Sarasota Bay
Water Quality Management Plan

Prepared for:

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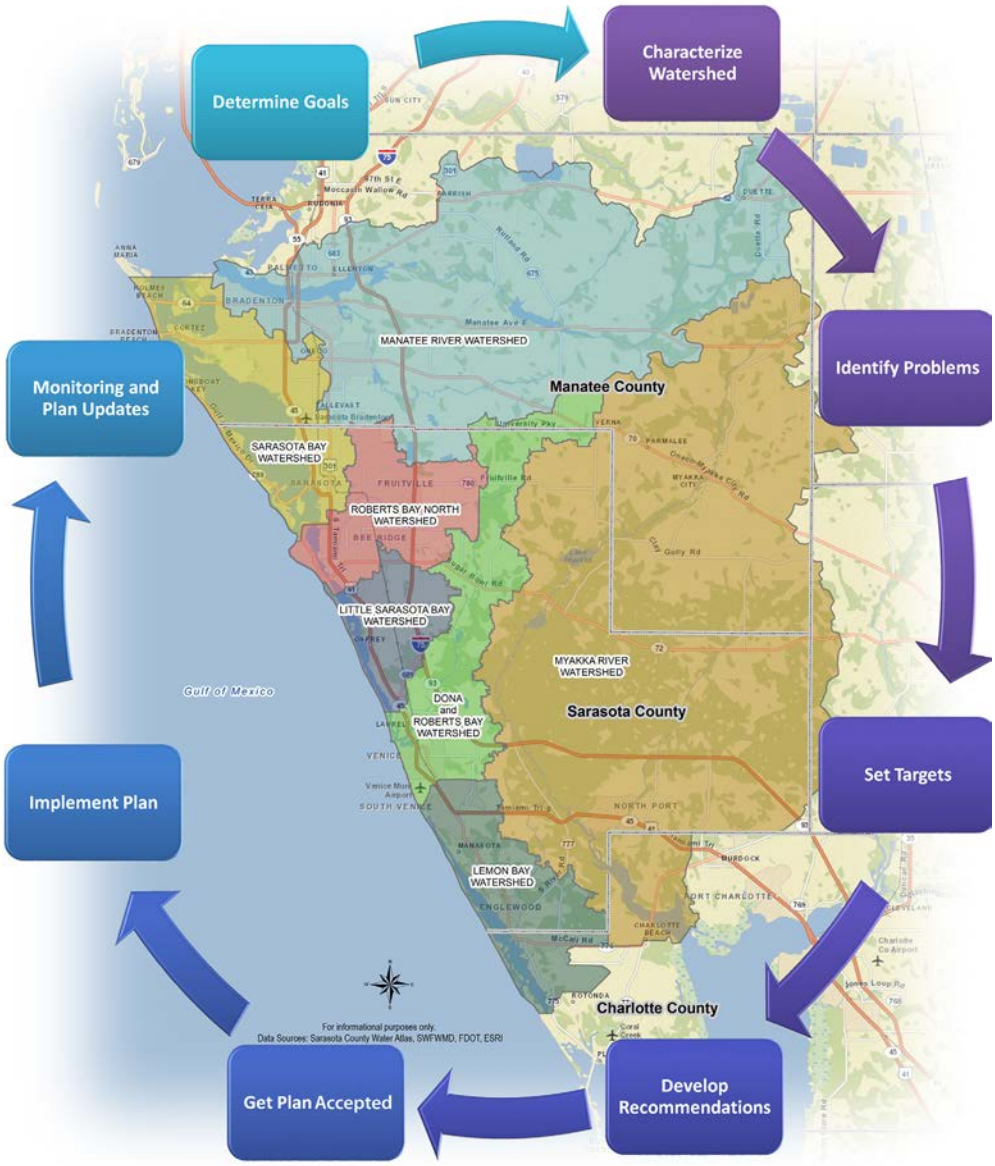


1.0 INTRODUCTION/PROJECT BACKGROUND

Sarasota County has six major watersheds located wholly or partially within its limits: Sarasota Bay, Roberts Bay North, Little Sarasota Bay, Dona and Roberts Bay, Myakka River, and Lemon Bay. Sarasota County has implemented the Comprehensive Watershed Management Program to address water quality, water quantity, flood protection, and natural resources in a comprehensive manner within each watershed. This program is consistent with the Sarasota County Comprehensive Plan (Chapter 4, Goal 2, Objective 2.2, Policy 2.2.1) and employs an approach consistent with the Southwest Florida Water Management District's (SWFWMD) four areas of responsibilities related to water resource management: Water Quality, Water Supply, Flood Protection, and Natural Systems. One component of this Comprehensive Watershed Management Program is to develop a Water Quality Management Plan (WQMP) for each of the six watersheds.

The County and SWFWMD have partnered on cooperative funding projects to develop the WQMPs for Little Sarasota Bay, Sarasota Bay, Roberts Bay North, and Lemon Bay. The Roberts Bay North and Lemon Bay Plans were completed in 2010.

While cooperative funding is provided by SWFWMD, the inclusion of proposed projects, corrective actions, and best management practices (BMPs) in this plan does not confer any special status, approval, permitting standing, or funding from SWFWMD. Requests for funding assistance will have to meet the requirements of funding programs and be subject to SWFWMD's Governing Board appropriating funds.

Further, all projects are subject to County and SWFWMD regulatory review and permitting and are designed to be consistent with the Sarasota County Comprehensive Plan and the Sarasota County Code of Ordinances. Where applicable, all regulatory authorizations shall be obtained before a project can begin. To address these concerns, regulatory coordination will occur at the planning stages for each project discussed in this WQMP to ensure a streamlined permitting review process and address consistency with the Sarasota County Comprehensive Plan and Sarasota County Code of Ordinances before the project is designed.

The recommended management actions contained in this WQMP address the segment of Sarasota Bay that is within Sarasota County and the watershed area that drains to the Sarasota County portion of Sarasota Bay (Figure 1-1). The Manatee County portion of the watershed was analyzed in regard to its pollutant load contributions to the bay; however, project and programs for this area were not recommended.

Watershed management requires a holistic approach to protecting water resources, one that integrates all of the physical and biological components of the landscape.

This WQMP presents scientific and community-based watershed management actions and the approach used to formulate, evaluate, and prioritize them. These actions will be holistic in recognition of the relationships and interdependencies of watershed functions as well as the related goals of state, regional, and federal partners.

The Sarasota Bay WQMP balances the goals of restoring natural systems, enhancing water quality, ensuring the sustainability of the water supply, and protecting against floods while expanding educational opportunities. This plan summarizes past, present, and future watershed conditions. The plan also contains recommendations for activities to help reach these goals and progress toward sustaining and enhancing the health of the watershed.

The following tasks outline the work elements completed by Jones Edmunds and Janicki Environmental during the course of the WQMP development:

- *Watershed Field Trip:* Conducted an initial visual watershed assessment with stakeholders.
- *Literature Search and Creation of Watershed Bibliography:* Performed a literature search and developed an online bibliography.
- *Characterization:* Characterized the watershed.
- *Current, Historical, and Future Water Budgets:* Estimated the historical, current, and future targeted water budgets for the Sarasota Bay Watershed.
- *Flood Protection:* Summarized current County flood protection programs and practices.
- *Sediment Management Plan:* Evaluated sediment conditions in the watershed, developed a sediment management plan, and identified and field-investigated potential projects to reduce erosion and remove sediment and pollutants from drainage system.
- *Water Supply:* Evaluated the change in direct runoff from historical to current conditions and identified stormwater harvesting opportunities.
- *Natural Systems:* Evaluated critical estuarine and lotic natural resources, performed habitat assessment and potential improvement strategy, and established a Natural Systems Level of Service (LOS).
- *Water Quality:* Assessed status, trends, and targets; analyzed pollutant loads; set Water Quality LOS; and identified potential water quality improvement opportunities.
- *Project Analysis:* Developed conceptual plans and cost estimates for recommended programs and projects.
- *Watershed Report Card Coordination:* Provided the County with detailed information to develop the Watershed Report Card.
- *Water Quality Management Plan:* Summarized comprehensive WQMP efforts.

The analysis and recommendations were applied to the Sarasota County portion of the Sarasota Bay Watershed, which consists of one bay segment and three subbasins (Figure ES-1). Approximately half of the Sarasota Bay Watershed is located north of the County boundary in Manatee County. For this WQMP, the Sarasota Bay Coastal (SBC) Basin has been subdivided into two portions: SBC-South, which includes the basin area in Sarasota County, and SBC-North, which includes lands outside the County. To assess Sarasota Bay as a whole, the entire watershed was evaluated for hydrologic and pollutant loadings; however, all management options address only areas within Sarasota County.

Bay Segments

- Sarasota Bay

Basins

- Sarasota Bay Coastal Basin-South
- Whitaker Bayou Basin
- Hudson Bayou Basin
- Manatee County Basins
  - Sarasota Bay Coastal Basin-North
  - Bowlees Creek
  - Cedar Hammock Creek
  - Palma Sola Drain – Bayshore
  - Canal Road Drain

This report is organized into six sections, including this introduction. Following the goals and objectives (Section 2.0), the technical analyses and recommendations are presented by basin in Section 3.0 and Section 4.0. Each basin section provides a summary of the watershed study for the particular basin. Additional details concerning the study are provided in the Appendices. Each basin section includes a characterization and analyses. The analyses cover relevant information for each area of responsibility (AOR)—water supply, water quality, natural systems, and flood protection conditions. The analyses are followed by recommendations as well as a summary and conclusions for each basin.

Much of the background information for each AOR is provided in the Sarasota Bay Watershed section (Section 3.0) and is not repeated in subsequent basin sections. Section 3.0 describes the program recommendations directed at the entire basin. The analyses presented in Section 3.0 include the entire Sarasota Bay Watershed. The characterization, water quality, and natural systems information in Section 3.0 are focused on the bay itself.

To make this plan more relevant to the individual watersheds, the characterization, analysis, and project recommendations are broken out by basin. Section 4.0 is for the tributary basins draining directly to Sarasota Bay.

Plan implementation is described in Section 5.0, and Section 6.0 seeks to link goals with management actions.

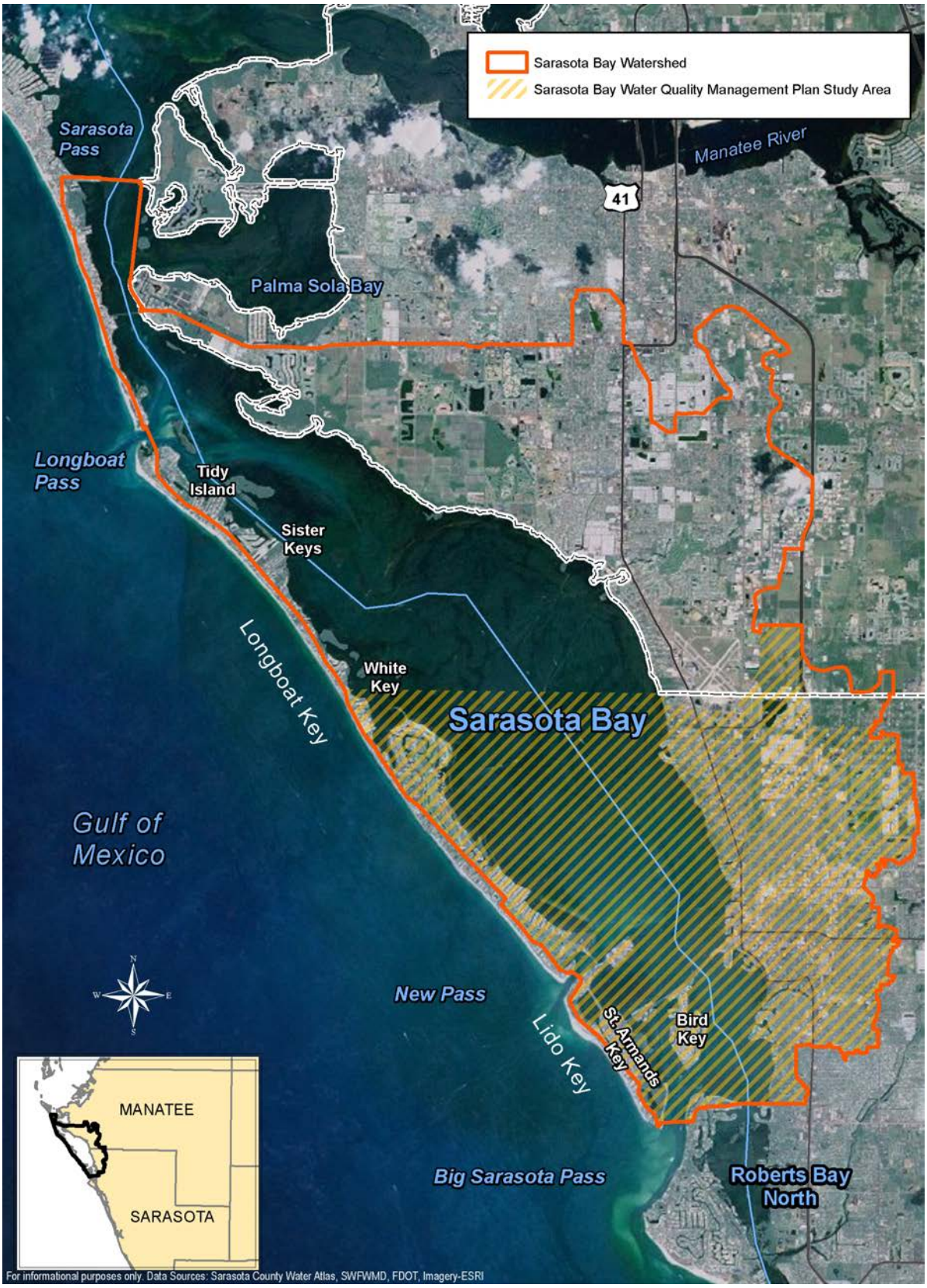


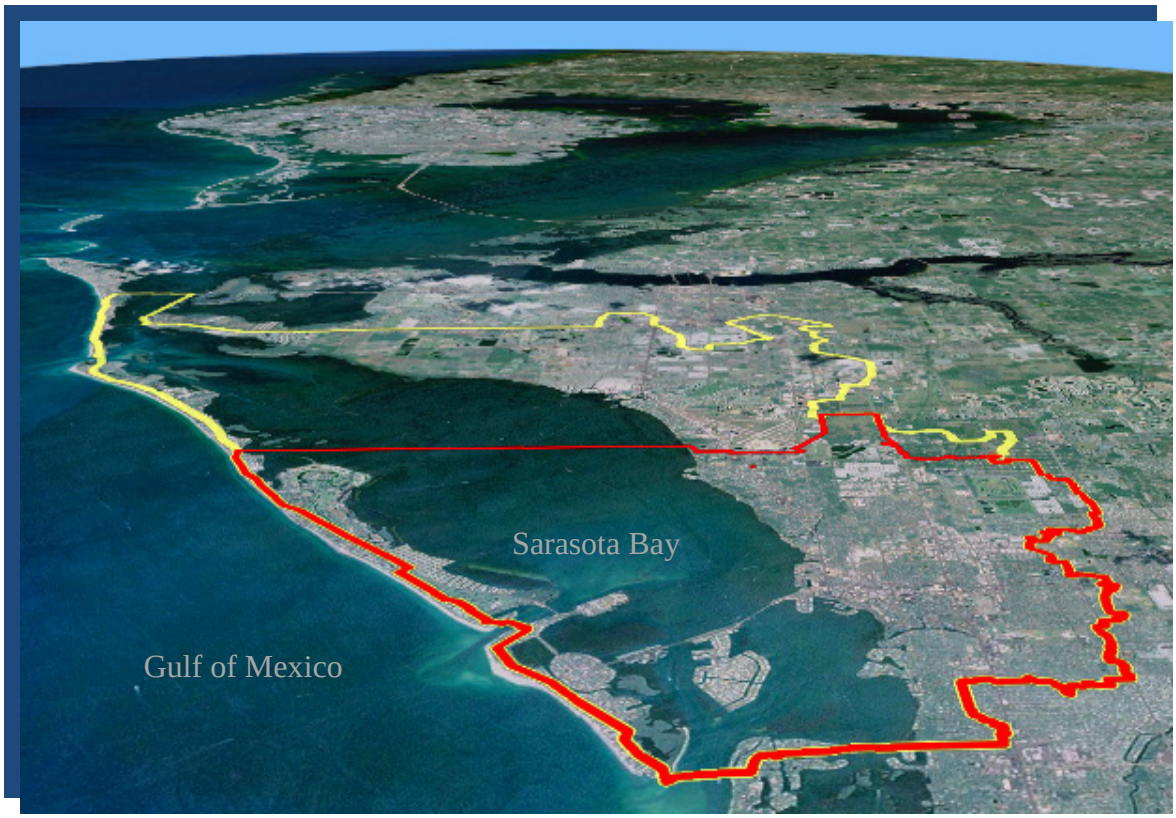
Figure 1-1 Sarasota Bay Water Quality Management Plan Study Area

2.0 GOALS AND OBJECTIVES

The Sarasota Bay WQMP is a regional initiative to develop and implement a water quality management plan for Sarasota Bay and its watershed to help achieve the following objectives:

- Improve water quality.
- Restore to the greatest extent possible the historic natural hydrologic regime.
- Protect property owners from flood damage.
- Protect, enhance, and restore natural communities and habitats.
- Identify potential sustainable surface water supply options.

The Sarasota Bay WQMP promotes and furthers implementation of other regional plans, including the *Sarasota County Comprehensive Plan*, the Sarasota Bay Estuary Program's (SBEP) *Comprehensive Conservation and Management Plan (CCMP)*, and the SWFWMD's *Southern Coastal Comprehensive Watershed Management Plan*, and SWFWMD's *Sarasota Bay Surface Water and Improvement (SWIM) Plan*.



