Hand and Paulic 1992). During the same period the average nitrogen concentration exceeded 2.0 mg N/l (Table 5-5), placing the site among the poorest 20 percent when compared to other Florida streams.

Prairie Creek/Shell Creek

During the period 1990-1995, the average TP concentration measured at the USGS monitoring site on Prairie Creek (near Ft. Ogden) was 0.10 mg P/l, placing the site near the median of Florida streams. The average TN concentration was 1.5 mg N/l, placing it among the poorest 35 percent when compared to other Florida streams. The average TP concentration measured at the Shell Creek site (near Punta Gorda) was 0.20 mg P/l, among the poorest 30 percent when compared to other Florida streams. The average TN concentration was 1.2 mg N/l, near the median of Florida streams.

During the period 1971-1995, increasing trends are evident in TP and (possibly) DIP concentrations at the Prairie Creek-Ft. Ogden gage site. Insufficient data were available to assess trends in DIN or TN during this period. The Shell Creek-Punta Gorda site shows no apparent trend in DIP or TP concentrations but an increase in DIN and a possible increase in TN over the period. Because they are occurring in tributaries which have traditionally been among the least impacted in the Peace River watershed, these increasing nutrient concentrations are a matter of concern from a water quality management perspective.

Tidal Peace River and Charlotte Harbor

The District's SWIM Department and the WQMP department, with assistance from FDEP and Environmental Quality Laboratory, Inc., conducted monthly monitoring of water quality conditions at four sites in the tidal Peace River and 10 sites in Charlotte Harbor from January 1993 to December 2000. Salinity conditions during the years 1993-1995 ranged from tidal fresh (<0.5 parts per thousand (ppt) salinity) to oligohaline (<5 ppt) at the most upstream Peace River sampling site (CH-029), which is located above Mary Point in the river's main channel. Mesohaline conditions (ca. 10-20 ppt) prevailed at the remaining river sites, which are located at the US Highway 41 bridge (CH-004), the mouth of Alligator Bay (CH-05B), and the river mouth (CH-005). Polyhaline conditions (ca. 25-35 ppt) predominated in Lower Charlotte Harbor (CH-011) and Boca Grande Pass (CH-013, CH-014).

Salinity regimes in the tidal Peace River reflect the mixing of fresh and marine waters, and vary in response to changing fresh water inflows from the Peace River watershed. Because the low-salinity habitats present in tidal rivers represent important habitat for the larval and juvenile stages of many estuaries fish and shellfish species, SWIM has attempted to develop resource-based freshwater inflow and salinity targets for this river reach (Coastal Environmental, Inc. 1995*c*). Results of this project suggested that, during the period 1966-1993, freshwater inflow to Charlotte Harbor at the mouth of the Peace River has exhibited a 6 percent reduction which cannot be explained on the basis of rainfall reductions alone (Coastal Environmental, Inc. 1995*c*).

Although a portion of this unexplained flow reduction may be due to natural watershed characteristics, a portion also appears due to anthropogenic activities in the watershed (Hammett 1990, Coastal Environmental, Inc. 1995*c*). Those activities include substantial withdrawals of groundwater by industrial and agricultural facilities, and physical alteration of the landscape and its hydrologic characteristics by the phosphate mining industry, which are concentrated in the northern portion of the Peace River watershed.

The Peace River represents the largest single source of nutrient loadings to Upper Charlotte Harbor (Coastal Environmental, Inc. 1995*a*), and nutrient concentrations measured at the SWIM monitoring sites show clear gradients that extend from the river to the upper and lower Harbor and Boca Grande Pass (Table 5-4). Average TP concentrations at the Mary Point site exceeded 0.70 mg/l during 1993-1995, placing water quality in this river reach among the poorest 20 percent of Florida streams. TP concentrations declined to 0.25 mg/l at the river mouth and 0.04 mg/l in Boca Grande Pass (Table 5-4), reflecting progressive dilution by lower-nutrient estuaries and Gulf of Mexico waters.

Average chlorophyll-*a* concentrations observed during 1993-1995 ranged from <10 micrograms per liter (μg/l) at the tidal fresh/oligohaline Mary Point site, where low residence times caused by high rates of river flow presumably inhibited the development of dense algal populations, to >15 μg/l in mesohaline reaches of the lower river (Table 5-5). Annual average chlorophyll concentrations below 10 μg/l are considered indicative of “good” water quality, and values exceeding 10 μg/l are considered indicative of “fair” water quality, in Florida estuaries (Hand and Paulic 1992). Very high chlorophyll concentrations (>80 μg/l), indicating the presence of algal blooms, were observed episodically at the US Highway 41 and river mouth stations during the 1993-1995 period. These values are considered indicative of hypereutrophic water quality conditions in some estuaries classification systems (e.g., NOAA 1995). Long-term data collected by Environmental Quality Laboratory, Inc., indicate that such blooms have occurred on a seasonal basis in the area since regular monitoring began in 1976 (R. Montgomery, EQL, Inc., personal communication 1998).

Minimum dissolved oxygen levels frequently fell below 2 mg/l at the tidal Peace River and Upper Charlotte Harbor monitoring sites during 1993-1995 (Table 5-5). These hypoxic conditions are highly stressful and potentially lethal to many estuaries animals. As was the case with phytoplankton blooms, however, long-term studies indicate that seasonal hypoxia has occurred in this area since regular monitoring was initiated in 1976 (R. Montgomery, EQL, Inc., personal communication 1998). Hypoxic events typically occur during periods of high river flow when the water column becomes vertically stratified and a layer of fresh water flows with little mixing over a layer of salty, higher-density bottom water.

BOD in the sediments and water column acts to reduce dissolved oxygen concentrations in the lower water layer, which is not counteracted by inputs of atmospheric oxygen during periods when the water column remains strongly stratified. Anthropogenic nutrient loadings may exacerbate this natural flow-related phenomenon by causing increased BOD in the sediments and water column, perhaps causing hypoxic conditions to persist over larger areas and longer time periods than would otherwise occur. This possibility is being investigated by a SWIM study which began in 1995.

2. GROUNDWATER QUALITY

2-1. Existing Conditions and Previous Studies

Ground water quality in the Peace River basin is variable between aquifer systems and geographically from the northern region to southern regions of the watershed. Ground water in the northern basin, from the headwaters in central Polk County to north-central Hardee County, typically has a freshwater-bearing upper Floridan aquifer, one or two water-producing zones in the Intermediate aquifer system, and the surficial aquifer. The hydrogeology in southern portion of the watershed, from central Hardee County to Charlotte County, is more complex, with a surficial aquifer, and an Intermediate aquifer system having two or three producing units of variable water quality. Also in the southern watershed, water quality in the Upper Floridan aquifer is degraded by the effects of upwelling mineralized water along regional structural features in the rock formations (Jones and Upchurch 1991), and influences from the coastal saltwater interface (SWFWMD 1996*e*).

Water quality data for the three aquifer systems in the Peace River CWM area have been documented in numerous investigations across the watershed, and several ongoing programs are continuing to collect groundwater quality data. A compilation of historical water quality data by Black and Brown (1951) provides the earliest available groundwater quality analyses in the watershed. A report on the groundwater resources of Polk County (Stewart 1966) summarizes water quality in the northern watershed, and provides references to earlier reports as well. Also, Wilson (1977) covers the groundwater resources of Hardee and DeSoto counties in the central and southern watershed. An assessment of the potential for groundwater contamination in Polk County (Barr 1992) presents a comprehensive review of hydrogeologic conditions in the northern Peace watershed and sources for groundwater contamination in the region. Lewelling and Wylie (1993) investigated the effects of phosphate mine reclamation on water quality in the surficial and Intermediate aquifers in Polk County. Several publications are also available through the District's WQMP that catalog existing groundwater quality data by county (SWFWMD 1996*a*, 1996*b*, 1996*c* and 1996*d*) and provide interpretations of geochemical data by geographic regions of the District (SWFWMD 1990, 1991).

2-2. Ground-Water Interactions with the Peace River

The Peace River is in direct hydrologic contact with the Intermediate and Upper Floridan aquifers from Polk County to central Hardee County (Lewelling and others 1998) where seasonally dependent discharge and recharge is evident. The quality of surface water in the Peace River can have localized effects on groundwater quality where river water is siphoned through sinkholes in the river channel, but currently there are no explicit studies that characterize the effects of direct surface water recharge on groundwater quality in the Peace watershed. Prior to extensive groundwater supply development associated with the phosphate processing and citrus crop irrigation, groundwater discharge from the Intermediate and Upper Floridan aquifers contributed significant base flow to the upper Peace River. Historical discharge from Kissengen Spring, a second magnitude spring located south of Bartow in Polk County, contributed an average of 19 million gallons a day to the Peace River below the spring (Peek, 1951). The spring ceased to flow in 1950 and has been inactive since then, due largely to the impacts of groundwater pumping that has resulted in sustained declines in Floridan aquifer water levels (SWFWMD 2000*a*). Recovery of water levels in the artesian aquifers over time could restore groundwater discharge to the northern Peace watershed, resulting in improved base-flow conditions and water quality in the Peace River.

