LIVING SHORELINES:

Guidance for Sarasota Bay Watershed

SARASOTA BAY
ESTUARY PROGRAM
Protecting Our Water Heritage

Prepared for
Sarasota Bay Estuary Program

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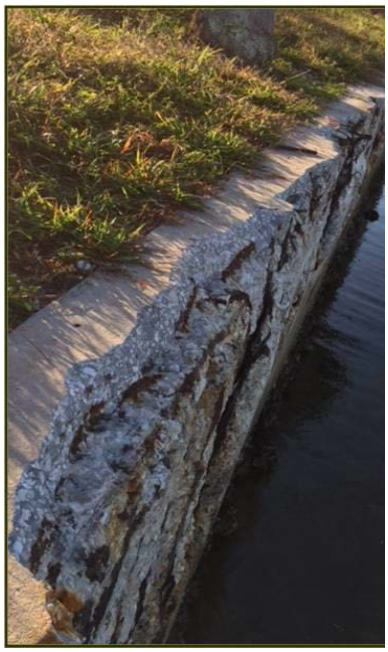
ESA SCHEDA



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SECTION 1
Purpose of the Document

Southwest Florida is one of the fastest growing urban areas in the United States. As the population and density of residents along the shoreline increases, there is a heightened demand for hardened shorelines within the Sarasota Bay Watershed. Southwest Florida shorelines are eroding at -0.8 to -0.9 meters per year, and over 50% of the shoreline is experiencing erosion (Morton *et al*. 2004). These figures are low compared to much of the rest of the Gulf Coast, however, the region's urban nature makes erosion a complicated and expensive problem for local governments to address. It is the intent of this document to share potential nature based options for shoreline stabilization that provide wildlife habitat, adapt to changing sea levels, and protect properties from storm damage.

This "living shoreline" concept addresses multiple action plan goals outlined in the Sarasota Bay Estuary Program's (SBEP's) 2014 Comprehensive Conservation and Management Plan (CCMP). The freshwater and saltwater wetlands action plan goal is to restore shorelines and wetland habitats and eliminate further losses. For fisheries and other living resources, the action plan goal is to restore and sustain fish and other living resources in Sarasota Bay. The preponderance of armored shorelines throughout Sarasota Bay and its smaller embayments precludes the full realization of these goals. For regulatory agencies charged with protecting the health of our estuaries, the management challenge is finding ways to allow property owners to protect their real estate while minimizing long-term environmental damage to fish, wildlife, and the systems that support them. This document will provide the tools necessary for individual homeowners, marine contractors, regulators, scientists, and coastal engineers to decide if a living shoreline is a suitable option for protecting and enhancing various waterfront properties. Specifically, the document will: summarize existing living shoreline and shoreline restoration projects in South Florida, review the benefits of living shorelines, provide sample "in the ground" project locations, and information on siting, design, and permitting considerations to facilitate the incorporation of living shorelines concepts into public and private project sites.

SECTION 2
Living Shoreline Overview

2.1 What Are Living Shorelines?

Researchers from the University of North Carolina-Chapel Hill and the National Oceanic and Atmospheric Administration (NOAA) have documented approximately 12,500 miles of coastline in the United States which been hardened with manmade structures (RAE, 2015). This distance represents approximately 14% of the entire United States (US) shoreline and 66% of the hardening has taken place in the southern Atlantic and Gulf Coast regions. Florida has one of the longest shorelines within the US and much of this has been altered by the addition of structures such as seawalls and bulkheads.

Armored shorelines are often perceived to be necessary to protect coastal lands and developments from being inundated with tidal waters. Over time, collective observation and rigorous scientific studies of these structures has shown the opposite and revealed their damaging effects. Seawalls and bulkheads perpetuate erosion by deflecting wave energy and causing erosion to adjacent properties. Their presence eliminates the intertidal zone which is critical habitat to many fish, invertebrates, birds, and floral species. They can also degrade water quality by preventing the growth of intertidal plants that remove nutrients from the water column and by increasing turbidity. Finally, armored shorelines interfere with natural sediment transport and reduce public water access. These structures are costly to maintain and ultimately fall into disrepair. Additionally, over the last 100 years, sea levels in Florida have risen in accordance with the global average of six to eight inches (Merrifield 2009). The rate at which the level of the sea is rising began increasing more sharply in the 1990s and current global predictions for the year 2100 range from 10 inches to over three feet over current levels (IPCC 2013). Seawalls and bulkheads are static structures which do not provide any adaptive benefits to dealing with rising water levels. The living shoreline concept can reverse the negative effects of hardened shorelines in many scenarios.

There are many definitions of what a living shoreline is; the recent Restore America's Estuaries' definition is now widely used (RAE 2015). This defines living shorelines as: "any shoreline management system that is designed to protect or restore natural shoreline ecosystems through the use of natural elements and, if appropriate, manmade elements. Any elements used must not interrupt the natural water/land continuum to the detriment of natural shoreline ecosystems." This concept seeks to restore natural shorelines in an effort to protect a wide range of ecosystem services, control erosion, prevent catastrophic flood and storm damage, and restore critical habitat to wildlife and plants. Living shorelines are not exclusive to coastal areas, they can also provide

erosion protection and ecological benefits for non-tidal waterbodies such as creeks, rivers, and lakes.

2.2 Why Hardened Shorelines are not Always the Answer for Erosion Protection

Vertical structures such as bulkheads and seawalls have been the most commonly used technique for shoreline protection and in some areas where there is high wave energy, they may be the most effective alternative. However, in many situations hardened structures are not always the best solution. Some of the detrimental effects of armoring include:

- Perpetuation of erosional forces;
- Causing erosion to adjacent property owners;
- Sediment scour in front of the wall;
- Costly to construct and maintain;
- Loss of habitat due to the elimination of the intertidal zone;
- Degradation of water quality due to lack of nutrient uptake by vegetation; and
- Interference with the natural sediment transport.

Failed Seawall

2.3 What are the benefits associated with living shorelines?

Living shorelines provide a nature based alternative in lieu of hardening when the site conditions are favorable. Below are some of the most notable benefits for utilizing a living shoreline:

- Erosion control;
- Restore and enhance shoreline habitat for valuable and protected species;
- Increase aesthetics and property values;
- Improve water quality by incorporating plants for nutrient uptake;
- Property protection i.e. absorb wave energy, storm surges, flooding events;
- Less expensive than traditional hardened shorelines; and
- Adaptive capacity for sea level rise.

Living Shoreline Solution after Removal of a Seawall at the Honi Hanta Girl Scout Camp in Bradenton, Florida

SECTION 3
Status of Shorelines in Sarasota Bay Watershed

In 2002, a study was conducted which sought to characterize the shorelines of the Sarasota Bay Watershed. This research is publically available on the SBEP website in the State of the Bay Report (CCMP, 2014). Anna Maria Island in the north, to just north of Lyons Bay to the south. Aerial photography from 1998, 1999, and 2001 was provided by the Southwest Florida Water Management District (SWFWMD), Sarasota County government and Manatee County Government. Photointerpretation of this data and select field-verification were used to map shoreline features. The following classifications and definitions were used for this research.

- Beach – Sandy, sloped area with little or no vegetation;
- Bulkhead – Seawall, usually made of poured concrete, or corrugated metal;
- Deep wetland – Continuous vegetated buffer composed of wetland plants >5 meters in width;
- Patchy wetland – Non-continuous seagrass buffer <5 meters in width;
- Rip-rap – Shoreline armoring consisting of piled-up rocks, stones, or concrete rubble, designed to reduce erosion;
- Solid wetland – A continuous vegetated buffer composed of wetland plants <5 meters in width; and,
- Upland shoreline – High and dry, unarmored shoreline, usually resulting when a canal is cut through an upland area; may or may not be vegetated.

The results of this study are notes in **Table 3.1.** At the time of the study, 45% of the Sarasota Bay watershed shorelines consisted of bulkheads. Note that bulkheads have the greatest total linear footage of all seven classification types.

TABLE 3.1 2002 SARASOTA BAY WATERSHED SHORELINE MORPHOLOGY STUDY RESULTS

Shoreline Classification	Linear Footage	Percent of Total
Beach	92,207	4%
Bulkhead	967,198	45%
Deep wetland	544,952	25%
Patchy wetland	75,201	4%
Rip-rap	197,873	9%
Solid wetland	183,193	9%
Upland shoreline	82,445	4%
Total	**2,143,069**	**100%**

In 2016, Sarasota County staff conducted a Mangrove Shoreline Assessment of shorelines in unincorporated Sarasota County (Mangrove Shoreline Assessment, Poster 2016). One of the intents of this extensive field analysis was to quantify the extent of mangrove trimming throughout the County. As part of the data collection effort, staff scientists also identified existing hardened shorelines. The results are summarized in Table 3.2. The two studies are not directly comparable because the Sarasota County study does not fully encompass the Sarasota Bay watershed, but the new information does emphasize the vast numbers of hardened shorelines in Sarasota County.

TABLE 3.2 SARASOTA COUNTY SHORELINE MORPHOLOGY 2016

Study Area	Bulkhead	Revetment	Other	Unknown	Mangroves	<30% Mangroves
Alligator Creek	7	21	41	1	98	26
Blackburn Bay	120	150	54	16	304	218
Forked Creek	223	31	33	1	9	
Gottfried Creek	28	35	3	3	61	230
Grand Canal	736	75	55	1	123	48
Hatchett Creek	86	7	5	3	142	728
Lemon Bay	171	72	78	5	15	86
Little Sarasota Bay	636	67	135	2	431	249
Lyons, Dona & Roberts Bay	260	106	37	35	447	666
Phillippi Creek	140	83	52	7	339	311
Roberts Bay	146	30	3	2	98	236
Shakett Creek	68	164	99	38	189	131
South Creek	2	121	8	2	278	167
Curry Creek			8		105	54
Total Parcels	2,623	962	611	116	2,639	3,150

Another recent study entitled Living Shoreline Treatment Suitability Analysis: A Study on Coastal Protection Opportunities for Sarasota County (Dobbs et.al) utilized geographic information system (GIS) to provide a suitability analysis for different types of living shoreline treatments along the coastlines throughout Sarasota County.

The model identified three types of coastlines:

1. Areas that are suitable for a living shoreline treatment;

2. Coastlines suitable for a hybrid solution (combination of natural and structural methods); and

3. Not suitable for living shorelines.

The designations were based on a variety of parameters that could be assessed utilizing existing GIS information. The parameters included: bathymetry, land use, land value, population, shoreline habitat, sensitive shorelines, tree canopy, wave energy and the results from the individual analysis for each parameter was combined and used as an overlay approach to provide a suitability analysis for the study area. The results of the study encouraged alternative methods of coastal protection for Sarasota County shorelines. The results of this suitability analysis stated that 95% of the shorelines in the County may be candidates for hybrid living shorelines (Dobbs et. al).

The most recent comprehensive data source that gives an overview of the status of shorelines is provided by NOAA's Environmental Sensitivity Index (ESI) Shoreline Data, which was cross referenced with GIS parcel data that identifies publically owned lands within in the Sarasota Bay Watershed. The information gleaned from this GIS effort identified over 50 waterfront public parcels,many of which have dilapidated seawalls or no shoreline protection at all. All of these parcels could be candidates for living shoreline projects. The potential projects will need to be ground-truthed to assess existing conditions before recommendations for living shorelines are identified.

It is imperative to choose the appropriate site-specific living shorelines and often the best way to make that decision is to assess other projects and learn what works and what does not work. Section 4 provides specific examples of regionally important and success Living Shoreline projects.