3.0 SARASOTA BAY/WATERSHED

3.1 CHARACTERIZATION

Located on the west-central coast of Florida, the Sarasota Bay Watershed is famous for its sandy beaches, keys, sparkling blue water, and array of marine life, such as dolphins, manatees, loggerhead turtles, fish, and crabs. The watershed spans approximately 100 square miles from Anna Maria Sound in Manatee County, south to Roberts Bay North in Sarasota County, and includes the City of Sarasota to the east. Sarasota Bay is bound to the west by stretches of barrier islands, including Longboat Key and Lido Key, and to the east by the mainland of Manatee and Sarasota Counties. Sarasota Bay is a subtropical estuary with tidal tributaries and small creeks, coves, inlets, and passes. New Pass and Big Sarasota Pass connect the bay with the Gulf of Mexico and promote tidal mixing and circulation (Figure 3-1).

The Sarasota Bay Watershed once consisted of an expanse of pine flatwoods and other upland systems, numerous wetlands, and marshy tributaries that slowly drained into the bay. These native natural systems provided habitat, flood control, and improved water quality. Many of these natural systems were altered and degraded by urban and agricultural development over the past 100 years, resulting in major changes in the watershed.

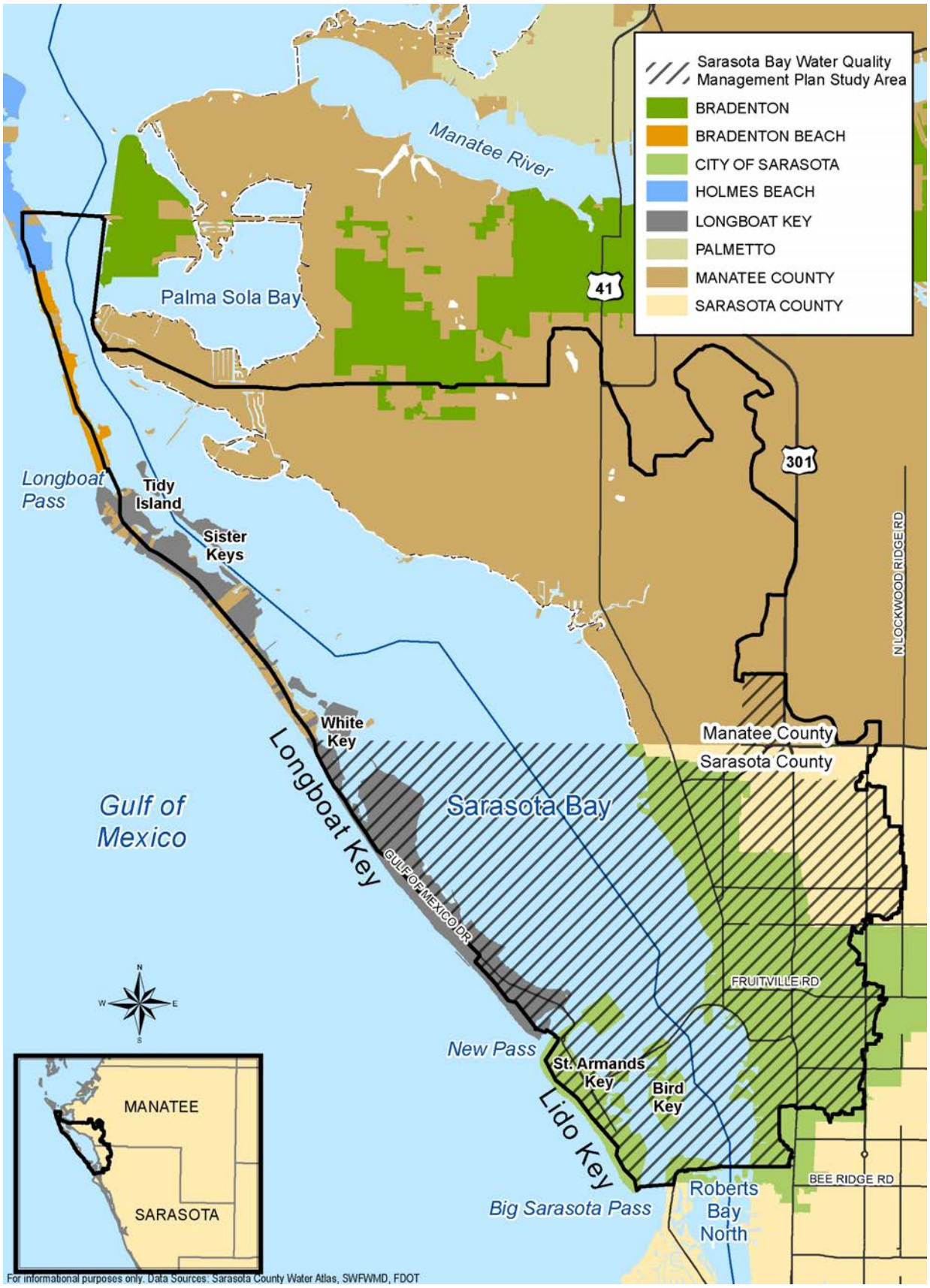


Figure 3-1 Location of the Sarasota Bay Watershed

Archaeological evidence suggests more than 10,000 years of occupation in the watershed by native peoples. The first records of the Sarasota Bay Watershed date back to the European explorers in the early 1500s (Figure 3-2). By the late 1800s, hotel resorts were built and Sarasota Bay was advertised as a place for recreation in the northern states as well as overseas. By the beginning of the 20th century, paved streets, sidewalks, an electric plant, water and sewer services, and the Florida West Shore Railway attracted even more settlers. The area experienced a period of rapid growth, mainly along the coast and tributaries, in the early 1920s, tripling the population.

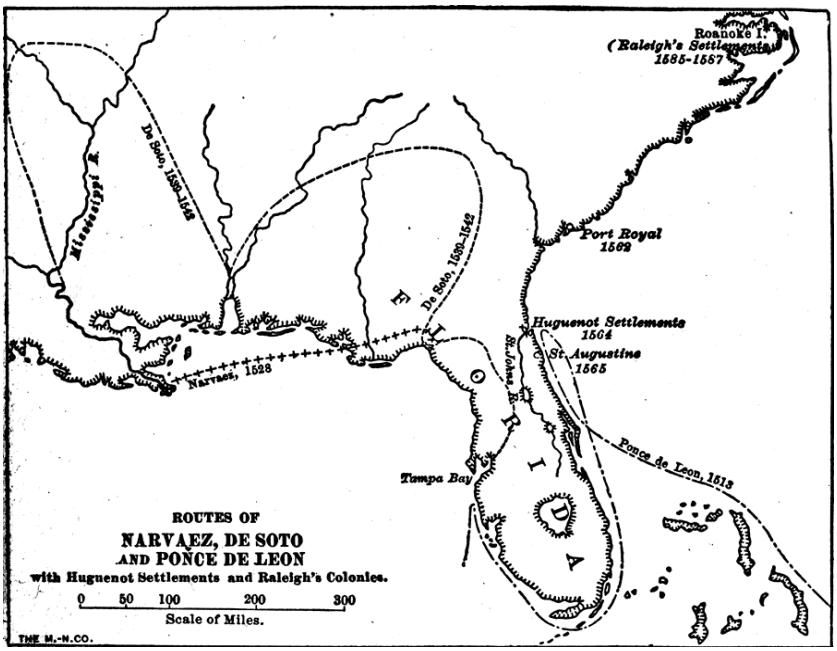


Figure 3-2 Routes of European Explorers (Courtesy of the private collection of Roy Winkelman)

As development continued, natural mangrove shoreline was replaced by concrete sea walls, reducing nursery areas essential to many marine species in Sarasota Bay (Figure 3-3). Ditches within tidal areas, a common mosquito control technique at the time, were constructed. Wetlands, and flatwoods that once provided habitat, flood control, and improved water quality were altered and degraded. Inland in the watershed, the natural tidal creeks of Hudson and Whitaker Bayous were dredged and extended and wetlands were filled to accommodate agriculture, businesses, and residences. By the mid-1950s, most of the coastal mainland was developed and growth persisted inland and across the barrier islands. Lido Key was formed from several small mangrove islands, and Bird Key was constructed of fill material taken from shallow grass beds. These two artificial uplands near Big Pass have both reduced the benefits of tidal interactions with the Gulf of Mexico and have replaced natural habitats with urban development. Dredging activities in the bay, including dredge-and-fill projects and channel excavation and maintenance, have resulted in deep holes that act as sediment traps, especially for fine-grained particles. This concentrates sediment that may otherwise cloud and contaminate the water column. The deeper areas also provide a refuge for fish during periods with colder than normal water temperature. Channel dredging has also created spoil islands, some of which have become vegetated with mangroves. These created habitats include Sister and Jewfish Keys south of Anna Maria Pass along the Intracoastal Waterway (ICW).

Figure 3-3 Sarasota Bayfront, looking southwest circa 1935 (Credit: George I. Pete Esthus) vs circa 2000 (Sarasota County Water Atlas)

Today, the watershed is almost entirely developed and lies within an area designated by SWFWMD as the Southern Water Use Caution Area (SWUCA), which is an area where water resources are or will become critical in the next 20 years. Additionally, Sarasota Bay is classified as an Estuary of National Significance, OFW, and SWFWMD SWIM Priority Waterbody and is designated as a Florida priority estuarine conservation area by the Fish and Wildlife Conservation Commission (FWC). Sarasota Bay west of the ICW is designated as Class II (suitable for shellfish propagation or harvesting), and the bay east of the ICW is Class III Marine (suitable for recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife).

The Sarasota Bay Watershed is currently regulated by the Florida Department of Environmental Protection (FDEP) and by extension the US Environmental Protection Agency (EPA), SWFWMD, two counties (Sarasota and Manatee), the City of Sarasota, and the Town of Longboat Key. Each regulatory agency is responsible for the health of the bay and can regulate specific activities throughout the watershed. In general, State regulations should be followed unless one of the counties has adopted a more stringent rule. The same policy applies to cities within a county boundary; the more stringent regulations always take precedence. This WQMP discusses the goals and objectives for Sarasota County and the measures the County is taking to meet these goals. This plan does not encompass the portion of the Sarasota Bay Watershed in Manatee County; however, Manatee County is also taking measures to meet similar goals for Sarasota Bay.

Historically, watershed management focused solely on flood control wherein the common practices of ditching, channelizing streams, and the use of structural measures hasten drainage. In addition, most of the development in the watershed occurred before stormwater regulations were implemented in 1982, so stormwater from most of the watershed's developments flows into the bay without treatment. Drainage activities, flood-control projects, and the construction of impervious surfaces have changed the natural hydrology of the watershed, resulting in higher

peaks in the natural flow and increases in the delivery of pollutants to the bay. Hydrologic alterations within the Sarasota Bay Watershed include:

- Reducing on-site rainfall storage by filling and ditching natural depressions and wetlands.
- Increasing stormwater runoff rates by channelizing natural streams and creating networks of interconnected ditches that flow to the bay.
- Reducing infiltration by introducing pavement and other impervious surfaces.
- Altering flow patterns by constructing water control weirs and increasing sedimentation in the channel from upland erosion.

Rainfall and surface water runoff are critical to maintaining the natural resources of any estuarine system and its supporting watershed. However, maintaining appropriate quantity and quality of runoff through effective resource management is essential to these beneficial properties. The Sarasota Bay Watershed is relatively flat and has an average annual rainfall of 53 inches.

The majority of the Sarasota Bay Watershed has been altered, leaving only isolated natural and conservation areas that provide infiltration and habitat for many threatened and endangered native species. Only about 10% of the watershed is undeveloped, which significantly affects water quality, water quantity (flow), habitat, and flooding risks. The highly urbanized watershed consists of a lot of older neighborhoods that provide only minimal stormwater retention or detention. The surface water runoff from the rainfall flows across the watershed terrain through ditches, storm drains, creeks, and wetlands, and eventually into Sarasota Bay. The untreated runoff contributes sediment and associated pollutants to Sarasota Bay and its tributaries. Previous studies show some sediment in the Sarasota Bay tributaries contains substantial levels of contaminants including toxic metals, pesticides, petroleum, and other organic compounds. However, sediments in the bay proper have been reported to be uncontaminated.

Widespread alterations to the surface hydrology of the watershed have occurred over the past decades, resulting in significant changes to the volume and timing of freshwater inflows to the bay.

The freshwater inflows result in a net outflow from the estuary, generally on a tide-driven basis. Tidal communication between the bay and the Gulf of Mexico via Anna Maria Pass, New Pass, and Big Sarasota influences circulation patterns in the bay. These narrow flow paths are relatively shallow except for the deeper ICW channel, which enhances circulation and flushing and reduces retention time of water in the bay, reducing the accumulation of pollutants.

One of the main challenges of protecting the water quality in the watershed is to decrease the amount of stormwater runoff to limit the amount of freshwater, sediments, and nutrients entering the streams and bay.

Sarasota Bay has three major tributaries that connect to the bay: Hudson Bayou and Whitaker Bayou in Sarasota County and Bowlees Creek in Manatee County. For this plan, the Sarasota Bay Watershed has been divided into four basins: the Whitaker Bayou Basin, the Hudson Bayou Basin, the Sarasota Bay Coastal (SBC) Basin, and the Manatee County Basin (Figure 3-4). The focus of this WQMP is the Whitaker Bayou, Hudson Bayou, and SBC Basins. The Whitaker Bayou Basin consists of Whitaker Bayou, one of three major tributaries to Sarasota Bay, and its drainage basin, which extends from Sarasota County slightly north into Manatee County. The Hudson Bayou Basin includes Hudson Bayou, another major tributary, and its drainage basin, which is entirely within the City of Sarasota city limits in Sarasota County. The SBC Basin includes the Sarasota County portion of the barrier islands, including Siesta Key, Lido Key, Bird Key, and south Longboat Key. This basin also includes the Sarasota County coastal mainland that drains directly to the bay and the Sarasota County portion of Sarasota Bay.

Clean water resources, healthy streams, and safety from flooding are important for residents, businesses, and the local economy. Managing water and other natural resources is necessary to sustain the economy and environmental health of the community. Because of proper management actions since the late 1980s, wastewater pollution in the watershed has decreased as a direct result of the development of reclaimed water in combination with removing aging sewage treatment facilities and replacing leaking septic tanks. As a result, water quality, seagrass beds, and habitat for birds and fish have improved in Sarasota Bay; improvements include decreases in nitrogen levels, fewer impaired areas, and thousands of acres of new or improved seagrass beds. Although the bay currently meets State water quality standards as a whole, the watershed still has numerous instances where standards have not been consistently met at a smaller scale such as in some tidal creeks, as discussed in following sections.

This plan will present opportunities to implement stormwater treatment in already developed areas throughout the watershed. Advances in stormwater system technology can better help balance the needs of the environment with those of the community.

For more information on the watershed attributes, such as land use, topography, and geology, see Section 3 of Appendix A – Watershed Characterization. Information on the public lands, recreational facilities, and threatened and endangered species within the watershed can be found in Sections 5 through 7 of Appendix A.

Figure 3-4 Sarasota Bay Watershed Basins

3.2 WATER QUANTITY AND WATER SUPPLY

Developing a sustainable water supply is a goal of Sarasota County. The County is committed to providing a sustainable water supply through protecting water resources from harm, optimizing the use of alternative water supplies such as reclaimed water and surface waters, providing reliable and cost-effective water supply to the County's residents, and reducing demands on water resources through conservation and Low-Impact Development (LID).

Sarasota County meets its water supply needs through several sources. The bulk of the County's annual average daily demand of 19.0 million gallons per day (MGD) is supplied by the Peace River Manasota Water Supply Authority and Manatee County. Demand on average is expected to increase nearly 6 MGD over the next 6 years with the majority of the new supply coming from existing contracts and its own wellfields. Additional details concerning Sarasota County's water supply and demand are provided in Section 2 of Appendix B.

Stormwater runoff is a potential water source for non-potable uses that have been traditionally supplied by groundwater or other potable water sources. Current surface water flows in Sarasota Bay are about 20% higher than historical flows, and future flows are expected to remain near current levels. Section 3.2.2 of this plan summarizes the flow analysis, or water budget, and results that are detailed in Section 3 of Appendix B.

Section 6 of Appendix G provides specific project and program recommendations to capture and use excess flow. The recommendations focus on stormwater-derived alternative water supplies for irrigation and programs aimed at reducing the potable water supply demand. Potable and reclaimed sources are covered under the County's Comprehensive Plan and water and wastewater master plans.

3.2.1 Water Supply and Demand

Water supply planning is the process by which an agency assesses the projected water demands for a period and the potential sources of water available to meet the demands. The Water Supply Plan helps the county manage one of its greatest resources, water. Water does not have boundaries; it is found in the sky and on, in, and under the ground. Water is seemingly abundant, with a continual supply falling from the sky and stored in the ground and in our bodies. However, recent droughts and the impacts of over pumping have shown us that water is not as abundant as Floridians once thought, and therefore a plan is needed to help neighboring communities share and protect this important resource.

Sarasota Bay Watershed is within SWFWMD's SWUCA, which is defined as an area where water resources are or will become critical in the next 20 years. Regulatory requirements stemming from this distinction are described in the SWUCA Recovery Strategy (SWFWMD, 2006). For detailed information on Water supply and demand in the Sarasota Bay Watershed see Section 2 of Appendix B.

3.2.1.1 Water Sources

Potable and reclaimed water within the Sarasota Bay Watershed are distributed by Sarasota County Utilities, which falls within SWFWMD's region for supply management.

3.2.1.2 Sarasota County Supply and Demand

Water demand projections were compiled as part of the County's *10 Year Water Supply Facilities Work Plan* (June 2012). Projected annual average water demands from Sarasota County are shown in Table 3-1.

Table 3-1 Annual Average Water Demands (WSMP, Carollo, 2011)

	2010	2015	2020	2025	2030
Sarasota County	17.54	21.15	23.51	25.51	27.19
City of Sarasota	7.712	7.924	7.959	7.994	8.108
Town of Longboat Key	2.021	2.021	2.021	2.021	2.021

Table 2-3 in Appendix B summarizes average annual and maximum month water demands, facility capacities, and permitted quantities for Sarasota County Utilities based on the upper band of the demand projection cone. New water supply will need to begin development soon after 2020. The County is working on several options for future supply including the Dona Bay wastewater treatment facility and expansions of existing County-owned facilities (Carollo, 2012).

