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MYAKKA RIVER BASIN PROJECT: MANAGEMENT GUIDELINES AND GOALS FOR THE MYAKKA RIVER BASIN

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APR 92

MYAKKA RIVER BASIN PROJECT

MANAGEMENT GUIDELINES AND GOALS FOR THE MYAKKA RIVER BASIN

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The Myakka River is an Outstanding Florida Water and a State-designated Wild and Scenic River. Much of the relatively undeveloped watershed consists of rural uses and publicly-owned land. The river flows into Charlotte Harbor, one of the largest and most productive estuaries in Florida. Information and data compiled during the first two years of the project were used to develop a GIS based computer model to be used as a management tool. The model can be used to predict and monitor cumulative impacts of human activities in the basin. Recommendations for management of water quality, fresh water flow, land use, and land acquisition are provided.

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"Going to the Myakka is a pleasant and profitable habit that grows on one...Many a haggard face has grown calm and less wretched from a soothing sojourn on the Myakka; and many frivolous, unthinking souls have grown more noble from gazing upon the handiwork of God."

Mrs. Neal Wyatt Chapline. 1914. *Florida the Fascinating.*

"As the evening sun touched with gold the rich green tops of the palms, and brightened the somber hues of the live-oaks festooned with grey masses of spanish moss, and relieved by the bright green leaves of the wild vine and crimson and white blossoms of the parasitic air-plant, while it reflected its own glowing image in the dark water, until we seemed to be floating in a river of fire, I thought my mortal eyes would never look on any more gorgeous display of tropical colouring."

F. Trench Townshend. 1875. *Wildlife in Florida with a Visit to Cuba.*

"We passed through mile wide meadows of partly submerged bulrushes backgrounded by forests of pine, with clumps of cedar to the fore and dotted with tall palmettoes, singly and in groups. As we ascended the river the pines came nearer, the water grew shoal and was dotted with islands, while tall ferns adorn the banks. As we continued to advance the river narrowed to fifty yards and became a fresh water stream with a strong current, so crooked that we traveled 12 miles to make six and in doing so went in every direction. ...As we ascended, the river continued to narrow and deepen. On both sides were great white sand banks, six to ten feet in height."

Anthony Dimock. 1915. *Florida Enchantments.*

EXECUTIVE SUMMARY

The objective of the Myakka River Basin Project was to provide a technical basis for management goals and recommendations that would protect the natural resources of the Myakka River and its estuary, Charlotte Harbor. The first and second years focused on collection, compilation, and preliminary analyses of information on rainfall, stream-flow, water chemistry and biological communities. The major task for the third year was to conduct a geographic information system (GIS) analysis and use the results to develop management goals and recommendations that are the subject of this report.

The Myakka River flows through approximately 66 miles in a southwesterly direction through Manatee, Sarasota, and Charlotte Counties before it discharges into Charlotte Harbor. It drains a watershed of approximately 1,559 km^2. Much of the watershed consists of rural uses and publicly owned lands. Water quality of the river is generally good. However, population growth projections for the region and concern over the potential environmental impacts associated with growth require planning to protect river resources from future degradation.

Existing and potential impacts that affect the natural resources of the river include wetland alteration, agricultural and urban stormwater runoff, phosphate mining, wastewater discharge and septic tanks, groundwater pumping, ditching, impoundments, shoreline alteration, and recreational overuse. Analysis based on water quality data and stream flow show that nutrient export is 20 to 66 percent higher from Howard Creek and Myakka Head sub-basins than from sub-basins with less intensive land uses. Approximately 74 percent of the annual input of the dissolved nitrogen is removed by primary production within the estuary. Metal concentrations were low and no anthropogenic organic compounds were found in excess of detection limits.

A GIS based computer model was developed for estimating relative contributions of runoff and chemical loadings by sub-basin to the Myakka River. The model can be used as a management tool as new monitoring data and land use data become available for updating. It can be used to project cumulative impacts of human activities in the basin. Recommendations for management of water quality and freshwater flow, land use, and land acquisition are provided.

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1.0 INTRODUCTION

In 1987 the Coastal Zone Management Section of the Florida Department of Environmental Regulation (FDER), with funds made available through the National Oceanic and Atmospheric Administration (NOAA), established an "Estuarine Initiative" with the objective of improving the research and management of selected estuaries in the state. Projects were initiated in Perdido Bay in Northwest Florida, Turkey Creek in Southeast Florida, the Little Manatee River in the southern portion of Tampa Bay, and the Myakka River basin in Manatee, Sarasota, and Charlotte Counties.

The objective of the Myakka River Basin Project (MRBP) was to provide a technical basis for management goals and recommendations that would protect the natural resources of the Myakka River and its estuary, Charlotte Harbor. The Myakka River is in part an Outstanding Florida Water as well as a State-designated Wild and Scenic River. Much of the watershed consists of rural uses and publicly-owned land. Charlotte Harbor is one of the largest and most productive estuaries in Florida. Population growth projections for the region, and concern over the potential environmental impacts associated with growth, highlight the need for planning now to protect the resources of the river. The size, significance, and relatively undeveloped nature of the Myakka River Basin made it a good candidate for the subject study.

The MRBP was conducted through a contract by FDER with Sarasota County. The first year (1989) focused on data collection and compilation. Information was collected on rainfall, stream-flow, water chemistry and biological communities. The river shoreline was characterized. Continued data collection and preliminary analyses were performed during the second year. The major task for the third year consisted of a geographic information system (GIS) analysis of the water quality and land use data. The results of this analysis were used to develop management goals and recommendations for their implementation. The GIS analysis and recommendations for basin management to protect the natural resources of Myakka River and Charlotte Harbor are the subject of this report.

2.0. DESCRIPTION OF THE MYAKKA RIVER WATERSHED

2.1 Overview

The Myakka River originates in marshes near Manatee/Hardee County line and flows through approximately 66 miles in a southwesterly direction through Manatee, Sarasota and Charlotte Counties before it discharges into Charlotte Harbor (Figure 2-1). It is a meandering blackwater river that drains a watershed of approximately 1,559 km^2 (Hammett 1989).

Pine flatwoods interspersed with wetalnds is the dominant habitat type in the watershed and ranching is the principal land use. Mixed hardwood hammock or marsh alternate in areas adjacent to the river.

The river channel is very narrow in its upper reaches near Myakka Head in Manatee County. Approximately six river miles below the headwaters, Wingate Creek joins the Myakka River. The first of four large depressions within the Myakka River watershed, Flatford Swamp is formed from the confluence of seven tributaries: Myakka River, Wingate Creek, Ogleby Creek, Long Creek, Maple Creek, Youngs Creek, and Taylor Creek. Immediately below Flatford Swamp the river runs through marsh and popash swamp.

In Myakka City the river shows some channelization and alteration of the riverbed. Below Myakka City, there is a transition in the river bank vegetation from marsh and hardwood swamp to cabbage palm, live oak and laurel oak hammock. Adjacent land use is primarily agricultural and rural residential.

Just above Myakka River State Park, the river channel splits into Clay Gully and the Myakka River. Both watercourses run into Upper Myakka Lake. Approximately a half mile of the Myakka River flows through the southeastern part of Tatum Sawgrass Marsh before entering the park,. This 4,300 acre marsh is the second of the four natural depressions within the Myakka River watershed. A series of dikes were constructed in Tatum Sawgrass Marsh in 1974 to allow conversion to agricultural land. These dikes reduced the water storage capacity of the marsh.

Twelve miles of the Myakka River are within the boundaries of the Myakka River State Park. The dominant water features of the river in the park are the Upper and Lower Myakka Lakes, the remaining two of the four topgraphic depressions along the river.

Downriver from Upper Myakka Lake, the Myakka River flows through a large marsh area known as Big Flats. Originally a secondary water course from the Upper Myakka Lake passed through Vanderipe Slough, but was severed by a dike constructed near the lake in the 1930's

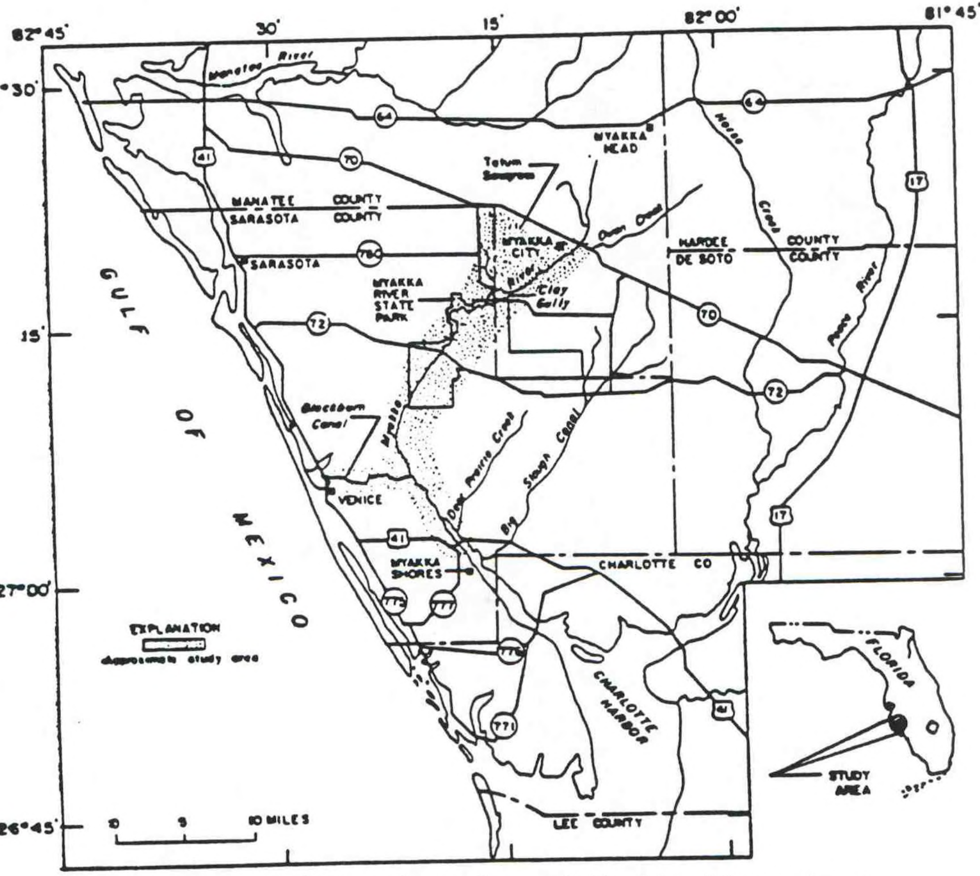

Figure 2-1 - Location of Myakka River Area
Source: Hammett et al. 1978

and 1940's. South of State Road 72, hardwood hammock closes in on the river channel for a short reach before again opening into marshes at the northern end of Lower Myakka Lake. Downriver from Lower Myakka Lake, hardwood hammock again borders the river channel. Approximately 0.5 miles below the state park boundary, a private dam has been constructed across the river. Locally known as Downs' Dam, it can retain approximately four feet of water depth.

Downriver of Downs' dam, the river channel is deeply incised, meandering, and bordered by hardwood hammock. At several locations the river cuts through higher ground, with pine-palmetto flatwoods extending to the river's edge, creating a number of bluffs along this river segment. The outside edge of many meanders displays evidence of erosion, with sand bars accreting on the inner edge of the meanders. A large segment of the river bottom below Down's Dam to Rocky Ford consists of hard limestone and limestone outcrops along the river banks occur in many areas. The bottom and banks in many places are also also covered by relict marine shells.

Near Interstate 75, there are a number of cottages and small subdivisions along the banks. Below I-75 there are only a few homes and commercial establishments. Between this river section and U.S. Highway 41, no development occurs along the river.

Just downstream from Snook Haven, the influence of brackish water on the river bank vegetation is evidenced by the occurrence of halophytic plants. Mangroves grow as far upstream as the mouth of Deer Prairie Creek. As the river approaches Charlotte Harbor, tidal marshes and mangroves become more extensive.

Downstream of US Highway 41, both shorelines of the river are developed. The river widens and is relatively shallow with a sandy bottom. Two small mangrove islands are the sites of bird rookeries. Limited development occurs along the western river bank to the Sarasota-Charlotte Line, in contrast to the eastern bank which contains several large, fully built subdivisions. Between the Sarasota/Charlotte County line and the El Jobean Bridge (County Road 771), most of the native landscape has been replaced with bulkheads and finger canals associated with residential development. Downriver from El Jobean, the river banks are relatively natural as they widen into Charlotte Harbor.

2.2 Physiography and Geology

Physiography

The Myakka River lies within two prominent physiographic regions, the Gulf Coastal Lowlands and the Desoto Plain. The watershed is part of the Manasota Basin and dominates the eastern and central portions of Manatee and Sarasota Counties, respectively. Most of the basin lies within the Gulf Coastal Lowlands (Joyner and

Sutcliffe 1976). The elevation at the river's headwaters is 35 m above sealevel.

The topography of the Myakka River watershed represents a series of elict marine terraces and is characterized as low flatland, with moderate to gentle slopes limited to the peripheral areas in the northern half of the watershed. The terrain is generally flat.

Geology

The surface and subsurface geology of the Myakka River basin are directly related to fluctuations in sea level. The rise and fall of sea level through geologic time resulted in the deposition of limestone and other sedimentary rocks.

The uppermost stratigraphic unit consists of undifferentiated deposits from 0-60 feet thick of the Holocene and Pleistocene eras. These are mostly fine to medium grained quartz sand underlain by marine terrace deposits of sand and marl, including clay, shell and peat deposits. The unit is underlain by the Caloosahatchee Marl, up to 20 feet thick, which consists of shallow marine deposits that include marl and shell beds, limestone and some phosphate. Next is the Bone Valley formation, 0-20 feet thick, which is a mostly non-marine deposit consisting of clay with lenses of quartz sand and terrestrial vertebrate fossils. It also includes some marine fossil fragments, phosphate nodules and quartz pebbles. Below the Bone Valley Formation is the Tamiami Formation, 0-50 feet thick, which is a shallow marine deposit consisting of sandy calcareous clay, sandstone, limestone and some phosphate. Deeper are the Hawthorn Formation (200-400 feet thick) and the Tampa Limestone (150-300 feet thick). Both are marine deposits. Below the Tampa Limestone are the Suwanee Limestone (120-420 feet thick), Ocala Limestone (300-400 feet thick), Avon Park Limestone (600-700 feet thick) and the Lake City Limestone (950 feet thick).