SECTION 4
Regionally Successful Projects

4.1 Examples of Regionally Success Living Shoreline Projects

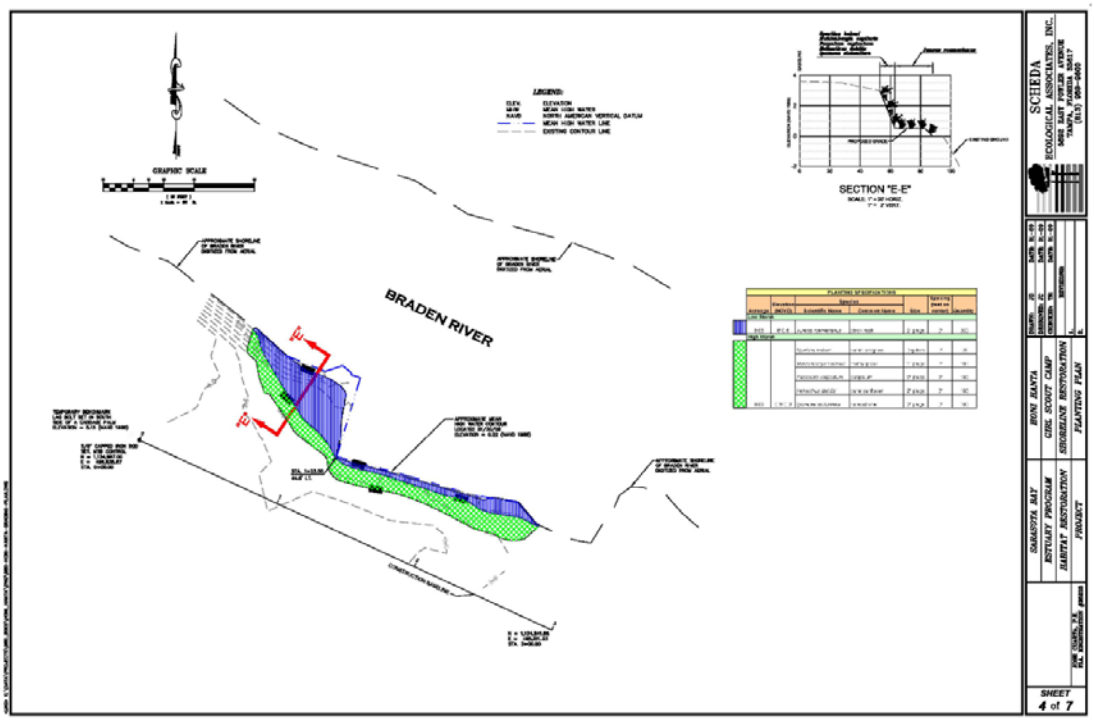
The following example projects were assembled to illustrate effective living shoreline implementation sites within this region. Each example sheet includes design plan views, projects facts, and site photos to illustrate potential types of living shoreline solutions applicable to this region. Please note that each design solution was customized for that particular site and may not be applicable to other potential site locations as there are many factors that must be considered inclusive of slopes, sediment types, water depths, and energy climates which will affect the ultimate design options. Special attention was given to projects that encourage sediment accretion and potential mangrove recruitment.

A broader summary of existing living shorelines projects permitted within south Florida is provided in **Appendix A.** These 36 projects were identified by consulting with Sarasota County, Manatee County, the Florida Department of Environmental Protection (FDEP), SWFWMD, Florida Atlantic University, and the Nature Conservancy; this was supplemented with information provided by Thomas Ries who has extensive experience in living shoreline projects. This report focuses primarily on living shoreline projects, as defined by RAE. Although there are some Seawall Enhancement Projects (SEPs) within the region, which do provide some ecological value via the installation of riprap with native vegetation in front of an existing seawall, these projects were not included in this summary as the vertical structure (seawall) is still in place and thus they are not considered a true living shoreline example, since they are only short term solutions and area still vulnerable to rising water levels.

Honi Hanta Girl Scout Camp, Sarasota, Florida

The SBEP, in cooperation with the Girl Scouts of Gulfcoast Florida, Inc. (Girl Scouts), collaborated on a restoration project at Camp Honi Hanta, located on the Braden River. The selected habitat restoration project was accomplished through the removal of approximately 250 feet of seawall as well as the adjacent nuisance exotic vegetation, regarding of the slopes to reestablish a more natural bank slope, and the planting of native vegetation. Re-vegetation with native plants increased the water quality and wildlife habitat for this area. In this case, the restored banks were planted with native marsh grasses, with the help of the girl scouts, and within two years, mangroves trees naturally recruited the site, as anticipated. Approximately ½ acre of earthwork and 2 acres of exotic removal and re-vegetation were performed at this site. This restoration effort greatly improved juvenile fish habitat and help to increase fish production within Sarasota Bay. The overall benefits of this living shoreline project included the elimination

non-native plants, improved water quality, re-established natural shoreline gradient, and the recovery of mangrove and salt marsh communities. It is believed that the loss of these vital habitats and associated declines in water quality has resulted in historic reduction of fisheries in Sarasota Bay.



Before

After

Funding: US Fish and Wildlife Service (USFWS)

Type of Living Shoreline: Native Vegetation

Materials: Seawall removal, Excavation, Native Estuarine Plants

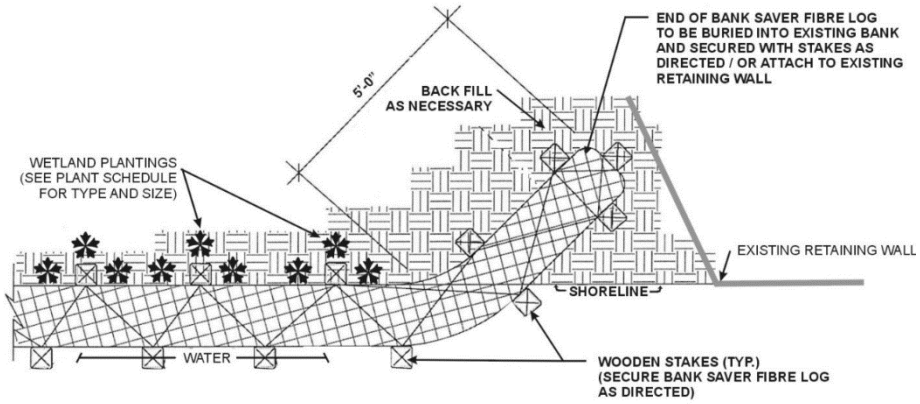
Energy Level: Low

Contact Person: Dr. Jay Leverone (SBEP) 941-955-8085

Lessons Learned: Perfect example of a site that never should have had a seawall installed.

Rivercrest Park, Tampa, Florida

For this City of Tampa project, the banks were re-contoured to a gentle slope and Fibre™ Logs were placed water ward of the newly installed native wetland plants. The Fibre™ logs naturally breakdown over time (~18 months). By then the native vegetation is well established and protecting the shoreline.



Before

After (2 years post-installation)

Grant Funding: Tampa' Shoreline Restoration Initative (TSRI) and National Fish and Wildlife Foundation (NFWF)

Type of Living Shoreline: Native Vegetation and Fibre™

Materials: Mangroves, Geo Web (canoe launch site), and Coir Fiber/Coconut

Energy Level: Low/Moderate

Contact Person: Thomas Ries, ESA Scheda 813-989-9600

Lessons Learned: The fiber log protected the immature plants and they coalesced quicker than anticipated.

Living Shoreline Demo Project at Bayfront Park, Sarasota, Florida

The Sarasota Bay Estuary Program (SBEP) worked with the City of Sarasota to implement a living shoreline demonstration project at City Park in downtown Sarasota. For this project, ESA Scheda designed a planting palette of native wetland species that can be used to stabilize low energy shoreline areas in Sarasota Bay. The photos show the before and after results. The site has a large informational sign that explains the purpose of the de. The sign also included a Quick Response (QR) code that directs people using their smart phones to the SBEP's website and further educates the general public about the benefits of living shorelines.

Before

After

Funding: SBEP and Southwest Florida Water Management District (SWFWMD)

Type of Living Shoreline: Native Vegetation

Materials: Native Estuarine Plants

Energy Level: Medium

Contact Person: Dr. Jay Leverone (SBEP) 941-955-8085

Lessons Learned: This site has subsequently withstood hurricanes (Matthew and Irma - Cat 2)

Canaveral National Seashore

University of Central Florida (UCF) professors Drs. Linda Walters and Melinda Donnelly along with their students worked on three living shoreline projects designed to promote sediment accretion at a rate that exceeds sea level rise, which resulted in more than 720 meters of living shoreline. The three living shoreline zones consist of red and black mangroves in the upper tidal zone, smooth cordgrass in the middle zone, and oysters in the lower intertidal zone. Post construction monitoring documented an increase in sediment landward of the oyster bags and increased wildlife utilization.

Funding: Brevard Zoo, National Park Service, Coastal Conservation Association, New Smyrna Beach Marine Discover Center, Indian River Lagoon NEP, local public schools from five counties, and NOAA.

Type of Living Shoreline: Combination of native plants and oyster bags

Materials: Mangroves, native estuarine plants, oyster shell from local restaurants

Photo from PATimes.org

Energy Level: Medium

Contact Person: Melinda Donnelly, Melinda.Donnelly@ucf.edu

Lessons Learned: Post construction sediment measurements showed an increase of 3 cm. within six months landward of the oysters.

Lake Worth Lagoon Living Shorelines

A 2,000 ft. long rock revetment was installed 8 ft. waterward of the existing seawall in the Lake Worth Lagoon. A filter fabric was placed under the rock and red mangroves were planted between the rock and seawall.

Photo from Florida Living Shorelines website

Within Lake Worth Lagoon the **Bryant Park** site included a 575 ft living shoreline and a 125 ft. wetland planter that retained soils for intertidal plants, provided substrate for oyster recruitment, while still alloweing fish passage.

Funding: Lake Worth Lagoon- Palm Beach DERM, FDEP, Palm Beach County, and the National Endowment for the Arts

Type of Living Shoreline: Combination of native plants and rock revetment; infront of a seawall

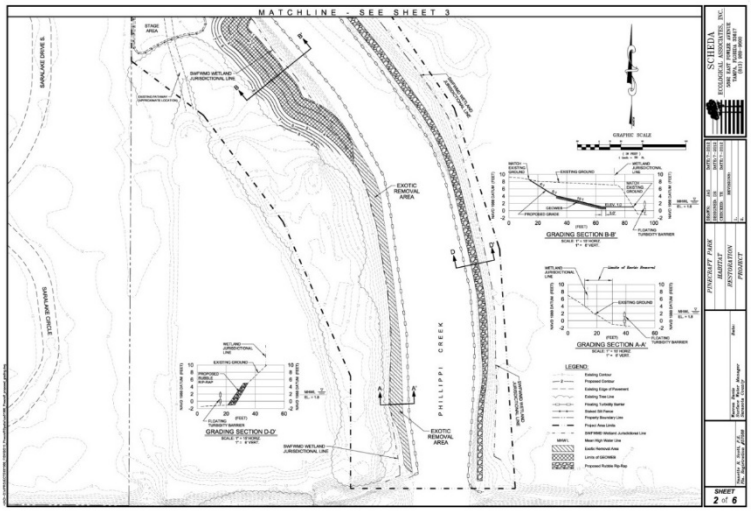
Materials: Mangroves rock or concrete

Energy Level: Medium

Contact Person: Eric Anderson, 561-233-2400

Pinecraft Living Shoreline Project along Phillippi Creek, Sarasota

This project was designed with Geoweb™ material to stabilize the banks and allow for the installation of native freshwater wetland species. One year later, the resultant living shoreline slope is pictured below.



Funding: Sarasota County

Type of Living Shoreline: Native Vegetation

Materials: Geoweb™, Native Freshwater Plants and Coconut Fiber Mat

Energy Level: Low

Contact Person: Dianne Rosensweig, ESA Scheda 941-373-1547

Lessons Learned: Upstream conditions consisted of dense exotic vegetation creating a constant seed source issue which requires perpetual maintenance.

Stewart Middle School – Shoreline Restoration Project, Tampa, Fl.

One of the longest living shoreline projects (2,000+ linear feet) ever completed along the Hillsborough River in Tampa, this project is located on Hillsborough County School District property, specifically at the Stewart Middle School site. The shoreline had a 4-6' escarpment and was completely covered with non-native vegetation, specifially lead trees (*Leucaena leucocephala*), thus the river was not visible or accessible for educational purposes. The selected design (below) included reshaping the shoreline, stabilizing with Geoweb™ textiles and cocnut mat, and then planting with native freshwater wetland species. The design also featured a small (1' x 2') breakwater component to buffer boat wakes.