3.2.1.3 Per Capita Consumption

The average gross per capita water consumption from 2003 through 2007 in Sarasota County was 87 gallons per capita per day (gpcd). This value accounts for water use by commercial and industrial users, as well as for lost and unaccounted-for water. Although the County water system provides approximately 87 gpcd to its customers on average, a demand factor of 100 gpcd was selected to use for planning. This value accounts for any potential changes in water use patterns or shifts in demand. Conservation activities have reduced per capita water use from approximately 110 gpcd in 1992 Carollo, 2012).

Picture yourself carrying 87 gallons of water in a bucket from a well or stream. Would you still use that much water?

3.2.2 Water Budget

Water follows numerous pathways in the atmosphere, on land, in freshwater water bodies, and in estuaries and the ocean. Water from the atmosphere falls to the land and the open water in liquid or solid form. Water that falls to land can either seep in the soil and become shallow or deep, confined groundwater, remain on the land surface and be transpired or evaporated back into the atmosphere (evapotranspiration – ET), or flow from the land to a freshwater or marine water body as runoff. Shallow groundwater can also re-enter a surface water body through baseflow and septic tank effluent seepage. Freshwater also enters the estuary as discharges from point sources such as wastewater treatment plants and industrial facilities.

Societal activities in the watershed affect the magnitude, timing, and distribution of freshwater inputs to the estuary. Land use changes alter how precipitation is partitioned when it reaches the ground. Urbanization reduces the area of open land that allows water to infiltrate from the ground surface to lower soil strata. Natural wetland and upland areas are also filled and cleared of vegetation, which reduces ET levels and on-site storage. Surface water management for drainage control often results in the channelization of natural streams which reduces aquatic and upland habitat, degrades water quality, and can increase erosion and sediment transport. However if ditching reaches a depth that intersects the water table, baseflow may be increased.

The volume, timing, and distribution of freshwater inflows significantly affects the balance of aquatic life in an estuary. Maintaining an appropriate range of freshwater inflows delivered from the watershed to the estuary is crucial to protecting the ecological health of the entire aquatic system. Freshwater plays diverse roles in supporting estuarine communities, including the following.

1) Freshwater inflows affect circulation in an estuary. Circulation can be enhanced during periods of high inflow—for example during the wet summer months. Increased circulation has several benefits including dispersing pollutants such as excess nutrients, increasing dissolved oxygen (DO) levels in the water, and transporting suspended organisms.

2) Freshwater inflows affect residence time of water in an estuary. If water is not circulated from nutrient-rich coastal areas excessive algal growth can occur that may result in high chlorophyll levels. Consequences of this may include lower water clarity and reduced DO levels, both of which are undesirable for aquatic biota. During periods with abundant rainfall, freshwater inflows to an estuary increase and residence time decreases. Conversely, during dry periods freshwater inflows are low and residence time increases.

3) Freshwater inflows affect salinity levels in an estuary. During dry periods the salinity concentration in Sarasota Bay is close or equal to that in the Gulf of Mexico. However, in the wet summer months freshwater inflows mix with the saline water to lower overall salinity, and to form a concentration gradient within

the estuary. Many commercially and recreationally important fish and benthic species rely on the lower salinity (oligohaline) conditions of estuaries for at least some portion of their life cycle.

The salinity gradient is especially important near the mouth and in the lower reaches of tidal creeks, or coastal streams as they are called in the Sarasota County Comprehensive Plan. Freshwater mixes with salt water to form a salinity gradient in the stream that ranges from marine to fresh water. The low salinity zones are important habitat, providing areas for feeding and nursery for a variety of fish and benthic organisms.

4) Freshwater inflows supply sediments and nutrients to an estuary. The delivery of watershed-based suspended and dissolved materials is important to the health of an estuary and provides many benefits. However, excessive loadings may cause detrimental effects to the receiving water body. High sediment loading may smother the bay bottom and degrade benthic habitat. Elevated nutrient loads can result in high algal growth, which can cause lower DO levels and reduce water clarity.

   Many of the ecological problems that are manifested in estuaries are caused by activities in the watershed. Watershed-based actions that can adversely affect an estuary include alterations to the surface water and groundwater systems that deliver freshwater. Water can be diverted into or out of an estuary, changing the volume of freshwater delivered to the receiving water. Urbanization and channelization of natural streams also affects the magnitude, timing, and distribution of freshwater inflow to an estuary.

   This relationship between the watershed and estuary is the focus of the water budget investigation. By understanding how altering freshwater inflows affects the health of the estuary, we can better manage watershed-based activities to protect and enhance Sarasota Bay's aquatic resources.

The objective of evaluating freshwater inflows to Sarasota Bay is to provide answers to the following questions:

1) Have historical land use changes or other watershed-based activities significantly altered freshwater inflows to the bay on an annual and seasonal basis?
2) Can we expect future land use changes or other watershed-based activities to affect freshwater inflows?
3) Have land use changes altered the relative contributions of the individual sources of freshwater inflows to the bay?
4) Can environmental problems in the estuary be linked to changes in freshwater inflows?

3.2.2.1 Methods and Assumptions

Water budgets for Sarasota Bay and its watershed under historical, current, and future conditions were developed using the Sarasota SIMPLE (Spatially Integrated Model for Pollutant Loading Estimates) model. The model integrates rainfall, land use, and soils data with algorithms using rate constants developed for local conditions to calculate the water budget using six components:

- Atmospheric deposition (direct rainfall to the open water estuary).
- Direct runoff (stormwater).
- Baseflow (shallow groundwater seepage).
- Irrigation (seepage and runoff from reclaimed water land application).
- Point sources (wastewater treatment plant and industrial discharges).
- Septic tanks.

The current conditions were provided by a SIMPLE model run for 1989 through 2008. The original modeling was completed for a project funded by SBEP (*Numeric Nutrient Criteria for Sarasota Bay*, prepared by Janicki Environmental [2010]).

The water budgets were developed using current conditions rainfall for all three scenarios and varying the other inputs to simulate historical and future conditions. The results provide a basis for comparing historical and current conditions, and for current and future conditions, due to anthropogenic activities, without having to account for changing rainfall patterns.

A Decision Memorandum was developed by the Project Team to specify assumptions, data, and approach be used to estimate inflows for historical and future conditions. The memorandum outlined changes regarding land use, wastewater treatment and septic tanks, and other elements that may result in changes to freshwater inflow patterns. A detailed description of the Decision Memorandum is provided in Appendix B – Water Quantity.

3.2.3 Sarasota Bay Watershed Water Budget

Historical, current, and future freshwater inflows to Sarasota Bay were estimated using the methods summarized above and detailed in Appendix B. Selected results are presented below. The analyses of these data included examining and comparing the spatial and temporal variation in freshwater inputs to Sarasota Bay. Spatial, annual, and seasonal variations in rainfall are described, followed by comparisons of historical\current and current\future inflows and sources. These analyses are essential to understanding the role of freshwater to the health of the bay for several reasons:

- An assessment of rainfall is critical to the analysis, as rainfall drives many natural processes in the bay.
- Examining historical conditions allows us to compare freshwater inflows from the past to current conditions. This helps identify to what extent changes in the watershed have affected freshwater inflows to date.

- Comparing current to future conditions is also important for effective resource management, as it helps identify potential future problems and facilitates developing pro-active, preventative actions.

3.2.3.1 Rainfall

Annual rainfall averaged approximately 48 inches per year across the watershed during 1989 through 2008 and ranged from about 33 inches per year in 2000 to approximately 66 inches in 1995. Only a 20-year period of rainfall was evaluated and may not apply to the long-term rainfall record. Annual rainfall totals for Sarasota Bay and the watershed are shown in Figure 3-5.

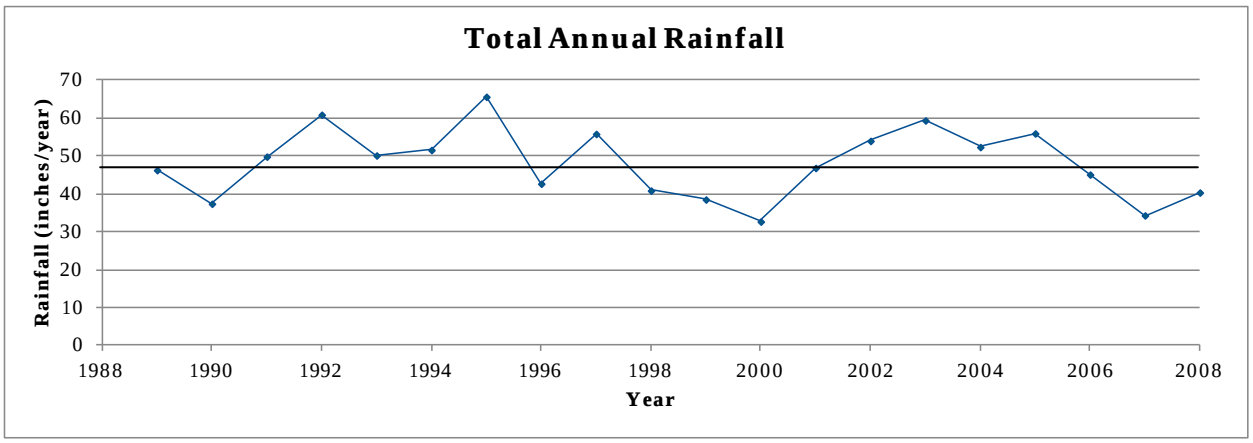


Figure 3-5 Total Annual Rainfall to Sarasota Bay and its Watershed

A distinct seasonal signal in precipitation occurs in the watershed. As is typical of peninsular Florida, June through September are significantly wetter than the other 8 months. The four wet season months have average rainfall of between 6 and 8 inches, while the eight dry season months average between 2 to 3 inches. Monthly rainfall for the Sarasota Bay Watershed is presented in Figure 3-6.

A spatial trend in precipitation for Sarasota Bay and its watershed is evident. For 1989 through 2008 significantly higher amounts of rain fell in the most inland portions of the watershed with lower precipitation along the coast. The precipitation gradient is striking—more than 10 inches per year difference over a distance of less than 10 miles, as shown in Figure 3-7.

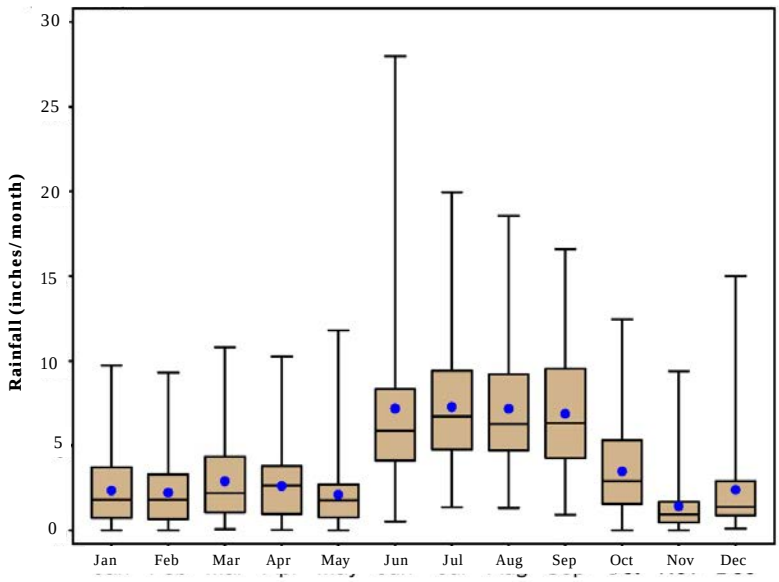


Figure 3-6 Variation in Total Monthly Rainfall within Sarasota Bay and its Watershed (1989–2008)

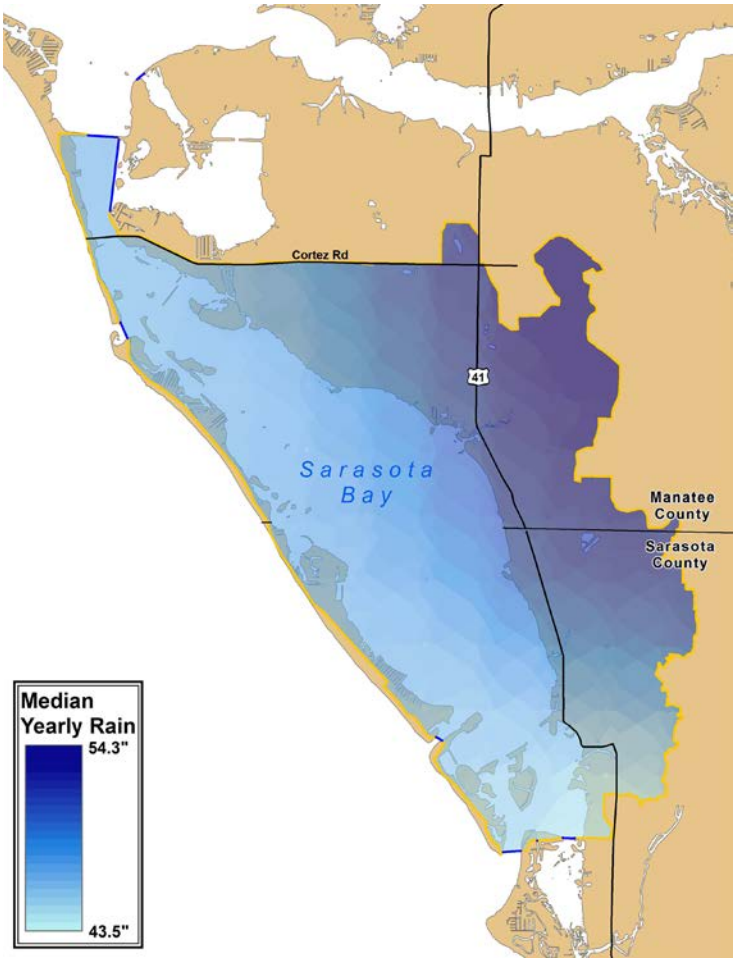


Figure 3-7 Median of Annual Rainfall (1989–2008) used in the SIMPLE Model to Estimate Freshwater Inflows to Sarasota Bay

Freshwater inflows to Sarasota Bay originate from sources in nature and from human activities. Rainfall is the primary source of freshwater in the Sarasota Bay system. Atmospheric deposition (direct rainfall to the open water estuary) contributes the most freshwater to Sarasota Bay of any source. This is because the relative size of the open water estuary is large with respect to the watershed land area.

Sources of freshwater inflows that are rainfall-dependent but are also influenced by human activities include direct runoff (stormwater) and baseflow (shallow groundwater seepage). These sources vary in direct response to rainfall patterns but are also influenced by alterations to the drainage system and land use changes. Replacement of natural uplands and wetlands with urban land uses has a profound effect on the timing and volume of freshwater reaching the bay. Although the seasonal patterns do not change, the rate of runoff from individual storms can be greatly altered as a result of land use changes.

Other sources of freshwater inflows are totally controlled. Irrigation (seepage and runoff from reclaimed water land application), point sources (wastewater treatment plant and industrial discharges), and septic tanks seepage all vary according to human activity and control. In general these sources contribute much less freshwater than rainfall, direct runoff, and baseflow, and their management is more important with respect to controlling pollutant-loading rates.

As stated above, the historical and current periods were both evaluated using current rainfall so that effects due to land use changes and other watershed-based activities could be better identified. The results of the analyses indicate that total freshwater inputs to the bay for the current period (1989 through 2008) were, on average, approximately 26% higher than during the historical period. Although this change is substantial, portions of the Sarasota Bay Watershed were already developed in the historical period (circa 1950). If urban land uses had not been developed to the extent they were, the increase would have been greater.