Soils

The soils that occur in the portion of the Myakka River basin lying within the DeSoto Plain are characterized as nearly level, poorly drained, sandy soils, with weakly cemented sandy subsoil and poorly drained sandy soils throughout. The soils at the river's headwaters are nearly level sandy soils with a dark colored subsoil. Most are poorly drained and either weakly or not cemented in the subsoil. Delray-Floridana soils are found along the flood plains of tributaries to the Myakka River in this area. These are nearly level, very poorly drained sandy soils mainly in depressions with loamy subsoil. Felda-Wabasso soils, nearly level, poorly drained soils with loamy or dark sandy subsoils, occur in the floodplain of the river. Nearly level, very poorly drained organic soils are found in Tatum Sawgrass Swamp (Hyde and Huckle 1983).

Flatwoods soils comprise the majority of the Myakka River basin in

Sarasota County. These are the EauGallie-Myakka-Holopaw-Pineda soils. They are nearly level, poorly drained to very poorly drained and have a sandy surface layer and sandy and loamy subsoils (Hyde et al. 1991).

Felda-Holopaw-Delray soils occur along some tributaries to the Myakka River. These are nearly level, very poorly drained, sandy soils with a loamy subsoil. Delray-Felda-Pompano soils and Wabasso-Eaugallie-Felda soils border most of the Myakka River itself. These are nearly level, poorly drained, and very poorly drained sandy soils that may have a loamy subsoil. Downstream of these soils to the river mouth, Kesson-Wulfert soils border the Myakka River. These are nearly level very poorly drained sandy and organic soils in mangrove swamps and tidal marshes (Henderson 1984).

2.3 Water Resources

Hydrogeology

The hydrogeologic units in the Myakka River watershed consists, in general, of the surficial aquifer, two intermediate aquifers, and confining units, and the Floridan aquifer. The surficial aquifer is contained within the surface deposits, the Caloosahatchee Marl and the Bone Valley formation. The intermediate aquifers are contained in the Tamiami and Hawthorn Formations and parts of the Tampa Limestone. The Floridan aquifer includes part or all of the Tampa Limestone, Suwanne Limestone, Ocala Limestone, and the Avon Park Limestone (Joyner and Sutcliffe 1976).

The water table is approximately within 5 feet of land surface. Fluctuations in the water table are seasonal. Lowest water table levels typically occur during May or June and the highest water table levels occur in September or October. The quality of water in the surficial and intermediate aquifers is usually acceptable for potable water except near the coast. Water from the Floridan aquifer is too mineralized for potable water use and is used primarily for agricultural purposes.

Surface Waters

The surface waters of the Myakka River basin include the Myakka River and its tributaries, the Upper and Lower Myakka Lakes, Little Salt and Warm Mineral springs and numerous small depressional wetlands. Density of isolated wetlands in one typical upland area in the watershed is $70/km^2$ (Winchester et al. 1985).

Three critical aspects of the value of the Myakka River as a water resource are the water quality, the quantity of discharge, and the timing of the discharge. These three variables are not only important to the continued health of the Myakka River, but vital to the health of the Charlotte Harbor estuary as well.

Water Quality. The Myakka River generally has good water quality. The Myakka River is designated as Class I waters (potable) from the Myakka City through the Upper and Lower Myakka Lakes to Manhattan Farms. The Florida Wild and Scenic River segment in Sarasota County is an Outstanding Florida Water. From Manhattan Farms (north of the Interstate 75 crossing over the river) to North Port and upstream of Myakka City, the river is designated as Class III, i.e. suitable for recreation, propagaition and maintenance of healthy populations of fish and wildlife. From North Port south to Charlotte Harbor the water is Class II, i.e. suitable for shellfish propagation or harvesting. Big Slough is Class I waters down to the dam at US 41. The Charlotte County reach of the Myakka River is a Florida Aquatic Preserve.

A small portion of the river above Myakka City is considered to have fair water quality, partially meeting the designated use. Two major tributaries of the Myakka River, Deer Prairie Creek and Big Slough are also considered to have fair water quality partially meeting the designated uses. The lower river just upstream of Charlotte Harbor is considered to have fair water quality, partially meeting its designated use (Hand et al, 1988).

Upper Myakka Lake experiences water quality problems, primarily from high nutrient levels and seasonally low dissolved oxygen concentrations, and a seasonal infestation of exotic aquatic vegetation.

Two major springs exist within the Myakka River basin, Little Salt Springs and Warm Mineral Springs. These springs discharge to the Myakka River through tributaries. The water discharged from Warm Mineral Springs and Little Salt Springs is highly saline and is the result of upward migration of water from the Floridan aquifer.

Big Slough (Myakkahatchee Creek) is a main tributary of the Myakka River. It is a Class I water and supplies potable water to North Port and port of Port Charlotte. The lower few miles are designated Class III waters.

The quality of tidal river waters is influenced by the Charlotte County portion of the river, because river discharge is generally low and tidal exchange of water, salt and organisms is significant.

Water quality sampling and analysis were a major part of the

Myakka River Basin Project. Water quality is discussed in detail in later sections of this report.

Water Quantity. The base flow of streams in the Myakka River basin is principally controlled by the following factors: permeability and porosity of the surficial deposits and the interrelations among these deposits and older underlying beds; the relative altitudes of the water table and the channel bottom; soil moisture conditions and evapotranspiration rates; man-induced alterations to drainage systems and water use; and the time distribution of precipitation. The streamflow of the Myakka River is highly variable. Highest mean flows occur from June through October, with a weak secondary peak January through March. Lowest flows occur in May (Duever and McCollum 1990).

All non-tidal reaches of streams cease natural flows during droughts, and many go dry during most years. During the dry season, drainage from agricultural lands may contribute between 10 and 60 percent of stream discharge. Near zero flow has occurred in the Myakka River for periods of up to 6 months, and even in normal water years the river will experience near zero flow for approximately 2 months.

The average annual rainfall in the Myakka River basin is 56 inches, approximately 60 percent of which occurs from June to September. Because there is a lag time of river discharge following rains, the maximum river discharge generally occurs from July to October.

Average discharge of the Myakka River to Charlotte Harbor is 7.2 m^3 per second which reflects no-flow conditions for many days in some areas. The maximum recorded discharge is 246 m^3 per second. This is much lower than the discharge from the Peace and Caloosahatchee Rivers into Charlotte Harbor. Analysis of water flows at two sites on the Myakka River and three sites on rivers in adjacent watersheds has shown no major changes in mean, meaximum, or minimum flows over periods of record ranging from five to 52 years (Duever and McCollum 1990).

Myakka River Subbasins

For this report, subbasins were combined to constitute eight major drainage areas that were sampled for water quality and water flow (Table 2-1). The subbasins are Myakka Head/Wingate Creek, Ogleby Creek, Owen Creek, Tatum Sawgrass, Howard Creek, Clay Gully, Mossy Island Slough, Deer Prairie Slough, Myakkahatchee Creek, Middle River, and Lower River (Figure 2-2).

Myakka Head B110. This subbasin contains the headwaters of the

Table 2-1 - Subbasins and associated drainages

Sampling Station	Major Basin	Minor Basin(s)
B110	Myakka Head	Johnson Creek
		Wingate Creek
		Coker Creek
		Taylor Creek
		Sand Slough
		Young Creek
		Long Creek
		Boggy Creek
		Ogleby Creek
		Maple Creek
		Owen Branch
		Sand Branch
		Owen Creek
		Three (3) unnamed drainage areas
B120	Howard Creek	Howard Creek
B130	Tatum Sawgrass	Tatum Sawgrass Slough
		Sardis Branch
		One (1) unnamed drainage area
B140	Upper Lake	Indian Creek
		Clay Gully
		Mossy Island Slough
		Howard Creek
		One (1) unnamed drainage area
B150	Upper Big Slough	Bud Slough
		Wildcat Slough
B160	Lower Lake	Fish Camp Drain
B170	Deer Prairie Creek	Deer Pairie Slough
B180	Lower Big Slough	Mud Lake Slough
		Big Slough

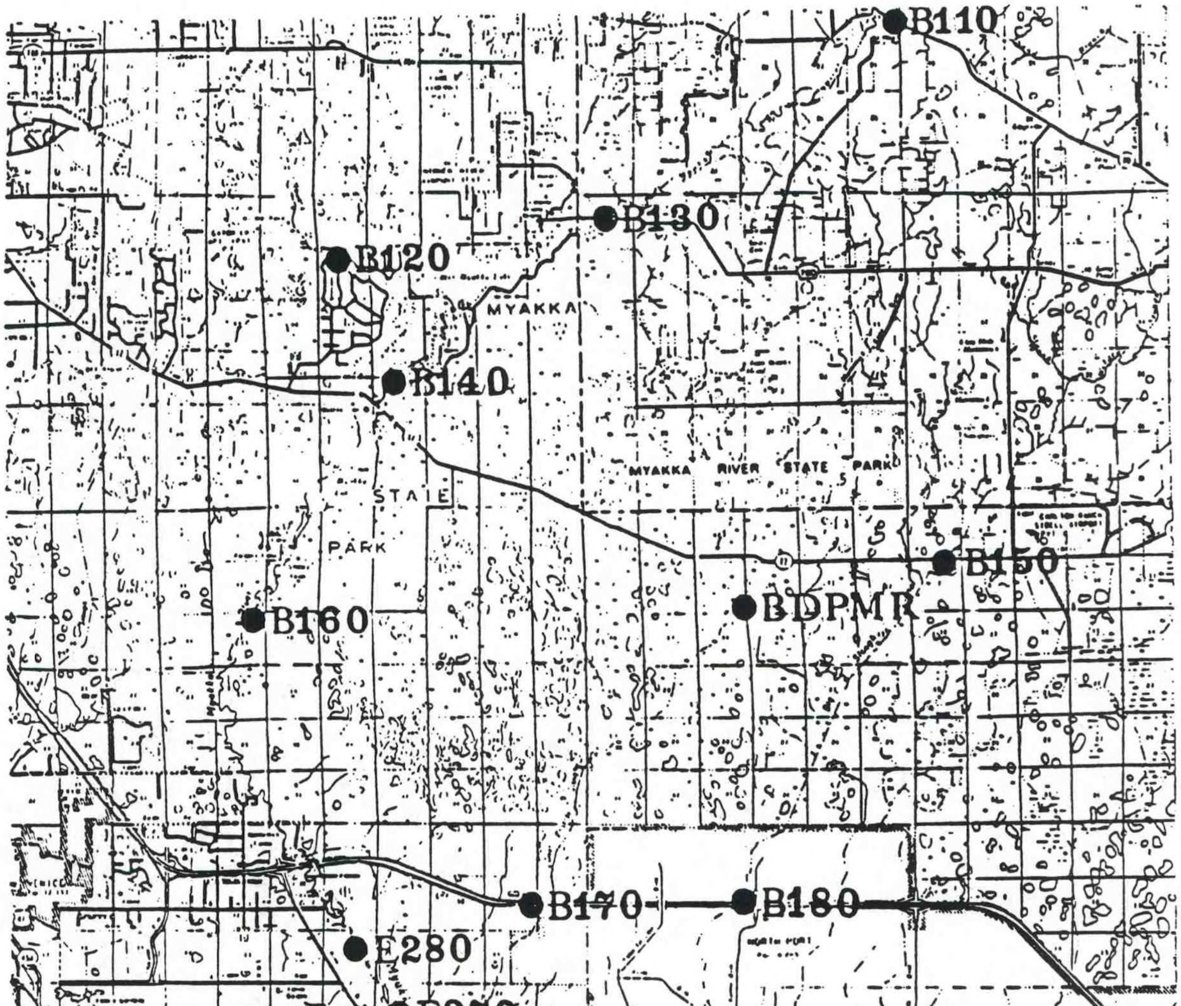

Figure 2-2 - Myakka River Basin Sampling Sites

River. It drains 323.75 km^2, in eastern Manatee County and western Hardee County.
Howard Creek B120. This subbasin drains 51.8 km^2 in area. It discharges into the western tip of Upper Myakka Lake. More than 90% of this subbasin has been drained and cleared.

Tatum Sawgrass B130. The subbasin drains 103.6 km^2 . It contains Tatum Sawgrass Marsh, a large freshwater wetland. The installation of dikes and ditches for agricultural purposes reduced its storage capacity and increased the magnitude and frequency of flood events downstream (Hammet et al. 1978).

Upper Lake B140. This subbasin is 114 km^2 and includes parts of northeastern Sarasota County and the northern portion of the State Park. Much of this basin is publicly owned. Historically, it had two outfalls, the Myakka River and Vanderipe Slough. In the 1930's the outfall to Vanderipe Slough was blocked with an earthen dam. Low density (1 unit per 5 acres) residential use occupies the north and west of Upper Lake. Agricultural lands are also included.

Upper Big Slough B150. The gaging station at State Road 72 represents a drainage area of 94.5 km^2 for this major tributary to the Myakka River. Primary land use is agriculture.

Lower Lake B160. This is the fourth major depression in the watershed. It is a shallow depression, similar to Upper Lake. It contains what appears to be a collapsed sinkhole, referred to as Deep Hole, which has a diameter of 91.5 meters (m) and depth of 45 to 55 m.

Deer Prairie Creek B170. The area drained is 86 km^2 in central Sarasota County. The creek drains the T. Mabry Carlton Jr. Memorial Reserve, the wastern portion of the Myakka River State Park, and agricultural operations. An earthen dam was constructed to prohibit brackish water from moving upstream.

Lower Big Slough (Myakkahatchee Creek) B180. The gaging station at Interstate Highway 75 represents a drainage area of 130.3 km^2. Big Slough has been dredged to provide more efficient transport of water to North Port which uses this tributary as a source of drinking water.