Conversely, the quality of groundwater from the surficial or artesian aquifers may influence water quality in the Peace River, especially under base-flow conditions. Relationships between river stage and head conditions in the Intermediate and Floridan aquifers provide the potential for groundwater discharge directly into the Peace River, or into the overlying surficial aquifer, with subsequent seepage into the river basin. Lewelling and others (1998) report that potential discharge conditions are evident in the central and southern sections of the Peace River, although geologic controls, specifically confining beds within and separating aquifers units, appear to inhibit movement of artesian groundwater into the surficial aquifer and river. The surficial aquifer is a constant source of base flow to the Peace River, and the upper permeable zones of the Intermediate aquifer may discharge into the surficial aquifer and Peace River, where confining beds are thin or locally discontinuous. Higher concentrations of dissolved solids reflecting the chemistry of groundwater would be expected if substantial Intermediate aquifer discharge were occurring, although runoff of groundwater from agricultural irrigation or phosphate mining areas could also be affecting the water quality in tributary creeks to the Peace River.

2-3. Current Programs

Refer to Atlas Map 8 for District monitoring sites.

<u>Quality of Water Improvement Program</u>

In 1974, pursuant to Chapter 373, *Fla. Stat.* the District began the QWIP to restore hydrologic conditions affected by abandoned artesian wells. Problems associated with abandoned or improperly constructed wells include loss of artesian pressure from wells flowing freely at ground surface, and water-quality degradation between different aquifers connected through the abandoned wells. The initial focus of the QWIP was in the southern Peace River Basin, where problems with abandoned wells were most severe. Hundreds of wells that were drilled for farming, and depended on the artesian pressure for ditch irrigation, had experienced degraded water quality over time and the farm fields were abandoned. Methods for properly abandoning these wells were developed in 1974 and have been used to plug 233 wells in Charlotte County, 58 wells in DeSoto County and 10 wells in Hardee County. Since then, the QWIP well plugging activities have also concentrated on Sarasota and Manatee Counties, and coastal regions of southern Hillsborough County. As of October 1, 1998, the District had inspected 4,761 wells and funded the plugging of 2,357 wells throughout the District's SGWB.

To assist the property owners with the expense of plugging abandoned artesian wells, the District had offered a 50/50 cost sharing agreement. In January 1994, the District began a funding assistance initiative designed to serve as an added incentive for property owners to come into compliance with well plugging requirements. Property owners are entitled to reimbursement for the cost to plug eligible abandoned artesian wells, not to exceed $6,000 per well, with the amount reimbursed determined by the depth and diameter of their abandoned artesian wells. Effective June 1, 1996, the District reduced the maximum reimbursement amount from $6,000 to $5,000 per well, and in October 1, 1996 funding was eliminated for 2" and 3" diameter wells to provide additional funds to plug higher priority wells. The intent of the present funding assistance initiative is to provide an incentive for landowners to help mitigate environmental impacts resulting from abandoned artesian wells, while increasing the overall number of wells plugged per year. This funding assistance initiative has proven very effective.

In the years preceding the funding assistance initiative, the QWIP plugged an average of 50-75 wells per year. Since it's inception in January 1994, the funding initiative has reimbursed property owners for the plugging of 1,403 detrimental abandoned artesian wells for an average of 280 wells plugged annually.

Regional Observation Monitoring Program

The District's ROMP has been conducting an ongoing monitor well construction and aquifer testing program in the SWUCA. The groundwater monitoring sites, many of which are located in the Peace CWM area, undergo a rigorous test drilling program to determine site-specific hydrogeologic characteristics. The data is incorporated into regional groundwater models to evaluate water use and determine regulatory strategies within the SWUCA. The completed monitor wells are also included in water level and WQMNs for long-term data collection.

Recent attention has been focused on developing water resources from the intermediate aquifer system in the southern portion of the SWFWMD. The District's Resource Conservation and Development Department is currently working with the USGS Water Resources Division to complete a hydrogeologic characterization of the Intermediate aquifer system within the SWUCA. The testing program will define the unique character of the Intermediate aquifer system, will help to define the nature of water quality, and aquifer properties of the Intermediate aquifer system.

The District is currently conducting a pilot project to acquire borehole geophysical log data from agricultural irrigation wells which have a WUP. The voluntary program requires the well owner to remove the pump for the District to collect borehole data from the well. The project is a cooperative effort between several sections within the District. Data will be submitted to the Resource Regulation and Resource Conservation and Development departments. These data will be a valuable source in developing a refined hydrogeologic model for the SWFWMD, satisfy WUP conditions, and provide well construction and initial water quality for the Water Use Permit Network (WUPNET).

Water Use Permit Network

Recent efforts to improve groundwater quality monitoring in the SWUCA has resulted in the redesign of the District's Regulatory WUPNET. The network redesign involved a statistical modeling approach using spatial analysis of potential monitor wells and wells permitted for groundwater withdrawals (Environmental Resources Management-Southeast, Inc. 1999). Although the primary focus of the WUPNET redesign was for monitoring coastal saltwater intrusion, the analysis covered the entire SWUCA and included all counties comprising the Peace River CWM area. The redesigned sampling network now consists of a Sentinel Network of monitor wells for the Intermediate aquifer and Upper Floridan aquifer that are currently being sampled three times yearly. Additionally, a set of randomly selected wells are proposed for sampling on a five-year cycle. The improved WUPNET monitoring program will provide a statistically-based data set to evaluate water quality in the Peace River Basin and SWUCA as increased demands for groundwater continues, and new strategies for water supply development are implemented in the region.

Coastal Groundwater Quality Monitoring Network

Groundwater quality monitoring for saltwater intrusion in coastal regions of the District has been conducted through the Coastal Groundwater Quality Monitoring Network (CGWQMN) since 1991(SWFWMD 1995). In the Peace River CWM area, this effort has included the southernmost portion of the Peace watershed in Charlotte and DeSoto counties, where proximity to Charlotte Harbor and the Gulf of Mexico dictates groundwater contamination vulnerability through saltwater intrusion. Originally, fifteen wells in the Floridan aquifer and 24 wells in the Intermediate aquifer have been sampled on a regular frequency in the southern Peace watershed. Refinement of the sampling network and implementation of the revised WUPNET in the region has increased the number of sites to 19 wells in the Floridan aquifer and 29 wells in the Intermediate aquifer. Wells having a sufficient record of data have been analyzed for water quality trends, and are reported in the most recent CGWQMN publication (SWFWMD 2000*a*).

Integrated Water Resource Monitoring

As previously outlined the FDEP, in conjunction with the State's water management districts and other governmental agencies, has implemented the IWRM strategy, which seeks to link both surface and groundwater quality monitoring in a three-tiered environmental resource-based assessment. Groundwater quality monitoring entails categorizing the resource in unconfined (surficial aquifer) and confined aquifers, and randomly selecting wells in the two categories for sampling on rotating schedule for the basins delineated in each FDEP District. Tier I monitoring of the groundwater resource in the Peace River Basin is currently scheduled to be conducted in 2002.

Chapter 6
Natural Systems

Fish Boats in Port – Punta Gorda, Florida

From the Florida State Photographic Collection: Louise Frisbie Collection (approximate date 191–)

CHAPTER 6. NATURAL SYSTEMS

1. INTRODUCTION

As stated previously, the District's overarching goal regarding natural systems is: *"To protect, preserve and restore natural Florida ecosystems and to establish minimum water levels and flows necessary to maintain these natural systems".* The following discussion describes the current status of natural systems within the Peace River watershed and establishes the basis for the strategies and actions outlined in Volume II of this Plan.

2. EXTENT AND NATURE OF PHYSICAL ALTERATION

Based on the overall extent and nature of its physical alteration, the Peace River watershed ranks as one of the most highly-altered watersheds in Florida. A watershed-wide analysis of land use and land cover, based on 1995 data, indicates that over 60 percent of the total land area has been converted from its pre-alteration natural land cover (Table 6-1). The primary sources of conversion, listed in descending order of total lands converted, have been: agricultural development (648,500 acres, or 42.5 percent of the watershed); "structural" development to support residential, commercial and industrial land uses (135,000 acres, or 8.8 percent of the watershed); and "extractive" uses (131,280 acres, or 8.5 percent of the watershed), which have consisted primarily of phosphate mining in the upper watershed. The FDEP Bureau of Mine Reclamation has estimated that approximately 5,000 additional acres are mined for phosphate each year. In addition, most of the increase observed in the areal coverage of open water (14,570 acres more than historic coverage) is accounted for by artificial water bodies that are a remnant of prior phosphate mining. As such, the information presented here underestimates the actual areal extent of alteration resulting from phosphate mining activities. The predominant agricultural land uses in the watershed are pasture (approximately 402,500 acres, or 26 percent of the watershed) and citrus cultivation (approximately 210,500 acres, or 14 percent of the watershed).

Most of the "structural" development has taken place in the urbanized population centers. The largest of these are the cities of Lakeland, Bartow and Winter Haven at the northern end of the watershed and unincorporated Port Charlotte at the southern end. Other population centers, situated along the middle reaches of the Peace River, include Fort Meade, Zolfo Springs, Bowling Green and Arcadia.

The nature and areal extent of land alteration varies somewhat from sub-basin to sub-basin. Some of the larger sub-basins still support substantial areas of natural land cover. Approximately 52 percent of the Shell Creek/Prairie Creek sub-basin, which at nearly 276,000 acres is the largest sub-basin in the watershed, still supports natural vegetation (see Atlas Map 2 for delineation of sub-basins). This proportion of remnant natural land cover is exceeded only by that of the Horse Creek sub-basin (156,500 acres), which supports natural vegetation over approximately 53 percent of its total land area.