Both direct runoff and baseflow were higher during the current period. This is a result of land use changes, and alterations to the surface water drainage system including filling natural storage areas and channelizing natural streams. However, annual and within-year variability were similar for both periods, as shown in Figure 3-8 and Figure 3-9. The figures demonstrate that freshwater inflows for both periods mainly depend on rainfall, and that land use changes do not influence the seasonality of freshwater inflows to the bay

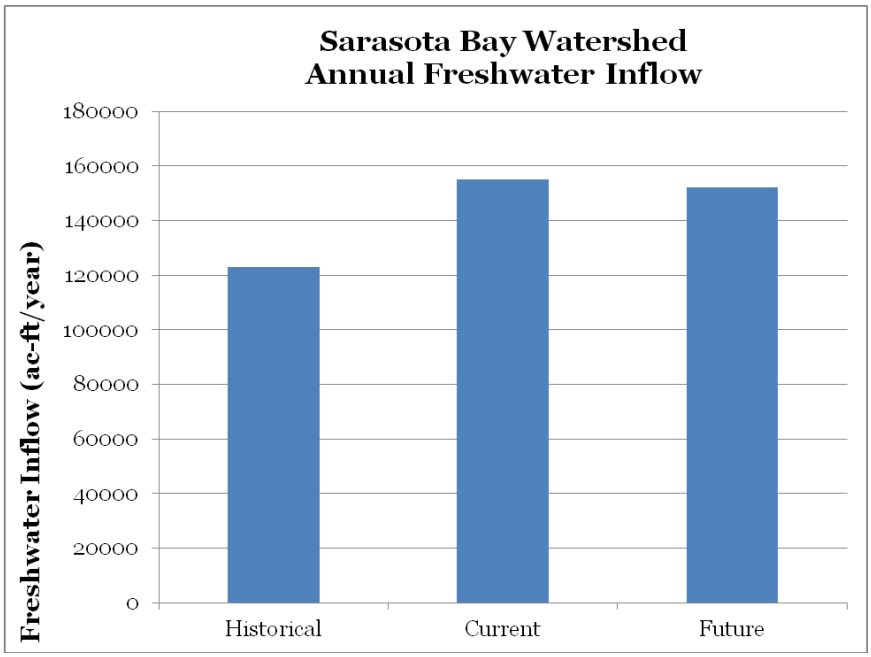


Figure 3-8 Annual Total Freshwater Inflows to Sarasota Bay for Historical, Current, and Future Conditions

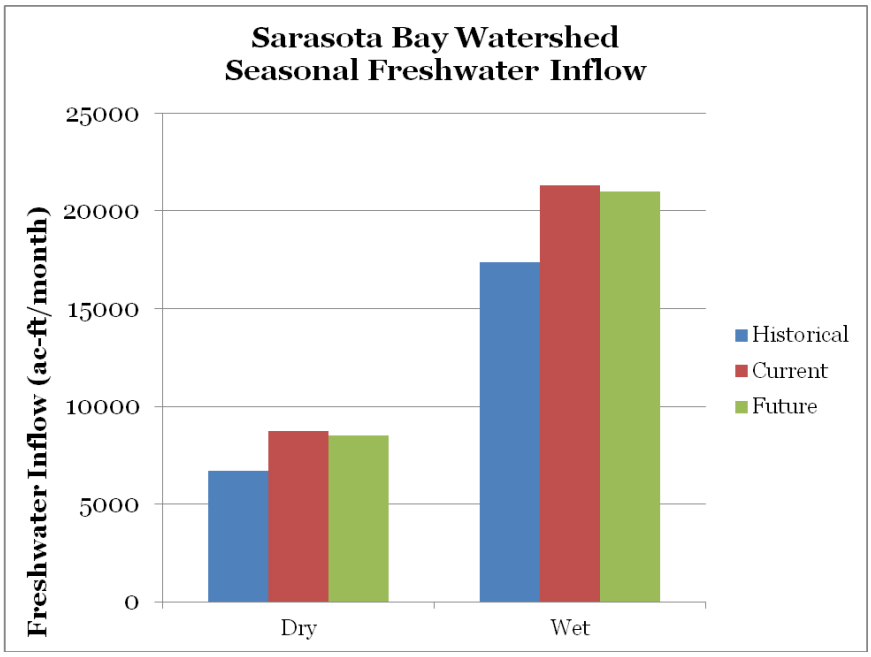


Figure 3-9 Seasonal Variability in Total Freshwater Inflows to Sarasota Bay for Historical, Current, and Future Conditions

The relative contributions of sources of freshwater for current and historical conditions were compared. The relative importance of all sources has remained constant for both periods. Atmospheric deposition was the main freshwater contributor for both periods and contributed over half of all freshwater entering the bay. Figure 3-10 shows the relative contributions of freshwater inflows by source for current and historical conditions. The results indicate that

although the overall volume of freshwater inflows to the bay has changed, the relative importance of individual sources has not changed significantly.

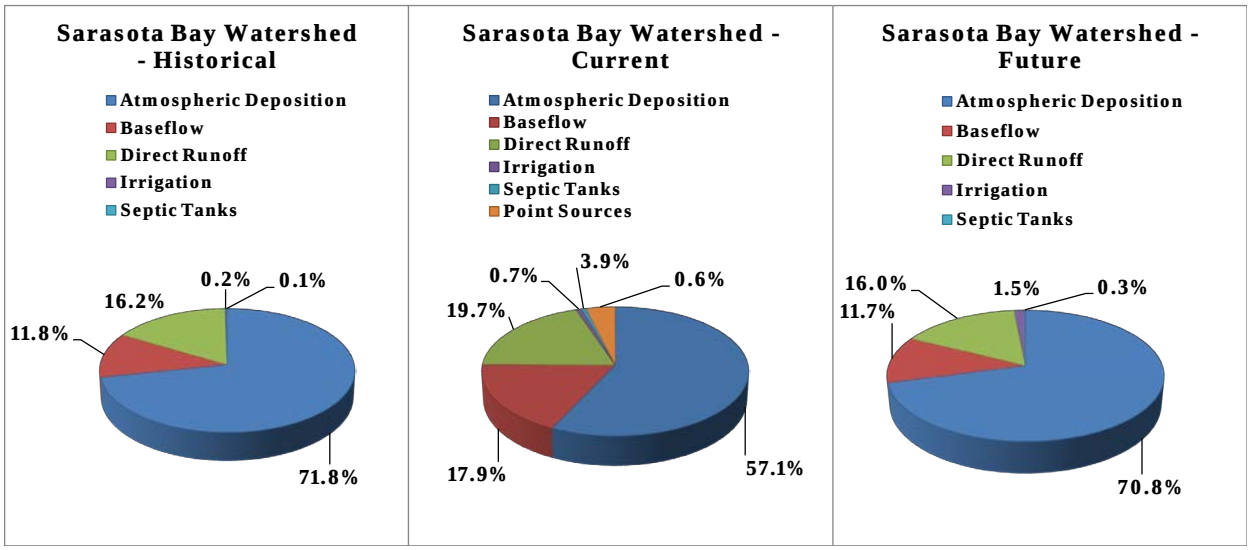


Figure 3-10 Relative Contributions of Freshwater Inflows to Sarasota Bay by Source for Historical, Current, and Future Conditions

The greatest change in any source is the point source contribution. There were no point sources during the historical period, but the City of Sarasota wastewater treatment plant now periodically releases treated effluent to the bay via Whitaker Bayou. The discharges account for only 4% of the total inflow to the bay.

As stated above, the freshwater inflow analysis was completed using the results of the SIMPLE computer model. The watershed was delineated into nine drainage areas for use in the SIMPLE model. These drainage areas are the basis of the analyses described in Appendix B. For the WQMP, the nine drainage areas were aggregated into four basins. The basins are shown in Figure 3-4 (Section 3.1) and Table 3-2.

Table 3-2 Sarasota Bay Watershed Plan Basins and SIMPLE Basin Names

Plan Basin Name	SIMPLE Drainage Area Name
SBC-South	SBC-South
	Longboat/Lido Key
Whitaker Bayou	Whitaker Bayou
Hudson Bayou	Hudson Bayou
Manatee County Basins	Canal Road Drain
	Longboat Key
	SBC-North
	Palma Sola Drain – Bayshore
	Cedar Hammock Creek
	Bowlees Creek

Additionally, the relative contribution of individual sources remains constant year-to-year, although the magnitudes of source-specific inflows change. Rainfall, direct runoff, and baseflow all vary much more than the controlled sources but always represent the bulk of the inflows. This is illustrated in Appendix B, Figure 3-8.

The current and future periods were also evaluated and compared. Current rainfall was used for both scenarios so that potential effects due to projected land use changes and other watershed-based activities could be better identified. The results of the analyses indicate that freshwater inputs for the future period were, on average, approximately 2% lower than during the current period. This change is small and reflects the current urban nature of most of the watershed. Because land use change is the major cause of changes in modeled freshwater inflows, the small change in future conditions is expected. The small increases in runoff and baseflow are offset by the larger reduction in point source contributions (see Table 9, Appendix B). The City of Sarasota wastewater treatment plant is expected to cease surface water discharges to the bay, so no point-source inflows are in the future period.

Annual and within-year variability were similar for both periods, as shown in Figure 3-9 and Figure 3-10. The figures demonstrate that freshwater inflows for both periods mainly depend on rainfall, and that land use changes do not influence the seasonality of freshwater inflows to the bay.

The relative contributions of sources of freshwater for current and future conditions were compared. The relative importance of all sources has remained constant for both periods. Atmospheric deposition was the main freshwater contributor for all periods and contributed over half of all freshwater entering the bay. Figure 3-10 above shows the relative contributions of freshwater inflows by source for historical, current, and future conditions. The results indicate that although the overall volume of freshwater inflows to the bay has changed between scenarios, the relative importance of individual sources has not changed significantly. The greatest change in any source is the point-source contribution. Point-source inflows occurred during the current period, but the City of Sarasota wastewater treatment plant will stop its discharges to the bay in the future. The current point-source discharge accounts for only 4% of the total inflow to the bay.

Thus, land use changes in the past have changed the volume but not the timing of freshwater entering Sarasota Bay. Also, the relative importance of individual sources of freshwater has not changed significantly. The current urban nature of the watershed precludes major land use changes in the future, and future changes to freshwater inflows are expected to be small.

The results of the analysis suggest that although freshwater inflows have increased since the historical period, future freshwater inflows should very much resemble current inflows. No adverse effects due to changes to freshwater inflows are expected for the future.

3.3 WATER QUALITY

This section provides a framework for managing the estuarine and freshwater aquatic resources of Sarasota Bay and its watershed by protecting and enhancing in-bay and tributary water quality. Maintaining appropriate water quality is crucial to protecting the health of the bay's living resources, many of which depend on managing watershed-based activities. The bay and watershed system depend on water quality in the bay. Water quality in the bay is affected by natural process and anthropogenic activities in the watershed and can be characterized by several parameters:

- *Seagrass* is not a water quality parameter, but its abundance and distribution depends on several water quality constituents. Thus, seagrass can be used as a keystone species, which acts as an integrating metric of the bay's health. Seagrass requires light to grow; subsequently if water clarity and resultant light penetration are low, seagrasses are confined to shallow areas of the bay. If nutrient levels reach extreme levels, high algal growth will limit the extent of seagrass growth by increasing shading in the water column. Thus, the extent of seagrass coverage in the bay provides insight into overall water quality conditions.
- *Salinity* is a measure of dissolved salt in the water. The salinity gradient in the bay and tidal segments of tributaries varies constantly according to precipitation, tidal action, and internal circulation. Salinity is a major factor controlling the distribution of estuarine flora and fauna.
- *Dissolved Oxygen (DO)* is the amount of O_2 dissolved in water. Aquatic animals need oxygen to survive, and low DO levels can deplete areas of valuable fish and benthos.
- *Nutrients* are important sources of food for vegetation. However in excessive amounts nutrients can cause high algal growth rates which can negatively affect DO levels and water clarity. Nitrogen and phosphorus promote vegetation and algal growth; however, nitrogen is the controlling or limiting nutrient in many estuaries including Sarasota Bay. Thus, the control of nitrogen inputs must be a priority for a successful management plan.
- *Chlorophyll* is a measure of the abundance of algae in water. High chlorophyll levels are an indicator of high algal growth rates. If chlorophyll is uncontrolled, eutrophication can result in detrimental effects to water clarity and DO levels.
- *Water clarity* is a controlling factor in the depth to which seagrass, which depends on light penetrating the water, can grow. Thus water clarity largely controls the extent of seagrass coverage in the bay. Seagrass is an extremely valuable habitat and food source for many aquatic species, and also stabilizes bay bottom sediments.
- *Suspended solids* is the amount of fine-grained organic and mineral matter within the water column. Total suspended solids (TSS) can affect water clarity and, most

often after large rainstorms with high stormwater runoff, bury beneficial bay bottom habitat.

The Sarasota Bay WQMP discusses factors that affect water quality in the bay and tributaries, and the consequences of degraded water quality on natural resources. Specific activities completed in developing the WQMP included:

- Summarizing existing water quality characteristics of Sarasota Bay and its tributaries.
- Comparing existing water quality (nutrients and DO) to regulatory criteria and management targets.
- Estimating current and projected future pollutant loading levels to the bay and identifying "hot spots" in the bay and tributaries.
- Establishing water quality Levels of Service (LOS) standards for the bay and tributary tidal creeks.
- Presenting potential projects for the improvement and protection of water quality in the bay and tributaries.

3.3.1 Estuarine Water Quality Status and Trends

Monitoring water quality and assessing status and trends has several benefits:

- Describes current and past environmental conditions.
- Facilitates early detection of problems.
- Assesses the effectiveness of existing management efforts.

Water quality in the bay has been regularly monitored for salinity, nutrients (total nitrogen [TN] and total phosphorus [TP]), DO, TSS, water clarity, and other parameters since 1998. A review of in-bay concentration data shows:

- Statistically significant decreasing trends in TP, TSS, and turbidity over the period of record.
- No statistically significant trends in chlorophyll *a*, or TN, or water clarity.

These results indicate that current water quality conditions in the bay as a whole are good. Parameters that could indicate undesirable conditions (TN, chlorophyll) are stable. Additionally, targets for seagrass survival are being met or exceeded, signifying that existing water quality conditions are appropriate for seagrass growth, and that current management efforts to protect bay resources are successful. Figure 3-11 and Figure 3-12 show seagrass coverage and chlorophyll concentrations in the bay in comparison to targets (a desired ecological condition) and thresholds (a level above which undesirable conditions exist) that were adopted by SBEP in 2010.Targets and thresholds are further discussed below in Section 3.3.3.

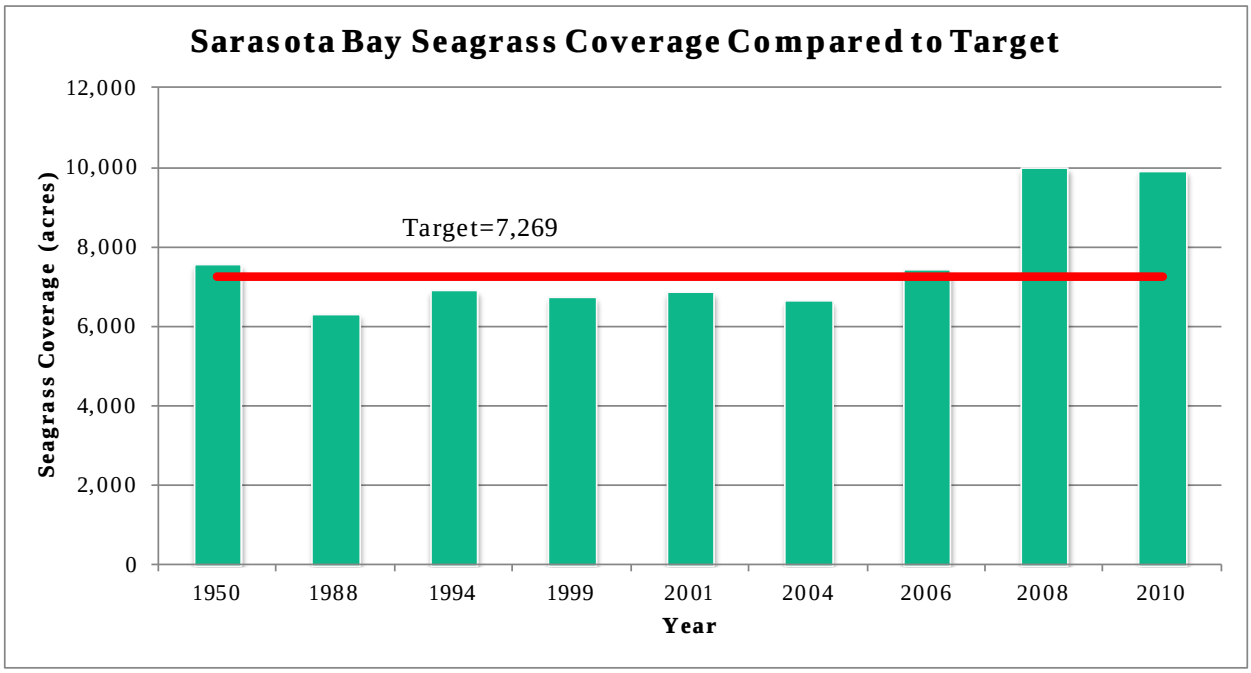


Figure 3-11 Sarasota Bay Seagrass Coverage shown with SBEP target (7,269 acres)

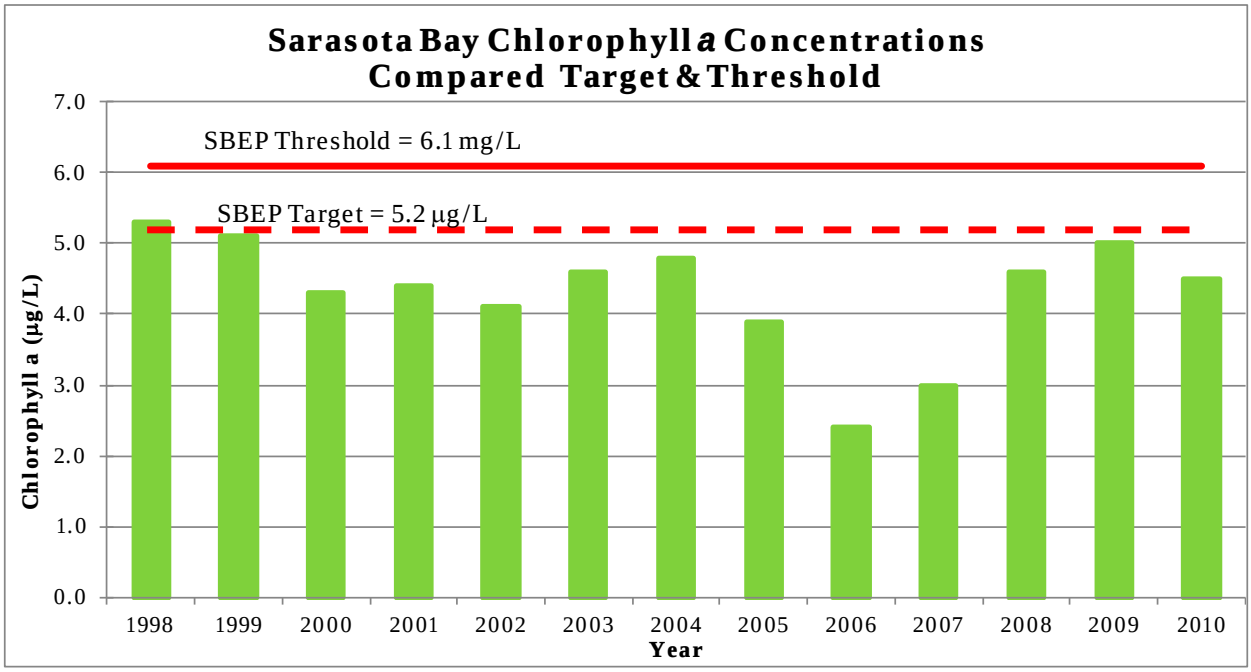


Figure 3-12 Sarasota Bay Chlorophyll Concentrations shown with SBEP Target (6.1 µg/L) and Threshold (5.2 µg/L)

3.3.2 Hydrologic and Pollutant Loading

Evaluating current levels of pollutant loading to the bay, especially nutrients and TSS, and projecting potential future loading rates, can provide an early warning to potential problems. Sources of pollutant loading to the bay include the following:

- Atmospheric Deposition (direct precipitation to the open water estuary).
- Baseflow (shallow groundwater seepage).
- Direct Runoff (stormwater that enters the bay).
- Irrigation (by reclaimed water).
- Point Sources (surface water discharges from wastewater treatment plants or industrial facilities).
- Septic Tanks.