2.4 Land Use

The portion of the Myakka River basin that is located in Manatee County is used primarily for ranching and and other agricultural operations and is not intensively developed. During 1990, phosphate mining resumed near Wingate Creek and is expected to expand (Neal Parker, Planning Dept., Manatee County, personal communication).

In Sarasota County land use in the Myakka River basin is also primarily agricultural. Much of the land along the Myakka River is in public ownership. Myakka River State Park, the Carlton Reserve, the Central County Complex (formerly Walton Tract) are all adjacent to the river. Downstream of these tracts are low density residential developments and some commercial water-related establishments. South of Highway 41 there are intensively developed trailer parks, and waterfront development on both sides of the river.

Most hydrological alterations in the watershed were initiated between the early 1940s and early 1950s. Dredging and canal excavation have continued since that time (Duever and McCollum 1990).

2.5 Flora and Fauna

Natural vegetation in the Myakka River basin consists primarily of pine flatwoods interspersed with numerous wet prairies. Other communities in the Myakka River basin include mesic hammock, dry prairies, scrubby flatwoods, freshwater wetlands, mangrove swamps, tidal marsh, and ruderal lands.

A total of 362 species of fishes, amphibians, reptiles, birds, and mammals have been recorded from the Myakka River basin (Layne 1978). These include 48 species of fresh water fish, twenty species of amphibians, 33 species of reptiles, probably 261 bird species, and 32 species of mammals.

A total of 37 animal species and 55 plant species listed by federal and state agencies as threatened, endangered, commercially exploited, or of special concern are known to occur or have a high probability of occuring in the basin (Table 2-2).

Pine Flatwoods

The pine flatwoods in the Myakka River basin are dominated by South Florida slash pine (*Pinus elliottii* var. *densa*), although longleaf pine (*Pinus palustris*) is found in some areas. Gallberry (*Ilex glabra*), saw palmetto (*Serenoa repens*), wire grass (*Aristida stricta*), and other fire tolerant shrubs and herbs are found in the understory. The abundance of wetlands within the pinelands provides additional food for many terrestrial species and habitat for aquatic and wetland species that require isolated wetlands to survive. Species that benefit from the proximity of open prairies to sparse stands of pine trees include osprey, bald eagle and red-tailed hawk, and bats such as the eastern yellow bat and evening bat. The opossum, armadillo, bobcat, gray fox, raccoon, and white-tailed deer occur in flatwoods. Other common residents include the rufous-sided

Table 2-2

Animals and Plants that Occur or Potentially Occur in the Myakka River Basin that are Listed as Endangered, Threatened, or of Special Concern

Animals

Scientific Name	Common Name	Listed by FNAI	FGFWFC	USFWS
Accipiter cooperi	Cooper's Hawk	s3		
Aimophila aestivalis	Bachman's Sparrow	s?		C2
Ajaia ajaja	Roseate Spoonbill	s2s3	SSC	
Alligator mississippiensis	American Alligator		SSC	TSA
Aramus guarauna pictus	Limpkin	s3	SSC	
Ardea herodias occidentalis	Great White Heron	s2		
Buteo brachyurus	Short-tailed Hawk	s3		
Casmerodius albus	Great Egret	s4	SSC?	
Drymarchon corais couperi	Eastern Indigo Snake		T	T
Egretta caerulea	Little Blue Heron	s4	SSC	
Egretta thula	Snowy Egret	s4	SSC	
Egretta tricolor	Tricolored Heron	s4	SSC	
Elanus caeruleus	Black-Shouldered Kite	s1s3		
Eudocimus albus	White Ibis	s4		
Falco columbarius	Merlin	s		
Falco peregrinus	Peregrine Falcon	s2	E	T
Falco sparverius paulus	Southeastern American Kestrel	s3?	T	C2
Felis concolor coryi	Florida panther	s1	E	E
Gopherus polyphemus	gopher tortoise		SSC	C2

Table 2-2 (Continued)

Animals

Scientific Name	Common Name	Listed by FNAI	FGFWFC	USFWS
Grus canadensis pratensis	Florida Sandhill Crane	s2s3	T	
Haliaeetus leucocephalus	Southern Bald Eagle	s2s3	T	E
Ixobrycmus exilie	Least Bittern	s4		
Laterallus jamaicensis	Black Rail	s3?		
Mustela frenata peninsulae	Florida weasel	s3?		C2
Mycteria americana	Wood Stork	s2	E	E
Neofiber alleni	Round-tailed muskrat	s3?		C2
Nyctanassa violacea	Yellow-Crowned Night-Heron	s3?		
Nycticorax nycticorax	Black-Crowned Night Heron	s3?		
Pandion haliaetus	Osprey	s3s4	SSC	
Pelecanus occidentalis	Eastern Brown Pelican	s3	SSC	
Picoides borealis	Red-cockaded Woodpecker	s2	T	E
Picoides villosus	Hairy Woodpecker	s3?		
Plegadis faleinellus	Glossy Ibis	s2		
Polyborus plancus	Crested Caracara	s2	T	T
Rana areolata	Gopher frog		SSC	
Sciurus niger shermani	Sherman's fox squirrel		SSC	C2
Ursus americanus floridanus	Florida black bear	s3	T	C2

Table 2-2 (Continued)

Plants

Scientific Name	Common Name	Listed by FNAI	FDA	USFWS
Acrostichum danaeifolium	giant leather fern		T	
Asclepias curtissii	Curtis' milkweed	S3	E	
Calopogon barbatus	bearded grass pink		T	
Calopogon multiflorus	many-flowered grass pink		T	
Calopogon pallidus	pale grass pink		T	
Calopogon toberosus	grass pink		T	
Ceratopteris pteridoides	water horn fern		T	
Encyclia tampensis	butterfly orchid		T	
Glandularia tampensis	Tampa vervain	S1	E	C1
Habenaria odontopetala	rein orchid		T	
Habenaria quinqueseta	long-horned orchid; Michaux's orchid		T	
Habenaria repens	creeping orchid; water spider orchid		T	
Harrisella filifornis	orchid		T	
Hexalectris spicata	crested coral root		E	
Hypolepis repens	Flakelet fern		T	
Ilex decidua	possum-haw, winterberry		T	
Isoetes flaccida	Florida quillwort		T	
Lilium catesbei	pine lily; catesby lily	S3	T	
Lobelia cardinalis	cardinal flower		T	

Table 2-2 (Continued)

Scientific Name	Common Name	Listed by FNAI	FDA	USFWS
Lycopodium alopecuroides	fox clubmoss; foxtail clubmoss		T	
Lycopodium appressum	southern clubmoss		T	
Lycopodium carolinianum	slender club moss		T	
Lycopodium cernuum	nodding club moss		T	
Lythrum flagellare	lowland loosestrife	S2S3		C2
Malaxis spicata	Florida adder's mouth		T	
Nephrolepis cordifolia	Boston fern		T	
Nymphaea jamesoniana	Sleeping-beauty water-lily	S2S3		
Ophioglossum crotalophoroides	Bulbous adder's tongue fern		T	
Osmunda regalis	royal fern		C	
Phlebodium aureum	golden polypody		T	
Platytheles quercaticola	None		T	
Polygala rugelii	big yellow milkwort		T	
Polypodium dispersum	polypody fern		T	
Polypodium plumula	Plume polypody fern		T	
Polypodium ptilodon	polypody fern		T	
Polystachya concreta	Pale-flowered polystachea		T	
Ponthieva racemosa	shadow-witch		T	

Table 2-2 (Continued)

Scientific Name	Common Name	Listed by FNAI	FGFWFC	USFWS
Psilotum nudum	Whisk fern; fork fern		T	
Pteroglossapsis ecristata	wild coco	S2	T	C2
Rhynchosia cinerea	brown-haired snoutbean	S3		3C
Sabal minor	dwarf palmetto; bluestem		T	
Salix floridana	Florida willow	S2	T	C2
Spiranthes odorata	fragrant ladies' tresses		T	
Spiranthes praecox	grass leaf ladies' tresses		T	
Spiranthes vernalis	spring ladies' tresses		T	
Thelypteris dentata	downy shield fern		T	
Thelypteris interrupta	Wilidenow's maiden fern		T	
Thelypteris palustris	marsh fern		T	
Tillandsia fasciculata	wild-ping; air plant		C	
Tillandsia setacea	wild-ping; air plant		T	
Tillandsia utriculata	giant wild-pipe; giant air plant		C	
Vittaria lineata	shoe-string fern		T	
Woodwardia areolata	netted chain fern		T	
Zephyranthes simpsonii	Simpson zephyr lily	S2S3	E	3C

Table 2-2 (Continued)

KEY

FNAI - Florida Natural Areas Inventory
- s1 - Critically imperiled because of extreme rarity or because of extreme vulnerability to extinction
- s2 - Imperiled because of rarity or vulnerability to extinction
- s3 - Either very rare and local or found locally in a restricted range
- s4 - Apparently secure within the state but may be rare in places

FGFWFC - Florida Game and Fresh Water Fish Commission
- E - Endangered
- T - Threatened
- SSC - Species of Special Concern

USFWS - United States Fish and Wildlife Service
- E - Endangered
- T - Threatened
- TSA - Threatened due to similarity of appearance
- C2 - Candidate for which information indicates listing is possibly appropriate, but for which not enough data are available to support listing at this time.

FDA - Florida Department of Agriculture and Consumer Services
- E - Endangered
- T - Threatened
- C - Commercially Exploited

towhee, cotton rat, brown-headed nuthatch, northern cardinal, box turtle, pine warbler, bobolink and pine snake. In the past, black bear was observed both in pinelands and in hammock.

Mesic and Hydric Hammock

Mesic and hydric hammocks occupy most of the Myakka River floodplain and occur as small stands adjacent to larger isolated wetlands. The overstory consists of slash pine, live oak (*Quercus virginiana*), laurel oak (*Quercus laurifolia*), cabbage palm (*Sabal palmetto*), and American elm (*Ulmus americana*) (Milligan 1990). In contrast to river hammocks elsewhere in the state, cypress (*Taxodium distichum*) does not occur naturally anywhere along the Myakka River corridor. Common understory species include buttonbush (*Cephalanthus occidentalis*), popash (*Fraxinus caroliniana*), water locust (*Gleditsia aquatica*), and willow (*Salix caroliniana*) (Milligan 1990). Mesic hammocks are distinguished from hydric hammocks by the lack of laurel oak and elm and by the presence of saw palmetto.

Canopy and understory species in the hammocks provide cover and mast for numerous species including the gray squirrel, fox squirrel, cotton mouse, wood duck, belted kingfisher, eastern mole, raccoon, green treefrog, wild turkey, and red-eyed vireo.

Dry Prairies

Dry prairies occupy soils and terrain that are similar to the pine flatwoods; however, they lack the overstory necessary to tree-dwelling vertebrates. These systems support the activities of fossorial animals such as the gopher tortoise, gopher frog, burrowing owl, and pocket gopher. The burrows of the gopher tortoise provide shelter from fires and desiccation for numerous commensals such as the eastern diamondback rattlesnake, eastern indigo snake, gopher frog, and Florida mouse. Other species which prefer to forage and/or nest in dry prairies include the sandhill crane, black racer, common nighthawk, peregrine falcon, and Audubon's crested caracara.

Scrubby Flatwoods

Well drained sandy soils with scrub vegetation are not extensive in the Myakka basin. These higher elevation flatwoods Wildlife species potentially occurring within this habitat type in the Myakka River basin include the grasshopper sparrow, vesper sparrow, prairie warbler and Florida scrub jay.

Freshwater Wetlands/Aquatic Habitat

Freshwater wetlands include swamps, wet prairies and marshes, and aquatic habitats such as lakes, ponds, Myakka River and its associated waters. These systems support species such as fish and frogs, toads, amphiumas, salamanders, aquatic turtles and snakes, West Indian manatee, otter, and birds such as loons, grebes, ducks, pelicans, herons, ibises, and ospreys. These species are completely dependent on standing water for at least part of their food base or reproductive stage.

The fish fauna is characterized by abundance of sun fishes (Centrarchidae) and top minnow (Cyprinodontidae). There are four species of shiners (Notropis), a genus that is very common in northern United States but becomes scarce in southern peninsular Florida (Layne 1978). *Notropis hyspelopterus* reaches the southern limit of its range in the Myakka River.

The dominant fish species in the tidal waters of the Myakka River are the bay anchovy (*Anchoa mitchilli*) and hogchoker (*Trinectes maculatus*) (Estevez et al. 1991). The tidal freshwater reach of the river was the nursery-ground for several species that are marine and estuarine as adults (Estevez et al. 1991).

A survey of the Myakka River conducted in 1989 and 1990 from Downs Dam to Snook Haven showed a total of 200 benthic macroinvertebrate taxa represented in the infaunal collections and 13 uniquely epifaunal taxa. Only 10 taxa were considered dominant, comprising at least 5% of each community during the study (Milligan 1990).

Chironomids accounted for 31% of all individuals collected during the study. *Corbicula manilensis*, an exotic clam was the most abundant organism encountered.

Densities and diversities of taxa decreased at all stations from April to September. In September the community at the station that was furthest downstream included many euryhaline taxa with a decline of oligochaetes and chironomids.

Milligan (1990) compared the sampling results to a classification scheme proposed to categorize the health of streams in Florida based on presence or absence of specific insect species or genera (Beck 1954). Of the 39 taxa in the classification, 10 taxa were collected during the study. The majority of these taxa were considered Class I organisms by Beck (1954), i.e. organisms that are intolerant of organic pollution. The abundance of Class I organisms throughout the study area indicate a fairly homogeneous community of clean water organisms.

Mangrove Swamps

Mangrove swamps are most conspicuous near the head of Myakka Bay. The upriver limit to red mangrove (*Rhizophora mangle*) is upstream of the mouth of Deer Prairie Creek, although newly rooted recruits are found further upstream (Estevez et al. 1990). Black and white mangroves (*Avicennia germinans, Laguncularia racemosa*) and buttonwood (*Conocarpus erecta*) are much more abundant in Charlotte County and decrease in occurrence and size upriver.