Other large sub-basins with relatively high proportions of natural land cover include Peace River (46 percent), Charlie Creek (38 percent), Peace Creek Canal (36 percent) and Saddle Creek/Lake Hancock (33 percent). These stand in contrast to the more highly-altered sub-basins, which support limited remnant natural vegetation, including Whidden Creek (4 percent natural), Mined Area (4 percent natural), Sink Branch (11 percent natural), Bear Branch (12 percent natural), Hog Branch (15 percent natural), Thompson Branch (18 percent natural) and Max Branch (19 percent natural).

The result of the high rate of land conversion described above has been a correspondingly high rate of degradation to natural systems and widespread habitat destruction and fragmentation. Extensive modifications to surface hydrology, including particularly the channelization or severance of natural drainage features that have historically discharged to the Peace River, has resulted in severe impacts to the aquatic communities of the river. These impacts are attributable to declines in both quantity and quality of water and have been discussed previously in the plan. Impacts to terrestrial communities have been equally severe. Much of the remaining natural land cover occurs as small, disjunct patches scattered across a highly modified landscape or as narrow threads of floodplain forest lining the creeks and other small drainages that discharge to the Peace River.

Table 6-1. Comparisons of Existing and Historic Land Cover of the Peace River Watershed

Land Cover Category	Current Coverage (Acres)	Percent of Total	Historic Coverage (Acres)	Percent of Total	Area Lost (Acres)	Percent Historic Remaining
Disturbed	293,500	19.2 %	142,000	9.3 %	NA	NA
Agricultural	648,500	42.3 %	NA	NA	NA	NA
Herbaceous Wetland	103,500	6.8 %	192,630	13 %	89,130	53 %
Forested Wetland	131,000	8.5 %	160,500	10.5 %	29,500	81 %
Pine Flatwoods	275,000	18.0 %	776,250	52.4 %	505,500	35 %
Xeric Uplands	6,000	0.4 %	115,250	7.6 %	109,250	5.5 %
Upland Hardwoods	2,750	0.2 %	41,900	2.8 %	39,150	6.7 %
Saltmarsh	2,870	0.2 %	2,240	0.1 %	+ 630	128 %
Mangrove	7,680	0.5 %	4,870	0.3 %	+ 2,810	157 %
Open Water	60,000	4.0 %	45,430	3.0 %	+14,570	132 %

NOTES:

All land cover estimates were generated by the Mapping and GIS Section of the SWFWMD. Existing land use is based on photo interpretation of 1995 color infrared photography. Estimates of historic land cover are based on an analysis of soil surveys conducted by the US Soil Conservation Service. Historic land cover was extrapolated by assigning each soil type to the general land cover category most likely to occur on that soil type. Disturbance associated with mining activities and other development that pre-dated the soil surveys precluded inference of historic land cover over portions of the watershed, which accounts for the occurrence of a "disturbed" category under historic vegetation. Increases in coverage of open water due to creation of artificial water bodies.

The difficult challenge of maintaining a network of representative, sustainable natural areas within the watershed is exacerbated by a relative absence of protected conservation lands. Hardee and DeSoto counties, which lie almost wholly within the Peace watershed and account for over half of the total watershed area, have been distinguished as the two Florida counties with the lowest percentage of their total land area in protected conservation status (Cox, et al.

1994). Although Polk County fairs considerably better in this measure of natural systems protection, the vast majority of conservation lands in Polk County lie outside the Peace River watershed. The state-owned Babcock/Cecil Webb Wildlife Management Area in Charlotte County accounts for more than 40 percent of all conservation lands in the Peace River watershed.

Table 6-2 provides a complete listing of conservation lands in the watershed and Atlas Map 13 shows the location of conservation lands. Several of the tracts listed are not located wholly within the Peace River watershed. The Babcock/Cecil Webb Wildlife Management Area, RV Griffin Reserve and Saddle Blanket Lakes Preserve straddle the watershed boundary and are located partially in adjoining watersheds. It is also important to note that the Tenoroc State Recreation Area, Saddle Creek Strip Mines and Saddle Creek Park sites consist of reclaimed phosphate mine land. The Paynes Creek State Historical Site is relatively small and is managed to preserve a site of historical and cultural significance. Although the site protects valuable lands in the Peace River floodplain, the long-term preservation of natural values is not the prevailing management priority at this site. The superlative natural values of the Bright Hour Watershed property, which remains in private ownership, are assured long-term protection through a conservation easement that was purchased by the District. The District's recent purchase of the Deep Creek Preserve site District provides the most significant protection of natural lands in the Peace River floodplain. The 1,988-acre tract is a portion of the Lower Peace River SOR Project and protects a mixture of floodplain swamp, marsh, and an adjoining buffer of pine flatwoods at the downstream end of the river.

In summary, the 84,627 acres of conservation land in the Peace River watershed amount to only 5.5 percent of the watershed's total land area. Over 48 percent of the total conservation lands inventory consists of reclaimed phosphate mine lands or less-than-fee ownership. Fewer than 2,000 acres of intact riverine floodplain have been preserved through public ownership along the entire 75-mile length of the Peace River.

The District has generated a map of historic vegetation in order to more accurately assess and characterize the full impact of land alteration in the Peace River watershed (Atlas Map 19). Soil surveys conducted by the Natural Resources Conservation Service (formerly the Soil Conservation Service) were used to extrapolate the pre-alteration composition and distribution of land cover. Table 6-1 quantitatively summarizes the overall extent of alteration and denotes the differential impact on each of the general vegetative associations that occurs in the watershed. It is apparent that the well-drained xeric upland associations, which consist of scrub and sandhill, have been most severely affected. The natural incidence of these associations in the low, flat terrain of the watershed was quite low historically and their attractiveness for development made them particularly susceptible to large-scale alteration. Pine flatwoods and herbaceous wetlands, which historically were the two most prevalent natural communities in terms of areal extent, have also been severely affected. Although they remain the most prevalent natural communities in terms of total areal coverage, only 35 percent of the original acreage of pine flatwoods and 53 percent of the historic coverage of herbaceous wetlands remain.

Table 6-2. Conservation Lands in the Peace River Watershed			
Name of Conservation Tract	**Total Acreage**	**Location**	**Managing Entity**
Babcock/Cecil Webb Wildlife Management Area	67,426 (Approx. 35,000 in watershed)	Charlotte County	FFWCC
Deep Creek Preserve	1,988 acres	DeSoto County	SWFWMD
RV Griffin Reserve	5,849 (Approx. 3,000 in watershed)	DeSoto County	SWFWMD
Paynes Creek State Historic Site	391	Hardee County	FDEP
Tenoroc State Recreation Area	6,040	Polk County	FFWCC
Highlands Hammock State Park	4,896	Highlands County	FDEP
Saddle Creek Strip Mines	1,473	Polk County	FDEP
General Development Utilities/Peace River Tract	588	DeSoto County	FDEP
Saddle Blanket Lakes Preserve	878 (Approx. 500 in watershed)	Polk County	The Nature Conservancy
Saddle Creek Park	750	Polk County	Polk County
Bright Hour Watershed	31,989[a]	DeSoto County	SWFWMD
Total Watershed Acreage in Conservation = ca. 84,627			

NOTES:

[a]Less-than-fee ownership, i.e., conservation easement

3. PREVIOUS STUDIES

A number of studies have been conducted that describe the natural systems of the Peace River watershed. There are also many other sources of information available that are relevant to an examination of natural systems issues for this area of the District. These and other references were used to provide guidance in identifying and addressing important issues related to natural systems protection in the watershed. The following discussion provides a partial inventory of such studies and sources of information.

3-1. Closing the Gaps in Florida's Wildlife Habitat Conservation System

The Florida Game and Fresh Water Fish Commission published this report (Cox, et al. 1994) in 1994. It identifies important habitat for more than 30 focal species and certain rare communities or natural features. The Strategic Habitat Conservation Areas and Biodiversity Hot Spots identified in the report were an important data set in the District's GIS-based analysis of important core wildlife habitat and dispersal corridors remaining in the watershed. Atlas Map 18 shows the location of Strategic Habitat Conservation Areas and Atlas Map 20 shows the location of core habitat areas and linkages.

3-2. Habitat Conservation Needs of Rare and Imperiled Wildlife in Florida

This recent report (Cox and Kautz 2000) was published by the FFWCC as a follow-up to the previously-discussed Closing the Gaps report. It evaluates the ability of the Strategic Habitat Conservation Areas identified in the original study to serve as habitat for a greatly-expanded list of focal species.

3-3. Fish and Wildlife Inventory of the Seven-County Region Included in the Central Florida Phosphate Industry Area-Wide Environmental Impact Study

Scientists at the Archbold Biological Station conducted this study (Layne, et al. 1977) in the 1970s on behalf of the US Fish and Wildlife Service (USFWS). The purpose of the investigation was to project the wildlife impacts associated with future expansion of phosphate mining in this region.

3-4. Florida Forever Conservation Needs Assessment

Published in December 2000, the Florida Forever Conservation Needs Assessment (Florida Natural Areas Inventory (FNAI) 2000) was undertaken to help guide land acquisition efforts under the Florida Forever Program. This state-wide assessment of natural lands will be used to establish land acquisition priorities based on site-specific resource values, including habitat value, water management benefits, and presence of significant historical or archaeological resources. The study was conducted by the FNAI on behalf FDEP's Division of State Lands.