Current and projected future loadings to the bay were estimated with the SIMPLE-Monthly computer model, which was used for SBEP, Sarasota County, and SWFWMD pollutant-loading studies. Future loads were estimated by making assumptions developed in concert with the County and SWFWMD regarding likely conditions for land use, wastewater treatment and disposal options, and atmospheric deposition rates for an unspecified future period. The 1989–2008 rainfall was used to generate both current and future conditions loads. Using current rainfall for future conditions was the preferred approach because future rainfall is difficult to predict, but even more importantly, using the same rainfall for both conditions allows a comparison of loadings for both scenarios due only to changes in anthropogenic conditions and not natural variability.

Figure 3-13 shows annual loadings for 1989 through 2008, which represents current conditions. Inter-annual variation is largely a function of rainfall, as sources other than atmospheric deposition, direct runoff, and baseflow (all are driven by rainfall) are relatively small. Future loadings to the bay are somewhat smaller than current as a result of the projected elimination of surface water discharges from the City of Sarasota's wastewater treatment plant (with more reclaimed water for irrigation), and a projected reduction in atmospheric deposition TN loading based on estimates developed by EPA (Dennis and Arnold, 2007). Because the watershed is generally urbanized at present, no large changes in land use-based loadings such as direct runoff and baseflow are foreseen.

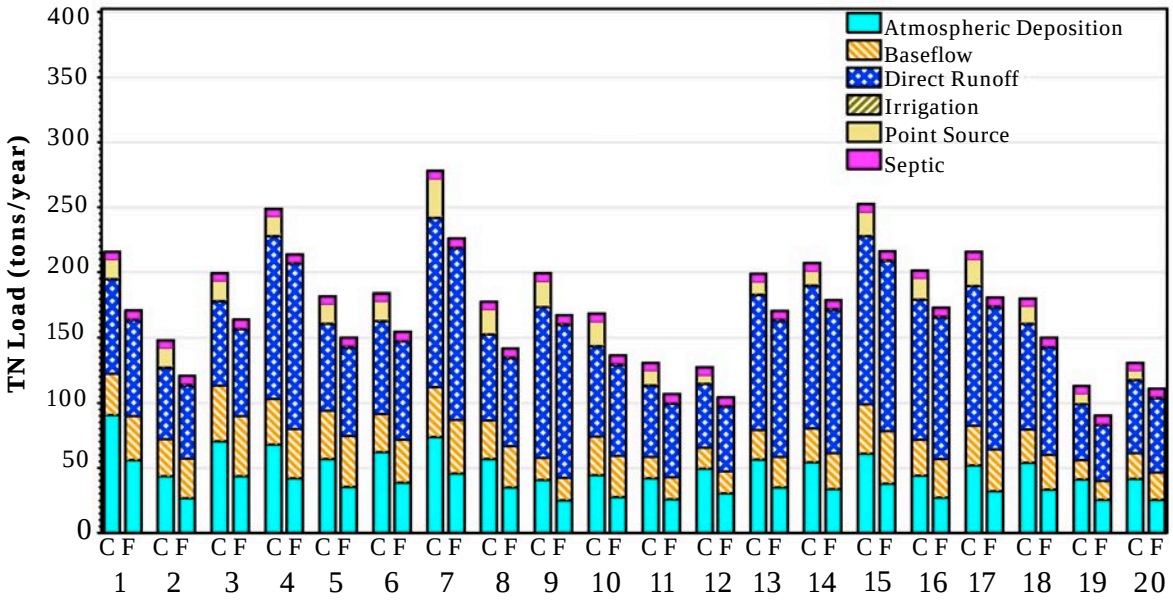


Figure 3-13 TN Loads to Sarasota Bay for Current (C) and Future (F) Conditions. Values across the horizontal axis (1–20) represent years of rainfall used for both scenarios (1989–2008)

3.3.3 Comparison of Ambient Water Quality to Regulatory Criteria and Management Levels of Service (LOS)

Setting resource protection LOS is one of the most important elements of an effective watershed management plan. An overall approach for protecting Sarasota Bay's resources has recently been established through the work of SBEP, SWFWMD, Sarasota County, other local governments, FDEP, and other interested parties.

In-bay water quality was compared to current and existing water quality criteria (targets and thresholds). The development of Water Quality LOS is based on a paradigm that distinguishes targets from thresholds, i.e., that distinguishes water quality management levels from regulatory levels. A **target** is a desired water quality condition and can be used as an "early warning" of undesirable change in water quality. However, there may be years in which water quality targets may be exceeded without causing significant changes in the receiving waterbody. Therefore, some allowable amount of variation should not elicit a significant degradation in water quality and, subsequently, seagrass coverage. **Thresholds** have often been set to allow for variability in annual conditions, and to meet the need for a regulatory level. Where these regulatory levels have not been established, there remains the need for a second water quality management level that elicits significant responses to their exceedance. Therefore, a distinction is made between a target, i.e., a desired water quality condition, and a threshold, i.e., a water quality level above which undesirable conditions exist.

For the SBEP work, a target for seagrass coverage was set for the bay. Water quality conditions that coincided with periods of desirable seagrass coverage were then identified. These water

quality conditions were used to develop targets and thresholds that would be protective of seagrasses. Targets and thresholds are further discussed in the WQMP Appendix C Water Quality, Section 5 – Water Quality Levels of Service and Section 6 – Dissolved Oxygen.

The comparison of bay water quality to existing and proposed targets and thresholds includes the following findings:

- Seagrass extent meets the adopted SBEP acreage coverage criteria of 7,269 acres (Figure 3-11). SBEP (of which Sarasota County and SWFWMD are members) sponsored an investigation to determine a desirable, realistic goal for seagrass growth based on a review of current and historical data (Janicki Environmental, Inc., 2010).
- Ambient chlorophyll concentrations meet the adopted SBEP chlorophyll criteria (Figure 3-12). SBEP also sponsored extensive investigations to determine appropriate limits for chlorophyll in the bay that would promote seagrass growth (Janicki Environmental, Inc., 2010, 2011).
- Ambient TN concentrations meet SBEP NNC (Figure 3-14). TN loads, and TP concentrations and loads also meet their respective criteria. A criterion is not met if it is not achieved in any 2 years of a 3-consecutive-year period. Although the TN concentration was not met in 2010 (Figure 3-14), it was met in 2008 and 2009; thus, the criterion was met. SBEP, Sarasota County, SWFWMD, and others supported work that resulted in establishing these nutrient targets and thresholds for the purpose of limiting algal growth rates and keeping chlorophyll concentrations at levels that promote seagrass growth.

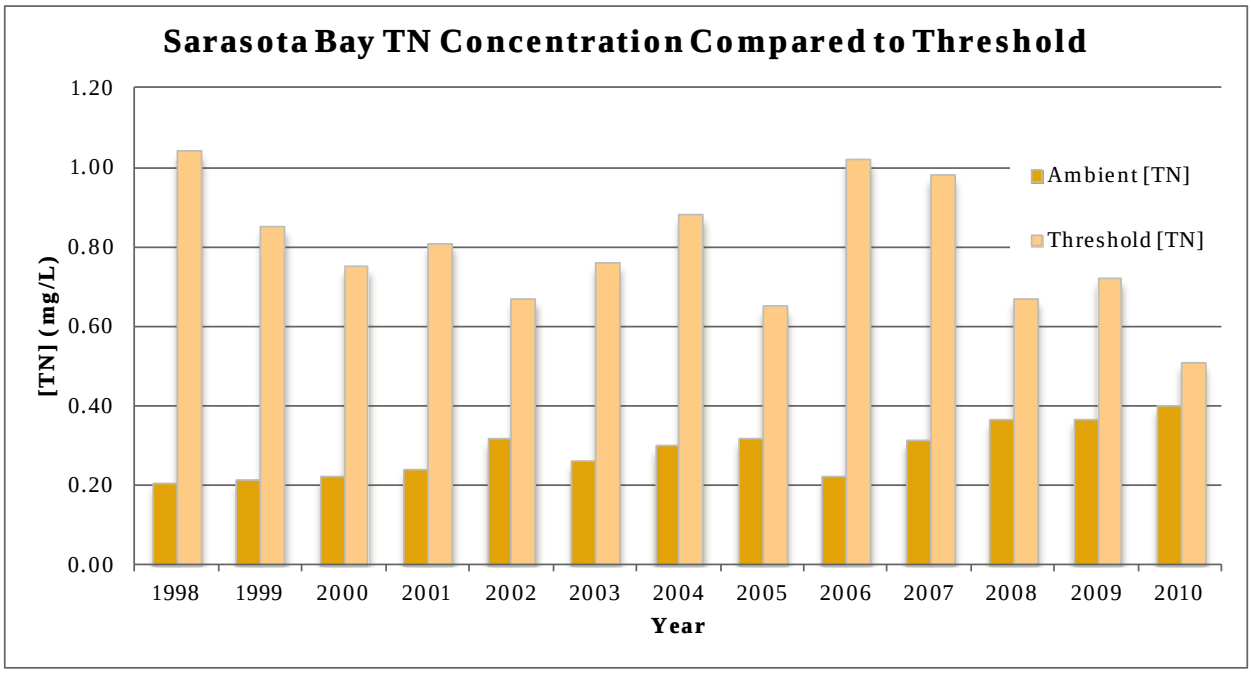


Figure 3-14 Comparison of Annual TN Loadings to Sarasota Bay to SBEP Threshold, which varies by year

❖ DO levels in the bay meet current and proposed DO criteria. In Florida DO has traditionally been held to a standard based on concentration. The DO standard for marine waters is a minimum concentration of 4.0 mg/L. Recognizing that the standard does not allow for variability in natural conditions based on water temperature or salinity, FDEP has proposed DO criteria based on percent saturation, which is the expected amount of DO in aquatic environments given ambient conditions. For predominantly marine waters (Class II and III, which includes Sarasota Bay), those standards are:

- The daily average percent DO saturation shall not be below 41.7%.
- The 7- and 30-day average percent DO saturations shall not be below 51.0 and 56.5%, respectively.

A review of in-bay DO concentration data revealed that both the existing and proposed standards were met each year of the period of record (1998 through 2010). This shows that algal growth, which can cause depressed DO at excessive rates, and inputs of oxygen consuming organisms (biochemical oxygen demand – BOD) are being successfully controlled in Sarasota Bay.

❖ No open bay segments are considered impaired under the State's Impaired Waters Rule (IWR) (Chapter 62-303, FAC). FDEP administers the EPA's Total Maximum Daily Load (TMDL) program in Florida. The TMDL program is intended to identify water bodies that are receiving a higher pollutant load than can be assimilated while maintaining the water body's designated use. If a water

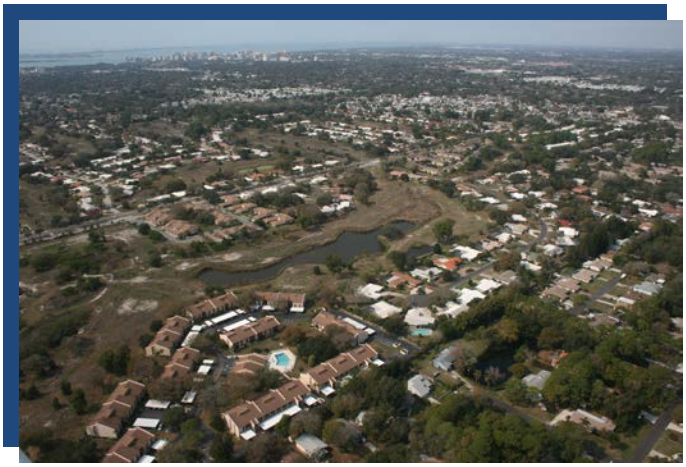
body does not meet State water quality standards according to IWR protocol, that water body is deemed "impaired." A TMDL may result that identifies excessive pollutant loadings and sources and specifies required reductions in pollutant loads to enable the water body to meet its designated use. No portions of the open water bay have been deemed impaired under the TMDL program, again providing evidence that water quality conditions in the bay are good overall.

Table 3-3 summarizes ambient water quality in Sarasota Bay as compared to Water Quality LOS. Although the above indicators provide abundant evidence of a healthy estuary, some local areas of the bay and some tributaries have water quality issues. A defensible strategy for managing bay water quality is to maintain current conditions overall; however, if isolated problem areas are identified then remedial action should be considered. Coastal areas and tidal portions of tributaries with limited circulation are especially vulnerable to water quality problems, as discussed below in Section 4.1.3, Section 4.2.3, Section 4.3.3, and Section 4.4.3.

Table 3-3 Summary of Water Quality LOS Targets for Sarasota Bay

Variable	Targets	Status
Seagrass (acres)	7,269	Meets criterion
Chlorophyll *a* (µg/L)	5.2	Meets criterion
TN Concentration (mg/L)	0.38	Meets criterion
TN Load (tons/year)	215	Meets criterion
TP Concentration (mg/L)	0.15	Meets criterion
TP Load (tons/year)	31.8	Meets criterion
Impaired Water Body	Varies by Parameter	Not Impaired

3.4 NATURAL SYSTEMS



While the Sarasota Bay Watershed still contains some beneficial upland, wetland, stream, and estuarine natural systems, the effects of urbanization and other land development have diminished their abundance, diversity, and beneficial functions. Approximately 10% of the watershed is comprised of undeveloped upland habitats and freshwater and estuarine (mangroves and saltmarsh) wetland natural systems, but only a fraction of these natural systems is in public ownership. As a result, the protection of the benefits provided by these remaining natural systems is even more essential.

3.4.1 Critical Estuarine Systems

3.4.1.1 Seagrass

Seagrasses are a fundamental component of the ecological structure of most Florida estuaries. Seagrasses provide numerous benefits including stabilizing sediments, providing refuge for juvenile fishes and invertebrates, and serving as a food source for manatee and sea turtles.

SWFWMD has performed aerial seagrass mapping surveys approximately biennially since 1988. Sarasota Bay appears to be somewhat stable with respect to seagrass persistence over time relative to other segments in Sarasota County. Despite the lack of persistence, the estimated acreage in 2010 (9,917 acres) (Figure 3-15) was 31% higher than that estimated from 1948 historical photographs (7,557 acres) and exceeds the target of 7,269 acres. The reason for the increase over time is not known but could reflect improved water clarity and quality. The improved water clarity and quality observed within Sarasota Bay are likely a result of improvements to the wastewater treatment system and expansion of the service area as well as stormwater regulations and LID retrofits/improvements that have been made. Seagrass targets for the bay are presented above in Section 3.3.3.

As previously mentioned, seagrasses are a critical component of estuaries such as Sarasota Bay and are important and useful indicators of the ecological health of an estuary. The recovery and positive seagrass coverage trends observed in Sarasota Bay is a true ecological success story and the continued effort of stakeholders should support this trend.

Photo Credit: Sarasota County

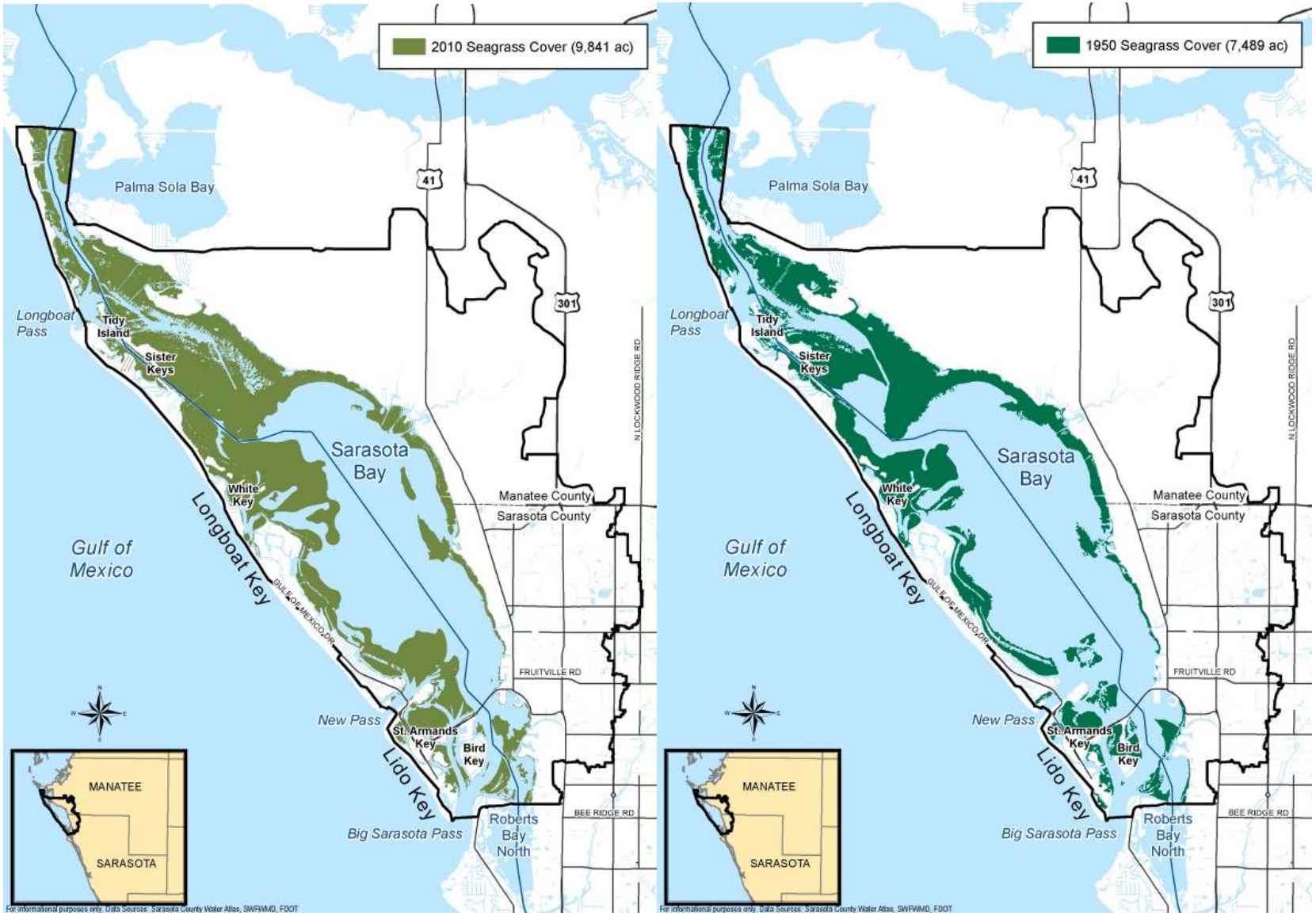


Figure 3-15 Left: 2010 Seagrass Coverage in Sarasota Bay; Right: Circa 1950 Seagrass Coverage in Sarasota Bay

3.4.1.2 Shoreline

The Sarasota Bay shoreline is not only the boundary of the estuary and the watershed but also plays an important role in the ecology of the system. Shorelines define the land-water interface and are ecological transition zones between terrestrial and aquatic life. Shorelines include a littoral zone where diverse habitat types affect the organization of floral and faunal assemblages and the interactions between terrestrial and aquatic plants and animals. Littoral zones are especially important in tidal water bodies. Human activities including mechanical dredging and filling and depositing channel spoil material have significantly altered the bays' shorelines since population began growing along the coast in the 1920s.

