



COASTAL MANAGEMENT

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DATA, INVENTORY, AND ANALYSIS



COASTAL MANAGEMENT ELEMENT

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INTRODUCTION

The City of Delray Beach is well known for its vibrant downtown leading up to an award-winning beachfront with plentiful public access. The purpose of the Coastal Management Element, in agreement with the Florida Department of Economic Opportunity, is "to plan for, and where appropriate, restrict development activities that would damage or destroy coastal resources, endanger human life, and limit public expenditures in areas that are subject to destruction by natural disaster, such as within the Coastal High Hazard Area". Coastal management is a multifaceted effort. Proper management ensures both the protection of life and property from natural disasters, as well as the conservation of natural resources. It strives at once to maintain and enhance the quality of life of citizens who value the area as a recreational asset, to protect wildlife and natural ecosystems, to maximize economic benefits generated from tourism, and to safeguard human life and public investment from natural disasters. Coastal Management requires a careful balance between the natural and built environments.

To effectively provide management, it is important to understand the existing components of the coastal zone, how they have been developed over time, and what the projected needs are for the future. The data, and analysis provided in this Element provides an inventory of coastal resources

to guide the City's decision-making, support the City's Coastal Management Goals, Objectives, and Policies, and be consistent with adopted plans and permits covering activities in the Coastal Planning Area.

Coastal High Hazard Area

According to the Federal Emergency Management Agency (FEMA), the Coastal High Hazard Area is identified as Zone V on Flood Insurance Rate Maps (FIRMs). Special floodplain management requirements apply in V Zones, including the requirement that all buildings meet minimum elevation criteria.

Section 163.3178(2)(h)9, Florida Statutes, defines the Coastal High Hazard Area as an area particularly vulnerable to the effects of coastal flooding from tropical storm events, specifically the area below the elevation of the category 1 storm surge line as established by a Sea, Lake, and Overland Surges from Hurricanes (SLOSH) computerized storm surge model. This definition is used for this Element.

THE COASTAL PLANNING AREA

The Coastal Planning Area includes the offshore reef, the barrier island, the Intracoastal Waterway, and the waterway's western shoreline. The Coastal Planning Area (CPA) for the City of Delray Beach includes all land within the Coastal High Hazard



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Area (CHHA), as defined by Florida Statutes and depicted on Map AD-13 (Coastal High Hazard Area).

The City's Coastal Planning Area historically was bounded by the north and south City limits, the Atlantic Ocean to the east, and including properties along the western edge of the Intracoastal Waterway. The Coastal Planning Area has been extended westward to include all properties located along waterways that adjoin the Intracoastal Waterway, as well as properties more susceptible to flooding in major storm events (1% annual chance of flood) based on updated Flood Insurance Rate Maps (FIRM) provided by Federal Emergency Management Agency (FEMA) and adopted by the City in October of 2017. The Coastal High Hazard Area is approximately 786 acres; the most recent flood zones are depicted on Map AD-15 [Coastal Areas Subject to Flooding (FEMA Flood Zones)].

INVENTORY & ANALYSIS

Land Uses

The land uses within the Coastal Planning Area are depicted in Map AD-14 (Coastal High Hazard Area and Existing Land Uses). The barrier island varies in width from 1,000 to 2,000 feet and is essentially built-out, with only individual lots available for development. The land use is mostly residential with more than half of the area zoned for single family detached housing. Some commercial land uses are found along Linton Boulevard, Atlantic Avenue, and George Bush Boulevard.

TABLE CME-A Coastal Planning Area Land Use		
LAND USE	AREA (ACRES)	% OF TOTAL AREA
Residential	632.50	80.49%
Commercial	50.97	6.49%
Education, Public, & Intuitionial	30.97	3.90%
Industrial	0.00	0.00%
Recreation & Open Space	61.97	7.89%
Vacant	9.67	1.23%
TOTAL	785.78	100.00%

Beach and Dune System

The beach and dune system serve as the City's primary protection against storm surge and waves. This critical protective system has been managed over time by a series of nourishment events since 1973 and has been calculated to provide annual storm damage reduction benefits valued over \$16 million (CPE, 2001). Analyses conducted for the United States Army Corps of Engineers (USACE), which consider only primary benefits (storm damage reduction and loss of land benefits, not including recreational or tourism benefits) have determined that the Delray Beach renourishment project has a Benefit-to-Cost Ratio of over 11:1 (CPE, 2001).

An Analysis and Recommendations for the Management of the Coastal Dune at Delray Beach was prepared for the City in 2015 (Barron, 2015). According to the Study, the man-made dune measures the entire 6840 foot shore parallel length of the Public Beach, with the shore normal width averaging 160 feet from the seaward edge of the turfgrass along A1A east to the limit of native dune grass on the nourished beach. Width of the dune varies along the private shoreline from 140 shore normal feet to the north of the public beach, to 200 feet between Casuarina and Atlantic Dunes Park, and 125 feet south of Linton.

Windblown sand has accumulated in the vegetation, throughout this area, with as much as eleven vertical feet of accretion above the nourished beach elevation of +9 feet NGVD, in some places. This increased elevation has created a foredune ridge and left one or two low troughs, or swales, between the grassy foredune and the scrub plants along the sidewalk. Short term growth of the profile can be rapid, in the exposed seaward area, especially during a strong, dry, onshore wind event, while sand trapping and the general microclimate farther upland in the swale is buffered. The development of this foredune/backdune zonation is allowing species succession to proceed on a compressed scale, and providing an environment for a broader palette of plant choice for continued City



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replanting efforts to restore a more complete strand zone habitat.