3-5. Save Our Rivers Resource Evaluations

Resource evaluations are prepared by the District in order to provide a comprehensive assessment of a candidate site's suitability for acquisition through the Water Management Lands Trust Fund, a.k.a. the SOR Program, or other land acquisition programs administered by the District. Several sites in the Peace watershed have been nominated for acquisition through the program and have been formally evaluated. These include the Upper and Lower Peace River Corridor projects, an addition to the RV Griffin Reserve (formerly known as the General Development Corporation tract) and a project to protect the Charlie Creek floodplain. These resource evaluations provide broad information regarding the hydrologic and geohydrologic characteristics of these tracts, in addition to discussions of the natural systems encompassed by the projects.

3-6. Bright Hour Watershed Water Management Lands Trust Fund/Save Our Rivers/Preservation 2000 Project Proposal Application

This document was prepared by The Nature Conservancy and submitted to the District to serve as a nomination for the less-than-fee acquisition of a 28,000-acre tract in southeast DeSoto County (TNC 1996). It provides a wealth of information on the resources of this site. A GIS-based analysis of the watershed that was conducted independently by the District to identify the most important areas of remaining wildlife habitat distinguished the Bright Hour Ranch tract as the most important privately-owned expanse of “core” habitat remaining in the entire watershed. With assistance from The Nature Conservancy, the District purchased a conservation easement over nearly 32,000 acres of the ranch property in 1998. Additional lands have also been approved for less-than-fee acquisition as part of the Bright Hour project.

3-7. Florida Atlas of Breeding Sites for Herons and Their Allies

This publication (Florida Game and Freshwater Fish Commission 1991) provides a comprehensive, county-by-county listing of documented colonial nesting sites. It includes site-specific information on the species composition of all known rookeries and estimates of productivity during the period preceding its publication.

3-8. South Florida Multi-Species Recovery Plan

Recovery plans prepared by the USFWS to help guide recovery efforts for threatened and endangered species are an additional resource for identifying significant natural areas, especially those that provide important habitat for imperiled species. The South Florida Multi-Species Recovery Plan (USFWS 1999) is a comprehensive assessment of habitat protection and other recovery needs for threatened and endangered species across all of south Florida. It provides a wealth of species-specific information on habitat needs and patterns of distribution.

3-9. Endangered Ecosystems: A Status Report on America’s Vanishing Habitat and Wildlife

This report (Noss and Peters 1995) was prepared by one of the world’s preeminent conservation biologists on behalf of the Defenders of Wildlife. It documents the most imperiled natural communities and habitats occurring on the North American continent, including several that occur in the Peace River watershed (Noss and Peters 1995).

3-10. County Soil Surveys

The Natural Resources Conservation Service (formerly the Soil Conservation Service) has prepared soil surveys of each county in the Peace River watershed. These documents provide maps and soil descriptions and also provide information regarding the suitability of the soils to support various land uses (e.g., agriculture). Collectively, these surveys served as the basis for the map of historic vegetation included in this plan.

3-11. Other Sources of Information

A variety of other sources of information related to natural systems is available. For example, the University of Florida’s GeoPlan Center, under contract to FDEP, developed a GIS-based approach to identifying important native ecosystems and connective corridors. The study employed a landscape-scale approach and will be used to help guide land acquisition priorities across Florida. The FNAI is a cooperative effort of FDEP and The Nature Conservancy that seeks to maintain an inventory of endangered ecosystems and species. Some of the data compiled by FNAI has been used to distinguish Areas of Conservation Interest (ACIs) and Potential Natural Areas (PNAs). The ACIs, PNAs, and occurrences of threatened and endangered species documented by FNAI served as important data sets in the District’s GIS-based analysis of priority natural areas in the Peace River watershed.

4. SPECIAL REGULATORY ISSUES OR PROTECTIVE STATUS

Florida's remaining natural ecosystems are rapidly disappearing or being severely degraded as growth and development cause conversion of these systems to urban, agricultural or other uses. This is particularly true within the Peace River watershed where a majority of the watershed has been altered by past land use activities. Special protection efforts are necessary to preserve and/or protect from further degradation those land and water resources considered to be of ecological significance and importance. The two primary methods of accomplishing this include environmental regulation and land acquisition programs. Regulation provides a legal means of protecting valuable natural resources by preventing or mitigating the impacts associated with proposed development activities. Public acquisition of land may provide the greatest level of natural resource protection by precluding future development and implementing a land management approach that places a priority on the preservation and/or restoration of natural systems. The following discussion describes some of the mechanisms or programs that serve to protect or maintain natural systems. Many regulatory programs that are not discussed below, e.g., the regulatory protection of wetlands by the USACOE, also play a pivotal role in natural systems protection.

4-1. Special Waters

The FDEP adopted rules in 1979 establishing water quality standards to protect the public health or welfare and to enhance the quality of waters of the state. The standards were established taking into consideration the use and value of waters of the state for public water supply; propagation of fish and wildlife; recreational use; agricultural, industrial, and other purposes; and use or value for navigation. The present and future "most beneficial use" for all waters of the state have been designated by means of a classification system pursuant to s. 403.061(10), *Fla. Stat.* Water quality classifications are arranged in order of the degree of protection required, with Class I waters having generally the most stringent water quality criteria and Class V the most lenient.

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

The majority of the Peace River is classified as Class III waters. However, three tributaries discharging to the lower portion of the river include Class I waters requiring a greater degree of protection. These tributaries include the lower portion of Horse Creek from the northern border of Section 14, Township 38 South, Range 23 East, southward to the Peace River, as well as the headwaters of Prairie Creek to the Charlotte County line and headwaters of Shell Creek to the Hendrickson Dam. These tributaries (or portions of) serve as potable water supply sources for the city of Punta Gorda, the city of North Port, and several surrounding counties (Charlotte, Sarasota and DeSoto). Many of these jurisdictions are served by the PR/MRWSA.

The Peace River discharges to Charlotte Harbor, Florida's second largest estuary. Protecting and improving the river's existing water quality is important to maintaining the ecological values of Charlotte Harbor. Water quality conditions within Charlotte Harbor are presently considered to be good. Charlotte Harbor has been designated as Class II waters in recognition of it existing water quality conditions and ecological importance. It has also been designated an

OFW and most falls within the boundaries of four established aquatic preserves. Although there are no established water quality standards specific to aquatic preserves, the FDEP affords the highest level of water quality protection to OFWs, which are considered to be water bodies of exceptional recreational or ecological significance. Generally, water quality conditions in OFWs are to be protected from any future diminution or degradation. In order to help accomplish this, more stringent stormwater treatment standards have been established for systems that discharge to OFWs and new development or point source discharges must satisfy the non-diminution requirement. In addition, a setback distance of 3,000 feet is required for the land application of sewage sludge, in contrast to the 200 foot setback established for non-OFW water bodies.

4-2. Preserve Lands

Public land acquisition programs represent a non-regulatory approach to environmental protection and help to ensure the greatest possible degree of protection to sensitive land areas by precluding future development. Generally, any future development on such lands must be compatible with resource protection needs and is typically associated with resource-based recreational usage. A subsequent section of this chapter describes the primary land acquisition and preservation programs relevant to the Peace River watershed. Proper management of such sites is a critical element in the protection of on-site natural resources and must be regarded as a priority by the managing entity.

4-3. Endangered Species

Threatened and endangered species are designated and protected at both the federal and state levels. The US Endangered Species Act of 1973 (ESA) established a national mandate to protect endangered and threatened species and is administered by the USFWS. The ESA prohibits the "take" of designated, or "listed", species. It also requires that federally-funded projects that may potentially affect listed species must be evaluated by USFWS to ensure that negative impacts are avoided or minimized. Development projects that will destroy habitat for listed species, including agricultural development, also falls under the ESA.

The State of Florida maintains its own listing of threatened and endangered species and prohibits the "taking" of such species. Florida's regulation allows for a "species of special concern" designation to be applied to those species that are expected to become threatened or endangered without protection or intervention. The FFWCC is responsible for protecting listed wildlife species and the Florida Department of Agriculture is responsible for ensuring the protection of listed plant species. The Florida regulation provides a mechanism for protecting those species that appear to be secure on a national level but imperiled on a state-wide basis.

4-4. Regulation of Agriculture

The Federal Food Security Act/Swampbuster Provisions were originally enacted in 1985 and have since been amended two times. They are designed to discourage the conversion of natural wetlands within agricultural landscapes to crop land use. With some exceptions, producers converting a wetland area to crop land may lose eligibility for many US Department of Agriculture program benefits. Also, since 1994, the US Department of Agriculture Natural Resources Conservation Service, via an executed Memorandum of Agreement published in the Federal Register, has been recognized as the lead Federal agency for wetland delineations on agricultural lands. This streamlining change has enhanced communications between agency people and the farmer, thus promoting more wetlands preservation through the implementation of monetary incentives.

The Florida Nitrate Rule (Chapter 5E-1, FAC) was promulgated by the FDACS and became effective in 1996. As originally written, this rule applied to citrus operations in vulnerable soils. To date, interim nitrogen BMPs have been adopted pending further BMP research. Growers who properly notify FDACS expressing their intent to comply with the BMPs can enjoy indemnification pursuant to possible future nitrate contamination of groundwater, relieving them of responsibility for any required rededication.