Grant Funding: SWFWMD and National Fish and Wildlife Foundation (NFWF)

Type of Living Shoreline: Sill & Native Plants

Materials: Mangroves, Native Estuarine Plants, Rip Rap, Geo Web, and Coir Fiber/Coconut

Energy Level: Medium

Contact Person: Thomas Ries, ESA Scheda 813-989-9600

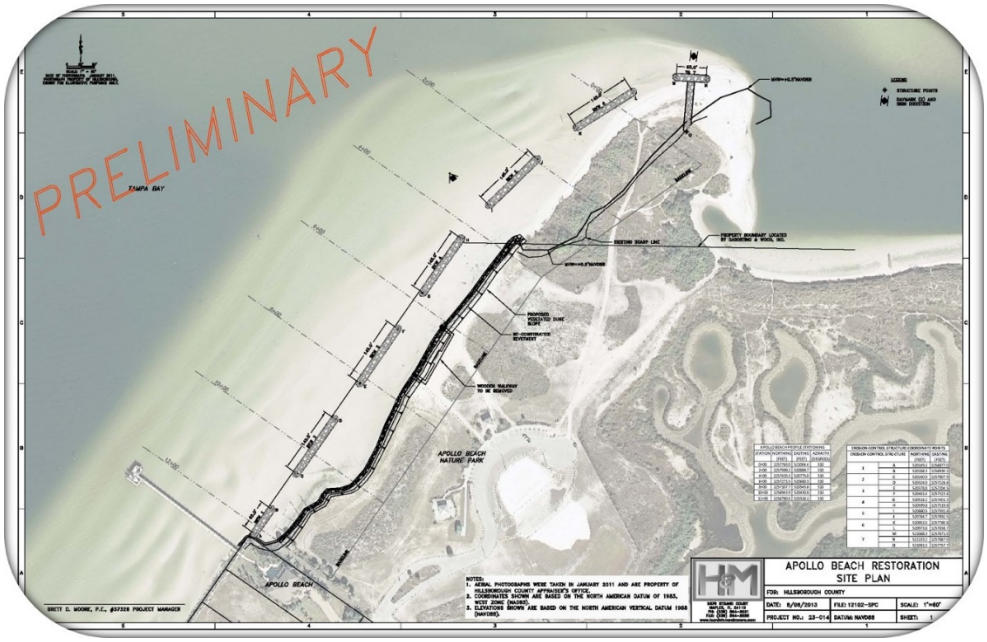
Lessons Learned: Partnering with the School Board was beneficial to the students as well as the environment.

Before

After

Apollo Beach – Shoreline Restoration Project, Tampa, Florida

The restoration of the severely eroded shoreline at the Apollo Beach Nature Preserve required the design of breakwater structures, revetment stabilization, and incorporated a "living shoreline" feature. The project design included additional shoreline stabilization with planting of dune species and currently seagrass beds are thriving behind the breakwater features.



Before

After

Funding: Hillsborough County

Type of Living Shoreline: Combination of breakwaters, rock revetment, and wetland plants

Materials: Rock revetments, Geoweb, plants

Energy Level: High

Contact Person: Thomas Ries, 813-989-9600

Lessons Learned: Need for coastal modeling, softer application design not appropriate for this high energy site; required breakwater features prior to the installation of the living shoreline components.

SECTION 5
Siting and Design Considerations

The siting and ultimate design of a living shoreline is critically important initial step in the implementation process. Each site is unique, thus there is not a "one size fits all" solution! There are many factors that must be taken into consideration before a suitable design is selected. In the Sarasota Bay watershed, these considerations include the following physical factors:

- Wave energy field (wind driven verses boat/ship wakes)
- Wind energy assessment (fetch, prevailing direction, etc.)
- Storm frequency and intensity
- Water depth (static verses tidal regimes)
- Bathymetric composition (slopes and uniformity)
- Sediment types (rock, sand, mud, etc.)
- Vegetation opportunities (inclusive of grazer pressures)

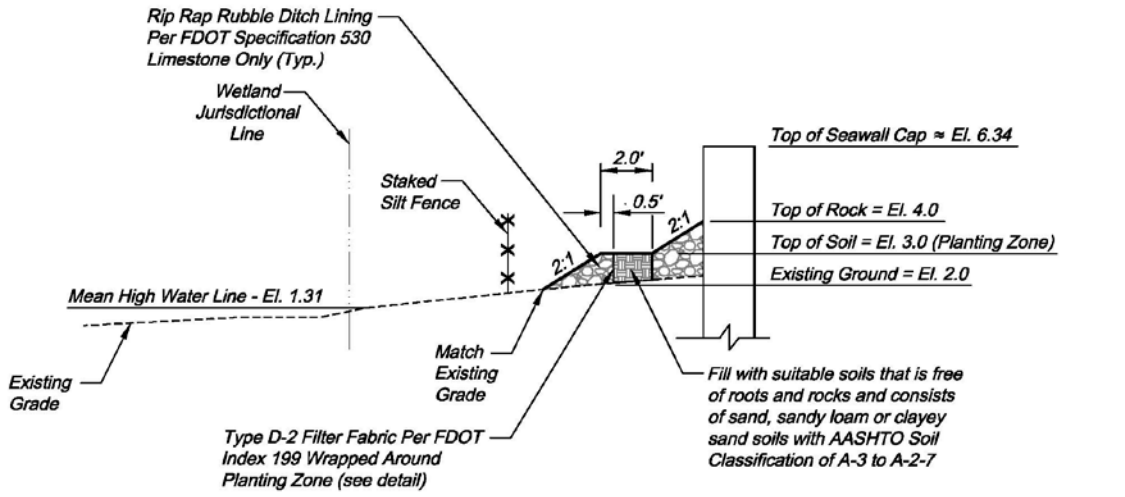
Once the energy climate is fully understood, a design option can then be analyzed. It is imperative to select a design option that fits the potential energy pressures the site may experience over time. There are some sites, particularlyhigh energy locations, where a living shoreline will not be suitable and should not be installed without some sort of offshore protection features. However, if a site is classified as a moderate to low energy climate; there likely is a solution that would be feasible as well as practical for implementation. In these energy conditions, there are many design options available ranging from merely planting appropriate species with a properly sloped shoreline to the installation of some wave energy protection measures. These protection measures range from temporary features such as fiber-logs to more permanent structural features such as oyster bags or small rock (or wood) sills. In even higher energy fields, an offshore breakwater structure (rip-rap, oyster domes, or similar structures) may need to be employed to dissipate the wave energies. In all cases, the bank can then be reestablished with native plant species which can then effectively hold the bank in place.

Living shorelines do require some initial monitoring to assess the integrity of the designed solutions and to evaluate whether there are any maintenance needs. In many cases, not all of the installed plants immediately thrive and in these situations additional plants may need to be installed until the plants have coalesced. Also, non-targeted nuisance plant species may need to be controlled to achieve the desired plant composition. Once the bank slopes are stable these

systems then become self-sustaining and under normal energy pressures they should remain stable and also provide the desired beneficial ecosystem functions.

5.1 Seawall Enhancement Projects

Unfortunately, there are hundreds of thousands of miles of seawall already in place in the US, and in some locations these cannot removed due to the proximity of infrastructure and utilities or due to very high energy climates. In these cases, seawalls or bulkheads cannot easily be removed or replaced with a living shoreline option. These vertical walls provide little to no ecosystem benefits and do not effectively dissipate wave energy. To improve these circumstances, there are options that are superior to a vertical wall feature alone. These are commonly referred to as Seawall Enhancement Projects (SEP). SEPs include a variety of options that have been successfully deployed such as the addition of rock or rip-rap in front of the seawall. The mere placement of this rock will, at a minimum, help dissipate the wave energy and wave refraction properties which is superior to a vertical wall by itself. The rock also provides interstitial spaces for organisms to thrive. There are other design options that are viable, including the addition of "planters" within the rip-rap that are installed in front of an existing non-removable seawall. These planters require specific design considerations such as water level analysis and the incorporation of suitable sediment embedded within filter fabric to allow the installation of native plants. If these planters are installed within tidal regimes then it may be possible for the design of two distinct planters to capitalize on the high and low tide elevations.



If properly designed, these hybrid rock revetment features allow native plants to thrive thus providing habitat for many more species (fish, crustaceans, crabs, etc.). In the proper locations, mangrove trees can be planted within these planters and these trees will ultimately provide additional habitat opportunities including structure for bird roosting and even nesting opportunities. The red mangrove species, with its root propagule features, will also help hold the rock in place and the entire structure will provide energy dissipation to prolong the life of the seawall structure. If mangroves are likely to colonize the rip rap planters, then the resultant view shed needs to be discussed and understood. For many waterfront land owners, view shed is an extremely important objective and with the addition of a living shoreline or even a SEP feature, their views will potentially be limited if mangroves begin to thrive. To address this concern, mangrove trimming abilities should be incorporated into the regulatory permit process so the landowner can window the mangroves to allow views, while still providing many of beneficial attributes of a living shoreline.

Finally, there are a number of innovative design options in the form of fabricated structures that are designed to be placed in front of an existing vertical wall. These structures are designed to dissipate wave energy while providing more edge effects in the form of ledges and openings for fish and crabs to utilize. These same structures should include planter boxes just at or above the standard water levels to allow the installation of native plants. These newly designed structures should be field tested for their longevity and effectiveness - not only for their purported energy dissipation properties but also for their usefulness as habitat for fish and wildlife. If these structures can address these objectives and withstand the energy fields, then these should be considered as a superior option to a vertical structure alone.

It should be noted that living shoreline designs are the superior and recommended design solution for the long term stability of a shoreline. The SEP option does not allow the natural migration of vegetation upslope in response to changes within the environment, such as sea level rise. Seawall structures cannot withstand repeated inundation with water. These flooded conditions will result in the catastrophic failure of the seawall structure, even if it had a SEP feature in place. The preferred solution, in the appropriate energy field, is the removal of the vertical wall and the installation of a properly designed living seawall solution.

5.2 Recommendations for Shoreline Projects in Sarasota Bay

Low Energy

Native Plants

In some instances, planting native plants along the shoreline may be sufficient. The plants hold the ground in place and provide habitat for faunal species that utilize intertidal habitat. If the wave energy is too much for the plants to tolerate, it may be necessary to utilize other options. the document *Living Shorelines a Guide for Alabama Property Owners* lists listed some recommended conditions where plants may be sufficient to protect the shoreline in a low-energy creek or cove if:

1. The water depth is less than one foot,
2. The fetch is short (less than a mile) and boat wakes are not excessive, and
3. The erosion rate is not too great.

The Guide also recommended pruning overhanging vegetation to there will be sunlight for the plants to grow. Grading the shoreline may be necessary prior to plant installation. (See Section 4 - Bayfront Park as an example of a vegetative living shoreline).

Coir Logs

Coir logs are biodegradable and made from coconut fiber. They can be staked in place and often are placed waterward of the plants and act to protect the vegetation and the substrate protection which gives the plants a chance to grow and coalesce (Section 4 - River Crest Park). Unfortunately, Coir logs do not hold up as well in tidal waters due to the decomposition of the material in saline waters.

Medium Energy

Oyster Bags or Sills

In areas that require additional protection from wave energy, structures that slow wave energy yet still provide habitat, such as oyster bags, can be used in combination with native vegetation. In some instances, the additional protection will actually increase sediment landward of the structure which allows for additional mangrove recruitment (See Section 4 - Stewart Middle School).