In 1948 Sarasota Bay had approximately 93 miles of shoreline, 37% of which was hardened. The historical areas with the most significant modification included the mainland in the City of Sarasota downtown waterfront as well as the barrier islands south of Longboat Key. Bird Key, St. Armands Key, Coon Key, City Island, and Bay Island were all products of early dredge-and-fill operations. Other areas along the mainland shoreline had also been modified by the late 1940s, as had the village of Cortez to the north, the north end of Longboat Key, and Anna Maria Island.

By 2008 the bay had 150 miles of total shoreline, an increase of over 60%. The additional shoreline is mainly dredge-and-fill canals but is also due to the emergence of numerous mangrove islands in the bay. Substantial shoreline hardening had taken place as well, increasing by over 150% to 138 km. See Appendix D, Section 2.3 for detailed information and figures showing the shoreline changes.

3.4.1.3 Oysters

Oysters are an important indicator of estuarine health, and their status can help identify water-management problems. Oyster reefs serve several valuable ecological functions. They provide habitat for estuarine fauna, including conch, mud crab, fish, and other bivalves (Wells, 1961; Tolley and Volety, 2005) and help improve water quality by filtering as they feed.

Sarasota County conducts an oyster monitoring program throughout its estuaries with two sites in Sarasota Bay—one in Hudson Bayou off Osprey Avenue and one in the bay south of the mouth of Hudson Bayou—to document the viability of existing oyster bars in the County's bays and tidal creeks. For the most recent 6 years of data collected, the percent-live oysters ranged from a high of 78% in fall 2006 to a low of 62% in spring 2009. These scores were generally

higher than percent-live oysters at an upstream site, which ranged from a low of 55% in fall 2006 to a high of 81% 6 months later.

Sarasota County contracted with Photo Science, Inc. in 2010 to conduct a photogrammetric survey of all oyster bars within County waters. In the south half of Sarasota Bay, oysters were most prolific along the shore of Longboat Key and City Island to the west and in the tidal reaches of Hudson and Whitaker Bayous to the east (Figure 3-16). A total of 87 individual oyster bars ranging in size from 0.01 to 0.25 acre and having a total areal extent of 3.8 acres were identified. Historically, oysters had a much greater range in the bay (Figure 3-16).

3.4.1.4 Scallops

Scallops are also an important indicator of estuarine health. Once plentiful along Florida's southwest coast, they now exist locally in greatly diminished abundance. Several potential causes of the decline in the scallop population include decline in available habitat, changes in water quality, and over-harvesting. This decline led to drastic changes in the way scallops were managed in State waters. In 1994, waters south of the Suwannee River were closed to commercial harvesting while recreational limits were reduced. Through a combination of restoration and management practices, the recreational fishery was re-opened in West-Central Florida but still remains closed in the Sarasota Bay estuarine system.

Sarasota County has partnered with Fish and Wildlife Research Institute (FWRI) and Albritton Farms in placing scallop monitoring traps in bays throughout the County. Drifting scallop spat attach themselves to the traps, which are collected every other month and taken to FWRI for laboratory analysis. Additionally, Sarasota County and Sarasota Bay Watch conduct annual scallop searches in the County's bays. Figure 3-17 shows the results of the 2008 search (Sarasota County, 2008). Based on field notes from the scallop searches, the most scallops were observed either near passes and/or in areas with seagrass meadows, their preferred habitat. The number of scallops observed in recent years has dropped, with 947 found in 2008, 136 scallops in 2009, and only 12 in 2010. However, as this is a volunteer effort, the number of scallops found may reflect the number of participants in the searches or may be caused by natural variability. Sarasota Bay had by far the most scallops found in any SBEP bay segment during the 2008 search.

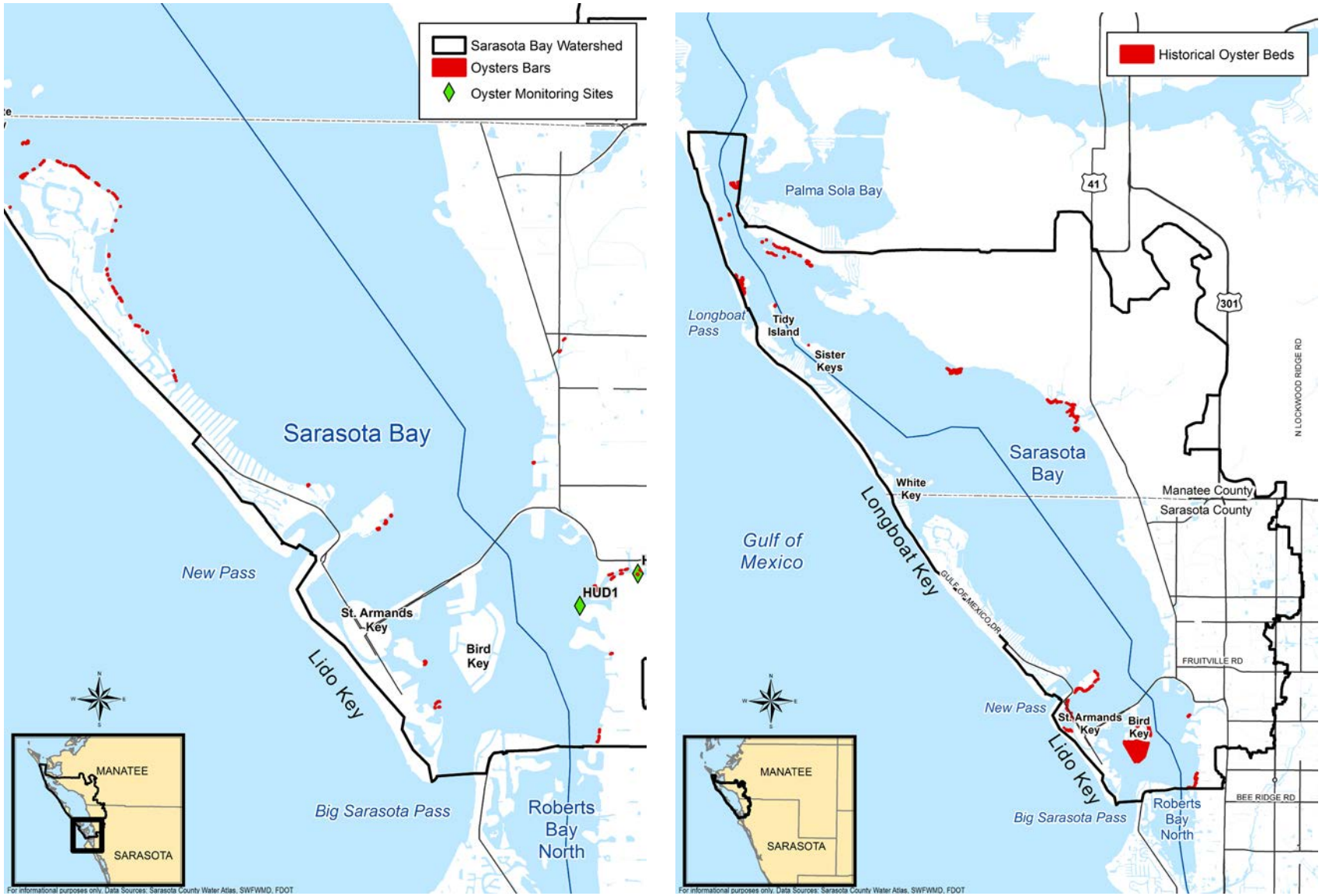


Figure 3-16 Left: Oyster Bars within Sarasota Bay; Right: Estimated Historical (1948) Oyster Beds in Sarasota Bay (Photo Science, Inc., 2007)

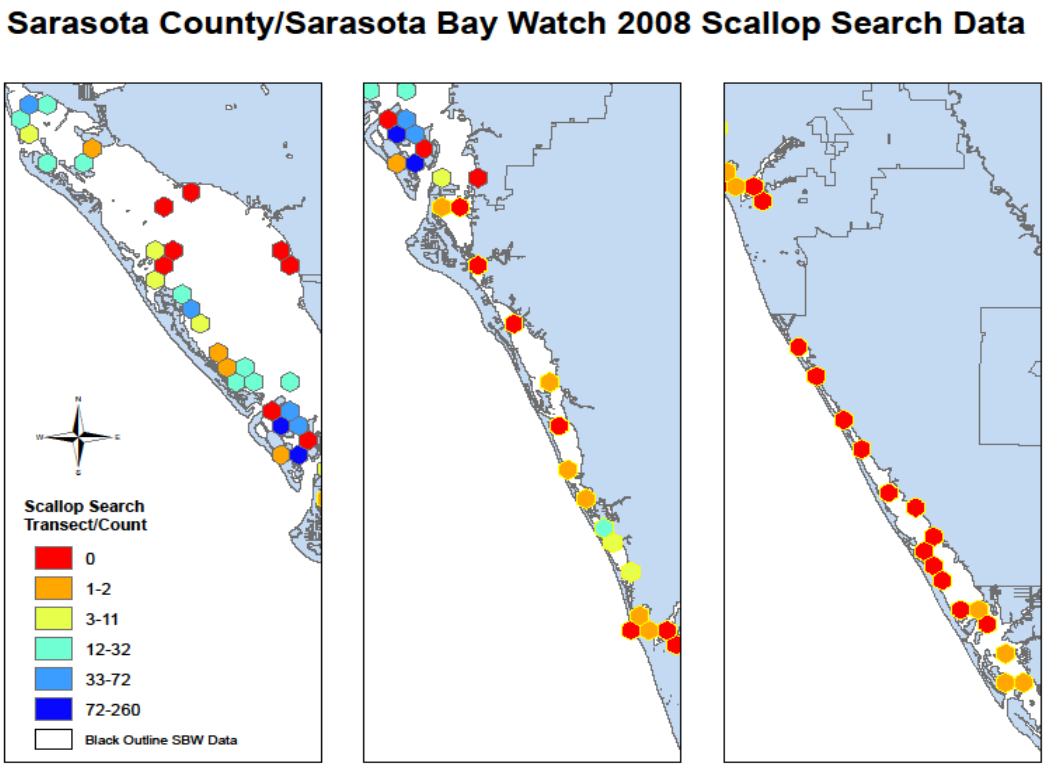


Figure 3-17 Results of 2008 Sarasota County/Sarasota Bay Watch Scallop Search

3.4.1.5 Tidal Creeks

Tidal creeks, or coastal streams as they are called in the Sarasota County Comprehensive Plan, are relatively small coastal tributaries that link between freshwater, terrestrial, and estuarine systems. Because of their close connection to the marine and freshwater systems, tidal creeks play a unique and integral role in the ecological function of coastal estuaries.

Two tidal creeks are tributaries to Sarasota Bay—Whitaker Bayou and Hudson Bayou. The physiography and history of these creeks have been documented in Appendix A – Project Background and Physical Setting, Section 1.3. As reported, these tidal creeks and their watersheds have been developed for urban land uses, with little remaining natural wetlands and floodplain.

Sarasota County conducted ecological monitoring and assessment in coastal creeks for the Sarasota County Tidal Creek Condition Index (TCCI) from 2008 through 2011. (Figure 3-18). Sixteen tidal creeks in Sarasota County are assessed annually. Whitaker Bayou was ranked lowest (poorest ecological quality) of the creeks scored, and Hudson Bayou had the fourth lowest score. The low scores suggest that these are significantly altered creek systems with ecological stresses caused by their urbanized watersheds.

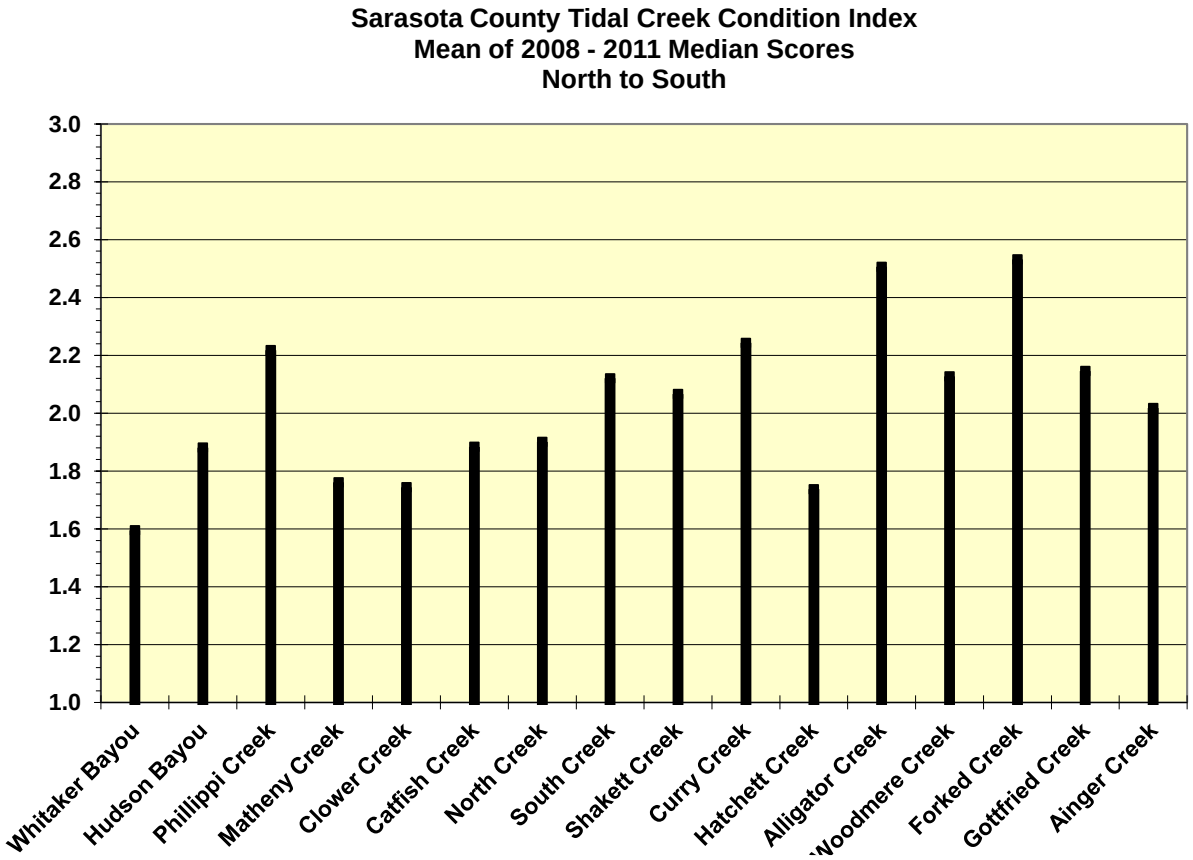
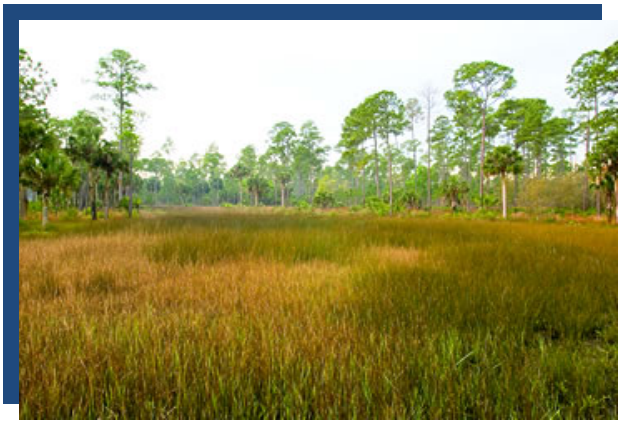


Figure 3-18 Tidal Creek Condition Index Scores (2008–2010)
Creeks in the Sarasota County portion of the Sarasota Bay Watershed (Whitaker and Hudson Bayous) are shown at left.

3.4.2 Freshwater Natural Systems

3.4.2.1 Streams



Small streams and wetlands provide crucial linkages between aquatic and terrestrial ecosystems and between upstream watersheds and tributaries and the downstream rivers and lakes. The health of Sarasota Bay's small streams is critical to the ultimate health of Whitaker Bayou, Hudson Bayou, and Sarasota Bay. The health of streams is often linked to changes that occur to the stream channel such as dredging, straightening, and removing the bank and adjacent vegetation. Due to the extensive

residential and commercial development that has occurred in Sarasota Bay, a majority of Whitaker and Hudson Bayous' freshwater tributaries have been dredged and channelized and are referred to as canals.