Florida Certified Organic Growers and Consumers, Inc., is a non-profit organization whose purpose is to assist organic growers who want to become certified by FDACS after a mandated three year period in which no synthetic pesticides were used on the farm. By virtue of their conservation mindedness, this "up and coming" segment of the agricultural business may not be as predisposed to offsite non-point source water quality degradation as their conventional farming counterparts.

4-5. Local Regulation

Individual local governments within the Peace River watershed have a myriad of regulations that may potentially affect efforts to protect the watershed. The State of Florida, through the Local Government Comprehensive Planning and Land Development Regulation Act of 1985 (Chapter 163, *Fla. Stat.*), has directed that each local government within the state must develop a comprehensive land use plan that will guide future growth and development within their area of jurisdiction. To ensure that future growth is compatible with the natural resources of an area, the plan must evaluate and recognize the significance of these resources and provide for their protection or preservation. All local governments within the watershed have now adopted such plans and a variety of land development regulations and ordinances have subsequently been adopted to implement the plans.

The degree to which local governments in the Peace River watershed have successfully implemented their comprehensive plans through land development regulation and local ordinances has not been sufficiently evaluated for the purposes of this discussion. A complete assessment of local regulations that assist in watershed management efforts will be completed at a later date, with possible assistance from affected local governments.

5. OTHER GOVERNMENTAL INITIATIVES AND RELATED ACTIVITIES

There are other ongoing governmental initiatives that overlap or parallel the goals of the District's CWM program. Coordination among these various programs can potentially increase the effectiveness and efficiency of implementation of the Peace River CWM Plan. The following discussion describes the other major initiatives with which the Peace River CWM effort will be coordinated.

5-1. Charlotte Harbor National Estuary Program

Charlotte Harbor was designated an estuary of national significance in 1995 by its inclusion in the NEP. While the Charlotte Harbor water body itself consists of 270 mi^2 of open water, its watershed encompasses a land area of approximately 4,400 mi^2, including the 2,400 square mile Peace River watershed and the neighboring Myakka River watershed. Like the Peace River CWM effort, the CHNEP Program recognizes the inextricable relationship between health of the Charlotte Harbor estuary, and the human activity and development occurring throughout the entire contributing watershed. The following goals for Charlotte Harbor were developed through the combined efforts of 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 of the CHNEP Program included the identification of the region's *priority problems*. These are:

1. *Hydrologic Alteration* – Adverse changes to amounts, locations, and timing or freshwater inflows, the hydrologic function of floodplain systems, and natural river flows.

2. *Water Quality Degradation* – Including, but not limited to, pollution from agricultural and urban runoff, point source discharges, septic tank system loadings, atmospheric deposition, and groundwater discharge.

3. *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 CHNEP CCMP was finalized and approved by the program's Management Conference. The plan incorporates the above listed goals and priority problems and details the actions needed to protect and improve the estuary. The CCMP lists specific quantifiable objectives for each of the priority problems. It also lists priority actions, or strategies, that identify the specific activities needed to achieve the quantifiable objectives. The CCMP was signed by all participating agencies, including the District, on April 13, 2000.

5-2. Charlotte Harbor Surface Water Improvement and Management Plan

The Florida Legislature, through the SWIM Act of 1987, directed each of the state's water management districts to design and implement plans and programs for the improvement and management of surface waters. Charlotte Harbor was designated one of the District's eight priority water bodies for which a SWIM Plan would be produced. The Charlotte Harbor SWIM Plan was approved in 2000 and addresses management of the Charlotte Harbor estuary and its contributing watershed, i.e., the Peace and Myakka Rivers. Charlotte Harbor remains relatively pristine despite significant urbanization along its shoreline and extensive agricultural and phosphate mining operations within its watershed. This pristine condition distinguishes Charlotte Harbor from the District's other SWIM priority water bodies in that the primary emphasis of the SWIM Plan is protection and maintenance, versus improvement and restoration.

A number of SWIM-initiated projects have been implemented as outlined in the approved SWIM Plan. A pollutant loading model that included the entire Peace River was completed in 1995 and identified priority sub-basins where water quality degradation was a problem. Consistent with other water quality information for the watershed, the sub-basins upstream of Zolfo Springs were found to have been degraded by point and non-point pollution sources. However, trend analysis determined that in the whole, pollutant loads to the Harbor had been reduced over the preceding 20 years. Monthly water quality monitoring associated with the SWIM effort is continuing at 3 sites on the Peace River. These data will assist in the establishment of PLRGs. An interim PLRG, which limits loading to current levels, has been established for the Charlotte Harbor and Peace River water bodies.

Freshwater inflows to the Harbor have also received considerable attention, particularly given plans to increase the amount of water withdrawn for public supply purposes. An analysis seeking to partition flow reductions attributable to variations in rainfall and human alteration have confirmed that the most significant flow reductions have occurred in the upper watershed. An analysis of the coverage of oligohaline vegetative communities has also been implemented and has determined that there has been no expansion in total coverage. Another analysis devoted to questions revolving around water quantity issues investigated the cause of hypoxic conditions in Charlotte Harbor and the Lower Peace River. The results of the investigation suggest that the hypoxia was associated with extremely high river flows, which induced stratification in the water column and thereby allowed gradual depletion of the oxygen levels in bottom sediments.

The primary focus of the Charlotte Harbor SWIM Plan is: (1) the protection of water quality in the estuary and its tributaries, with an emphasis on prevention of excessive nutrient enrichment; (2) maintenance of optimum freshwater flows to the estuary; (3) habitat protection and restoration, with an emphasis on the acquisition of specific parcels; and (4) development of a campaign to educate the public about problems facing the Charlotte Harbor estuary and potential solutions to those problems. A series of projects related to the major themes enumerated above have now been implemented and include:

1. a diagnostic assessment of pollution sources in the Charlotte Harbor watershed, including both the Peace and Myakka River systems;

2. development of resource-based freshwater inflow and salinity targets for the tidal reaches of the Peace River;

3. design of a long-term monitoring program for the estuary and tidal portions of the Peace and Myakka River systems;

4. an assessment of the causes of hypoxia in Charlotte Harbor;

5. mapping of the status and trends in streamside vegetation in the tidal reaches of the Peace and Myakka River systems;

6. mapping of seagrass status and trends in Charlotte Harbor; and

7. an assessment of causes of light attenuation in Charlotte Harbor.

The SWIM Program will continue to play an important role in long-term efforts to protect and manage Charlotte Harbor and the Peace River. A series of habitat restoration projects was recently completed by the SWIM Program, including a 15-acre site in Punta Gorda and 20 acres along Alligator Creek. A number of additional projects, addressing the development of resource-based water quality and pollutant loading targets for the tidal portions of the Peace and Myakka Rivers, are currently in progress. Management of the watershed will be coordinated with SWIM to ensure consistency among the programs and to avoid duplication of efforts.

5-3. Whole Mine/Whole Basin and Old Lands Phosphate Permitting and Reclamation

A major priority for natural systems protection in the Peace River watershed revolves around reclamation planning for sites that have been, or are proposed to be, mined for phosphate. As noted previously, some of the most severe impacts to the natural systems of this watershed have resulted from mining activities conducted in the upper reaches of the river. A number of sub-basins that historically discharged to the upper river have been severed hydrologically from the Peace River system, and the resulting loss of discharge is a primary source of the reduced river flow and associated impacts to aquatic ecosystems of the upper watershed. Mining of these sub-basins, and subsequent reclamation, took place in a relatively piecemeal fashion that did not allow for a holistic approach to reclamation. The extreme changes in topography that result from mining, in combination with piecemeal reclamation, have produced reclaimed landscapes that support lacustrine communities in closed sub-basins, rather than functional drainage systems that continue to discharge to the river.

Even under the piecemeal approach bemoaned above, the permitting process for phosphate mining is a laborious and complex enterprise. A team approach to permitting is now in progress for 3 proposed mines: the Ona and Pine Level sites, submitted for review by IMC Phosphates; and a proposal by Farmland Hydro. Collectively, the 3 proposed mines would encompass a total land area of approximately 57,000 acres. The team permitting approach, which coordinates a joint review by all agencies with jurisdiction over the proposed mining-related activities, is much more broad in scope than previous reviews for phosphate mining and provides a vehicle for addressing mining on a "whole mine/whole basin" basis. If the process proceeds effectively, the resulting reclamation plans should produce post-mine landscapes that maintain hydrologic connections with the Peace River.

The destruction of natural lands through mining has also resulted in severe impacts to wildlife. The landscape of the phosphate region supports a hodgepodge of active mines; reclaimed mine sites; unreclaimed sites where mining operations took place prior to the enactment of modern regulatory requirements for reclamation; and natural lands that remain undisturbed by mining. The result has been a highly-fragmented landscape that cannot support the diversity of wildlife that originally occurred here. Whole mine/whole basin review of the new mining proposals, via the team permitting approach, should seek to create and preserve a linked network of reclaimed and unmined lands that will maintain connectivity with surrounding areas of core wildlife habitat. Creation of such a network may represent an important source of the "net ecosystem benefit" that is the goal of the team permitting process and would be consistent with goals of the FDEP and FFWCC to create an IHN.