Geoweb

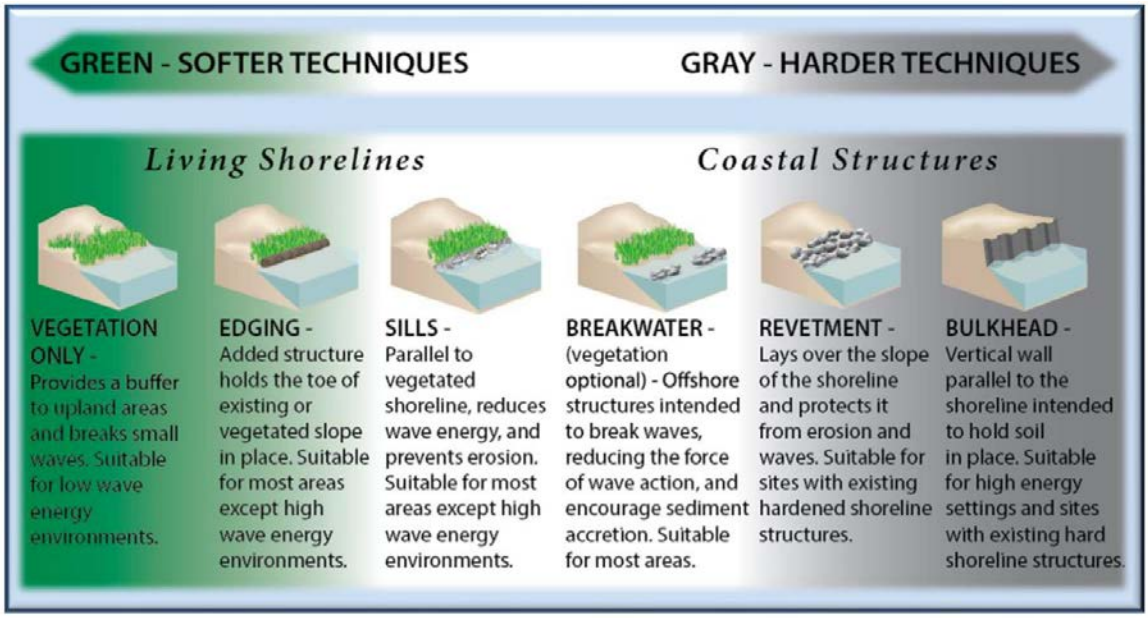
Geoweb can help stabilize slopes after grading. It also helps to stabilize newly installed plants (See Section 4 - Pinecraft Park & Stewart Middle School).

Sills/Terracing

If the shoreline is steep and there is not sufficient room to pare back the bank to a more gradual (>4:1 slope) slope, sills can be used to keep the soil intact so native plants can be installed and will not be washed away. Another benefit of sills is that the rain run-off collected within each module will water the plants and reduce erosional forces (Section 4 - Stewart Middle School).

High Energy

In high energy areas, a living shoreline may not be sufficient to protect the shoreline from erosional forces. Breakwaters or other structures such as reef balls or concrete pods placed offshore and parallel to the shoreline reduce wave energy. A combination of structures and a planted living shoreline is often a good solution (Section 4 - Apollo Beach). Below is a graphic that depicts some of the more common combination techniques utilized under different energy conditions.



A range of shoreline stabilization techniques (NOAA, 2015).

A summary of potential living shorelines projects in the Sarasota Bay watershed is provided in **Appendix B**. These 21 projects were identified by consultation with the groups that provided information on existing projects. More public sites than private sites were identified, as public sites easily accessible to the public may serve as demonstration sites which can educate and inspire private landowners to adopt the living shoreline concept on their property. One example of an existing highly visible demonstration site is Bayfront Park in downtown Sarasota (See Section 4). The table below summarizes recommended living shoreline treatments for various energy levels.

TABLE 5-1 RECOMMENDED LIVING SHORELINE TREATMENTS FOR VARIOUS ENERGY LEVELS

Energy Level	Conditions	Living Shoreline Recommendations
Low Energy	Water Depth <1 ft. Low Fetch (< 1 mile) Minimal Boat Wakes Low Erosion Rate	Native Plants Coir Logs Coconut Fiber Geoweb w/Plants
Medium Energy	Potential Fetch Some Boat Wakes Medium Erosion Rate	Oyster Bags Sills Terracing Hybrid Geoweb and Plants
High Energy	Fetch Potential High Winds Potential High Boat Wakes High Erosion Rates	Hybrid Structures and Plants Breakwaters Rip-rap Oyster Bags

SECTION 6
Cost Considerations

Table 6-1. is adapted from the RAE's *Living Shorelines from Barriers to Opportunities* report (RAE 2015). The table shows estimates of the cost per linear foot of different living shoreline approaches on the eastern coast of the U.S. and the Gulf of Mexico.

TABLE 6-1. COST ESTIMATES FOR SHORELINE MANAGEMENT APPROACHES (AVERAGE COST PER LINEAR FOOT)

Cost Guide to Coastal Erosion Control Measures			
Erosion Control Measure	Unit	Unit Cost Range	Comments
LIVING SHORELINE MEASURES			
Marsh and Dune Plants	Sq. Yard	$2.50 to $5.50/Sq yard	Calculated at $.50 - $1 per plan at 18" centers (Delivery may cost $50-$75)
Clean Sand Fill	Cubic Yard	$15 to $20/cubic yard	Delivered - to coastal area
#3 Riprap	Ton	Less than $75/ton	Delivered. One cubic yard = 1.7 tons ≤ $127.50
Geofabric	Sq. Yard	Less than $12,40/sq yard	Determine needs and shop for better price.
Wooden Sills	Linear Foot	$65 to $100/linear foot	Installed
Oyster Shell	Bag	$2 to $5 per bag	Material cost only (not including labor)
Oyster Shell	Cubic Yard	$45 to $60/cubic yard	Material cost only (not including labor)
Concrete Reef Balls	Linear Foot	$100 to $200 per linear ft	Installed
ReefBLK™	Linear Foot	$175 to $250 per linear ft	Installed
Rock Breakwater	Linear Foot	$150 to $200 per linear ft	Installed
WADs®	Linear Foot	$350 to $450 per linear ft	Installed
BULKHEADS			
Vinyl Bulkhead	Linear Foot	$125 to $200 per linear ft	Based on four- to eight-foot height, including labor, materials, earthwork, and backfill. Toe protection is used to avoid scouring. Additional fill may be required over time.
Vinyl Bulkhead w/toe Protection	Linear Foot	$225 to $300 per linear ft	
Wooden Bulkhead	Linear Foot	$115 to $180 per linear ft	
Wooden Bulkhead w/toe Protection	Linear Foot	$200 to $280 per linear ft	
Concrete Bulkhead	Linear Foot	$500 to $1,000 per linear ft	
Sheetpile Bulkhead	Linear Foot	$500 to $1,000 per linear ft	

SECTION 7
Permitting Considerations

Until recently, the regulatory process favored the replacement of seawalls over the implementation of living shoreline options. This created a disincentive for living shoreline systems. However, the regulatory rules are beginning to change to help level the playing field; for example, in March 2017 the US Army Corps of Engineers (USACE) issued a newly authorized Nationwide 54 Permit specifically for living shorelines. For a project to qualify for this permit, certain conditions must be met. The living shoreline should have a substantial biological component that maintains the natural continuity of the land-water interface and retain or enhance shoreline ecological processes. In addition, the following design conditions must be met:

- The structure and/or fill area cannot extend more than 30 ft. from mean low water in tidal waters or ordinary high mark in the Great lakes.
- The activity is no more than 500 feet in length along the bank.
- Structural materials (coir logs, oyster shell etc.) must be anchored or be sufficiently weighted to prevent relocation b wave action or flows.
- Native vegetation should be utilized.
- The discharges of dredged or fill material must be the minimum necessary for the establishment and maintenance of the living shoreline.
- The activity must be designed, constructed, and maintained so that it has no more than minimal adverse effects on water movement between the waterbody and the shore and the movement of aquatic organisms.
- The living shoreline must be properly maintained.

In addition, there is a new Florida Department of Environmental Protection Statewide Programmatic General Permit that will expedite the review times if a proposed living shoreline project meets the State's design limitations (< 500 linear feet, <35 feet off shore, etc.). These new state and federal regulations will help expedite the permitting process so that land owners will consider these design options related to shoreline stabilization techniques. Local governments are also looking for ways to promote living shorelines by revising the language in their existing comprehensive plans that allows for living shorelines that may include more natural components such as oyster bags, fiber rolls, etc. By simplifying the permit process and educating the public about options other than hardened shorelines, the regulatory agencies have increased awareness and promoted the benefits of living shorelines. Even with these new permitting

options, it is strongly encouraged that applicants schedule pre-application meetings with regulatory agency staff as early in the planning process as possible to further expedite the permit approval process.

SECTION 8

Living Shoreline Data Gaps, Barriers, and Opportunities

The many beneficial attributes of living shorelines have been recently documented and demonstrated. However, SEPs are considered "new technology" that still have data gaps which need to be addressed so that the proper design options can be recommended:

- Full evaluation of Sarasota Bay shorelines to determine the amount of hardened features, their condition, as well as an assessment of whether any of these structures could be enhanced with a SEP structure;
- Pilot Projects - Installation of living shorelines and SEPs as demonstration projects in highly-visible areas will provide real world examples of what these features look like so that property owners can visualize the final product;
- A comprehensive assessment of SEPs to determine wave energy dissipation effectiveness, species utilization, and project longevity;
- Education and outreach to inform the public about living shorelines and SEPs; and,
- Working with seawall contractors that could inform homeowners about additional shoreline stabilization options.

SECTION 9
Conclusions

Like estuaries themselves, shorelines are relatively small places within a much larger context of water and land interfaces. These ecosystems can be ranked as among the most productive in the world. In their natural form, estuarine shorelines overflow with habitat that wildlife depends upon, from mangroves and marsh grasses to wrack lines that provide forage for birds and crabs along white sand beaches. Man-made structures like seawalls, bulkheads, groins and jetties provide temporary protection for man-made infrastructure, but at a significant cost to the wildlife that once depended upon shoreline habitat. This guidance document was developed to assist homeowners, contractors, and waterfront entities in considering softer protection strategies for protecting their property from erosion while improving habitat for wildlife.

SECTION 10
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Appendix A

Existing Living Shoreline Project Descriptions in Florida

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Table 2. Summary of Existing Living Shorelines Project in South Florida

Name	Ownership	Owner	County	Year constructed	Energy level	Structure	Approximate Length (Linear Feet)
Ted Moorhead Lagoon House	Public	City of Palm Bay	Brevard	Unknown	High	Terracing, rip-rap, vegetation	308
22nd Street Park	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	795
Al Palonis / Gandy Park	Public	FDOT	Hillsborough	2004	Low	Vegetation	1,038
Apollo Beach	Public	Hillsborough County	Hillsborough	2015	High	offshore breakwater	902
Ballast Point Park	Public	City of Tampa	Hillsborough	1993	Medium	vegetation and rip rap	320
Black Water Hammock / Rowlett Park	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	Unknown
Cypress Point Park	Public	City of Tampa	Hillsborough	2004	Medium	Vegetation	659
Davis Island Yacht Basin	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	323
Fantasy Island	Public	Port of Tampa	Hillsborough	Multiple phases	High	Vegetation and oyster bags	453
Fort Brooke Contanchobee Park	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	994
Lowry Park	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	659
MacDill	Public	U.S. Air Force	Hillsborough	Multiple phases	High	Oyster bags and reef balls	4,193
McKay Bay Nature Park	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	2,481
Palm River Park (McKay Bay Bike Trail)	Public	SWFWMD	Hillsborough	2012	Low	Vegetation	3,693
Picnic Island	Public	City of Tampa	Hillsborough	2004	High	Vegetation	649
Ribbon of Green / USF at Riverwalk	Public	City of Tampa	Hillsborough	1996	Medium	Vegetation	107
Rivercrest Park	Public	City of Tampa	Hillsborough	2004	Low	Vegetation with fiber logs	500
Riverside Garden Park	Public	City of Tampa	Hillsborough	2011	Low	Vegetation and rip rap	1,721
Robles Park Outfall	Public	City of Tampa	Hillsborough	Unknown	Medium	Vegetation	384
Stewart Middle School	Pubilc	School Board of Hillsborough County	Hillsborough	2008	Medium	Rock breakwater	1,819
Temple Crest Center	Public	City of Tampa	Hillsborough	2004	Low	Vegetation	1,343
North Shore Park	Public	Lee County	Lee	2011	High	Rip-rap	128
Herb Dolan	Public	City of Bradenton Beach	Manatee	2011	Medium	Geoweb and vegetation	221
Honi Hanta	Private	Girl Scouts of Gulfcoast Florida	Manatee	2012	Low	Bank contouring and vegetation	236
Powell Crosley Estate	Public	Manatee County	Manatee	2006	High	Rip-rap and vegetation	152
Indian Riverside Park	Public	Martin County	Martin	Unknown	High	Reefballs, oyster bags, and vegetation	410
Peck Lake Park	Public	FIND	Martin	Unknown	Medium	Oyster bags and vegetation	168
Pendarvis Park	Public	SFWMD	Martin	Unknown	High	Oyster bags and vegetation	Unknown
Bayfront Park	Public	City of Sarasota	Sarasota	2013	Medium	Vegetation	891
Bird Colony Keys	Public	SSL	Sarasota	2007	High	Rip-rap breakwater	1,270
GWIZ	Public	City of Sarasota	Sarasota	2008	Low	Vegetation	879
Philippi Creek	Public	Sarasota County	Sarasota	2013	Low	Vegetation	954
Al Palonis / Gandy Park	Public	FDOT	Hillsborough	2004	Low	SEP	615
Water Works Park / Ulele Springs	Public	City of Tampa	Hillsborough	2014	Medium	SEP	328
Perico Bayou	Private	Minto Bradenton, LLC	Manatee	2016	Medium	SEP demonstration, rip-rap and vegetation	148
US 301 at Palmetto	Public	City of Palmetto	Manatee	2016	Medium	SEP	665

Note: grey shading indicates an SEP

Ted Moorhead Lagoon House

Information on this project was found at floridalivingshorelines.com. This living shoreline was installed on the bank of the Indian River Lagoon. The Marine Resources Council created terracing using large cabbage palm trunks, rip rap, and native plants. Large sapling mangroves were planted at the waterward edge of the project.