Mangroves play an important role as fish rookeries and nesting colonies. Mangrove swamps are also integral to the survival of strict habitat specialists such as the black-whiskered vireo, mangrove fox squirrel and mangrove cuckoo. Two mangrove islands located in the Myakka River near the Sarasota/Charlotte County line support large rookeries of a variety of wading birds, including the endangered wood stork.

Manatees occur in the lower portion of the Myakka River.

Tidal Marshes

Tidal marshes occur at and below river-mile 14 and extend downriver to the Sarasota-Charlotte County line and El Jobean. Black needlerush (*Juncus roemerianus*) is the most common species in these marshes. Bulrush (*Scirpus validus*) is an indicator of lower salinity, invading downstream during period of high river discharge and retreating upriver during drier periods (Estevez et al. 1990a).

Tidal marsh provides valuable foraging habitat for species of shorebirds such as gulls, terns, plovers, sandpipers, and rails. It is also good habitat for river rats, marsh rabbits, beach mice, raccoons, and alligators.

Ruderal Areas

Ruderal areas have been cleared of their historic natural vegetation and usually contain weedy and exotic species. They may provide suboptimal habitat for species typical of habitats historically located on these properties. The alteration of vegetative diversity and elimination of old-growth trees and snags reduce habitat value. Wildlife species that occur in these areas are readily adaptable to human presence and land alteration. Examples include the loggerhead shrike, raccoon, blue jay, European starling, cattle egret, muscovy duck, mourning dove, house sparrow and northern mockingbird. Exotic species often displace native species in altered habitats.

Myakka River Corridor.

The mosaic of habitat types situated throughout the Myakka River corridor provides food and cover for the life stages of numerous aquatic and terrestrial wildlife species. In addition, the river corridor provides access to many habitat types in adjacent properties that are vital to species that have large home ranges or that require a variety of habitats.

Exotic Plant Species.

Exotic plant species cover 36.7% of tidal river shorelines. Brazilian pepper (*Schinus terebinthefolius*) accounts for 93% of this coverage, with Australian pine (*Casuarina* spp.) accounting for the remaining exotic species coverage (Estevez et al. (1990b). Populations of Melaleuca (*Melaleuca quinquenervia*), Brazilian pepper, cattail (*Typha* spp.) have not attained significant levels in the Myakka River Basin.

Upper Myakka Lake is seasonally infested by hydrilla (*Hydrilla verticillata*). This submerged nuisance species has been controlled by treatment with the herbicide Sonar. Aquatic plant control is being done by the Southwest Florida Water Management District through funding from the Florida Department of Natural Resources and Sarasota County.

3.0 IMPACTS ON WATERSHED RESOURCES AND REGULATORY PROTECTION

3.1 Existing and Potential Impacts

The Myakka River basin influences the natural value of the river through filtration, storage, and discharge to the river system. Water is supplied through runoff from the land surface and the contribution of the cumulative inputs from tributaries and their associated subbasins. Activities in the basin that will affect the natural value of the river and the Charlotte Harbor estuary are described in this section.

Table 3-1 lists activities in the Myakka River Basin that can result in a variety of adverse effects on natural resources of the river and Charlotte Harbor.

Wetland filling, stormwater runoff from agricultural and urban land uses, phosphate mining, septic tank drainfields, wastewater discharge to surface water or poorly drained land, and land spreading of sludge can pollute surface water through excessive levels of nutrients, increased sediment load, and addition of toxic substances. Discharge from the Nu-Gulf phosphate mine in Manatee County drains into Wingate Creek and the Myakka River. This mine has applied for an expansion that will double its size (Neal Parker, Planning Department, Manatee County, personal communication).

Changes in timing and quantity of flow in the Myakka River and in the quantity of fresh water that discharges into the estuary can result from ground water pumping, surface water diversion, impoundments, ditching and excavation of canals.

The diking of wetlands and resultant loss of storage capacity, drainage canals which increase the rate at which stormwater runs off the surrounding land, and agricultural pumping for irrigation during the dry season increase freshwater discharge. Diversion channels (e.g. Blackburn Canal), withdrawal for public water supply, salinity barriers in Deer Prairie Creek and Big Slough, and water control structures at the outlet of Upper Myakka Lake and below the Lower Myakka Lake decrease freshwater discharge.

Increasing use of groundwater in the region is showing significant effects on aquifers that underlie the basin and the upstream watershed. Long term changes in the potentiometric surfaces of these aquifers may influence water supply to the river and the wetlands in the basin (Duever and McCollum 1990).

Land clearing for agricultural and non-agricultural uses, shoreline hardening with seawalls, riprap, and other installations directly reduce fishery and wildlife habitat and can result in water pollution and flow changes. Intensive recreational uses such as unrestricted boating and overfishing can also destroy habitat and

Table 3-1.

ACTIVITIES IN WATERSHED THAT AFFECT NATURAL RESOURCES OF MYAKKA RIVER AND CHARLOTTE HARBOR

Sources of Impacts	Inc Sediment	Inc N,P	Low O_2	Inc Toxics	Dec Instream Flow	Inc Rate of Flow	Timing of Flow Regime Changed	Wildlife Habitat Loss	Fisheries Habitat Loss
	Potential Effect on Resources								
Wetland Alteration	X	X	X	X	X	X	X	X	X
Agricultural Runoff	X	X	X	X		X	X		X
Phosphate Mining	X	X	X	X	X		X	X	X
Urban Runoff	X	X	X	X		X	X		X
Septic Tank Fields		X	X						X
Wastewater Discharge to Surface Water		X	X			X	X		X
Sludge Land Spreading	X	X	X	X					X
Ground Water Pumping					X		X	X	X
Surface Water Diversion					X		X	X	X
Ditching	X	X	X	X		X	X	X	X
Borrow Pits	X				X	X	X		X
Impoundment	X				X		X	X	X
Shoreline Hardening	X							X	X
Land Clearing, Ag	X	X	X			X	X	X	X
Land Clearing, Non-Ag	X	X	X			X	X	X	X
Intense Recreational Use				X				X	X

Table 3-2

AGENCIES WITH REGULATORY AUTHORITY OVER IMPACTS IN MYAKKA RIVER BASIN

	Regulatory Agencies					
Sources of Impacts	COE	EPA	DER	SWFWMD	DNR	COUNTIES
Wetland Alteration	X	X	X	X	X	X
Agricultural Runoff						
Phosphate Mining	X	X	X	X	X	X
Urban Runoff		X				X
*Septic Tank Fields						X
Wastewater Discharge			X			X
Sludge Land Spreading			X			X
Ground Water Pumping				X		X
Surface Water Diversion	X		X	X		X
Ditching				X	X	X
Borrow Pits						X
Impoundments	X		X		X	X
Shoreline Hardening	X		X		X	X
Land Clearing, Ag.						
Land Clearing, Non-Ag.						X
Intense Recreational Use					X	

COE = U.S. Corps of Engineers
EPA = U.S. Environmental Protection Agency
DER = Florida Department of Environmental Regulation
SWFWMD = Southwest Florida Water Management District
DNR = Florida Department of Natural Resources

*The Department of Health and Rehabilitative Services is also involved in septic tank permitting from a human health standpoint.

Table 3-3

AGENCIES WITH ADVISORY AUTHORITY OVER IMPACTS IN MYAKKA RIVER BASIN

Sources of Impacts	Advisory Agencies				
	NMFS	FWS	SCS	GFC	MRCC
Wetland Alteration	X	X	X	X	X
Agricultural Runoff			X		X
Phosphate Mining		X		X	X
Urban Runoff					X
Septic Tank Fields					X
Wastewater Discharge to Surface Water					X
Sludge Land Spreading					X
Ground Water Pumping					X
Surface Water Diversion			X		X
Ditching			X		X
Borrow Pits					X
Impoundments			X		X
Shoreline Hardening					X
Land Clearing, Ag			X		X
Land Clearing, Non-Ag					X
Intense Recreational Use					X

NMFS - National Marine Fisheries Service
FWS - Fish and Wildlife Service
SCS - Soil Conservation Service
GFC - Florida Game and Fresh Water Fish Commission
MRCC - Myakka River Coordinating Council

reduce species populations.

Hardened shoreline (bulkhead and rip-rap) in the tidal portion of the river in Sarasota County totals 7.6 miles and comprises 7.9% of the total county shoreline (96.7 miles) in the tidal portion of the river. Most of the hardened shoreline is downstream of U.S. Highway 41 (Estevez et al 1990b).

In Charlotte County there are 10.8 miles of hardened shoreline which is 20.9 percent of the total county shoreline in the tidal river. A total of 70 storm drains was mapped, of which 70 percent occur in Charlotte County. Ramps and docks were not tabulated, but are much more numerous in Charlotte County than in Sarasota County (Estevez et al 1990b).

Gosselink et al. 1990), Fernald and Patton (1984), and Clark (1974) are comprehensive reports of how human activities in watersheds adversely affect rivers, wetlands, and estuaries. Priede.Sedgwick (1983), Deuver and McCollum 1990, Hunter Services, Inc. (1990) are just a few of many studies that describe impacts that are specific to the Myakka River watershed.

3.2 Regulatory and Advisory Authorities

Table 3-2 and 3-3 lists activities which impact the natural resources of the Myakka River and its estuary and the major regulatory and advisory authorities, respectively, that have jurisdiction over those activities. The authorities are described in this section. Advisory authorities are defined as those agencies that do not have authority to forbid activities, but do have an opportunity to review and recommend actions to be taken by regulatory authorities.

Regulatory Authorities

The United States Army Corps of Engineers (COE) issues permits for channel construction and improvements in navigable waterways. The COE is also authorized by Section 404 of the Clean Water Act of 1972 to regulate discharge of fill into waters of the United States which includes surface water bodies and most wetlands in the Myakka River basin. During review of permit applications, COE is supposed to consider water quality, wetland values, conservation, economics, general environmental concerns, fish and wildlife values, endangered and threatened species protection, and flood damage prevention. COE is also authorized, where it considers appropriate, to assess cumulative effects of activities in waters of the United States in considering whether to approve permits. Most agricultural and silvicultural activities are exempt from COE jurisdiction.

The U.S. General Accounting Office (1988) concluded after an investigation that COE often ignores recommendations by the National Marine Fisheries Service and the Fish and Wildlife Service, often does not consider practicable alternatives to filling wetlands, and rarely pursues monitoring or enforcement for unpermitted discharges. The Jacksonville District of the COE confirmed that the District does not consider cumulative impacts in making permit decisions, nor does it track its past performance (John Adams, Chief, Regulatory Division, personal communication, 1990).

U.S. Environmental Protection Agency (EPA). The EPA provides oversight to COE administration of the Clean Water Act. The EPA also issues permits to discharge pollutants into surface water under the National Pollutant Discharge Elimination System. Authority to issue permits for point source discharges, e.g. from a wastewater treatment plant or a power plant into surface water has been delegated to the Florida Department of Environmental Regulation.

A new EPA permitting program mandated by a 1987 amendment to the Clean Water Act requires National Pollutant Discharge Elimination System (NPDES) Permits for Stormwater Discharges from cities and counties with populations of 100,000 or more. The municipalities must show in the permit application that they have a comprehensive storm water quality management program intended to reduce the discharge of pollutants to the maximum extent practicable. They must also demonstrate a storm water quality monitoring program to assess the effectiveness of the management program. In addition, the EPA requires NPDES permits for stormwater discharges associated with industrial activities.

The municipalities must demonstrate adequate legal authority to control stormwater associated with the following pollutant sources: new commercial and residential land development; existing and new industrial activity and construction activity; illicit discharges; spills and dumping. Measures to reduce pollutants can include such measures as public street maintenance, programs to reduce pollutants from pesticide and fertilizer application, and wetland treatment systems.

Sarasota County and the City of North Port are preparing a permit application under this program. Once the 1990 Federal Census has been certified, Charlotte County and Manatee County will be required to obtain similar permits.

This program should significantly reduce pollution due to runoff from urban areas. Agricultural areas are not included in these NPDES permits, so pollution of the Myakka River, its tributaries, and Charlotte Harbor from rural stormwater runoff would not be reduced by the program.

Florida Department of Environmental Regulation (DER). The DER regulates water quality through control of pollutant discharges into surface waters and issues permits for dredge and fill activities in waters of the state which includes wetlands. Isolated wetlands are not protected by the State's dredge and fill permitting process. Many of DER's rules affect water quality and therefore indirectly influence the water quality in the Basin. Examples are rules that involve wastewater discharges and sludge spreading on agricultural lands. Dredge and fill of wetlands on agricultural lands are excluded from DER jurisdiction.

Florida Department of Community Affairs (DCA). The DCA oversees the Regional Planning Council's review of DRI applications and reviews local government comprehensive plans to ensure that the plans are consistent with the State Comprehensive Plan. This agency is not included in Table 3-2 because it indirectly influence the actions of local governments through oversight of comprehensive plans.

Florida Department of Natural Resources (DNR). The DNR manages the Myakka River State Park and affects the River through its management policies. The Division is authorized to cooperate with county governments in park and recreation matters and to negotiate interagency agreements with water management districts to manage district lands reserved for recreational purposes.

The DNR assisted in preparing the Myakka River Wild and Scenic River Management Plan that was required by the Myakka River Wild and Scenic Designation and Preservation Act. It took a strong lead in developing the Myakka River Rule enacted in July 1991, which authorizes DNR to review and issue permits for some activities on the River. The Rule regulates activities within the river segment and the bordering DER jurisdictional wetlands. This regulatory authority is new for DNR and the effectiveness of the rule remains to be seen.

Southwest Florida Water Management District (SWFWMD). SWFWMD has the authority to acquire land and to regulate surface water and stormwater systems and ground water consumption. They are one of the few agencies that regulate agricultural water systems and use. The Myakka River Basin is one of several river basins within the boundaries of the SWFWMD.

SWFWMD also acts as an advisory agency in designing and implementing a plan for Charlotte Harbor as part of the Surface Water Improvement and Management (SWIM) program. Implementation of the plan by local governments is voluntary.