A reclamation program dedicated to reclaiming lands mined prior to the establishment of requirements for reclamation may allow some of the severed sub-basins in the upper watershed to again contribute flows to the Peace River. The Old Lands or Nonmandatory Phosphate Lands Reclamation Program provides a source of funds for such reclamation projects. Future strategy for Old Lands reclamation should target those sub-basins that can be most effectively reclaimed to increase river flow, or that would be most important as elements of the IHN.

The Old Lands Program is currently very cumbersome to administer and can only be used by the owners of eligible lands. A large proportion of the Old Lands is either ineligible or “not evaluated”, meaning that the landowner can apply for eligible status. In the Peace watershed, approximately 14,000 acres are “ineligible,” meaning that funding under the program is not available, and approximately 14,500 acres are “not evaluated.” The FDEP Bureau of Mine Reclamation is attempting to modify the program to facilitate use of the trust fund, but a statutory change will be necessary to solve the major obstacles to implementation of the program. Currently, funds may be used to purchase land or reclaim land; however, total expenditures are capped at $3,551 per acre for clay settling areas and $5,685 per acre for mined areas. These amounts are adjusted annually by the Engineering and News Record construction cost index and are sufficient to perform earthmoving and revegetation to minimum standards as specified in Chapter 62C-17, FAC. Reclamation to “mitigation” standards requires roughly three to four times this amount and is, therefore, beyond the scope permitted by current constraints of the program. In addition, the program does not have condemnation authority and must rely on voluntary participation.

5-4. Mitigation Banking

There are a number of large development projects that will result in impacts to natural systems of the Peace River watershed. Mitigation requirements for these projects may present opportunities for addressing some of the pressing needs of natural systems management and restoration. The Upper Peace River Ecosystem Planning Committee (UPREPC), which is discussed in a subsequent section of this plan, is responsible for identifying mitigation options associated with a series of development projects and may provide a future forum for identifying such options on a watershed-wide basis. Some of the sub-basins that have been altered most severely by prior development may present mitigation banking opportunities that should be explored by UPREPC.

5-5. Ecosystem Management

In 1995, the FDEP implemented its Ecosystem Management Initiative. The overall goal of the program is to improve protection for Florida’s environmental resources, protect human health, encourage a conservation ethic and sustainable lifestyle to be applied by Florida’s citizens, and to help stimulate a healthy economy. A fundamental objective to help achieve the overall goal is to promote good stewardship of Florida’s ecosystems. The four cornerstones of ecosystem management; place-based management, common-sense regulation, cultural change, and foundations support stewardship (FDEP 1995).

1. Place-based management attempts to manage resources and human activities in the context of the ecosystem in which they occur and focuses on larger scale areas with adequate size to address major regional hydrological and ecological connections.

2. Common-sense regulation attempts to shift the focus of today’s regulatory programs to concentrating on a law’s intent, rather than on the law itself. This will allow the permitting process to become more flexible and to provide workable alternatives that provide incentives for the regulated public to go beyond compliance.
3. Cultural change applies to the interaction of government agencies and the public. Partnerships must be formed between government and the public and independently operating programs must be integrated.

4. The foundations of ecosystem management are intended to provide knowledge and tools for informed decision making, implementation guidance, and mechanisms to monitor results so that adaptive management can be used to achieve set environmental goals. These foundations are: a statewide natural resource atlas, public linear infrastructure planning, science and technology, research, monitoring, education, training, and program audit and evaluation.

The state was divided into EMAs, which are areas of sufficient size to address major regional hydrological and ecological connections. The EMAs typically coincide with major watershed and/or sub-basin boundaries, or a particular geomorphic feature, which exhibits a specific set of habitat conditions (i.e., Lake Wales Ridge) and include urban, rural, developed and undeveloped lands. The Peace River basin is a component of the Charlotte Harbor watershed, and is, therefore, a basin component of the Greater Charlotte Harbor Ecosystem Management Area (GCHEMA). Environmental issues within the EMA will be addressed by system-based, rather than site-based, methods by a local EMA team and interagency coordination.

By 1999, the Ecosystem Management Initiative's concepts and approaches had been successfully incorporated into FDEP's program responsibilities. While certain responsibilities of the EMA coordinators continued, such as Development of Regional Impact Review and participation on the CHNEP Technical Advisory Committee and mine permit and other interagency teams, the Initiative had evolved into primarily a mode of maintaining intragency and interagency relationships. In FDEP's Southwest District, which encompasses the Ecosystem Management Initiative evolved into watershed management.

The WMP is organized into two sections; Water Quality and Land Use Coordination. The Water Quality Section is comprised of surface and groundwater quality staff, while the Land Use Coordination Section consists of environmental planning and restoration staff with GIS support capabilities. Watershed Management staff continue to actively participate actively on interagency teams that facilitate decision making on a regional landscape and/or watershed basis.

5-6. Land Acquisition Programs

As one of the fastest growing states in the nation, Florida is experiencing many of the side effects that accompany rapid population growth. The state's unique and diverse natural resources, which attract tens of millions of visitors annually, are disappearing at a rapid rate as more and more areas are being developed to accommodate the growing population. The State of Florida, the water management districts and many local governments, however, are strongly committed to conserving this natural heritage and have instituted land acquisition programs for that purpose. The following discussion summarizes the various land acquisition programs of relevance to the Peace River watershed.

<u>Save Our Rivers</u>

In 1981 the Florida Legislature created the Water Management Lands Trust Fund (s. 373.59, *Fla. Stat.*), commonly known as the SOR, in order to provide the water management districts with a non-lapsing funding source to finance the acquisition of land. The lands to be acquired through SOR were mandated to meet certain criteria associated with water management values (e.g., water supply and protection of water quality) or the protection of natural systems. The Trust Fund is administered by the FDEP and is derived as a portion of the annual proceeds of the Documentary Stamp Tax. The districts are required by the legislation to manage the acquired lands in a manner that will ensure a balance between public access, general public recreational purposes, and restoration of their natural state and condition.

A series of amendments to the Program has progressively increased the proportion of SOR funds that can be applied to land management needs. Up to 100 percent of the District's annual allotment of SOR funds can now be applied to basic maintenance, capital improvements, habitat protection and wildlife conservation, prescribed burning, habitat restoration, fencing, road and bridge maintenance, and recreational use of District-held lands. The dedication of funds to such activities is essential to preserving the resources and natural values that have served as the basis for SOR acquisitions. As of July 1, 2001, the districts may no longer use any portion of the Trust Fund monies for land acquisition, relegating it to strictly a source of funds to support land management related activities.

The District has thus far acquired more than 364,000 acres. Where appropriate, the District has worked in partnership with state and/or local governments to conduct joint acquisitions or has acquired a less-than-fee interest in lands to ensure their conservation while allowing them to remain in private ownership. The Bright Hour Watershed Project, which is one of the largest less-than-fee simple acquisitions ever executed in Florida, was negotiated by the District in partnership with The Nature Conservancy and ensures the long-term protection of an extraordinary 28,274-acre tract in DeSoto County.

Conservation and Recreation Lands

Established in 1979 by the Florida Legislature, the Conservation and Recreation Lands (CARL) Program replaced the 1972 Environmentally Endangered Lands Program and expanded the scope of acquisition to include resource conservation measures for other types of lands, e.g., areas of high recharge. The CARL program is administered by the Division of State Lands of the FDEP with oversight provided by the Board of Trustees of the Internal Improvement Trust Fund, i.e., the Governor and Cabinet. Funding for the CARL program comes from several sources including severance taxes on phosphate mining, excise taxes on real estate and financial documents, and revenues from the sale of surplus state lands. Lands targeted for acquisition include those considered environmentally unique and irreplaceable that contain native, relatively unaltered flora and fauna representing a natural area unique to, or scarce within, a region of Florida or a larger geographic area. Like lands acquired through the SOR Program, CARL lands are managed to protect or preserve the natural resources contained within them. Land acquired through CARL is placed within one of several different categories which will dictate, on a site-specific basis, who the managing entity will be and what the management priority will be. For example, lands can be assigned to the State Forest system (managed by the Division of Forestry, FDACS), or can be assigned to the network of recreational lands managed by the FDEP (e.g., State Parks and State Preserves)

Preservation 2000

The Florida Legislature passed the Florida P2000 Act in 1990. The Act called for a 10-year program to provide $3 billion toward the purchase of environmentally-valuable lands. Most of the annual allotment of funds (80 percent) was used to supplement the SOR and CARL programs. The remainder was divided among various agencies and local governments to finance the purchase of inholdings, abandoned railroad rights-of-way to be used as recreational trails, and natural tracts of local significance. Acquisition of public lands were based on a comprehensive assessment of Florida's natural resources and planned to protect the integrity of ecological systems and to provide multiple benefits, including preservation of fish and wildlife habitat, recreation space, and water recharge areas. The Act further recommended that governmental agencies work together to purchase land jointly within ecological systems.

Florida Forever

In 1999, the Florida Legislature passed the Florida Forever Act to serve as a successor to the P2000 program. Florida Forever has natural resource protection objectives that are similar to those of P2000, and requires that all lands acquired through the program be managed for multiple-use purposes where compatible with the resource values and management objectives for such lands. "Multiple-use" includes, but is not limited to, outdoor recreational activities, water resource development projects, and sustainable forestry management objectives. In addition, each Water Management District must develop 5-year work-plans that integrate their existing SWIM plans, SOR land acquisition lists, stormwater management projects, proposed water resource development projects, proposed water body restoration projects, and other properties or activities that would assist in meeting the goals of Florida Forever.