22nd Street Park

The 22nd Street Park is located above the dam along the Hillsborough River. The shoreline consisted primarily of a freshwater marsh buffer. This shoreline contained approximately 35% cover of nuisance species and the shoreline was severely eroded. Due to the steep slope, the extent of available space for planting native species was limited. Never the less, the exotic vegetation was removed and the area was planted with native marsh grasses. Since this section of the river is a no-wake zone, the erosion of the shoreline has been minimal.

Al Palonis

The Al Palonis Park is located along the northeast quarter of the Gandy Bridge on Old Tampa Bay. This area consisted of a small embayment that is protected by a former offshore seawall feature. This project involved the removal of exotic vegetation and the planting of native wetland species. Subsequently, 75 tons of oyster bars were installed along the shoreline of to further provide shoreline protection as well as habitat values for Palonis Park.

Gandy Park

The Gandy Park shoreline is located on the south side of the Gandy Bridge along the eastern banks of Old Tampa Bay. This site consisted of an eroded seawall and was restored via the installation of “mac block” structures, which consists of specialized cinder blocks which were installed in a terracing fashion. Each block has a large void to allow plants to be installed within. Mangroves saplings were installed within each opening. Over time the mangroves did not survive, however the terraced seawall feature did protect the shoreline and mangroves naturally recruited into a few of the “mac block” openings.

Apollo Beach

The restoration of the severely eroded shoreline at the Apollo Beach Nature Preserve along the eastern shores of Tampa Bay required the design of breakwater structures, revetment stabilization, and incorporated a “living shoreline” feature. The project design included additional shoreline stabilization with planting of dune species as well as transplanting 2,626 square feet of unavoidable sparse seagrass impacts into the adjacent estuarine wetland restoration

area. This hybrid design provided the wave energy protection required, for this high energy environment, to protect the banks of this park and allow native wetland plants to survive behind the breakwater features.

Ballast Point Park

Ballast Point Park is located in the central area of Hillsborough Bay along the western side of the Bay. The entire shoreline had been faced with rip-rap, and native vegetation had been planted behind the and within the rip rap areas.

Three phases of restoration work were completed by the City of Tampa and the SWIM program. The initial mangrove restoration effort was completed on the east side of the property–Phase 1 in 1993, Phase 2 in 2000, and Phase 3, completed in 2004. These areas are all thriving and providing native shoreline ecotones.

Blackwater Hammock/Rowlett Park

This site is located in the upper most stretches of the Hillsborough River (above the dam). The restoration of the eroded sections of shoreline was completed by the City of Tampa via the removal of the exotic vegetation. These areas were subsequently planted native species adjacent to the shoreline to protect the shoreline banks.

Cypress Point Park

The Cypress Point Park is located along the eastern shoreline of Old Tampa Bay; the shoreline is a diverse mixture of habitats including: mangrove fringe, coastal dunes and coastal shrub. The dune system experienced some erosion during the 2004 hurricane season, creating several steep ledges. The park has undergone various levels of habitat restoration and restoration design over the years, the largest of which was the SWIM sponsored habitat restoration effort completed in 1998. Due to the Hurricane damage along the shoreline, the City lead a beach and dune stabilization project in 2005. The shoreline was regraded to reestablish the gradual sloping beach front and the dune system was rebuilt. The area was then planted with the appropriate native plant species.

Davis Island Yacht Basin

This site is situated along the eastern shore within the Davis Island Yacht Basin which is located in downtown Tampa. This area is exposed to limited wave energy and so it only required the installation of native marsh plants. Once these plants coalesced, it provided additional habitat values for the entire basin.

Fantasy Island

This small man-made island in Hillsborough Bay east of the Port Tampa Bay's dredge disposal island (D2) had experienced excessive erosion over the years so attempts were made to shore up the banks. First native marsh grass was planted; however, the wave energy was too great for plants along to stabilize the banks. Subsequent efforts included the placement of oyster bags coupled with marsh plantings, this helped to stabilize the banks, however some portions of the shoreline are still eroded. Future efforts will employ a formal wave energy analysis to select a

protective treatment plan that can withstand the occasional, but heavy wave action that can result during strong storm events.

Fort Brooke Cotanchobee Park

The Ft. Brooke Cotanchobee Park is located in the upper portions of Hillsborough Bay near the confluence of the Hillsborough River. The shoreline had been hardened by a seawall and rip-rap. The park has benefited from a series of habitat restoration activities. The initial phases (Phases 1 & 2) were completed in 2001 and consisted of removing the failed seawall and replacing it with a small rip rap feature to protect the newly restored shoreline. This area was then planted with native vegetation. Phase 3 was completed in 2004 and finished the restoration of the entire park shoreline area. The installation of rip-rap and native plants has greatly increased the habitat value of this shoreline.

Lowry Park

This City Park, along the Hillsborough River, had an eroded shoreline, primarily due to boat wakes. The design solution included softening the banks and installing a boardwalk along the eroded shoreline which included wake dissipation boards. Behind this structure the shoreline was then planted with native vegetation. In addition, the large existing water oak trees were also protected by the installation of custom built tree boxes.

MacDill

This site is located on the interlay peninsula separating Old Tampa Bay from Hillsborough Bay, and is home to MacDill AFB. The SWFWMD's Surface Water Improvement and Management (SWIM) program coordinated the design of a large scale habitat restoration project and included shoreline plantings to stabilize the shoreline. MacDill had previously coordinated the installation of a series of oyster bag and reef ball structures just offshore of the southeast shoreline. The combination of the breakwater features, in concert with the native plantings, has helped stabilized this shoreline.

McKay Bay Nature Park

This site is located along the northern boundary of McKay Bay (within Hillsborough Bay). The shoreline was infested with non-native vegetation along the entire shoreline and there was evidence of wave driven erosion. To improve the shoreline condition, all of the non-native vegetation was removed and replaced with native marsh grass and mangrove species.

Palm River Park (McKay Bay Bike Trail)

This project is located within McKay Bay just west of the City of Tampa's McKay Bay Park. When the bike trail was installed the entire shoreline area was regarded to soften the banks so that native estuarine plants could be installed to help stabilize the shoreline and provide protection against wind driven wave energy.

Picnic Island

Picnic Island Park is on the southwestern corner of the Interbay Peninsula. The shoreline contained a diversity of native species as well as major infestation of Brazilian pepper. However, the southern tip had been severely eroded due to ship wakes and waves due to the large open water fetch.

The City of Tampa worked with the SWFWMD SWIM program to address the large infestation of non-native vegetation within the 205-acre park, this restoration effort focused primarily on the western potions of the parcel and resulted in the creation of 8 acres of estuarine habitats and was completed in the in the early 1990s. To address the eroded area at the southern tip, the City coordinated with the FDOT to implement a wetland mitigation project which focused on creating habitat as well as the placement of rip rap to protect the shoreline. The estuarine wetland flourished behind the rip rap and is functioning as envisioned.

Ribbon of Green/USF at Riverwalk

The Ribbon of Green Park project is located along the lower reach of the Hillsborough River in downtown Tampa and had been overrun with exotic vegetation. This restoration project was funded by the Florida Communities Trust, the City of Tampa, and the SWFWM's SWIM Program. The project is an important piece of the Downtown Tampa Greenways and Trails Master Plan and includes trails, boardwalks, picnic areas, gathering areas, a stage/pavilion with restroom facilities, an educational resource center, environmental educational signs, architectural exhibits, estuarine wetland restoration, shoreline restoration and enhancement, and native demonstration gardens.

Rivercrest Park

This project involved the restoration of approximately 600 linear feet of eroded shoreline along the Hillsborough River at Rivercrest Park. As part of the design, an innovative solution was formulated to temporarily protect the restored shoreline from boat wake generated erosion forces. A line of 10" x 12" pre-formed coconut fiber 'logs' were installed along the toe of slope to buffer wake action within the river. Native freshwater vegetation, both herbaceous and forested species, were installed on either side of the logs to temporarily stabilize the shoreline until the banks planted material colonized the shoreline. These "logs" naturally decomposed within approximately 18 months, by which time the native marsh grass had coalesced and provided the bank stabilization desired.

Riverside Garden Park

The Riverside Garden Park is located along the middle sections of the Hillsborough River with a shoreline consisting of a mixture of freshwater marsh, riverine forest and hardened shoreline (seawall and rip-rap). The seawall was composed of eroded aluminum that has detached from the shoreline allowing water to get landward of the wall; although no native wetland species have

encroached the area. In several areas, the upland grass is being mowed down to the water's edge precluding native vegetative growth.
The SWFWMD's SWIM program designed a shoreline protection plan for the sea walled sections of the shoreline, which included the placement of rip-rap and the installation of native wetland plants. This project was completed in 2015 and now provides shoreline protection as well as habitat for fish and wildlife.

Robles Park Outfall

Robles Park is located with the urban portion of Tampa and away from the coast; however, the outfall of this stormwater retrofit project is located along the Hillsborough River. As part of the overall improvements to the stormwater pond, the outfall area was also restored. This entailed the softening of the shoreline, inclusive of the removal of rubble. The newly contoured shoreline was then covered with coconut fiber and planted with native species, inclusive of marsh grasses, red mangrove and buttonwood trees. This shoreline is now stable and the plants have coalesced along the entire section of the river.

Stewart Middle School

This project involved the creation of a "living shoreline" to improve the existing conditions along the Hillsborough River shoreline adjacent to Stewart Middle School (SMS), near downtown Tampa. The river shoreline was severely eroded and infested with exotic vegetation, and thus was unusable for the teachers and students. An eco-friendly shoreline protection project, rather than the commonly used hardened shoreline profile that is typical for this section of the river, was selected to address this bank stabilization issue. This 1,900 linear foot project included a small rock revetment structure and associated planting trough, landward of the structure. In addition, geoweb was used to stabilize the 3:1 slope areas and in the 2:1 areas the geoweb was stacked into terracing feature. All of these areas were then planted with native vegetation by the students of SMS.

Temple Crest Center

Temple Crest Park is located in the upper sections of the Hillsborough River. The shoreline consisted predominantly of a gradual sloping shoreline with mostly native trees and wetland vegetation, however, in some sections there was clumps of Brazilian pepper and areas of erosion. This project consisted of the removal of the non-native vegetation, softening of the bank escarpment, and planting of native marsh grass to help stabilize the shoreline features.

North Shore Park

This project was identified by a search of Florida Department of Environmental Protection (FDEP) shoreline permits. At this public park on the tidal Caloosahatchee River, Lee County received a permit to stabilize 145 linear ft of shoreline. The stabilization consisted of installing rip rap which has naturally recruited vegetation.

Herb Dolan

This project entailed the removal of an existing rip rap revetment along the shoreline of Herb Dolan Park, which is located at 2500 Avenue A, Bradenton Beach, in Manatee County. The rip rap was replaced with geoweb and planted with native vegetation. The purpose of the project was to create a "living shoreline" to promote environmentally-friendly stabilization techniques at a public facility. Herb Dolan Park consists of three City of Bradenton Beach-owned parcels located immediately adjacent to Sarasota Bay, a Class III Outstanding Florida Waterbody.