3.4.2.2 Wetlands

Wetlands are often referred to as the 'kidneys' of the landscape and are a significant factor in the health and existence of other natural resources of the watershed, such as rivers, streams, inland lakes, groundwater, wildlife, and estuaries. Wetlands play a key role in storing and modifying potential pollutants, such as chemical fertilizers, in ways that maintain downstream water quality. They also export organic carbon to streams and other downstream water bodies. In limited amounts, organic carbon is essential to maintaining a healthy aquatic ecosystem.

Based on 1940s aerial imagery, the Sarasota Bay Watershed contained approximately 11,463 acres of freshwater wetlands with herbaceous depressional marshes comprising 78% of the total wetland acreage. In 2008, Sarasota Bay had 1,384 acres of freshwater wetlands; 571 acres are herbaceous and 813 acres are forested. This is an 88% loss in wetland acreage for this 60-year period. Wetland losses are primarily due to filling to convert land to residential and commercial use or dredging to make water features (Figure 3-19).

Figure 3-19 Left: Pre-Development Aerial Depicting Numerous Freshwater Wetlands, Right: 2011 Aerial Depicting Historical Wetlands Now Residential and Commercial Land Uses

3.4.2.3 Natural Systems Results

Natural systems are self-sustaining living ecosystems such as wetlands, streams, seagrass beds, and upland vegetation communities that support a diversity of organisms and provide many valuable ecosystem-based services. Appendix D presented a summary and trends of the critical estuarine and freshwater natural systems found in Sarasota Bay. Six opportunities to enhance

existing or create natural systems on public lands were identified and conceptual designs developed (See Appendix G).

Positive trends were observed in seagrass coverage in Sarasota Bay, and efforts by stakeholders to achieve this should be a model for other watersheds. No clear trends were observed for oysters. Large losses of mangrove acreage have occurred in Sarasota Bay since the 1940s and before wetland protection regulations were implemented. However, small (<0.25 acre) patches of mangroves are now widely distributed in Sarasota Bay in areas not present historically. The County's mangrove monitoring program provides valuable data to assess mangrove extent and trimming practices. With over 90% of the parcels adjacent to major watercourses developed before 1995 and lacking a naturally vegetated watercourse buffer, the emphasis should be on persuading homeowners to incorporate naturally vegetated setbacks into their landscape rather than deterring buffer impacts on undeveloped parcels. An abundance of opportunities exists to work with homeowners to convert waterward portions of their backyards dominated by turf grass to native, low-maintenance species. Approximately 50% of the total shoreline in Sarasota County portions of Sarasota Bay has been hardened. The goal for natural shoreline should be to maintain existing extents while working to increase extents over time, even at a parcel-by-parcel level. Appendix D presents LOS targets and recommendations for several of these important natural systems.

3.5 FLOOD PROTECTION

The Sarasota Bay Watershed is subject to coastal and inland flooding. Coastal flooding sources include storm surge and wind-driven waves. Inland flooding results from excessive rainfall. Storm surges are caused by high winds, and coastal and inland flooding are usually associated with hurricanes or other tropical storms. The relatively flat and low-lying topography of Sarasota County makes it inherently prone to both types of flooding, and the County's "poorly drained" soils further promote inland flooding. Additionally, development has changed the natural environment within the Sarasota Bay Watershed and likely exacerbated the flooding problem before modern stormwater management regulations were implemented. Increased impervious surfaces throughout the heavily urbanized Hudson Bayou, Whitaker Bayou, and Sarasota Coastal basins have decreased rainfall infiltration, and gutters and storm sewers speed runoff to the channels. As a result, more water runs off more quickly, and drainage systems, including creeks, can become overloaded, leading to flooding.

The Sarasota County Watershed Management Program endeavors to address inland flooding. The County's goal with regard to flood protection is to minimize flood risk to protect human safety and property in existing developed areas while protecting natural and beneficial functions of the remaining floodplain. This WQMP does not contain new analyses of flood conditions since the conditions have been analyzed and recommendations for improvements were previously proposed. Instead, this WQMP provides an overview of existing flood-protection-related activities and previous flood-protection recommendations. This section is an important component of the WQMP as flooding in the watershed directly impacts water quality in the

tributaries and bay. Water quality best management practices (BMPs) are often designed to capture debris and sediment and remove pollutants during low-flow events and may not be as effective during larger storm events. Additionally, during large storm events, runoff may pool or flow in areas outside drainage systems, such as over roads or in parking lots, and may collect more debris and pollutants than a low-flow event fully contained within a drainage system with water quality BMPs. Therefore, reducing the risk of flooding is an important component of improving water quality in Sarasota Bay.

3.5.1 History of Flooding and Sarasota County Stormwater Program

Historically, the Sarasota Bay Watershed was predominately a mosaic of isolated wetlands and pine flatwoods. During normal seasonal cycles, the water in these wetlands expanded into pine flatwoods with wet-season rainfall and contracted to isolated pockets of wetlands during the dry season. In the early 1900s, residents of Sarasota County established a Mosquito Control District that installed ditches in mangrove areas along the coast and extended the natural creeks inland to connect many of the large, isolated wetlands. The result is a network of man-made drainage ditches that dramatically altered the movement of freshwater from the land to tidal creeks, estuaries, and bays and in turn extended the tidal influence inland. Over time many wetlands and floodplains were filled without mitigation or compensation, and impervious surfaces were created. As a result, flood storage capacity was reduced and runoff increased, raising flood stages and decreasing water quality in creeks and bays. Since much of the watershed is now densely populated, flooding affects homes, businesses, and agriculture in the floodplains, especially those areas developed before the adoption of County Land Development Regulations (LDR) in 1981 (Figure 3-20).

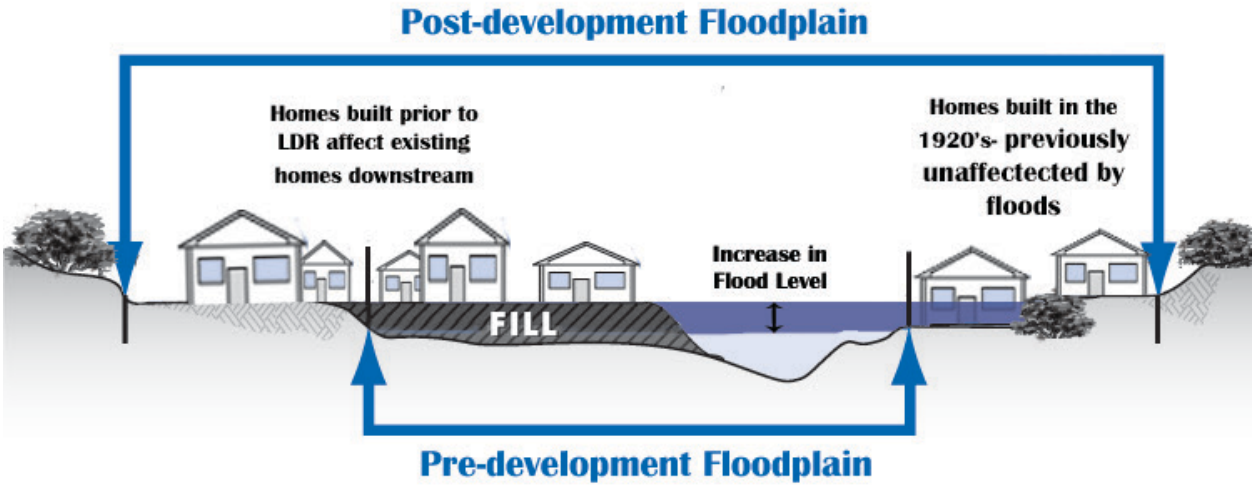


Figure 3-20 Floodplain Changes Schematic (Adapted from *www.dnr.sc.gov*)

Sarasota County took the first step toward developing a stormwater program in 1981 with the creation of the Stormwater Management Division. By the early 1990s, the Sarasota County Stormwater Environmental Utility (SEU) initiated a Countywide basin master planning project to

develop hydrologic and hydraulic models to identify problematic flooding areas for all of the County's major watersheds. These models are also used to analyze proposed drainage improvements to the County's stormwater system. The Hudson Bayou, Business District, and Whitaker Bayou Basin Master Plans were completed in 1994, 2002, and 2003, respectively. An addendum to the Hudson Bayou Basin Master Plan was issued in 1997. In addition, SEU continues to maintain the models by updating them periodically. The updated models are made available to developers to use as a base model to ensure that proposed projects will not impact neighboring areas.

In the mid-1990s, the LDR was modified to require stormwater systems to be designed for a 100-year storm (10 inches of rain in 24 hours). The County also started the first stormwater capital improvement assessments. The County then completed feasibility analyses for projects in problem areas identified in the Basin Master Plans. Several of these projects are included in the County's Capital Improvement Program (CIP). By the late 1990s, the SEU Strategic Plan was adopted and revenue bonds were issued to fund more stormwater improvement projects. Today, several CIP projects, such as stormwater control structures, retrofit projects, and retention and detention ponds, have been constructed throughout the Sarasota Bay Watershed.

For more information on Legislation and Ordinances in place to minimize damage caused by flooding, see Appendix E – Section 3.0.

3.5.2 Flood Protection Level of Service (FPLOS)

The stormwater quantity FPLOS requires that public and private stormwater management systems provide adequate control of stormwater runoff. The stormwater quantity or FPLOS and design criteria are defined in the Sarasota County Comprehensive Plan and LDR (Table 1) and used throughout the Basin Master Plan program (See Appendix E – Section 5.1).

The goal of the FPLOS design criteria is to prevent flooding of emergency shelters and structures providing essential services during storms equal to or exceeding the 100-year event (10 inches in 24 hours). The FPLOS goal for habitable structures and employment/service centers is no flooding from storms up to and including the 100-year storm. Flooding of garages, barns, sheds, and other out-buildings is not considered structure flooding. The FPLOS established for roadways varies depending on the classification of the street or roadway. The goal of these criteria is to prevent flooding of evacuation routes and major arterial roadways during storms up to and including the 100-year event. Figure 3-21 shows acceptable flooding for a 100-year storm. For more information the FPLOS and acceptable flooding criteria, See Appendix E – Section 4.0.

Figure 3-21 Acceptable Flooding for a 100-Year Storm

3.5.3 Planning Studies and Efforts

The drainage plans and programs from the early 1920s through the 1960s emphasized removing surface waters from the land, primarily for mosquito control and agricultural uses. Water quality did not begin emerging as a major concern until the late 1960s.

In 1984, the Board of County Commissioners recognized major inadequacies in the existing stormwater management system and authorized the preparation of a Stormwater Master Plan to assess the need for improving major drainage systems in the developed portions of the County. The objectives of the plan included:

- Assessing the adequacy of primary stormwater conveyance systems in developed or developing basins.
- Estimating the cost for public stormwater improvements as watersheds are developed to their ultimate use.
- Prioritizing stormwater management needs of each basin within a framework of the needs within the entire County.
- Developing a plan or identifying options available to the County for financing the cost of construction, operation, and maintenance of stormwater management facilities.

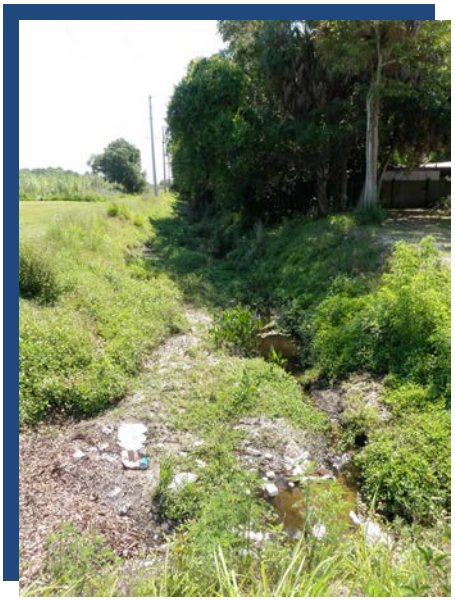
3.5.4 Basin Master Planning

Numerous hydrologic studies dating back to the late 1970s have been completed throughout the Sarasota Bay Watershed. The Basin Master Plans listed below were based on a detailed analysis of these studies, the existing and projected land uses, existing drainage facilities, and projected stormwater drainage management needs. This information was used to develop hydrologic and hydraulic models using ICPR’s routing engine to simulate runoff, conveyance, and flooding conditions for the Whitaker Bayou and Hudson Bayou Basins. Model results were used to identify the location and magnitude of existing flooding problems in the basins. Based on model results, the plans provide recommendations for facilities improvement and management standards that will need to be met by the private sector for new construction and the expansion of existing activities to bring stormwater conveyance systems within the basins into compliance with the recommended FPLOS criteria.

Sarasota Bay Watershed Basin Master Plans:

- *Whitaker Bayou – December 2003 and December 2004*
- *Hudson Bayou and Business District – September 1994*

3.6 SEDIMENT MANAGEMENT



Sediment production is a natural watershed process, but urbanization and other land-use changes can impact the processes associated with the sedimentation cycle: erosion, transport, and deposition. Within an urbanized setting like the Sarasota Bay Watershed, sediment production has two primary sources: wash-off from land surface and in-stream channel erosion. Bank steepness, degree of concentration (runoff velocity), and stability (e.g., vegetation) influence the quantity of the sediment load that reaches the waterbody. Increased sediment load from wash-off and in-stream erosion can affect water quality, natural habitat, navigation, flood control, and recreational uses downstream. In addition, alterations in circulatory patterns caused by dredging can re-suspend and transport existing sediments.

Sediment transported and deposited in waterbodies can disrupt aquatic ecosystems. Excess sediment can cloud the water, which can suffocate fish and block the light required by aquatic plants for photosynthesis. In addition, sediment-rich discharges tend to carry higher loadings of pollution because nutrients, pesticides, and heavy metals adsorb to and are transported along with sediment. Pollutants of concern including TSS, TN, and TP are associated with the sediment and contaminants attached to sediment in the Sarasota Bay Watershed.

Nitrogen and phosphorus are nutrients that occur in soils naturally. Increased erosion increases the nutrient load to the system. Other common sources of nitrogen and phosphorus in an urbanized area are septic systems, pet wastes, urban debris, grass clippings, fertilizer, industrial wastes, and landfills. Additionally, Florida's geology contains sedimentary deposits of marine origin, some of which are high in phosphorus content. The watershed's phosphorus-rich geology and soils, therefore, significantly influence the TP concentrations in the Sarasota Bay tributaries and estuary. Excess nutrients

combined with the tropical temperatures in Sarasota County can lead to excessive algal growth impacting the recreational aspects of the waterways as well as creating an oxygen deficit for the marine life and aquatic habitats.

Previous studies show some sediment in the Sarasota Bay tributaries (Whitaker Bayou and Hudson Bayou) contains substantial levels of contaminants, including toxic metals, pesticides, petroleum, and other organic compounds (Dixon et al, 1990, PBS&J, 2003). The Sarasota Bay Watershed is highly urbanized with older neighborhoods that provide only minimal stormwater retention or detention. The untreated runoff contributes sediment and associated pollutants to Hudson and Whitaker Bayous and Sarasota Bay. However, sediments in the bay proper have been reported to be uncontaminated.

Watershed management includes identifying sediment problems, identifying sediment sources, and recommending improvement projects that address the source as well as capturing sediment before it reaches the estuaries. Several potential sediment management projects were identified throughout the watershed for this plan. These potential projects incorporate strategies such as providing source control to reduce or remove solids in upland areas, implementing maintenance practices designed to reduce sedimentation, and improving eroding and sloughing banks for long-term stability.

Source control activities include activities such as LID projects, street sweeping, and construction-area silt fencing. Regularly scheduled maintenance activities include cleaning out baffle boxes, removing vegetation debris resulting from maintenance activities from swales and roadside ditches, replacing or repairing damaged infrastructure, and maintaining control structures, weirs, and pumps. Bank stabilization in an urban setting is challenging. For stabilization to be effective in the long term, management and restoration should not be limited to a single point in the stream but will be more effective when conducted as multiple projects along a channel system. Implementing projects that incorporate these strategies will reduce turbidity, increase clarity, and reduce nutrient and sediment load and therefore improve the overall health of the tributaries and Sarasota Bay.

See Appendix F for detailed Sediment Management Plan information for Sarasota Bay. Sediment management recommendations are summarized for each of the basins in Section 4 of this plan.

3.7 SARASOTA BAY WATERSHED SUMMARY AND RECOMMENDATIONS

The Sarasota Bay Watershed is relatively flat and has an average annual rainfall of 53 inches. The majority of the watershed has been altered, leaving only isolated natural and conservation areas for many threatened and endangered native species. Only about 10% of the watershed is undeveloped, which significantly affects water quality, water quantity (flow), habitat, and flooding risks. The highly urbanized watershed consists of a lot of older neighborhoods that provide only minimal stormwater retention or detention. The surface water runoff from the

rainfall flows across the watershed terrain through ditches, storm drains, creeks, and wetlands, and eventually into Sarasota Bay. The untreated runoff contributes sediment and associated pollutants to Sarasota Bay and its tributaries. Previous studies show some sediment in the Sarasota Bay tributaries contains substantial levels of contaminants, including toxic metals, pesticides, petroleum, and other organic compounds. However, sediments in the bay proper have been reported to be uncontaminated.

Freshwater inflows to Sarasota Bay originate from sources in nature and from human activities. Rainfall is the primary source of freshwater in the Sarasota Bay system. Atmospheric deposition (direct rainfall to the open water estuary) contributes the most freshwater to Sarasota Bay of any source (see Figure 3-22). This is because the relative size of the open water estuary is large with respect to the watershed land area.