SWFWMD has been authorized by the state legislature to develop a Model Water Conservation Landscape Code to be considered for adoption by local governments, if they deem the Code to be feasible. The Code has provisions that regulate water use, irrigation practices, minimize pesticide and fertilizer use, minimize impervious surfaces, and other practices that could reduce pollution and stormwater runoff and ground water use in urban areas.

Local Governments. Counties and other local governments have the most authority to regulate upland land uses and to coordinate upland and wetland land uses through control over land development regulation. Natural resources protection is often more influenced by land uses and development regulations controlled by local government than by state and federal permitting policies. Local governments can limit urban densities, regulate impervious surfaces, designate zoning, and set upland buffers that filter stormwater runoff and provide wildlife corridors. However, local government jurisdiction is limited only to the portion of a river basin that is included within its political boundaries, so that it cannot implement coordinated management throughout the basin.

Manatee County expects to retain agricultural land use in its portion of the Myakka River Basin. The Board of County Commissioners is considering a request by the Myakka River Coordinating Council to extend the Wild and Scenic River designation to the Myakka River in Manatee County (Karen Collins, Environmental Action Commission, personal communication). Manatee County would like to impose stricter standards on the new extension to the Nu-Gulf phosphate mine; however, restrictions that it tried to impose on the IMC phosphate mine in the Manatee River Basin are being challenged in court by IMC. (Neal Parker, Planning Department, personal communication).

Sarasota County comprehensive plan policies with regard to the Myakka River are as follows:

Conduct a baseline assessment of water quality in County coastal streams, bays, and estuaries including the Myakka River and its tributaries by 1991. Establish specific water quality parameters that will be improved by the year 2000. Policy 2.1.1

Continue to participate in local, state, or federal scientific modeling of Charlotte Harbor to determine the cumulative impact of development on the water resources of the Harbor. This study should also determine the impact of streamflows on the Harbor. Policy 3.1.1.

By 1990, enact ordinances and/or amend existing ordinances that protect the Myakka River and consider the results of ongoing study and management efforts by various organizations, agencies, and County Departments...Policy 5.2.4

Mining activities (phosphate) are not permitted or permissible under the County zoning regulations within designated areas of special environmental significance and/or sensitivity. The watersheds of...the Myakka River are designated areas of special environmental significance. Policy 5.2.5

Development proposals within the 100-year floodplain of the Myakka River shall provide reasonable assurance, prior to the approval of such development, that the development will not degrade the water quality and floodplain functions and values of the Myakka River. Policy 1.1.4

Most of the undeveloped land in private ownership in Sarasota County's portion of the watershed is zoned rural (one residence/5 acres). South of Interstate 75, some of this land is zoned semi-rural or one residence/2 acres). A comprehensive plan amendment to change the zoning from rural to semi-rural along River Road will be considered by the Board of County Commissioners.

The Carlton Reserve will be used as a source of potable water by pumping water from the Floridan aquifer and treating it. There have been proposals in the past to build a reservoir, use additional water from the Myakka River, and to apply treated wastewater to the Reserve. However, none of these activities are planned at present. An extensive hydrological and ecological monitoring program has been implemented on the Reserve to detect any effect on wetlands and groundwater levels from the pumping.

The City of North Port will consider the recommendations of a consultant who is conducting a watershed study of the Big Slough to determine measures necessary for both water quality and flood protection. Lots platted by General Development Corporation (GDC) as part of an approved development now abut the Myakka River. The City is negotiating with GDC so that they may revert to agricultural zoning (Jim McAllister, planning department, personal communication).

Charlotte County comprehensive plan policies that affect the Myakka River include:

..local government shall carefully evaluate proposals which would alter freshwater inflow to Charlotte County's coastal and estuarine waters. Policy 3.7

Local government shall pursue intergovernmental and interagency coordination as detailed in the Intergovernmental Coordination element to ensure that the waters...are protected from impacts which may occur to headwaters and upstream portions of water bodies which are not located within the County. Policy 3.8

Local government shall seek assistance....to develop a wildlife corridor plan for Charlotte County which ..implements procedures for intergovernmental coordination to connect natural reservations, preserves and conservation areas that are under different governmental jurisdictions. Policy 12.4

Charlotte County does allow direct discharge of stormwater runoff into tidal waters without attenuation. In addition most of the land that is in the Myakka River basin is platted into small parcels typically about 1/4 acre and zoned residential (Max Forgey, Planning Department, personal communication).

Advisory Authorities

U.S. Fish and Wildlife Service (FWS).
The FWS reviews COE dredge and fill permit applications, but their recommendations are advisory only. The FWS also administers the Endangered Species Act. Under Section 7 of the Act, Federal agencies must consult with the FWS whenever their actions jeopardize the continued existence of species listed under the act or result in the destruction or adverse modification of critical habitat of such species. However, the FWS recommendations are not mandatory and the final decision on how an action should proceed is left to the action agency.

Section 9 of the ESA makes it unlawful for a person to "take", i.e. harass, kill, harm, capture or collect, etc) a listed species. However, a landowner is allowed to engage in activities, such as habitat clearing, that "incidentally" take protected species. Since most listed species in the Myakka River basin are threatened by habitat destruction and not hunting or collecting, this provision does not adequately protect these species.

National Marine Fisheries Service NMFS. This agency, charged with protecting marine species, has the same advisory role with regard to permits as the FWS and the same weaknesses with regard to protection of species.

Soil Conservation Service (SCS). The SCS is not a regulatory body, but it is the only federal agency that exercises substantial influence over agricultural activities that affect wetlands and riparian sites. Their activities are mostly advisory, but eligibility for some federal programs that provide loans and grants to farmers depends upon compliance with Conservation Plans and Best Management Practices developed by the Soil Conservation Service.

Florida Game and Fresh Water Fish Commission (GFC). The GFC enforces freshwater fishing regulations and provides some protection for freshwater and upland faunal species listed by the state as endangered, threatened, and of special concern. The law protects listed species from being taken or directly killed, but it does not prevent clearing and development of habitat necessary for the survival of these species. Recommendations are provided to DER and to Regional Planning Councils for Development of Regional Impacts. These recommendations are not mandatory, but are usually followed to some degree.

Myakka River Coordinating Council (MRCC). The Myakka River Wild and Scenic Designation and Preservation Act required that a permanent council be established to provide interagency and intergovernmental coordination for management of the portion of the River that was designated as "wild and scenic." Representatives to the Council consist of one member each from the DER, Department of Transportation, GFC, DCA, Division of Forestry, Division of Archives, History and Records Management, Tampa Bay Regional Planning Council, SWFWMD, SWFRPC, Manatee County, Sarasota County, agricultural landowners, and environmentalists.

The Council meets every other month and has 29 members. Its purpose is to review and make recommendations on all proposals for amendments or modifications to the Act and to the Myakka River Management Plan, as well as on other matters related to protection of the River.

The large number of representatives has made it difficult for the Council to attain a quorum at its meetings, especially since the travel budget was cut for many of the state and regional representatives. Thus the Council often cannot conduct official business. The first part of its meetings are spent at work sessions in which the members separate into specific groups that discuss rulemaking, environmental impacts, and recreational use. The Council comes together after the work sessions and reviews issues as an official body. During this time matters affecting the River can be brought before the Council and other official business discussed.

At present the goals of the Council include extension of the Wild and Scenic River designation to the entire river and expansion of the protection zone defined in the Wild and Scenic River Management Plan to the entire watershed (Dr. Mary Jelks, personal communication).

The Council is advisory only, but does bring the attention of agencies and other interested parties to problems affecting the River through review of activities in the watershed that affect natural resources. The Council is also a forum for public education and support.

4.0 TECHNICAL ASSESSMENTS

4.1 Summary of Prior Project Technical Assessments

Lowrey, et.al. (1990) describe the first system-wide examination of the Myakka River Basin. In general, hydrologic conditions during the 1989 study were characterized as below normal. Historic rainfall records indicate that 1989 was the second consecutive year with rainfall below the long-term mean, and four of the six preceding years were below normal.

Annual chemical loads were determined for 1989 on continuous streamflow records and discharge-weighted mean chemical concentrations. Dissolved organic carbon was the only chemical constituent to exhibit a statistically significant relationship between discharge and concentration at all stations, and dissolved phosphate concentration was significantly related to discharge at six stations.

Windom (written communication, July 1991) in a third Quarterly Project Progress Report describes the transport of nutrients from the watershed. Exports of dissolved nutrients from the predominantly agricultural lands in the Howard Creek and Myakka Head sub-basins were reportedly similar. However, the greater abundance of swampy terrain reportedly contributed to a considerably higher export of particulate organic carbon from the Myakka Head sub-basin than from Howard Creek. Exports of nutrients from the Upper Big Slough and Deer Prairie Creek sub-basins were markedly lower (ranging from 20 to 66 percent) than from the Howard Creek and Myakka Head sub-basins. Windom attributes the lower relative export rates to less intensive land use within the Upper Big Slough and Deer Prairie Creek sub-basins.

Windom reports that the Upper and Lower Myakka Lakes retain nutrients and serve as "oxidation ponds" or "treatment plants." It is clear the "trap efficiency" of these lakes will diminish as lake bed sediments thicken with time and greater chemical loads will be transported further downstream from Lower Myakka Lake.

Windom also examined the mass balance of carbon, nitrogen, and phosphorus within the estuarine reach of the Myakka River. He concludes that about 67 percent of the dissolved organic carbon input to the estuary is oxidized and lost as CO_2 to the atmosphere. Approximately 74 percent of the annual input of the combined dissolved species of nitrogen is removed by primary production within the estuary. He concludes that phosphorus is not limiting and is recycled within the estuary.

Lowrey, et.al. (1990) reported that all measured metals concentrations in estuarine bed sediments collected during the 1989 study were low and fell within expected natural ranges. Ratios of total phosphorus and total nitrogen concentrations in sediments were higher than typical values found throughout the state and likely relate to regional deposits of phosphate rock. No anthropogenic organic compounds were found in excess of detection limits.

Using non-project County funds, a one-dimensional hydrologic model of the estuarine part of the Myakka River was developed by Mote Marine Laboratory. The model simulates the occurrence of saltwater within a 30-mile reach of the Myakka River upstream from its mouth. The model is driven by tidal harmonics specified at the mouth and by fresh-water inflows 30-miles upstream. The model simulates temporal variations in estuary water surface elevation, water velocity and salinity. Field observations of salinity were collected from August 1984 through July 1985 at three stations for model calibration purposes.

Model results indicate that under zero-flow conditions, as experienced during May 1985, average salinity concentrations of about 2 ppt (parts per thousand) may occur as far upstream as river mile 27. During August 1984 when streamflow averaged 150 cfs, the simulated 2-ppt salinity concentration occurred near river mile 10. It appears from a comparison of these extremes that the occurrence of saltwater in the estuary may be sensitive to a rather narrow range in fresh-water inflow.

4.2 Summary of Current Project Technical Assessments

The water quality data and stream discharge records used in assessment of historic data and for prediction of chemical loadings within the Myakka River Basin were derived from several sources. An inventory of basin data in electronic format was provided by the Florida Department of Environmental Regulation's (FDER's) Bureau of Surface Water Management from the STORET database during April 1992. A similar retrieval of water quality and discharge data was provided by the U.S. Geological Survey's (USGS) Tampa office. The USGS data for 1991 and 1992 are to be considered provisional until they are published in the annual water-data report. Additional sources of water quality data include Lowrey, et.al. (1990); Mote Marine Laboratory (1990); Dames & Moore and Environmental Research and Design (1990); and Hand, et.al. (1990).

The period of record, sampling frequency, and parametric coverage for these water quality sources varies. Also, quality assurance/quality control (QA/QC) sampling and analytical procedures and personnel associated with different monitoring efforts must be considered when reviewing Myakka River basin water quality data. In an attempt to compensate for the potential differences between data sets, measured concentrations of total phosphorus (TP), nitrogen (TN), carbon (TOC) and suspended solids (TSS) were utilized in loading calculations. These measurements provide a more complete database than selected dissolved and particulate analyzes. Total nutrient species and suspended solids measurement coverage also benefits from the ability to merge this expanded database with historic flows.

The gauging stations selected for data acquisition and use together with the type of records available are listed below. See Figure 4-1 for a map of Myakka River sampling sites used in the data evaluation.