Honi Hanta

The SBEP, in cooperation with the Girl Scouts of Gulfcoast Florida, Inc. (Girl Scouts), created a restoration project at Camp Honi Hanta, located on the Braden River and owned by the Girl Scouts. This habitat restoration project was accomplished through the removal of nuisance exotic vegetation, removal of approximately 250 feet of seawall, earthwork, and the planting of native vegetation. Removal of exotic vegetation and re-vegetation with native plants increases the water quality and wildlife habitat of this area.

Powell Crosley Estate

The Crosley Estate is located just north of the Manatee-Sarasota County line and west of US 41. Placed on the National Register of Historic Places in 1982, the Crosley Estate was rescued from commercial development through purchase in 1991 by the Manatee County Commission. The living shoreline component included the hand removal of exotic species and replanting with native vegetation by volunteers. The project provides an educational component as well as the environmental enhancement benefits.

Indian Riverside Park

Information on this project was found at floridaocean.org. According to the website: as part of an ongoing partnership between FOS and Martin County to restore local oyster reefs and shoreline, 15 reefballs were deployed in the Indian River Lagoon at this park. Additionally, 200 linear ft of shoreline were enhanced with oyster reefs, marsh and mangrove plantings.

Peck Lake Park

Information on this project was found at floridalivingshorelines.com. According to the website: Martin County received funding from the South Florida Water Management District (SFWMD) to construct multiple living shorelines. The Florida Oceanographic Society (FOS) was a partner and coordinated shell bagging and volunteer recruitment. Cultch bag reefs were constructed and smooth cordgrass (Spartina alterniflora) was planted landward.

Pendarvis Park

Information on this project was found at floridalivingshorelines.com. According to the website: Martin County received funding from the SFWMD which worked to construct multiple living

shorelines. The Florida Oceanographic Society (FOS) was a partner and coordinated shell bagging and volunteer recruitment. Cultch bag reefs were constructed and smooth cordgrass (Spartina alterniflora) was planted landward.

Bayfront Park

This highly visible demonstration project provides educational opportunities for the public as well as waterfront landowners to promote softened shoreline protection techniques. The construction entailed removal of some of the shell substrate, placement with organic soil, installation of a variety of native plant species for the different treatment areas, and signage that emphasizes the ecological benefits of "living shorelines."

Bird Colony Keys

Bird Colony Spoil Islands are located in Robert's Bay and consist of three small islands that are highly productive bird rookeries. To protect these eroding islands, a breakwater feature was designed. The breakwater also included the installation of native marsh grass behind the structure. This project reduced the ongoing erosion of the islands resulting from the high energy wave action from the Intracoastal Waterway. The project significantly reduced erosion, increased the island's mangrove footprint and provides quality bird nesting habitat.

GWIZ

This shoreline restoration project was designed to improve the existing conditions which included a severely eroded bank along Sarasota Bay. Initially, the failed shoreline protection features were removed and the shoreline was restored back to natural grades and native vegetation was planted. Subsequently, an undulating breakwater was installed to reduce wave energy to protect the adjacent upland while providing natural enhancement.

Phillippi Creek

Pinecraft Park is located on the bank of Phillippi Creek. Sarasota County's original design included hardening the shoreline with rip rap. However, it was decided that utilizing a more natural shoreline stabilization methodology would reduce environmental impacts and improve habitat for wildlife. The redesigned shoreline stabilization/habitat restoration project utilized a design that included a combination of geo-web and native vegetation to stabilize the slope along the east bank of the creek. The goal of this environmentally friendly stabilization technique was to reduce erosion and improve water quality. This effort included re-grading approximately 500 linear feet of shoreline to a 4:1 slope, installing geoweb, and then planting the bank with a high density of native wetland vegetation.

Waterworks Park / Ulele Springs

Located in highly urbanized downtown Tampa, the flow of Ulele Springs had been capped and diverted through a pipe system in the early 1900s, resulting in the filling of the spring run, and

piping of the flows to the Hillsborough River. The goal of this project was to remove the pipes and allow the spring run to once again flow naturally to the river. The project also included the restoration of estuarine and freshwater habitat between the spring outflow and the river. In addition, a 500-foot long Seawall Enhancement feature was designed along the existing seawall. This feature consisted of limestone rip-rap with a unique design component; earthen planters were embedded within the rip-rap which allowed the installation of native marsh grass as well as red mangrove trees. This design has proven to be very successful with 100% of all the mangroves surviving and now providing habitat and strength to the rip rap. The spring and the new living seawall feature are part of the Downtown Tampa Riverwalk and through the educational signage, it provides visitors the opportunity to learn about unique native habitat potentials within urbanized environments.

Perico Bayou

This private development site is located within Perico Bayou near Cortez, Florida. This site had a small section of seawall that was replaced due to the high energy climate at this site. The SBEP worked with the private land owner (Minto Homes) to design and implement a SEP along the replaced seawall feature. This SEP was comprised of rip-rap with an incorporated planter. The planted was inoculated with native wetland marsh grass species to provide some habitat values for this area.

US 301 at Palmetto / Palmetto Preserve

Palmetto Preserve is located along the western side of US 301 in Palmetto, Fl. This first-ever public/private partnership with the SWFWMD SWIM program and a private developer Riviera Dunes, LLC., united forces to address the shoreline erosion and poor ecological conditions within the parcel. The design included shoreline softening components and the planting of native marsh grasses. Ultimately the marsh has naturally succeeded into a mangrove fringe which is now stabilizing the shoreline and providing important estuarine ecotones for the area.

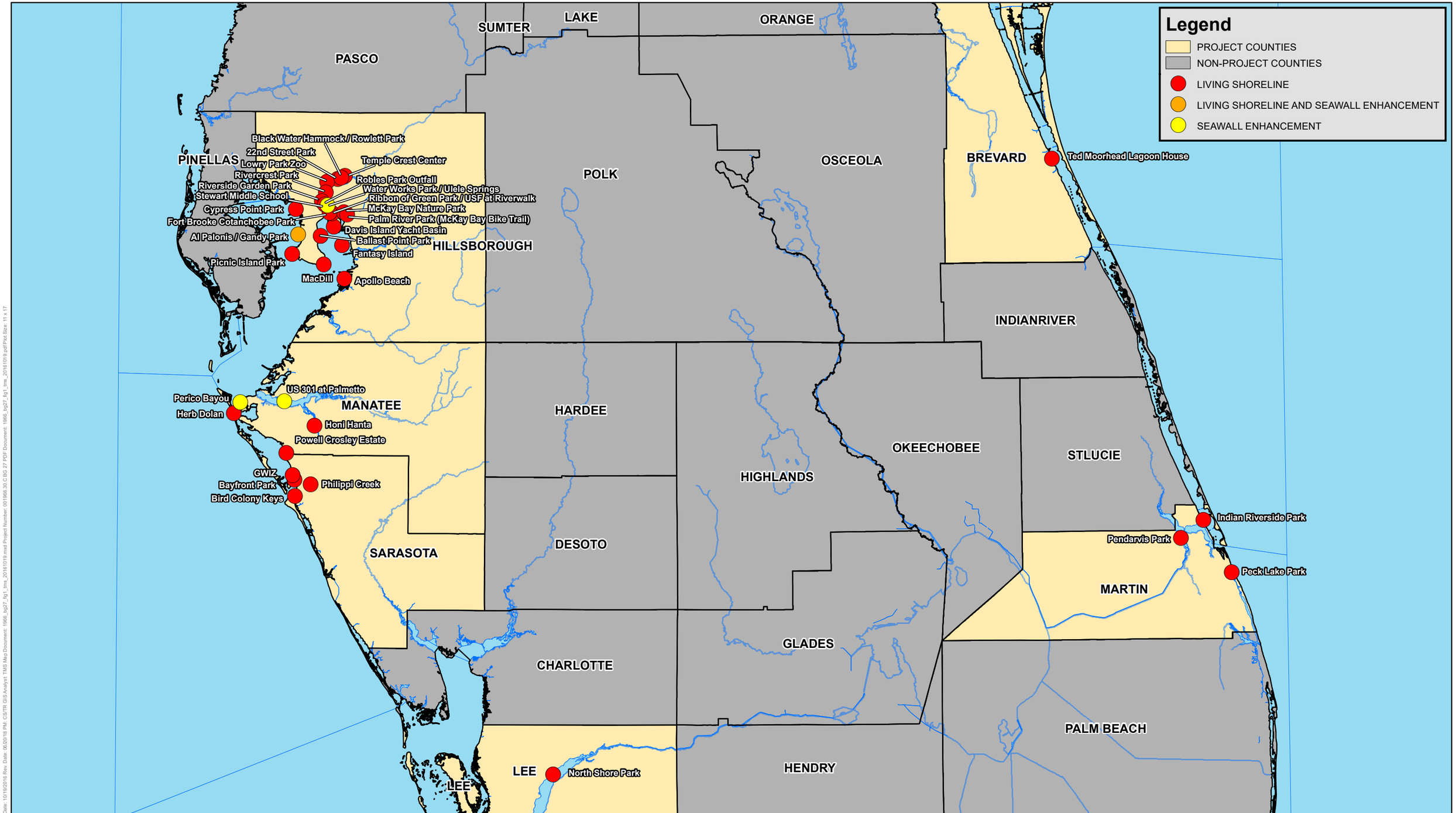

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Figure 1 - Existing Living Shoreline Projects
South Florida

Living Shoreline Primer
Various Counties, Florida

0 14 28 42 Miles

Data Source:
- ESA Scheda
Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida
State Plane West

N

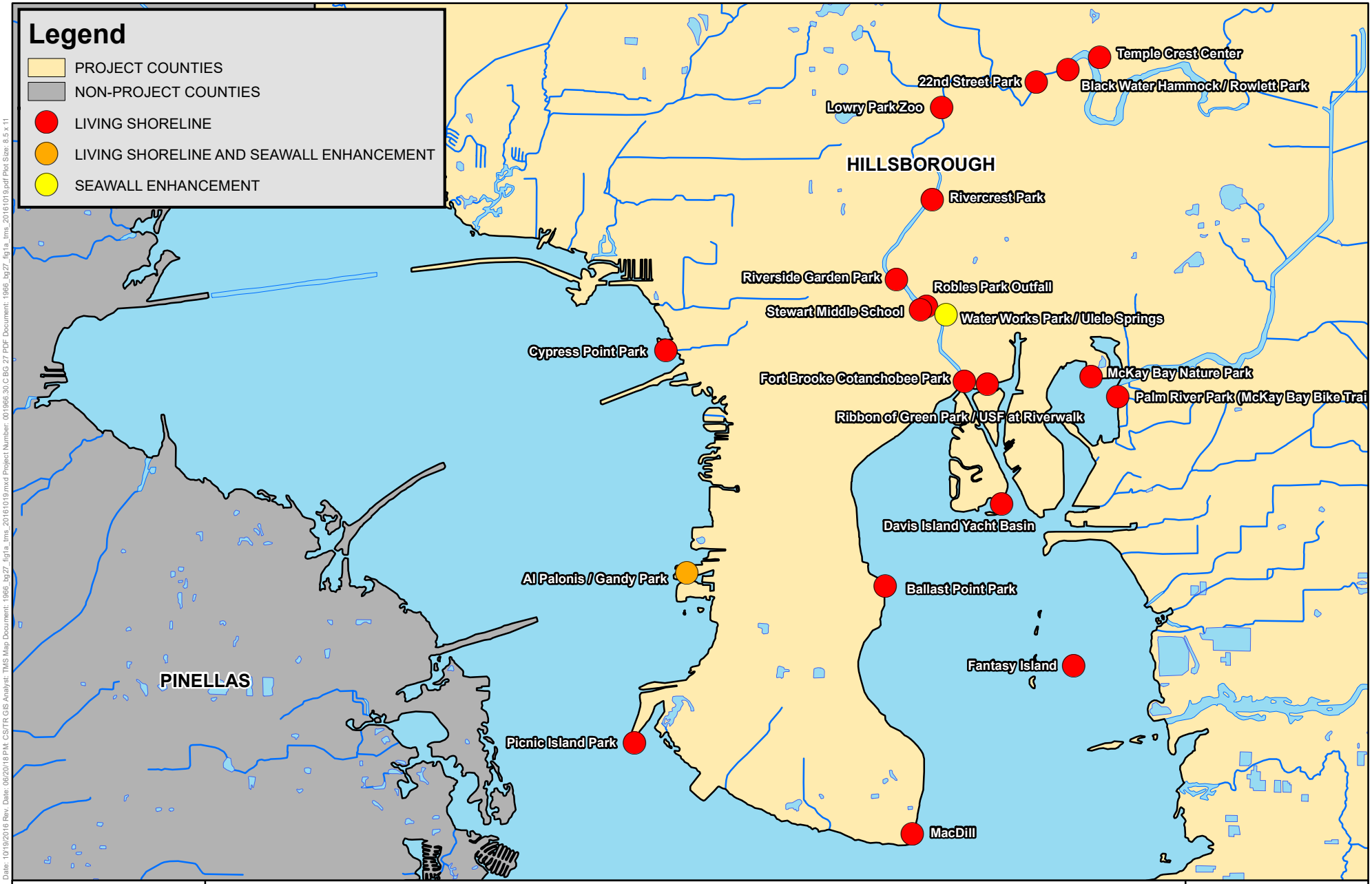

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Figure 1a - Existing Living Shoreline Projects Hillsborough County