Polk County

In 1994, Polk County voters approved the creation of a land acquisition program to actively pursue the preservation and protection of environmentally sensitive lands within the county. The land acquisition program is funded by ad valorem taxes. To date, Polk County has acquired 3,970 acres through joint acquisition partnerships with Florida Communities Trust and the District.

5-7. Upper Peace River Ecosystem Planning Committee

The UPREPC was created to serve as a forum for inter-agency review of mitigation options related to construction of the Polk County Parkway and other large-scale development projects. The responsibilities of UPREPC were established via a five-party MOU executed by the USACOE, FDEP, Florida Department of Transportation, FFWCC and the District. To date, UPREPC has focused almost exclusively on mitigation potential within the Tenoroc Fish Management Area. UPREPC may ultimately serve as a convenient vehicle for coordinating mitigation and mine reclamation throughout the Peace River watershed. The progress and effectiveness of the group will be monitored and the efforts of the Peace River CWM team will be coordinated with UPREPC to the greatest extent possible.

6. LAND USE IMPACTS ON THE WATERSHED'S NATURAL SYSTEMS

As detailed previously in this plan, human land uses such as mining, agriculture, and urban development have resulted in severe impacts to the watershed. This section discusses those land uses that have most greatly affected the natural landscape and specifically identifies humanity's impacts to natural systems within the Peace River watershed.

6-1. Phosphate Mining

Phosphate has been a major economic force in the Peace River watershed since the discovery of phosphate pebble in the Peace River in the 1880s (Blakely 1973). In Florida's "phosphate district," the vast majority of which occurs in the Peace River watershed in Polk, Hardee and DeSoto counties, approximately 194,000 acres have been mined (S. Partney, personal communication, FDEP 2001). Approximately 80,000 acres were mined prior to laws requiring mandatory reclamation (Reddick 1997). Approximately 50,000 acres of these "nonmandatory lands" were deemed eligible for nonmandatory (a.k.a. Old Lands) funding by the Zellars-Williams (1980) report, which is the guiding document for the nonmandatory program. Of these 25,000 acres have been funded by the program and reclamation completed on 10,000 acres. The remainder is in some stage of reclamation, which can require up to 10 years per parcel. Another 526,000 acres are either owned or controlled by the phosphate industry (Reddick 1997).

Phosphate ore is strip mined through the use of draglines. Historically, the phosphate ore matrix was 15 to 35 feet thick and was overlain by a thin (5 to 25 feet) layer of overburden. In present day mining situations, the phosphate matrix is typically about eight feet thick and is located beneath approximately 30 feet of overburden (Thurner 1998). The overburden is removed and stockpiled; then the ore is removed leaving a "moonscape" of high, steep piles of overburden soil and phosphate pits which fill with water. This type of mining severely disturbs all aspects of the landscape in which it occurs. What ever land use occurred prior to mining is completely disrupted during mining, and is likely to be forever changed. Wildlife habitat is destroyed, ecologic function is severely impacted, and geology and hydrology are altered forever.

Mining methods guarantee disruptions to natural systems that will be at least temporary in nature. Ecologic function, especially that of aquatic and wetland habitat, is dependent on hydrologic function in riverine watersheds. Natural hydrologic function is a critical aspect of the support system on which both wetland and upland ecosystems depend. Prior to wetland and floodplain regulations, no habitat was protected from mining if economically significant amounts of ore existed under them. Uplands, wetlands, even entire tributaries and associated watersheds were mined. Since 1975, State regulations have existed that require phosphate mining companies to reclaim land that is mined. Before the adoption of the Warren Henderson Bill in 1984, which brought Florida wetland laws into conformity with the Federal Clean Water Act, wetland regulations were local and largely ineffective.

Since that time, wetland regulations implemented and enforced by the State have evolved to our present day mitigation regulations. Any wetland disturbances are now required to be mitigated. For every acre of wetland disturbed, one to three acres of wetland is required to be enhanced, created, or purchased for preservation to offset the disturbance. Floodplain regulations differ by county, but typically the 25-year floodplain is always protected from mining.

Phosphate mining, by its very nature, alters the hydrology of the area being mined. Tons of earth are removed, areas in active mining are dewatered, and, even after reclamation, surface infiltration and groundwater flow are unlike historic characteristics. During the mining process, mines are required to retain all surface water runoff onsite. This precludes typical runoff from rain events that occur within the watershed from entering the tributaries or main stem of the river. This is a hydrologic alteration resulting in the alteration of periodicity of flow in the river. Periodicity of flow results in naturally occurring inherent disturbances (i.e., periods of higher flow) within the aquatic habitat that certain species have evolved to deal with. Elimination of these disturbances may favor some species over others.

This alteration in flow regime, whether temporary or permanent, alters aquatic habitat. Depending on how the watershed is reclaimed, that alteration may be only temporary or may well be permanent. Typically, mined land is reclaimed in a different land-form than it was prior to mining. Much of the mined land in the Peace River watershed has been reclaimed for pasture, other agricultural uses, residential, industrial, and as "land and lakes" suitable for residential or recreational development.

Extensive areas that originally served watersheds for tributaries to the river now occur as closed basins or lake watersheds as a result of mining. Clay settling areas, which collectively cover some 100,000 acres (Reddick 1997) have become raised, closed basins, which are impermeable to infiltration and lateral groundwater flow. It takes years for closed clay settling areas to become compacted enough to abandon. Only after abandonment are the dams reduced and breached so that water falling within the settling area can exit and again become part of surface water flow. Even then, however, flow is channeled through an outlet in the still above-grade dams, where once there was sheet flow over predominantly flat terrain. These areas account for much of the increase observed in "open water" land cover that was noted earlier in this chapter.
Relatively recent regulations now prohibit the mining of streams and tributaries and their associated floodplain habitat. However, tributary and main-stem river watersheds are still allowed to be mined. While streams are left intact, watersheds are reclaimed as a patchwork of different land uses; including pasture, residential, industrial, agricultural, and wildlife habitat.

Created, closed basin wetlands tend to function very well hydrologically (as closed basin systems) and are used heavily by certain types of wildlife, especially wading birds. While non-forested wetlands are relatively easy to create and their vegetative assemblages do not take long to mature, forested systems are very different and their creation is much more difficult.

Although reclamation of forested wetlands has met with some success, reclamation of forested uplands has met with very little success. Since restoration of forested habitat typically involves the planting of seedlings, it would take several decades for a reclaimed pine flatwood to mature. The same would hold true for other forested upland habitats. Non-forested uplands, however, could conceivably be restored as successfully as non-forested wetlands, given the proper soil conditions and management techniques (i.e., prescribed burn program).

While reclamation is very successful in creating landforms and vegetative communities, there is still a successional factor that is missing. Unless a reclamation project is "mulched" *(the practice of scraping and staging the existing topsoil prior to mining and spreading it over the newly created landform during reclamation)* the newly created landscape is missing the organics (i.e., leaf litter) and the micro-organisms (mycorrhizal fungi) that occur at the base of the food chain. Another missing component is the small animal population, with the exception of those that have been translocated. Translocation is a technique that has been used to populate some experimental upland scrub habitat reclamation. When large tracts of land are mined and reclaimed prior to or subsequent to adjacent tracts, as is the dominant case, habitat fragmentation occurs.

Wildlife population dynamics is skewed on reclaimed lands, especially on those large expanses where adjacent populations are missing and recolonization will take many years. Mining and reclamation interrupts the life cycles of those species dependent upon the habitat being mined. In the case of upland species that are dependent upon wetlands at some time during their life cycles (e.g., the gopher frog), mining of wetlands alone will interrupt those life cycles, even if the upland is left intact.

Prior to July 1, 1975, lands that were mined did not have to be reclaimed; and although reclamation is now required, the habitat or community that was destroyed by mining is not always the habitat or community type that is recreated in the reclamation process. Wetland mitigation is required, but uplands are generally reclaimed as some other land use, typically pasture. Of the 152,000 acres of nonmandatory lands, reclamation of 47,000 acres has been funded. Approximately 25,000 acres of this total are in the Peace River watershed. Another

28,500 have no funds dedicated to reclamation. Where lands have been mined, much has been reclaimed as wetland, however upland is typically reclaimed as some other land use.

Among phosphate companies, a highly-favored reclamation approach is development of "land and lakes." Land and lakes reclamation is functional for many types of land uses. If the land is not protected from development, it is very likely that it will be converted to residential use. This type of land use conversion results in a great loss of upland habitat, and there is no guarantee that reclaimed upland habitat will not be developed in the future if it is not protected legally. This alludes to the importance of protecting some strategically-located reclaimed areas through conservation easements, public acquisition, or other means that assure long-term dedication to conservation.

A considerable amount of the nonmandatory lands are not considered appropriate for reclamation by the FFWCC because the lands have revegetated naturally and are functioning as wildlife habitat in their present state (Thurner 1998). "Reclamation" of such lands would disturb those wildlife species using the existing habitat and could be counterproductive.

Nonmandatory reclamation lands, along with lands reclaimed as habitat and native range which are not subject to development, and preserved lands throughout the Peace River watershed form the IHN. A concept developed by the FDEP and the FFWCC, the IHN is a network of both public and private lands that serve as wildlife corridors. Much of this network is preserved riverine corridors within the Peace, Alafia, and Little Manatee River watersheds. Mined land reclaimed as wildlife habitat and native range, as well as naturally revegetated, unreclaimed nonmandatory lands are also included in the IHN.