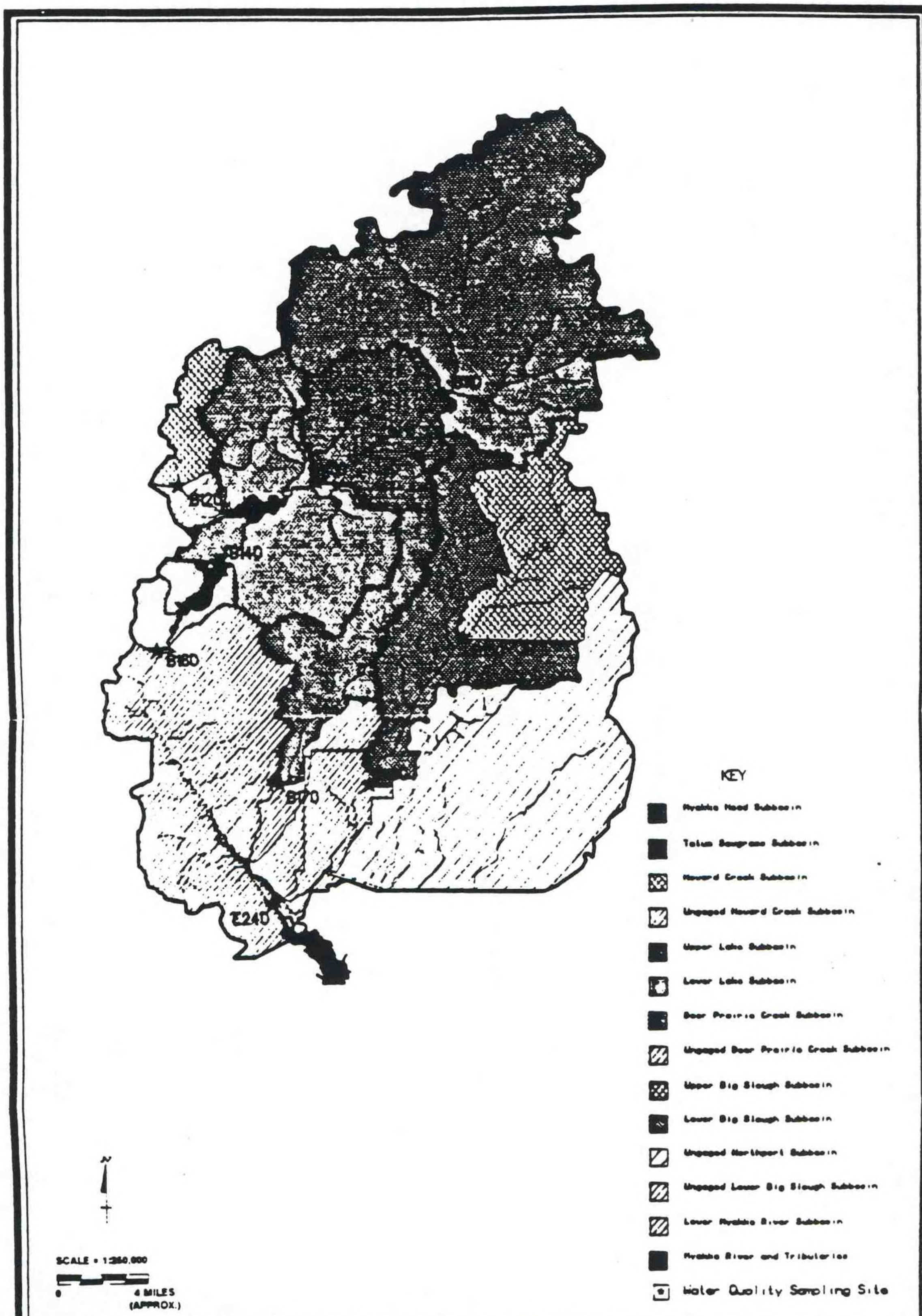

FIGURE 4-1
MYAKKA RIVER BASIN SAMPLING
SITES USED FOR DATA EVALUATION

ENVIRONMENTAL SCIENCE
& ENGINEERING, INC.

MYAKKA RIVER BASIN

USGS Gauging Station Number	County Water Quality Sampling Station Number	Station Name	Drainage Area, mi^2	Record Type[1]
02298608	B110	Myakka River at Myakka City	125.0	D, WQ
02298700	B130	Myakka River at S.R. 780 near Verna	165.0	D
02298760	B120	Howard Creek near Sarasota	20.0	D, WQ
02298830	B140	Myakka River near Sarasota	229.0	D, WQ
02298880	B160	Myakka River at control near Laurel	253.0	WQ
02298900		Myakka River near Laurel	258.0	WQ
02299160	B170	Deer Prairie Slough near N. Port Charlotte	33.2	D, WQ
02299410	B150	Big Slough Canal near Myakka City	36.5	D, WQ
02299455	B180	Big Slough Canal near N. Port Charlotte	86.2	D, WQ

[1] "D" denotes stream discharge; "WQ" denotes water quality.

Discharge and selected water quality data were categorized with regard to measurement frequency (e.g. daily, monthly). A similar tabulation of precipitation data for the Myakka River State Park received from the National Oceanographic and Atmospheric Association (NOAA) was performed. This exercise allowed a determination to be made of time frames common to the discharge, water quality and precipitation data sets used in later loading calculations and assessments. The common period of record selected for analysis is calendar years 1987 through 1991.

Runoff from only four of the nine study sub-basins was measured directly at gauging stations named Upper Myakka River at Myakka City, Howard Creek, Deer Prairie Slough, and Big Slough Canal at State Road 72. Hydrographs observed at four remaining gauging stations (three downstream Myakka River stations and Big Slough Canal at Northport) represent an integration of responses measured at upstream gauging stations and responses from ungaged intervening areas. Hydrographic features such as Upper and Lower Myakka Lakes significantly influenced hydrographs observed at the two most downstream Myakka River stations.

Hydrographs of monthly mean discharges and precipitation volumes were plotted for each station. Long-term average base flow was determined by inspecting each monthly discharge hydrograph and manually by "eye" selecting the typical minimum monthly discharge that occurred during the period of analysis. A monthly average direct runoff hydrograph was determined by subtracting the graphically-determined base flow from the observed monthly discharge hydrograph.

The selected approach for evaluating base flow differs from the base-flow analysis reported by Lowrey, et.al. (1990) in which two storm hydrographs observed in 1989 were analyzed on an hourly basis. The latter approach is more sensitive to antecedent soil-moisture conditions and may provide biased estimates of typical basin runoff characteristics. The selected approach integrates the basin response to extended periods of rainfall and drought and describes long-term average base-flow conditions.

The volume of direct runoff from a watershed is related to the volume of precipitation excess that occurs within the watershed. Precipitation excess is generally described as storm rainfall less the volume that infiltrates and ponds on the land surface. The volume of rainfall that infiltrates and ponds will (a) remain near land surface where it is removed from the watershed by evaporation and transpiration, (b) percolate downward and recharge the water table, and (c) move laterally through shallow soils and discharge into streams at later times in a way that sustains a base flow.

A modified form of the SCS method for estimating direct (storm) runoff will be used to evaluate Myakka River sub-basin contributions to total runoff within the GIS model described in Section 5.0 of this report. Direct runoff is estimated from the equation:

$$R = (P - E - 0.2S)^2/(P - E + 0.8S)$$

where

R = monthly direct runoff, in inches;
P = total monthly rainfall, in inches;
E = monthly evapotranspiration, in inches; and
S = monthly potential infiltration, in inches.

The SCS has related the potential infiltration, S, to a soil-cover dependent parameter referred to as a runoff curve number, CN, using the equation:

$$S = (1,000/CN) - 10 \quad .$$

The evapotranspiration term, E, is added to account for the appreciable volume of water lost from the watershed via evapotranspiration during a period of a month. The SCS method is typically applied on an hourly or daily time interval when losses such as evapotranspiration are minimal.

Each station's direct-runoff hydrograph for the period of analysis was compared to the corresponding monthly precipitation hyetograph reported for the Myakka State Park weather station. Nonlinear regression analysis was used to determine parameters related to the terms "E" and "S" in the above equation. The resultant equations are programmed in the GIS and allow the direct runoff, R, to be calculated for prescribed monthly values of total precipitation.

Median observed chemical concentrations were selected for inclusion in the GIS model described in Section 5.0 of this report. ESE computed summary statistics of the historic water quality data compiled from the literature. Preliminary analysis of the historic data indicate no statistically significant difference between median concentrations of TN, TP, and TOC observed at high and low flows.

Preliminary Chemical Loading Factors for GIS Model

	Total Concentration in mg/L				
Station Number	Organic Carbon	Phosphorus	Nitrogen	Suspended Solids	Source[1]
02298608	23.	0.31	1.0	6.0	S
02298880	21.	0.58	1.2	3.3	S, L
02298760	20.	2.0	0.1	6.0	L
02299160	20.	0.05	1.5	2.0	S, L
02299410	20.	0.23	1.1	10.0	S
02299455	20.	0.05	1.5	1.5	S, L

[1]Sources denoted by "S" for STORET and "L" for Lowrey, et.al. (1990)

No distinct relationships between stream discharge and the concentration of most water-quality parameters analyzed were reported by Lowrey, et. al (1990). Only dissolved organic carbon exhibited a statistically significant relationship. When a relationship between discharge and concentration is lacking, it is appropriate to calculate an "average" concentration, or measure of central tendency, for the period of analysis. Lowrey, et.al. (1990) describe five different weighting schemes and selected a discharge-weighted scheme to compute annual loads from sub-basins for the one-year period of analysis.

It is likely that differences between the quality of low and high flows actually exist. Mote Marine Laboratory (1990) reported significant relationships between discharge and concentrations of total phosphorus and dissolved ortho-phosphate at Big Slough at U.S. 72 and Big Slough at I-75. Long-term monitoring will be required to collect information over a wide range of flow conditions that allows for rigorous analyses of discharge-concentration relationships.

5.0 GEOGRAPHIC INFORMATION SYSTEM (GIS) AS A MANAGEMENT TOOL

5.1 Development of a GIS for the Myakka River Basin

A geographic information system (GIS) for the entire Myakka River Basin was developed by Environmental Science & Engineering, Inc. (ESE) for Sarasota County Natural Resources Department to act as a management tool for the basin. This GIS consists of over eleven different data themes that cover the entire geographic extent of the Myakka River Basin. PC ARC/INFO was the GIS software utilized by ESE to store, analyze, model and display the basin data. Almost all of the digital geographic data on the basin that were used for this project were generated by other governmental agencies in Florida and were already available in ARC/INFO format. ESE obtained several of the ARC/INFO generated GIS coverages through Sarasota County from the Southwest Florida Water Management District (SWFWMD) and from the Florida Department of Natural Resources. A few of the GIS data coverages were developed in-house by ESE to support the specific objectives of this project.

The following is a description of each Myakka River Basin GIS data coverage stored in PC ARC/INFO by ESE for this project and a summary of background information on the data:

a) **Land use/Land cover** - This data coverage was available through SWFWMD and was tiled into 1:24000 quad scale coverages. Land use/land cover was mapped to reflect Level II and Level III categories of the Florida Land Use and Cover Classification System (FLUCCS) published in 1985. This coverage reflects land use/land cover as of 1990.

b) **Detailed Soils** - This data coverage was available in part from SWFWMD. Soils were mapped at the level of detail seen in County Detailed Soil Surveys published by the Soil Conservation Service (SCS) and were obtained at 1:24000 quad scale coverage tiles. All soils data within the Myakka River Basin were available directly through SWFWMD with the exception of Sarasota County soils data which were obtained through the Sarasota County Planning Department. These data for Sarasota County were originally obtained from SWFWMD, however there is a more current version of the soils coverage for Sarasota County which is in the process of being revised and was not available through SWFWMD directly. The differences in soil classification for Sarasota County are minimal and would not affect the results of this GIS application.

c) **Basin and Sub-basin Boundaries** - USGS sub-basin boundaries within the Myakka River Basin were obtained from SWFWMD for the District as a whole. The Myakka River Basin itself was clipped out of the overall District-wide coverage.

d) **Topography** - Two foot and five foot topography data were partially available through SWFWMD. ESE did not receive all the necessary topography data from SWFWMD due to the fact that not all of the quads covering the Myakka River Basin had been compiled during the course of this project. Therefore, ESE made the decision to omit topography factors from the modeling performed as part of the GIS analyses.

e) Political Boundaries - County boundaries for the entire SWFWMD were obtained from that agency and clipped to the Myakka River Basin boundary. The Northport City boundary was originally developed by ESE using ARC/INFO on a prior Myakka River project and was obtained from ESE's prior client, FDNR.

f) General Hydrography - Hydrographic feature data for the Myakka River Basin were obtained from the FDNR and originally came from ESE's prior work on another Myakka River project. ESE had used ARC/INFO to clip USGS DLG hydrographic data to the Myakka River Basin.

g) Major Transportation Features - These roadway feature data were obtained from the FDNR and originally came from ESE's prior work on another Myakka River project. ESE had used ARC/INFO to clip USGS DLG transportation data to the Myakka River Basin.

h) River Mile Markers - This data coverage was originally developed by ESE on another Myakka River project for the FDNR using ARC/INFO. Mile markers are located every mile along the Myakka River within the basin with corresponding annotation.

i) Public Land Survey - This data coverage was obtained through SWFWMD for the entire District and was clipped to the Myakka River Basin by ESE. It includes section, township, and range lines and corresponding annotation.

j) Water Quality Monitoring Stations - This data coverage was generated by ESE using PC ARC/INFO. Published LAT/LON coordinates for the monitoring stations were input into a single coverage and transformed to a UTM coordinate projection consistent with other data coverages in the GIS. Some of the coordinate locations were in error according to their verbal descriptions of geographic location and were adjusted as needed using ARC/INFO's editing capabilities.

h) USGS Gauging Stations - This data coverage was generated by ESE using PC ARC/INFO. Published LAT/LON coordinates for the gauging stations were input into a single coverage and transformed to a UTM coordinate projection consistent with other data coverages in the GIS. Some of the coordinate locations were in error according to their verbal descriptions of geographic location and were adjusted as needed using ARC/INFO's editing capabilities.

i) Future Land Use/Land Cover - Future land use/land cover for a sub-basin of the Myakka River Basin was mapped by ESE and input into the GIS using PC ARC/INFO. This data coverage was used to demonstrate the modeling described in the next section.

All of the data acquired through SWFWMD were received by ESE on nine-track tape and were converted by ESE to 1/4 inch tape cartridge and DOS directory format for use in downloading the GIS data to PC ARC/INFO. PC ARC/INFO runs on a Compaq 386 PC at ESE offices. The UTM coordinate system was used by SWFWMD and was retained by ESE for use in registering all GIS coverages for the Myakka River Basin Project.

Data acquisition efforts were coordinated with the Sarasota County Stormwater Engineering Department to ensure cost-effective data procurement and data conversion. The County Stormwater Engineering Department will be using several of the same data coverages for a portion of the Myakka River Basin in their stormwater analyses using GIS.

5.2 GIS Based Hydrologic and Water Quality Model

ESE developed a GIS based computer model for estimating relative contributions of runoff and chemical loadings by sub-basin to the Myakka River. This GIS based model runs within PC ARC/INFO and directly draws input data from the existing GIS data coverages. This model was developed within a relatively short period of time to meet the objectives and time frame imposed by the project. It is a very generalized approach for assessing relative contributions by sub-basin only. However, the model was developed by ESE to be used on a continuing basis by the Sarasota County Natural Resources Department staff as a management tool.