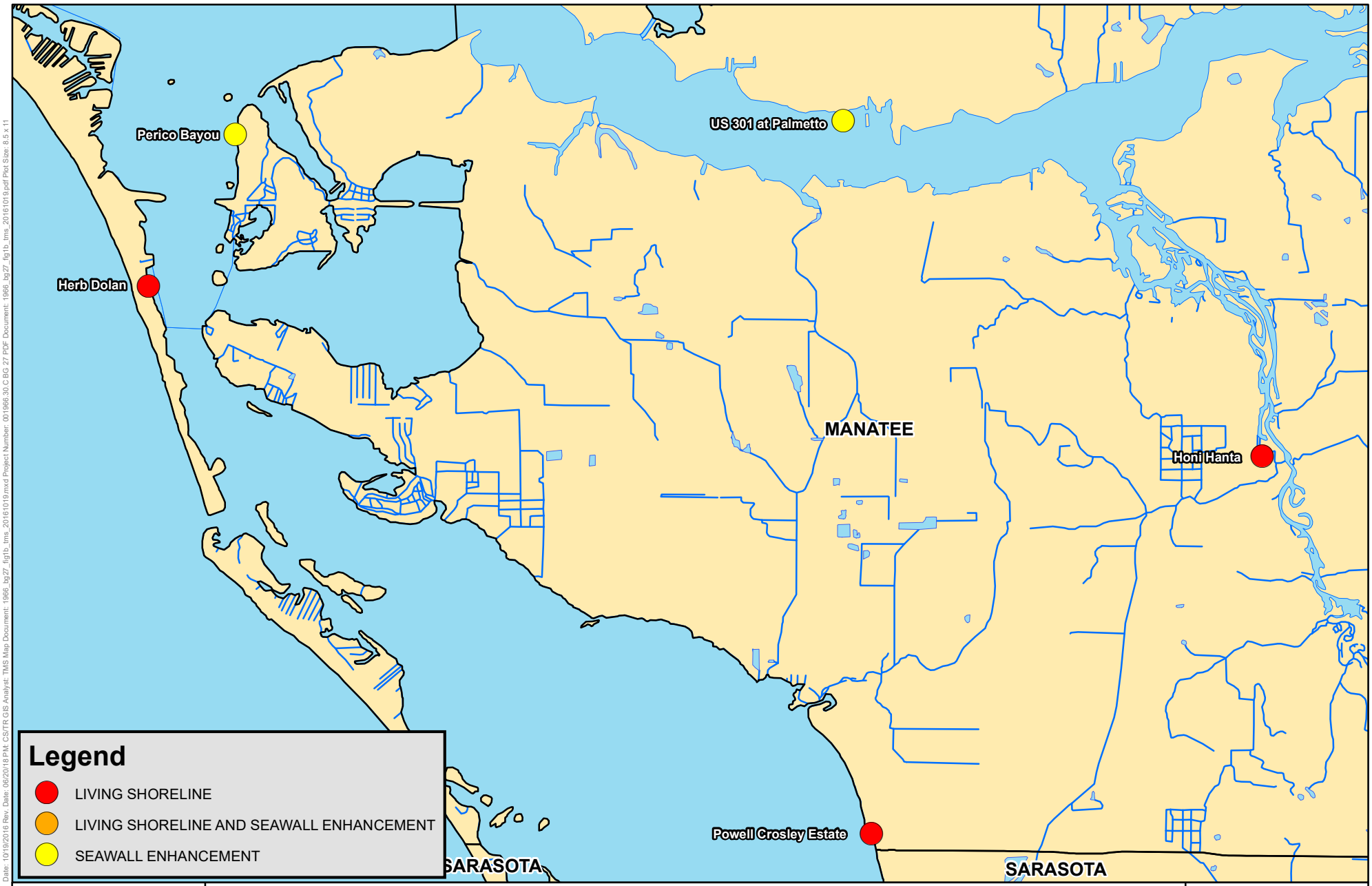
Living Shoreline Primer
Hillsborough County, Florida

0 12,500 25,000 37,500 Feet

Data Source:
- ESA Scheda
Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida
State Plane West

N



Date: 10/19/2016 Rev. Date: 06/20/18 PM: CS/TR GIS Analyst: TMS Map Document: 1966_bg27_fig1b_tms_20161019.mxd Project Number: 001966.30.C BG 27 PDF Document: 1966_bg27_fig1b_tms_20161019.pdf Plot Size: 8.5 x 11

ESA SCHEDA

Figure 1b - Existing Living Shoreline Projects
Manatee County

Living Shoreline Primer
Manatee County, Florida

0 8,000 16,000 24,000 Feet

Data Source:
- ESA Scheda
Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida
State Plane West

N

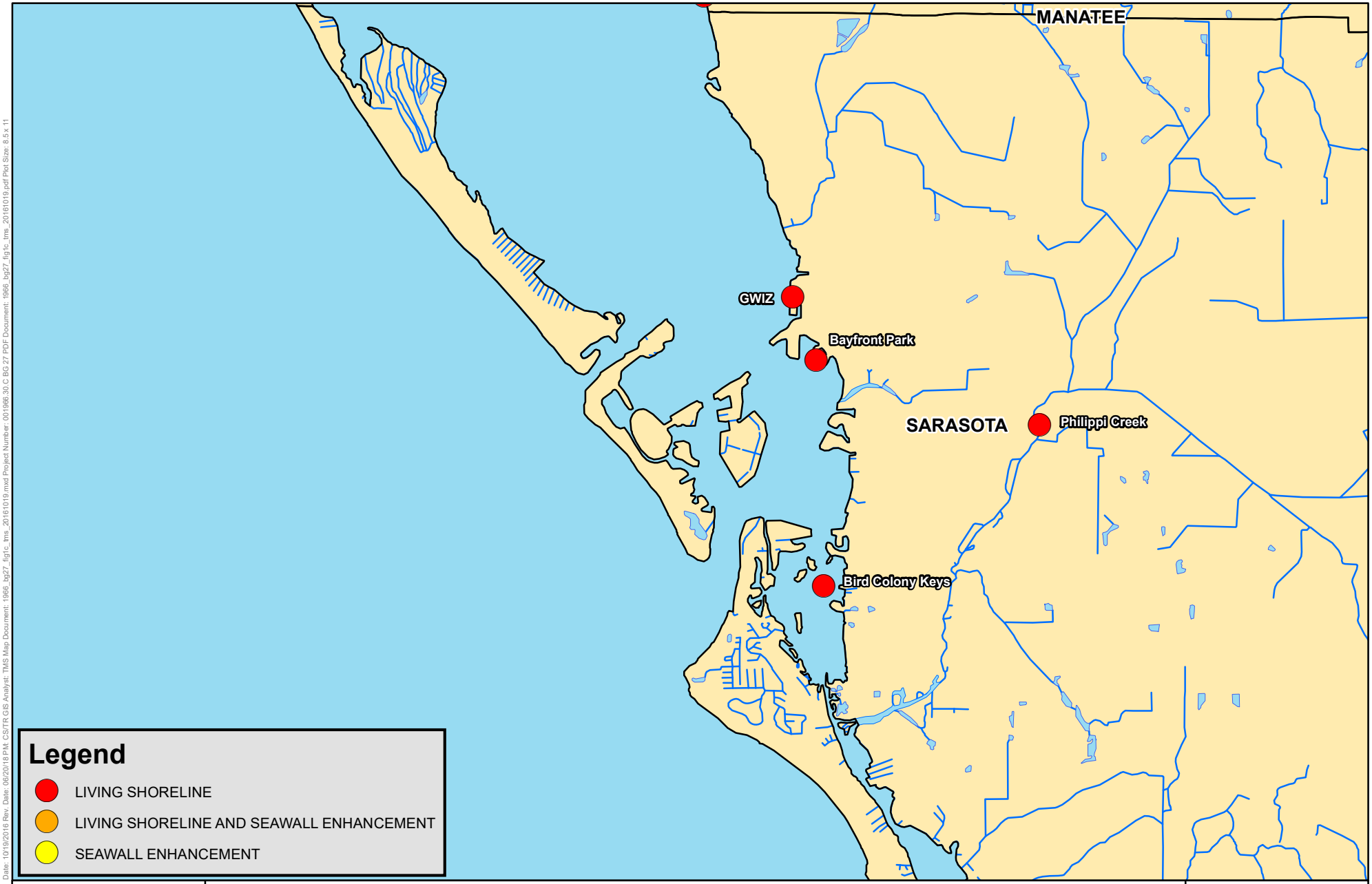


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Figure 1c - Existing Living Shoreline Projects
Sarasota County

Living Shoreline Primer
Sarasota County, Florida

0 8,000 16,000 24,000 Feet

Data Source:
- ESA Scheda
Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida
State Plane West

N

Appendix B

Potential Living Shoreline Projects in SBEP Watershed

ESA

Table 3. Summary of Potential Living Shorelines Project in Sarasota Bay Watershed

Name	Ownership	Owner	County	Energy level	Potential Action	Approximate Length (Linear Feet)
Bishop Point	Public	Manatee County	Manatee	Medium	Rip-rap and vegetation	716
Coquina Beach Boat Ramp	Public	Manatee County	Manatee	High	Breakwater and vegetation	686
Emerson Point	Public	Manatee County	Manatee	Medium	Vegetation	734
Kingfish Boat Ramp	Public	Manatee County	Manatee	Medium	Vegetation	1,618
Palma Sola Causeway	Public	FDOT	Manatee	High	Breakwater and vegetation	4,638
Portosueno Park	Public	Manatee County	Manatee	Low	Rip-rap and vegetation	412
Sanctuary Cove	Private	Sanctuary Cove (Bradenton) ASL	Manatee	Medium	Rip-rap and vegetation	2,235
Warner's Bayou	Public	Manatee County	Manatee	Medium	Vegetation	2,099
Bayfront Park	Public	Town of Longboat Key	Sarasota	Mediume	Remove seawall, install living shoreline	
Sarasota Conservation Foundation	Private	Sarasota Conservation Foundation	Sarasota	Medium	Breakwater and vegetation	89
Bay View Living Shoreline	Public	Sarasota County	Sarasota	Low	Remove seawall, install living shoreline	150
Nokomis Beach Boat Ramp	Public	Sarasota County	Sarasota	Medium	Combination structure and living shoreline	1,300
Bradenton Riverwalk	Public	City of Bradenton	Manatee	High	SEP	2,893
Coquina Beach Boat Ramp	Public	Manatee County	Manatee	High	SEP	130
Portosueno Park	Public	Manatee County	Manatee	Low	SEP	515
Powell Crosley Estate	Public	Manatee County	Manatee	Medium	SEP	296
Bayfront Park	Public	Town of Longboat Key	Sarasota	Medium	SEP	
Rose Park	Public	Manatee County	Manatee	Low	SEP	114
O'Leary's Living Seawall	Public	City of Sarasota	Sarasota	High	SEP	219
Sarasota Conservation Foundation	Private	Sarasota Conservation Foundation	Sarasota	Medium	SEP	114
Spanish Point	Private	Gulfcoast Heritage Association (Spanish Point)	Sarasota	Low	SEP	281

Grey shading indicates that due to the property’s current configuration, an SEP is the most feasible form of shoreline improvement option.