The relative contributions of sources of freshwater for historical, current, and future conditions indicate that although freshwater inflows have increased since the historical period, future freshwater inflows to the bay as a whole should very much resemble current inflows. The only exception is for inflows from Whitaker Bayou, which will be reduced from current levels when discharges from the City of Sarasota wastewater treatment plant stop. No adverse effects due to changes to freshwater inflows are expected for the future.

Although the water quality indicators provide abundant evidence of a healthy estuary, some local areas of the bay or in tributaries have water quality issues. The entire bay currently meets State water quality standards; however, some of the watershed's stream segments have listed impairments. A defensible strategy for managing bay water quality is to maintain current conditions overall; however if isolated problem areas are identified then remedial action should be considered. Coastal areas and tidal portions of tributaries with limited circulation are especially vulnerable to water quality problems.

Several potential projects were identified throughout the watershed for this plan. These potential projects incorporate strategies such as providing source control to reduce or remove solids in upland areas, implementing maintenance practices designed to reduce sedimentation, improving eroding and sloughing banks for long-term stability, capturing excess runoff before it enters the streams, improving natural habitats, and providing buffers to capture nutrients. Implementing these projects will help the Sarasota Bay remain a healthy system.

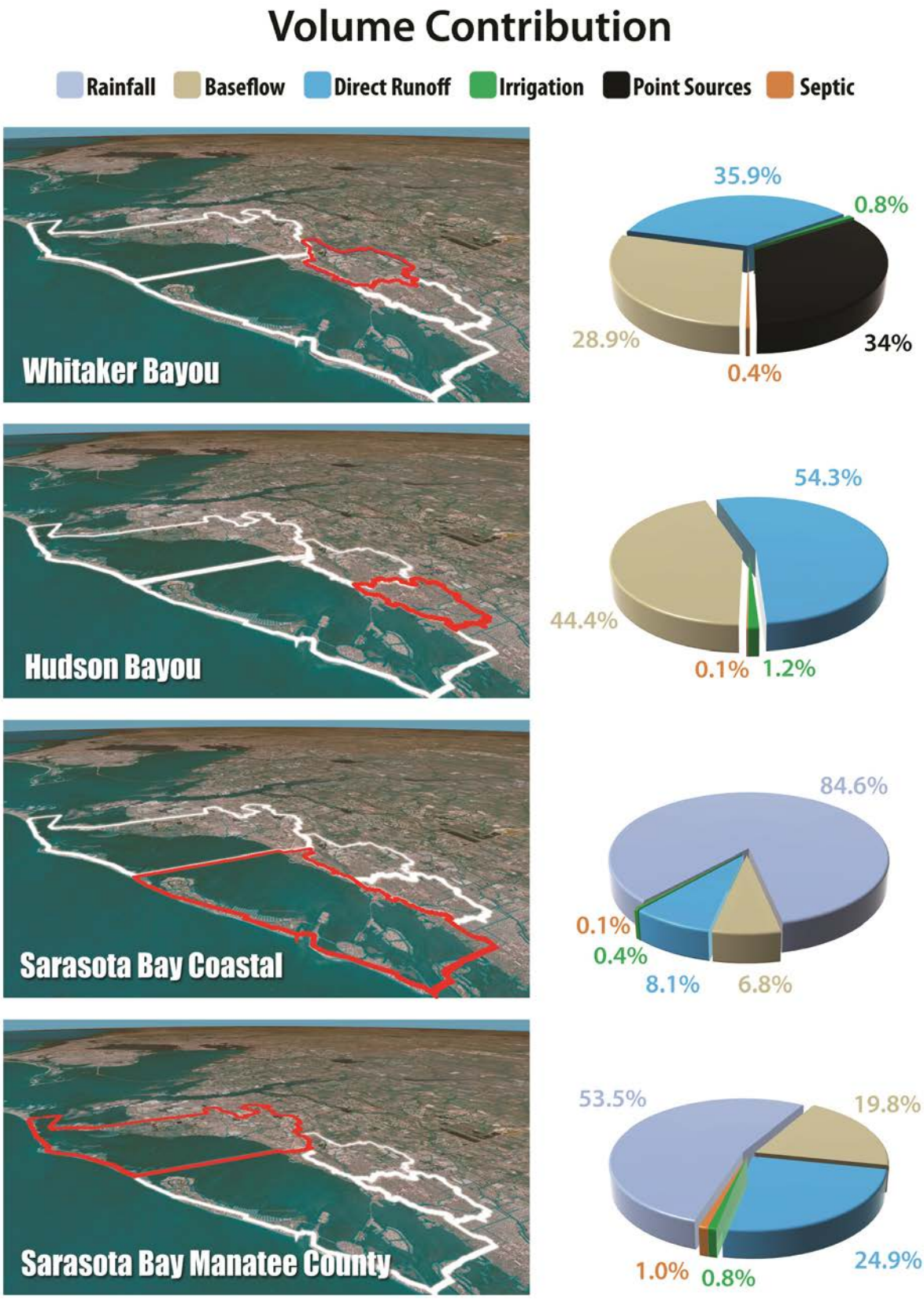


Figure 3-22 Volume Contribution by Source for each Basin

3.7.1 Project and Program Recommendations

Information was collected and assembled, including results from previous tasks, data collected from previous studies, GIS data, and stakeholder input, to identify potential projects in the Sarasota Bay Watershed. The investigation began with a GIS desktop analysis to identify water quality, sediment, natural systems, and water supply 'hot spots' throughout the watershed. These hot spots were then refined to potential project sites. Finally, field investigations were conducted to evaluate potential project options. This methodology is summarized in Figure 3-23. Benefits and costs, including capital and operation and maintenance costs, were calculated at a conceptual level for each recommended project. Non-quantitative benefits were also documented and considered in ranking the projects based on priority. See Section 4 of Appendix G for project benefits and Section 6 for conceptual-level project sheets and cost estimates.

While cooperative funding is provided by SWFWMD, the inclusion of proposed projects, corrective actions, and BMPs in this plan does not confer any special status, approval, permitting standing, or funding from SWFWMD. Requests for funding assistance will have to meet the requirements of funding programs and be subject to SWFWMD's Governing Board appropriating funds.

Further, all projects are subject to County and SWFWMD regulatory review and permitting and are designed to be consistent with the Sarasota County Comprehensive Plan and the Sarasota County Code of Ordinances. Where applicable, all regulatory authorizations shall be obtained before a project can begin. To address these concerns, regulatory coordination will occur at the planning stages for each project discussed in this WQMP to ensure a streamlined permitting review process and address consistency with the Sarasota County Comprehensive Plan and Sarasota County Code of Ordinances before the project is designed.

Twenty-eight projects are recommended throughout the Sarasota Bay Watershed. If all 28 projects were implemented, the County would benefit by removing approximately 1,900 pounds of TN annually and could prevent up to 26,511 cubic yards of sediment from entering the streams.

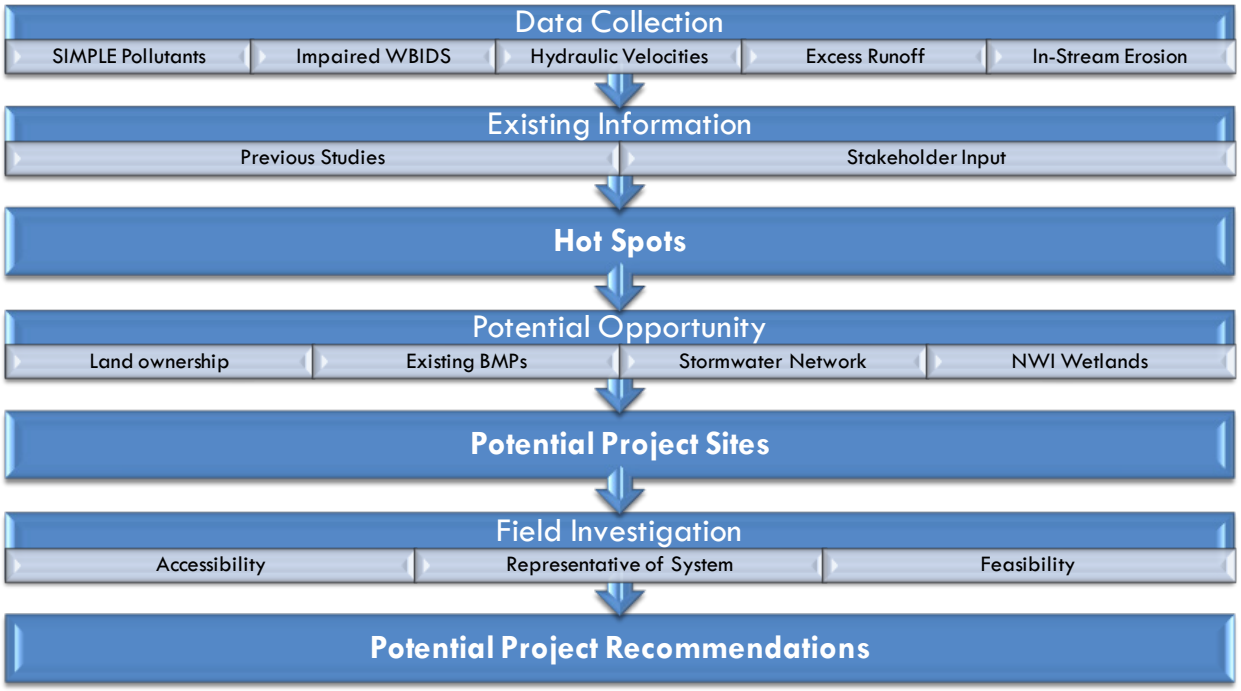


Figure 3-23 Methodology Used to Develop Potential Project Recommendations

Table 3-4 lists the projects by project rank calculated based on water quality regulatory impairments and benefit to cost ratio. Figure 3-24 shows the locations of each project in the watershed.

Table 3-4 Project Priority Ranks by Regulatory Requirement

Project ID	Project Name	Basin	Impairment	TN Reduction (lb/year)	Sediment & Erosion Prevention (cy)	Benefits / Costs	Priority Rank
Impaired WBID (FDEP Consent Decree) No TMDL							
NS5	Payne Park	HB	DO, Fecal Coliform	74	0	1.83	7
WS12	Lime Lake Park	WB	TN, DO, Fecal Coliform	0	0	1.67	8
NS6	Hudson Bayou Oak Street Canal	HB	DO, Fecal Coliform	9	0	1.07	12
WS05	Orange Avenue Park	WB	TN, DO, Fecal Coliform	18	0	1.06	13
WQ5	Hudson Bayou North Branch	HB	DO, Fecal Coliform	9	0	0.82	16
WQ10	Ringling Blvd. Sidewalks	HB	DO, Fecal Coliform	20	0	0.23	21
WS10	Martin Luther King Park	WB	TN, DO, Fecal Coliform	1	0	0.02	26
No Impairment							
NS4	North Water Tower Park	WB	-	775	0	5.10	1
WS04	Arlington Park and Aquatic Complex	HB	-	0	0	4.64	2
NS2	Bayfront Park Shore	SBC	-	0	2270	3.80	3
SMP6	Sarasota High School at Hatton Street	HB	-	105	21574	2.88	4
SMP2	Whitaker Canal at Leonard Reid Ave	WB	-	157	1400	2.86	5
NS1	Arlington Park	HB	-	61	0	2.54	6
SMP3	Orange Avenue	HB	-	90	85	1.37	9
WS07	Gillespie Park	HB	-	0	0	1.18	10
SMP7	Sarasota High School at Tamiami Trail	HB	-	16	0	1.17	11
WQ2	Bayfront Parking Lot	SBC	-	217	0	1.04	14
SMP5	Bayfront Park and Marina South	SBC	-	31	0	1.03	15

Table 3-4 Project Priority Ranks by Regulatory Requirement

Project ID	Project Name	Basin	Impairment	TN Reduction (lb/year)	Sediment & Erosion Prevention (cy)	Benefits / Costs	Priority Rank
WQ7	10th St Outfall	SBC	-	192	0	0.63	17
WS02	Bay Haven Elementary School	SBC	-	4	0	0.63	18
NS3	Longboat Key Bayfront Park	SBC	-	17	0	0.57	19
SMP4	Bayfront Park and Marina North	SBC	-	14	0	0.39	20
WS11	Robert Taylor Community Complex	WB	-	1	0	0.20	22
WQ1	North Gillespie Park	HB	-	0	460	0.11	23
WS06	Ken Thompson Park Preserve	SBC	-	11	0	0.11	24
SMP8*	10th St Boat Basin Dock	SBC	-	0	630	0.05	25
WQ9	Hudson Bayou East Branch	HB	-	0	92	0.02	27

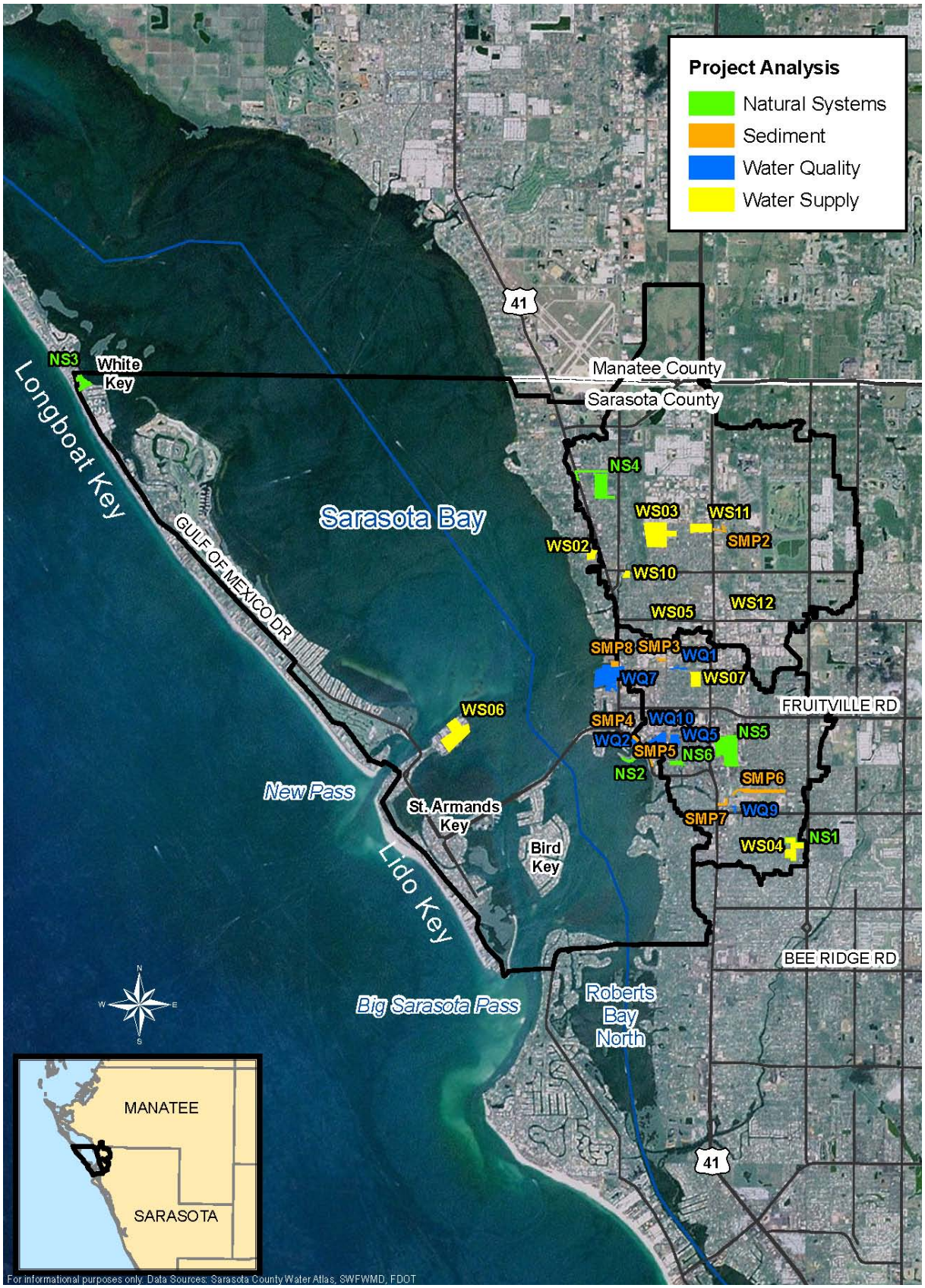


Figure 3-24 Location of Recommended Projects in the Sarasota Bay Watershed

In addition to the 28 projects identified above, 26 programs were also recommended as part of this WQMP. The recommended programs are centered on sustainability and conservation in Sarasota Bay and throughout Sarasota County (Table 3-5). Some have direct nutrient-reduction impacts, while others have less quantifiable impacts but are important to improving environmental quality throughout the County. See Appendix G – Section 5 for more information on recommended programs.

Table 3-5 Program Recommendations

Section	Program Name	Existing County Program
5.1	Stormwater Harvesting	
5.2	Rainwater Harvesting/Cisterns	Yes
5.3	Fertilizer Ordinance	Yes
5.4	Watercourse Setback	Yes
5.5	Septic Tank Pump-Out Regulation	Yes
5.6	Public Outreach and Education	Yes
5.7	Teacher Training/Campus Projects	
5.8	Aquatic Harvester	
5.9	Street Sweeping	Yes
5.10	National Pollutant Discharge Elimination System (NPDES)	Yes
5.11	Facilitating Agricultural Resource Management Systems	
5.12	Preservation Areas	Yes
5.13	Mangrove Monitoring	Yes
5.14	Shoreline Softening	
5.15	Septic Replacement Program	Yes
5.16	Septic to Cistern	Yes
5.17	Strategic Maintenance Manual	Yes
5.18	Stormwater Manual	Yes
5.19	Composting Pilot Study	
5.20	Low-Impact Development (LID)	Yes
5.21	Exotic Plants Management Program	Yes
5.22	Boat Ramp BMP Program	
5.23	Irrigation Utilities for New Development	Yes
5.24	Public Education on Water Conservation Practices	Yes
5.25	Potable Water Demand-Side Management Analysis	
5.26	Florida Water Star^{SM}	Yes