The GIS based model was created through a set of SML (Simple Macro Language) programs within the PC ARC/INFO environment. This model was purposefully developed to be flexible enough for future refinements to assumptions and input data by County staff. For example, as new monitoring data or land use/land cover data become available to the County, they will be able to update the model SMLs or the data coverages that act as input to the model. Model assumptions regarding curve number values or precipitation, for example, can be altered by the County and the model rerun by staff. This will allow the County to use the GIS model for assessing future land use/land cover impacts on relative contributions of water quantity and quality by sub-basin. It will also permit the refinement of the model assumptions over time given additional years of monitoring data. With these periodic updates and refinements, the GIS based model will become more and more accurate as a predictive tool for assessing contributions of runoff and chemical loads by sub-basin.

The GIS model has two major components; the first calculates total estimated annual runoff by sub-basin using the Soil Conservation Service (SCS) TR55 method. The second component of the model then applies chemical loading coefficients to the sub-basin flow for several chemical parameters and calculates estimated total annual mass loadings of chemicals to the Myakka River by sub-basin. The methodologies used for this model are described below in more detail.

5.2.1 Sub-basin Runoff Calculation

The magnitude of sub-basin runoff is affected by numerous factors including drainage area, precipitation, topography, soil types, land cover, and land use. Drainage area and precipitation are expected to be the most influential factors because the others do not vary appreciably except within the urbanized area of North Port.

ESE decided to use the SCS method for estimating direct (storm) runoff in evaluating sub-basin contributions to total runoff from the Myakka River Basin. This modified SCS approach for estimating direct runoff is discussed in detail in Section 4.2 of this report. Direct runoff can be estimated for nine study sub-basins with USGS gauging stations located at their outlets. See Figure 5-1 for a map of the study sub-basins showing gaged and ungaged areas of the Myakka River Basin.

Within the GIS based model, the PC ARC/INFO GIS will reduce land use/land cover down to nineteen land cover categories used by the SCS method. The detailed soils coverage used as input is given an additional attribute called hydrologic soil group and the coverage is reduced down to a hydrologic soil group coverage with four possible attributes; hydrologic soil group A, B, C, or D. Hydrologic soil groups are assigned to detailed soil classifications by SCS and can be found in County soil surveys. PC ARC/INFO is then programmed to overlay the land cover and the hydrologic soil group to produce a coverage of unique cover-hydrologic group combinations. Curve number (CN) values are then assigned to each polygon on the overlay map which has a unique combination of land cover and hydrologic soil group.

The resultant cover-hydrologic soil group coverage with CN values is then overlayed with the river sub-basin boundaries. The GIS model is programmed to calculate a weighted CN for each polygon given the CN value of the polygon and based on that polygon's area as a percentage of the sub-basin area in which it falls. The weighted CN values for each sub-basin are then summed and divided by the total sub-basin area to determine an overall weighted CN value for each sub-basin.

Total annual runoff will then be calculated within the GIS using the following steps:

1) A macro program cycles through a file containing 12 monthly total precipitation records (P) in inches and calculating total and annual monthly runoff using steps 2 through 4. The County will have the capability to revise the precipitation file and evaluate basin response to alternative climatologic conditions.

2) Monthly direct runoff, in inches, is calculated on a sub-basin basis by substituting each tabulated value of P and the tabulated sub-basin weighted CN into the modified SCS equation described in Section 4.2. This calculated depth of water is multiplied by the sub-basin drainage area, divided by the appropriate days in the month, and converted to an equivalent volumetric rate expressed in cfs.

3) Base flow from the sub-basin, in cfs, is calculated by multiplying the normalized value of sub-basin base flow (i.e. cfs/mi^2) stored within the GIS and drainage area.

4) The monthly direct runoff and base flow are summed to form a monthly mean discharge. Annual average discharge is computed by calculating the numerical average of the 12 monthly mean discharges.

5.2.2 Sub-basin Chemical Loading Calculation

The GIS model is programmed to calculate the individual loadings associated with base flow and direct runoff. The total annual loading from the sub-basin is represented by the sum of base flow and direct runoff loadings as follows:

$$L_R = L_{DR} + L_{BF}$$

or,

$$L_R = K \; [C_{DR}Q_D + C_{BF}Q_B]$$

where:

L_R = Annual total load of chemical constituent, in pounds per year

L_{DR} = Annual direct runoff load, in pounds per year

L_{BF} = Base flow load, pounds per year

C_{DR} = Sub-basin loading factor associated with direct runoff, in mg/L

Q_D = Average annual direct runoff, in cfs

C_{BF} = Sub-basin loading factor associated with base flow, in mg/L

Q_B = Base flow, in cfs.

K = Conversion factor to convert from mixed units of milligram, liter, cubic foot, and second to pounds per year.

Sub-basin loadings are computed by the GIS model which multiplies the computed total annual runoff and prescribed sub-basin median constituent concentrations identified in Section 4.0 of this report. The County will have the ability to change the macro program that calculates chemical loadings. Future enhancements might include seasonal variations in loading factors and the incorporation of discharge-concentration relationships. Any future enhancement should be substantiated by analyses of hydrologic and water quality data collected from a basin water-quality monitoring program.

Predictions for future land uses are prepared using the following steps:

1) Assign a future land use and chemical loading factor associated with that land use to a mapped sub-basin and recompute the sub-basin curve number, CN.

2) Recompute annual total and direct runoff rates (base flow remains the same) using the four-step procedure described for calculating runoff.

3) Recompute total annual sub-basin loads for select chemical constituents using the load-computation procedure described above.

A recently completed analysis of stormwater analysis of the Tampa Bay watershed (Dames & Moore, 1990) may be referenced for suitable loading factors when field observations are unavailable to determine an appropriate chemical loading factor. Loading rates for TOC (total organic carbon) were not reported in the Tampa Bay watershed analysis. Therefore, predictive loading rates may be based on the assumption that concentrations of TOC runoff concentrations for different land uses may be estimated using ratios of TOC and TP reported by Lowrey, et.al (1990).

6.0 RECOMMENDATIONS FOR MANAGEMENT OF WATERSHED

The goals and recommendations listed in the following sections are an initial framework for analysis of existing data and establishment of a long-term management program. The complex relationship of water quality to discharge, precipitation and land use necessitates the use of GIS to adequately evaluate and calibrate monitoring goals and objectives. Monitoring and evaluation of monitoring results should be followed with action by appropriate agencies to protect river resources.

6.1 Water Quality Goals

Water quality goals should be consistent with standards published in Chapter 17-302, Florida Administrative Code. From the county line southwesterly through the Upper and Lower Myakka Lakes in Sarasota County to Manhattan Farms at the north line of Section 6, T39S, R20E the river is Class I (Potable Water Supplies). The river is further designated a Florida Outstanding Water within Myakka State Park in which "no degradation of water quality" is to be permitted. Downstream from the western line of section 35, T39S, R20E at sampling station E250 near Route 41, the river is Class II (Shellfish Propagation or Harvesting). Big Slough Canal is classified Class I south to U.S. 41. All other waters including the headwaters of the Myakka River in Manatee County are Class III (Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife).

Water Quality Monitoring

The following water quality monitoring program is recommended within the Myakka River watershed to ensure that continued sampling and analyses provide technically defensible data for use for assessment of changes and trends and for predictive capabilities.

1. A network of fixed-station water-quality sampling stations should be maintained to monitor long-term trends in water quality and variations in chemical loadings due to land use.

   The following existing stations should remain in operation:

02298608	Myakka River at Myakka City (Local ID B110, drainage area = 125 mi^2)
02298760	Howard Creek near Sarasota (Local ID B120, drainage area = 20.0 mi^2)
02298830	Myakka River near Sarasota (Local ID B140, drainage area = 229 mi^2)
02298880	Myakka River at control near Sarasota (Local ID B160, drainage area = 253 mi^2)
02299160	Deer Prairie Slough near North Port Charlotte (Local ID B170, drainage area = 33.2 mi^2)
02299455	Big Slough Canal near North Port Charlotte

(Local ID B180, drainage area 86.2 mi^2)

New Stations:

a) Wingate Creek (to monitor influence of Wingate Creek mine)
b) Big Slough Canal at U.S. 41 (to monitor total discharge and loadings form Big Slough basin and compare to Big Slough Canal near North Port Charlotte to quantify impacts of urbanization)
c) Non-recording stage stations on Upper and Lower Myakka Lakes

Stream Stations

Discharge (stage-discharge ratings) - Continuous
Physical: pH, temp, SC, DO, salinity (lower station), TSS
Chemical: Total & dissolved Kjeldahl, NH4, NO2+NO3; P, PO4; C - Monthly & extreme high/low
Metals (Pb, Hg) - Seasonally
Biota: Macroinvertebrates (Hester/Dendy artificial substrates) - Quarterly

Myakka Lake Stations (Upper and Lower)

Low & High Water Stages: Seasonal
Chemical: Chlorophyll-a; secchi depth; profile temp, pH, SC, DO; alkalinity - quarterly & extreme high/low events (>10-year exceedance frequency)
Physical: Bathymetry for nutrient budget and hydraulic residence time, every 5 to 10 years;
Biota: vegetation surveys FDNR, every other year
Management: Continuous log of aquatic plant control

2. Spray schedules and other types of aquatic plant control conducted by FDNR, SWFWMD, and county governments should be logged as part of a complete management plan. The ability to correlate such activities with potential changes in water-quality parameters such as dissolved oxygen, biochemical oxygen demand, and trace metals may assist with identifying favorable conditions for spray, drawdown, or other management techniques.

3. Upland land use requiring spray schedules for agricultural operations should be incorporated into the management scheme. Knowledge of pesticide, herbicide and fertilizer application schedules and types will assist with evaluating water quality and biological changes. This information will be useful in determining whether Best Management Practices are being followed. The Soil Conservation Service could assist with obtaining this information.

4. Where possible, utilize <u>in situ</u> measurements during monitoring efforts to the maximum extent possible to reduce costs and

provide data. Conductivity, dissolved oxygen, temperature, pH, Secchi depth, stage, salinity, and depth provide useful information. Where pH is greater than 7.0 or in estuarine waters where salinity is greater than 2 to 3 o/oo, metals and other parameters with minimal solubility may be considered for elimination. Sampling and analysis of sediments should be considered only if effects from factors such as bioturbation and siltation are minimal to ensure the general reproducibility of results.

5. Groundwater quality and station location information associated with the SWFWMD's ambient groundwater quality monitoring program should be incorporated in the GIS. Similarly, groundwater quality and water level data associated with monitoring requirements should also be included. Particular emphasis should be placed upon the surficial aquifer because of its direct hydraulic connection with surface waters within the basin.

6. Available biological data related to water quality, such as bacteriological analyses, macroinvertebrate indices and fishery statistics) should be included in the GIS database. A search of the FDER's Permanent Network Stations (PNS) may reveal historic data, as well as contacts at Florida's Game and Freshwater Fish Commission and Department of Natural Resources. Biological species diversity data published in the FDER's 1990 Florida Water Quality Assessment 305(b) Technical Appendix should be referenced with respect to similarly acquired information used to assess conditions and changes within the Myakka River basin.

7. As part of an integrated management system, the Florida Department of Natural Resources aquatic plant surveys should be included for periodic review and entry into the GIS. These surveys have historically provided acreages of coverage associated with vegetative species such as water hyacinth and cattail within the respective lower Myakka River and North Port Water Control District areas. Additional surveyed sites within the Myakka River watershed include Upper Myakka Lake and the area to the north. This information will provide a useful indication of water level, nutrient and other conditions and changes within the watershed.

8. All sampling and analytical efforts should be supported by a Florida Department of Environmental Regulation-approved Quality Assurance Plan, consistent with quality assurance procedures outlined in Chapter 17-160, Florida Administrative Code.

9. Consistent with Item No. 10, all water samples requiring acid preservation should receive this addition in the field and be

analyzed within recognized holding-times established in Part 136.3, 40 CFR.

10. Calcium carbonate hardness should be measured when trace metals are measured, since metals criteria have been recommended based upon the concentration of calcium carbonate hardness.

11. All water quality sampling conducted within tidally influenced regions of the Myakka River should specify tidal conditions during collection activities.

12. The data developed by these monitoring efforts should be reported with their respective STORET code numbers to allow evaluation and comparison of data having equal units of measurement. The need to compare like data during evaluation of trends or loading calculations necessitates reproducible sampling and analytical procedures.

13. All monitoring data should be entered into a GIS for easy retrieval. These data may then be reviewed on a routine schedule (e.g., quarterly) to evaluate both spatial and temporal trends. This database will also allow assessment of water quality changes with respect to varying land use characteristics.

14. An annual review of parametric coverage is recommended to calibrate monitoring efforts. This exercise may focus on identification of key indicator parameters associated with specific land use (e.g., pesticides with agriculture), or limiting nutrients which favor eutrophication (e.g., nitrates).

Water Quality Management

Management action need not wait for the results of monitoring studies to minimize and control known major causes of water quality degradation. These include stormwater runoff from agricultural and urban areas, wastewater discharge, and shoreline and wetland alterations. Efforts of local government to minimize stormwater runoff and to upgrade wastewater treatment from septic tanks and package plants to advanced wastewater treatment facilities should continue. Reclaimed water use to conserve potable water and to dispose of wastewater should be expedited with assistance from state and federal programs. GIS analyses can be used to monitor the results of corrective actions and to prioritize preventive or remedial measures.

6.2 Freshwater Flow Goals

A significant change in freshwater inflow in the Myakka River would alter salinity patterns in the tidal reach, which would in turn affect vegetation and faunal communities in the river and at its junction with Charlotte Harbor. The mean freshwater inflow at the upstream end of the tidal reach is about 340 cubic feet per second (cfs), but the median inflow is about 100 cfs; this indicates very high inflow for short periods of time and low inflow most of the time. There is a 20 percent chance that there will be no freshwater inflow in the upstream end of the tidal reach for 90 consecutive days in any year (Hammett 1989). Obviously the location in the river of transition from freshwater to saltwater varies greatly depending upon the amount of inflow and the tidal conditions.

Changes in salinity levels and in the duration and frequency of atypical levels can cause long-term detrimental changes in the river's natural resources. Although most of the recent studies of salinity in the Myakka River were prompted by proposals to use the river to supply drinking water for Sarasota County, changes in inflow could also result from other human activities that divert or increase watershed drainage. A rise in sea level could also result in salinity changes in the Myakka River.