Though potential actions are listed in **Table 3**, each project would require a field assessment of feasibility. Careful consideration of the site's energy, permitting constraints, construction limitations, and ownership status would be required as a first step of planning. Scheda has industry knowledge of the following potential projects; brief descriptions are provided below.

Bishop Point

The Bishop Point project is located along the southern banks of the Manatee river in Bradenton, Florida. This site has an old dilapidated seawall structure that will be enhanced by the implementation of a living shoreline component. For this site the current conceptual design includes the addition of rip rap as well as mangrove plants in front of and behind the old seawall structure.

Portosueno Park

This small marina embayment area within Manatee County is located along the western shores of Palma Sola Bay. The entire shoreline is now hardened with a continuous seawall edge. The current conceptual plan is to remove sections of the seawall and replace those areas with a living shoreline. The areas where the seawall must remain, will be enhanced by the placement of a SEP feature in the form of rip rap with planters.

Bay View Living Shoreline

This recently acquired Sarasota County property has a dilapidated seawall. The County is currently investigating the feasibility of removing the seawall and replacing it with a living shoreline.

Spanish Point

Spanish Point is a 30-acre museum and environmental complex located on Sarasota Bay. There is an existing seawall and an area in front of the seawall where native vegetation could be planted to increase the intertidal zone.

Sarasota Conservation Foundation

This potential project would entail a partnership with the Foundation and the SBEP to utilize a combination of reefballs, oysterbags, and native vegetation for a living shoreline that would help to protect the property from erosion.

Nokomis Beach Boat Ramp

This highly utilized boat ramp/park has severe erosion issue. Sarasota County and the SBEP are discussing potential opportunities to incorporate structural and natural erosion protection measures.

PINELLAS
HILLSBOROUGH
MANATEE
HARDEE
DESOTO
SARASOTA
CHARLOTTE
Emerson Point
Bishop Point
Warner's Bayou
Palma Sola Causeway
Kingfish Boat Ramp
Sanctuary Cove
Rose Park
Bradenton Riverwalk
Portosueno Park
Coquina Beach Boat Ramp
Bayfront Park
Powell Crosley Estate
O'Leary's Living Seawall
Spanish Point
Sarasota Conservation Foundation
Bayview Living Shoreline
Nokomis Beach Boat Ramp

Legend

- PROJECT COUNTIES
- NON-PROJECT COUNTIES
- LIVING SHORELINE
- LIVING SHORELINE AND SEAWALL ENHANCEMENT
- SEAWALL ENHANCEMENT

Date: 10/19/2016 Rev. Date: 06/20/18 PM: CS/TR GIS Analyst: TMS Map Document: 1966_bg27_fig2_tms_20180620.mxd Project Number: 001966.30.C BG 27 PDF Document: 1966_bg27_fig2_tms_20180620.pdf Plot Size: 11 x 17

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Figure 2 - Potential Living Shoreline Projects in Sarasota Bay Estuary Program's Watershed

Living Shoreline Primer
Various Counties, Florida

0 6 12 18 Miles

Data Source:
- ESA Scheda

Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida State Plane West

N

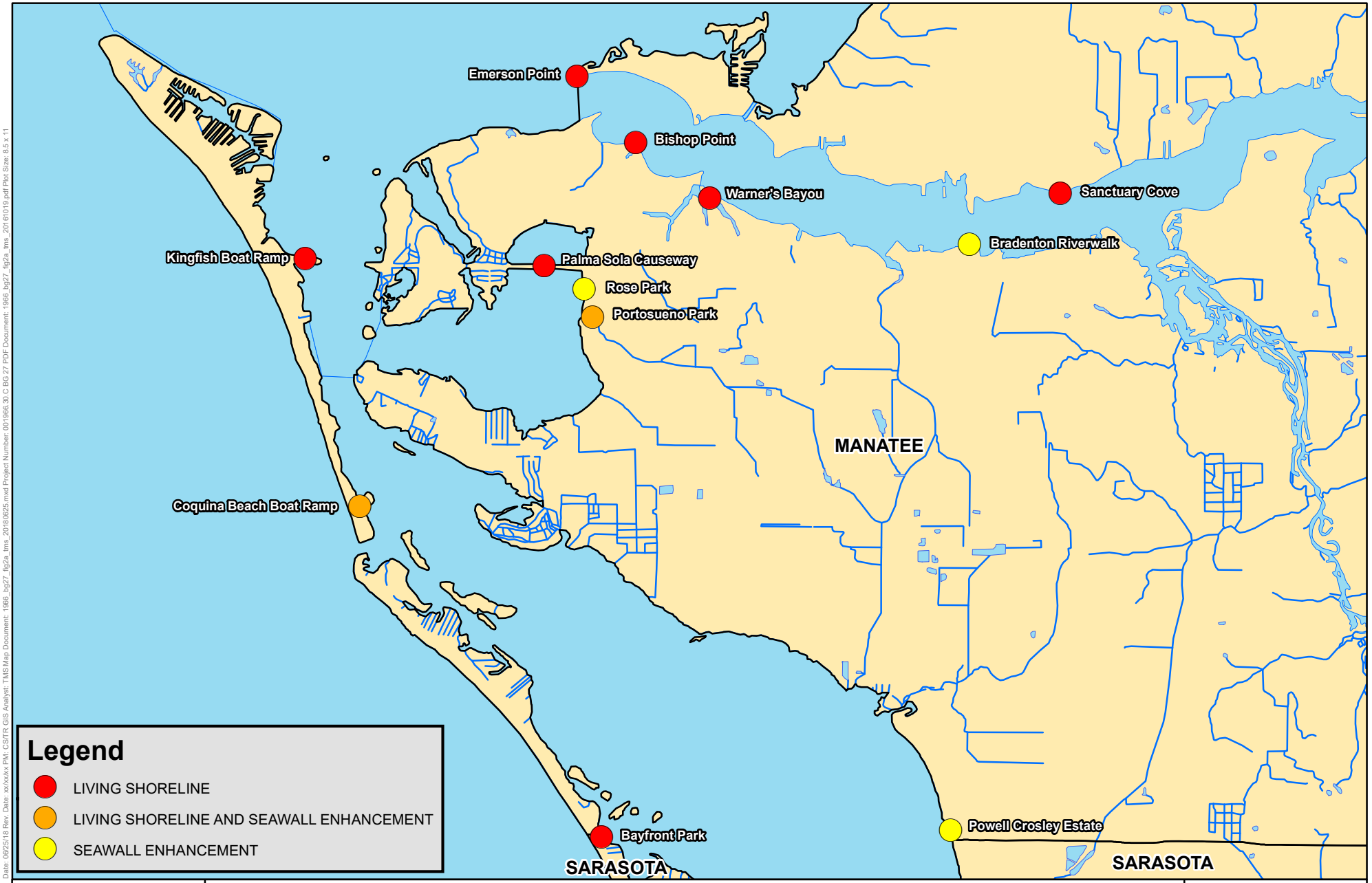

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Figure 2a - Potential Living Shoreline Projects in Sarasota Bay Estuary Program's Watershed Manatee County

Living Shoreline Primer
Manatee County, Florida

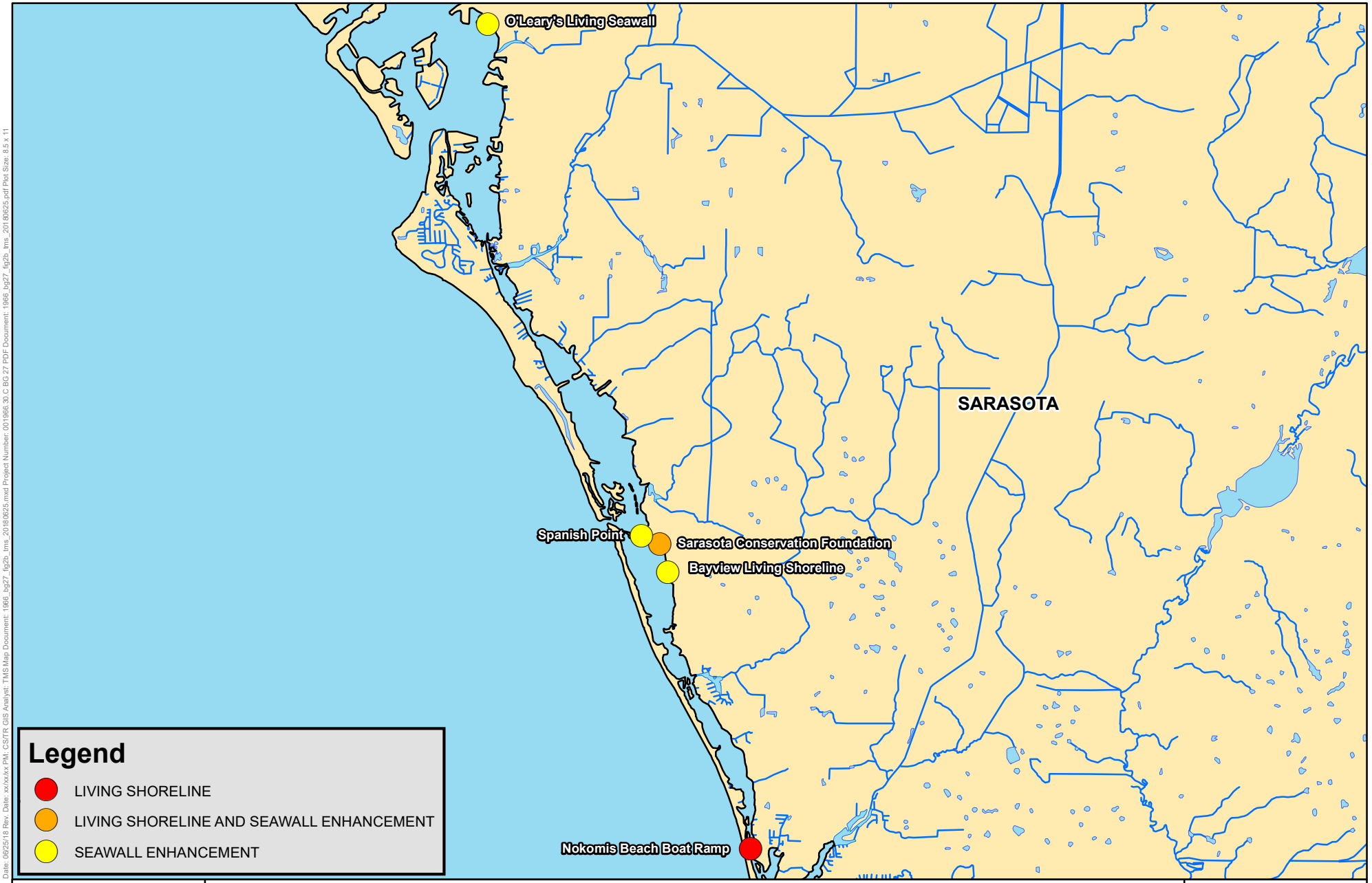
0 9,000 18,000 27,000 Feet

Data Source:
- ESA Scheda
Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida State Plane West

N

Date: 09/25/18 Rev. Date: xx/xx/xx PM: CS/TR GIS Analyst: TMS Map Document: 1966_bg27_fig2a_tms_20180925.mxd Project Number: 001966.30.C BG 27 PDF Document: 1966_bg27_fig2a_tms_20181019.pdf Plot Size: 8.5 x 11



ESA SCHEDA

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Figure 2b - Potential Living Shoreline Projects in Sarasota Bay Estuary Program's Watershed Sarasota County

Living Shoreline Primer
Sarasota County, Florida

0 12,000 24,000 36,000 Feet

Data Source:
- ESA Scheda
Imagery Source:
- NA

Coordinate System:
NAD 1983 Florida
State Plane West

N