As mined lands are reclaimed to natural landcover types and assured permanent protection through easements or other means, they will be incorporated into the IHN. Recent efforts have focused on reconnecting the historical connections of mined tributaries. These efforts will likely be significant in reconnecting reclaimed tributary sub-basins to the main stem of the river corridor and providing movement corridors for wildlife, as well as source areas for recolonization. Implementation of the IHN should be considered a key element in the recovery of the Peace River watershed.

6-2. Agriculture

Agriculture within the Peace River watershed is comprised primarily of cattle ranching operations and citrus production, otherwise known as citriculture. The watershed is particularly conducive to citricultural development because the sub-basins in the upper reaches feature highly permeable, sandy soils which are advantageous to citrus cultivation during the early post-planting years. With the exception of the southernmost sub-basins, the hydrogeology of the Peace River watershed provides fairly high yielding production wells, withdrawing principally from the Upper Floridan Aquifer, thereby providing ample water for the irrigation of crops. Paradoxically, development of citriculture in this "prime" citrus growing region affected the water resource as evidenced by declining lake levels on portions of the Lake Wales Ridge, which result in the area's designation as a WUCA and in the subsequent promulgation of new regulations in 1990.

According to the Florida Agricultural Statistics Service "Citrus Summary" published in January 1995, planted citrus acreage within the watershed totals approximately 240,000 acres. This acreage rivals the citrus production acreage within the entire state of California. The same document ranks Polk, Hardee, and DeSoto counties among the top ten counties state-wide in terms of acreage planted in citrus.

Beef cattle production within the Peace River watershed is equally noteworthy. In terms of cumulative acreage, pastureland accounts for most of the agricultural land use within the watershed. The Statistics Service reports that, relative to the total number of head of cattle, Polk, Hardee, and DeSoto counties are again ranked within the top ten state-wide. A subset of this grouping, the dairy industry, also enjoys considerable agricultural stature. Hardee County has approximately 8,000 dairy cows, making it one of the top five dairy producers in the state (Florida Agriculture May 1997).

Finally, row crops have emerged as a smaller, yet vibrant, sector of local agribusiness as vegetable farmers have capitalized on rotational farming. Permanent produce packing houses are now present in Hardee County, capitalizing on the presence of SR 17, which traverses the four counties that form the heart of the Peace River watershed. Pinpointing the row crop acreage under cultivation is difficult for two reasons: first, row crop farmers tend to be more transient in comparison to their citriculture counterparts, and thus do not readily provide a permanent photographic/geographic "signature" for aerial photointerpretation purposes; and, second, row crop production land is routinely rotated with beef cattle production/grazing. Current maps depicting agricultural land use may not accurately assess the current acreage of row crops. Many new row crop operations have appeared and have been authorized to construct surface water management systems through the District's Agricultural Ground and Surface Water Management (AGSWM) exemption program.

Historically, production agriculture has not been perceived as significantly increasing the post-development peak discharge rate for rainwater induced runoff. Agricultural development, particularly in the lower and middle reaches of the watershed, appears to have maintained base flows. It has also been suggested that, since a large portion of the citrus acreage within the watershed existed prior to the District’s promulgation of surface water rules pursuant to Chapter 40D-4, FAC, citriculture may contribute additional surface water or base flow to the river system.

Agricultural BMPs have been promoted by the agricultural industry for many years as a means of reducing the water quality impacts that are sometimes attributable to agriculture. Recently, the University of Florida's Institute of Food and Agricultural Sciences released a report which documented many of the water quality benefits of present day agricultural BMPs. Nonetheless, intensive agricultural production continues to represent a significant source of water quality degradation. As a result, many upstream farmers are keenly aware of the special regulatory status (Aquatic Preserve, NEP, etc.) that Charlotte Harbor enjoys. The role of the Peace River as the primary source of domestic potable water for residents of DeSoto, Charlotte, and Sarasota counties adds additional emphasis to the need for maintaining good water quality in the Peace River. The water quality impacts of agricultural land usage in the Peace River watershed is described in the Water Quality chapter of this plan.

High stocking rates, or cattle densities, of ranching operations on improved pastures and/or dairies typically produce point source (direct) or non-point source agricultural runoff with dissolved pollutants therein. These pollutants - elemental phosphorus being of particular concern - can quickly and significantly degrade the downstream receiving water body and affect the biota. In addition, double cropping, without properly analyzing residual soil nitrogen and other primary plant nutrients, may predispose some agricultural operations nutrient leaching and water quality degradation. A District research project completed in 1996 entitled, "A Survey of Outflow Water Quality from Detention Ponds in Agriculture" (Bahk 1996) evaluated both citrus grove and row crop discharges looking at various water quality parameters. Water quality results were compared to state water quality standards pursuant to Chapter 62-302, FAC. Some of the sampling sites for this project were within the watershed. Although the data is not conclusive in terms of significantly higher nutrient loadings from row crop runoff over established citrus groves, certain row crop operations may potentially produce higher levels of some nutrients. Data does not currently exist to accurately compare the performance of District permitted stormwater treatment ponds with systems approved through AGSWM that rely on strict BMPs with no ponds.

6-3. Exotic Species Control

The protection and preservation of the watershed's natural systems, including associated native plant communities, requires effective management of non-native "exotic" plant species. The invasion of native plant communities and ecosystems is widely-recognized as one of the primary threats to the environmental integrity of Florida's remaining natural areas. Due to their rapid growth and freedom from the population controls typically imposed by their natural predators and pathogens, invasive exotics can often displace native species, destabilize community structure, and reduce the overall abundance and diversity of species in the wild.

Non-native aquatic species, such as water hyacinth, water lettuce and hydrilla can negatively affect fish and wildlife populations and interfere with recreational use of surface waters. If left unmanaged, these invasive aquatic species can also degrade water quality, impede flows and increase sedimentation rates. The District conducts aquatic plant management operations on natural waters in coordination with the FDEP, the FFWCC, the USACOE and local government agencies. Funding is provided through the above agencies and by District Basin boards where appropriate (SWFWMD 1995). The Peace River Basin Board has provided such funding to control invasive, non-native aquatic species within the Peace River.

In addition to aquatic species, many exotic terrestrial species have become increasingly prevalent in recent years and pose concerns for management of upland natural resources. Species of particular concern in the Peace River watershed include skunk vine, old world climbing fern, tropical soda apple and cogon grass. Vines are especially troublesome due to their ability to climb native trees and shrubs and blanket the canopy, eventually killing the trees and understory vegetation. This characteristic growth pattern makes it difficult to control through the use of herbicides due to coincidental destruction of native, non-target species. Fire ecology is also disrupted as the vines often provide a conduit for fire to reach tree canopies, thereby killing native trees. The District has budgeted funds for a cooperative two-year biological control feasibility study of skunk vine in an attempt to develop effective control methods and is developing BMPs to guide ongoing control efforts for this species.

Cogon grass is one of the most widespread invasive exotic plants in Florida and has been identified as one of the ten most invasive weeds in the world. It has invaded a variety of disturbed areas, including roadsides, fence and fire lines, un-maintained pastures, power line rights-of-way and timber-harvested lands. Cogon grass is also beginning to invade undisturbed habitats, quickly replacing a diversity of native plant species. Impacts from cogon grass include disruption and alteration of natural fire ecology and displacement of native plants. Although it is widespread, most stands of cogon grass are relatively small and respond well to an aggressive herbicide control program.

Concerns about the continued proliferation of exotic plants led to the formation of the Inter-District Exotic Plants Committee in 1996. The goal of the Committee is to broaden cooperative efforts on exotic plant management through additional partnerships with other agencies, affected communities and the state university system. One product of the Committee was the 1997 publication of the cooperative inter-district report Exotic Plant Invasion On Florida's Water Management District Lands. The report provides an examination of the problems posed by invasive exotic plants, presents current efforts by the water management districts to manage problem species and provides specific recommendations for future cooperation on the issue (SWFWMD 1997).

Alternatives available for eradicating or controlling occurrences of exotic plant species normally rely upon mechanical, chemical, or biological methods. These methods, whether applied individually or in combination, may sometimes result in damage to non-target, native species. The possible impact of an eradication or control effort on native species must always be weighed against the perceived benefit and urgency of controlling the target species. Mechanical methods, which consist of physical destruction or removal, may potentially intensity or perpetuate problems associated with invasions of exotic plant species by disturbing soils or creating openings within existing layers of vegetation.

Many exotic plant species preferentially colonize disturbed sites or gain an initial foothold in such areas. Chemical methods of controlling exotic species utilize herbicides to destroy plant tissues and have great potential for destroying non-target native species, as noted previously. Herbicides can also affect native wildlife or pollute nearby surface waters, and must therefor be applied very cautiously and judiciously. Generally, biological techniques dependent on the introduction of a predator or pathogen that is very host-specific to the offending exotic species is preferable to either mechanical or chemical methods. These techniques will be incorporated into the District's land management program as they are developed by researchers, provided that they are safe and effective. In future land protection efforts that depend on less-than-fee acquisitions, i.e., conservation easements, covenants that require the landowner to control invasive exotic species should be incorporated into the easement. A coordinated effort to control such species on all publicly-owned conservation lands will continue to be pursued by the District.

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