The tidal reach of the Myakka River extends more than 25 miles upstream (Hammett 1989). The farthest upstream location of the saltwater-freshwater interface is typically at river mile 14, or about three miles upstream from U.S. Highway 41. About 10% of the time, the farthest incursion is downstream from river mile 10.6, and about 10% of the time it is upstream from river mile 19.3 (Hammett 1989).

The width of mangrove forests and tidal marshes decreases in proportion to salinity. These communities are displaced near Big Bend, the most downstream meander in the Myakka River (approximately river mile 16.5). Soil characteristics also change here from "sandy alluvial" to "tidal marsh". [Soil transition to tidal marsh in rivers may prove to be a marker that correlates with historic long-term salinity transitions (Estevez et al. 1990a)].

Mangroves dominate the lower river, salt marshes the central reach,and tidal freshwater marshes are upstream of the salt marshes (Estevez et al. 1990a). The occurrence of tidal freshwater wetlands coincides with the reach upstream between river miles 14.2 and 16.2.

Management goals should be to maintain the range of freshwater flow conditions that best meet requirements of the species in the river. Management action should be to use the best models available to project freshwater flow changes due to proposed human activities that influence flow. Additionally, indicators of long-term changes being met. Two and possibly three types of indicators are recommended to detect deleterious changes in fresh water flow.

Monitoring of Freshwater Flow

1. Changes in shoreline wetlands. Salinity shifts to upstream would eliminate tidal fresh water marsh because shoreline hammock limits upriver migration. Changes in saltwater marsh vegetation and in distribution and abundance of nuisance species such as cattail and Brazilian pepper would also occur. Site-intensive field monitoring of distribution and abundance of mangroves, nuisance species, submerged aquatic and emergent marsh vegetation should be performed in the river segment between U.S. Highway 41 and Big Bend (Estevez et al.1990a).

Aerial photography should be examined for the entire tidal river and ground-truthed on a recurring five year basis to identify long-term trends.

2. Permanent continuous conductivity recorders should be installed in the river at U.S. Highway 41, Big Bend, and at the Border Road bridge. These locations, 11.8, 16.2, and 21 river miles, respectively, are key saltwater-freshwater transitional sites (Estevez et al. 1990a). Analysis and comparison of data from these recorders could reveal changes in salinity regimes over time.

3. Larval and juvenile fish and benthic infauna have been described for the tidal reach of the Myakka River (Estevez et al. 1991, Milligan 1990). Many fish and macroinvertebrates have distinct salinity and habitat requirements. Suitable indicator species could be selected for quantitative studies to monitor for changes in aquatic communities in the river. Browder (1987) suggested the hogchoker as an indicator of the river's health, although seasonal variation in density due to spawning periodicity would need to be considered.

Freshwater Flow Management

1. Consumptive use (defined as the difference between water use and return flow to the river or tributaries) of surface water or shallow groundwater should be minimized to lessen the probability of upstream migration of the saltwater/freshwater interface within the estuarine portion of the Myakka River.

2. Consumptive use permit withdrawals for irrigation and potable use should be noted on the GIS for possible use when assessing wetlands impacts and altered streamflows.

3. The 100-year flood prone area of the Myakka River as identified by FEMA and delineated jurisdictional wetlands should be incorporated in the GIS. The information may be used to assess impacts associated with proposed development or

land use changes.

4. Precipitation data within the Myakka River watershed should be incorporated into the GIS to allow water quality/quantity budget analyses to be performed.

5. Stage-discharge ratings should be established at all USGS stream-gaging and water quality monitoring stations which currently lack these data. This background information is critical to the effective management of the Myakka River watershed, ranging from evaluation of pollutant loadings to assessment of development impacts. At tide-affected stations or locations where stable ratings do not exist, such as Big Slough Canal downstream from U.S. 41, alternative means of gaging such as electromagnetic or acoustic velocity meters should be installed.

6.3 Land Use Recommendations

GIS based analyses can be used to predict the effects of various land uses in the subbasins on water quality and flow and on species that use the Myakka River. Land use and zoning recommendations for the subbasins can be based on these analyses. The GIS database should be kept current on consumptive use, wetland alteration, NPDES, reclamation and mitigation efforts, and other permitting and monitoring data, because land use recommendations can change as present land uses are altered.

6.4 Land Acquisition Recommendations

Lands that are especially high in resource value or are important to maintaining river water quality are best protected by public acquisition. They can then be managed or restored to natural state. Existing publicly owned lands in the Myakka River basin and lands which are under consideration for acquisition by the Southwest Florida Water Management District are shown in Figure 6-1. These lands and additional lands that are recommended for acquisition are discussed by subbasin in this section.

Myakka Head

Flatford Swamp, primarily hardwood hammock, was recently purchased under SWFWMD's Save Our Rivers program. Total acreage of the site is 2,357 acres. This is the northernmost large depression in the Myakka River drainage. An expansion of the preserve that will provide a buffer for the swamp and additional land along Ogleby Creek, a tributary has been approved for acquisition by SWFWMD.

Upper Lake and Lower Lake

These subbasins in Sarasota County are predominantly in public ownership. They include Myakka River State Park, the Carlton

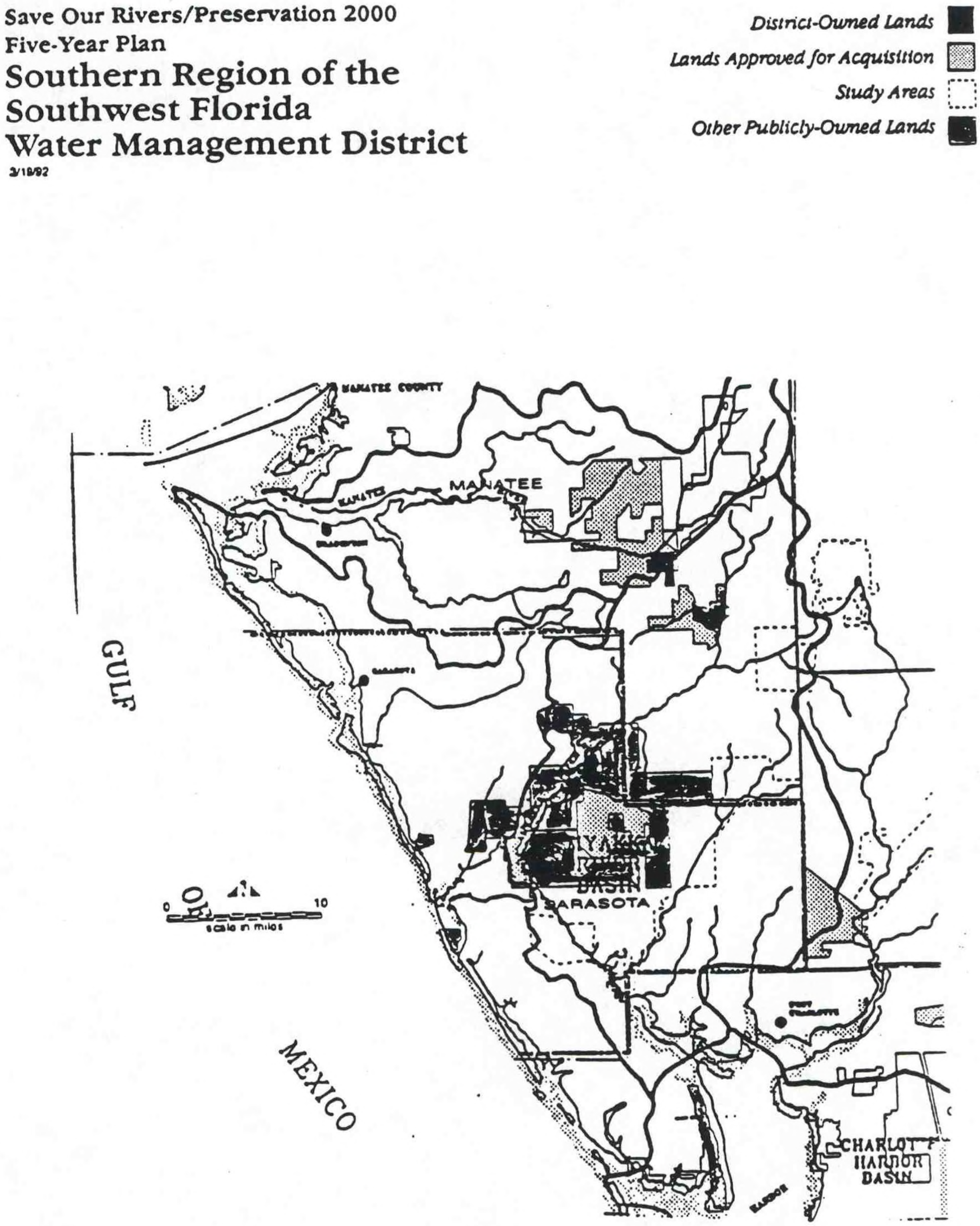

Figure 6-1 District-owned lands, lands under consideration for acquisition, and other publicly-owned lands

Reserve, and the Central County Complex. The Carlton Reserve will serve as a wellfield for Sarasota County and by special ordinance is to be managed for "ecologically benign resource-based recreational, educational, and research uses only. The Central County Complex is a 6,000 acre site of which approximately 550 acres will be used for a landfill; the remainder of the site is to be managed as native habitat. The MacArthur-Myakka Tract, an approximately 8,000 acre privately owned site in the middle of the Carlton Reserve has been approved for purchase by SWFWMD.

A 3,730 acre site south of the Central County Complex and on the western side of the Myakka River across from the Carlton Reserve has been approved for purchase by SWFWMD. However, an encumbered title for a key parcel for this site has prevented the transaction.

Deer Prairie Creek

Much of this basin is publicly owned as part of the Carlton Reserve.

Lower Myakka River

SWFWMD is studying a site for potential purchase that straddles the river in this drainage basin. The site is subject to imminent development. Rezoning to higher residential density has been requested in one parcel. Other portions are being developed for mining and citrus.

Charlotte County has applied for Florida Community Trust funding for a 300 acre site along Knight Creek which drains to the Myakka River outfall into Charlotte Harbor. The county also received 123 acres of land along the Myakka River as part of a settlement with the financially troubled General Development Corporation.

Lower Big Slough.

The City Of Northport has a drainage right-of-way that extends 150 feet from the Big Slough. The North Port Water Control District, expected to eventually become part of the city, owns property that extends another 150 feet from the drainage right-of-way, or 300 feet total of open space adjacent to the creek. The City of North Port plans to purchase property that is in its existing jurisdiction so that it, too, will own 300 feet of adjacent open space. The city recently purchased 40 acres (Myakahatchee Creek Native Habitat Preserve) that will be used to provide canoe access to the creek.

6.5 Regulatory Recommendations

Future proposals for study of the Myakka River watershed should be reviewed by the Myakka River Coordinating Council to ensure that data acquired from these efforts would be consistent with management objectives and goals for the watershed and Charlotte Harbor SWIM plan.

The portion of the Myakka River designated as an Outstanding Florida Water is subject to a "no degradation" policy pursuant to Section 17-302.700(1), F.A.C. The water quality for this segment should be analyzed and specific standards and criteria should be established to ensure this protection is maintained.

Reclassification of the upper Myakka River upstream from the Manatee County line to Class I should be considered to achieve the water quality goals for the reach within the Myakka State Park which is designated an Outstanding Florida Water. Lower water quality standards for the upstream waters is inconsistent with preventing degradation of the portion of the river within the park.

The bibliography of information compiled for this study should be maintained and updated with additional sources as they become available to enhance coordination. Interpretive and data-summary reports essential to management decisions and recommendations should be compiled and cataloged for efficient reference. Numerous public and commercial entities continue to collect information that describes the physical, hydrologic, and biological characteristics of the Myakka River watershed. At present these publications are retained at the Sarasota County Natural Resources Department. They may be transferred to the County's Environmental Library.

Analysis of the functions of advisory and regulatory agencies that have authority over various activities that degrade river resources (See Tables 3-2 and 3-2), demonstrates the following:

Many agencies have authority over wetland alteration, but none of them have a mechanism for considering cumulative impacts of many individual alterations when granting permits, even though they are enabled or required by legislation to do so. The COE does not even keep a record of approved permits that would enable them to track past actions (John Adams, COE, personal communication 1990). Permitting for other sources of impacts, e.g. shoreline hardening, wastewater discharge, does not consider cumulative impacts of regulatory action. The locations of sites where land-based permits have been granted and mitigation has been established should be recorded on GIS and used for evaluating cumulative impacts.

There is little regulatory control over the impacts of agricultural runoff and land clearing. Wetland alterations in agricultural lands are regulated only by SWFWMD. The SCS, predominantly an advisory agency, has most contact with farmers. SCS and SWFWMD should expand educational programs for BMP's which favor on-site retention of runoff, sediment control, integrated pest management, conservative irrigation, and proper timing of fertilizer and pesticides. Impacts to water quality and river biota should be studied as recommended in Section 6.1 to determine if a regulatory initiative is needed for agriculture.

Local government has authority over more sources of impact to the river than any other regulatory agency. Local government also has more regulatory authority over upland land uses than other agencies. The Myakka River Coordinating Council has the most comprehensive advisory authority over the river. The Southwest Florida Water Management District has the technical staff and capabilities to supervise monitoring studies, provide coordination for programs, and maintain a regional GIS. A workable structural framework for management of the river would have the following elements:
Local government that is accountable for enforcing its comprehensive plan policies, for some monitoring programs, and for developing a local GIS. The local GIS could be scaled to parcels to track permitting activities and to U.S.G.S. quadrangle size for other uses.

Myakka River Coordinating Council for comprehensive review of activities in the watershed and status of natural resources, forum for policy setting, and educational efforts. The MRCC could also recommend regulatory or enforcement actions that would ensure a link between research results and remedial action.

Southwest Florida Water Management District with oversight from state and federal agencies for continued regulation of surface and ground water activities, maintenance of regional GIS, supervision of monitoring programs, educational efforts, and funding of studies, retrofitting and protective measures, and land acquisition.

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