The seagrape near the roadway is pruned semi-annually to maintain height at about three feet above grade, and the sea oats dominated foredune grows without management, expanding seaward at five to eight feet yearly, controlled by active beach use.

Eight species had been planted, and about 25 native and ruderal species had voluntarily recruited to the renourished Delray Beach, prior to 1995, when the City conducted the first of several projects to remove the invasive exotic scaevola hedge, prune seagrape trees, and revegetate the hedge zone with native dune species.

A total of fifty native species have been added to date, including several listed as endangered or threatened by the State of Florida or the U. S. Fish and Wildlife service. Another 73 native plant species have recruited as volunteers into the system. The Floristic Inventory identifies an additional forty non-native species of a few individuals or small populations, which should be targeted for eradication

Atlantic Dunes Park, which has been managed by the City since the 1970s, is one of the few remaining coastal ecosystems in South Florida with a full transverse section of Beach/Dune, Coastal Strand and Maritime Hammock communities. The species diversity of the Park has suffered in the past thirty years from overshadowing by exotic plants, and more than a dozen of the native species, which used to exist there, have been lost. The maintenance and ongoing restoration of this area is a high priority.

Due to the significant risk posed by coastal erosion and the economic value of protecting the resources within the city, the City's entire beach is federally authorized as the Delray Beach Segment of the Palm Beach County Shore Protection Project. The Shore Protection Project for Palm Beach from the Martin County Line to Lake Worth

Inlet and from South Lake Worth Inlet to the Boca Raton Inlet was authorized by Section 101 of the River and Harbor Act of October 23, 1962 (PL 87-874). The project was authorized in accordance with the report of the Chief of Engineers, Department of the Army. The Chief's report and project description are contained in House Document 164/87/1. Through authorized extensions, the project authorization also provides federal participation in the cost of the periodic renourishments. (CPE, 2001) The current federal authorizations are set to expire in 2023.

Water-Dependent and Water-Related Uses

Water-related uses are depicted in Map CME-4. "Water Related Uses". The uses include beach and four marinas along the Intracoastal Waterway (Delray Harbor Club, Delray Beach Yacht Club, Marina Delray, and the City's Marina). Water-related uses include docking facilities and private marinas which are secondary to residential use. Three City parks provide water-related amenities: Veterans Park, with fishing and short-term dockage, Knowles Park, with boat ramp facilities, and Mangrove Park, with boat ramp facilities.

No additional water-dependent sites are needed relative to meeting level of service needs of the Coastal Planning Area; however, the City desires to provide additional water access through continued enhancement of Intracoastal Waterway and beach access opportunities, including enhancement of street ends that abut the Intracoastal Waterway. Potential grant funding from the Florida Inland Navigation District (FIND) may be available to support new street-end parks and water access improvements. New amenities, such as benches, picnic tables, trash receptacles, and launches for non-motorized vessels may be desirable additions in the community. These improvements could be coupled with seawall maintenance and improvement projects.

Conflicts Among Shoreline Uses

Delray Beach's ocean shoreline does not have fishing piers or public docks, and with limited redevelopment potential, conflicts among shoreline uses is not an issue. The most significant



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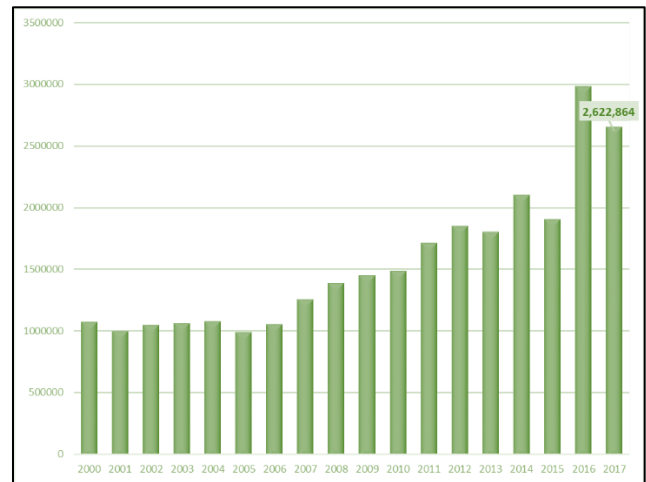
potential for conflict occurs with the preservation of the dune system and its vegetation, while providing accessibility to the beach. Continuation of existing beach and dune management programs will work to avert any such conflicts. The ongoing management plan calls for removal of invasive exotics and replacement with indigenous species, replicating the diversity of native dune environments as well as dune trimmings. The continued vitality of this ecosystem is to be retained through maintenance activities by the Parks and Recreation Department. Training by a biologist/dune professional on techniques for managing seagrasses and removal of exotics can help establish the most efficient and effective outcome of maintenance efforts.

Economic Base

Tourism and hospitality are legacy industries for the City of Delray Beach. The economy of the Coastal Planning Area is reflective of the economy of the city as a whole, and in turn, of the region: primarily residential, with limited commercial development that provides support for residents and visitors. A significant tourist and seasonal component within the local economy is oriented toward the beach resource.

In addition to the storm protective function, the coastal environment of Delray Beach is rich in both cultural and natural resources. As a result, the beach and nearshore waters are heavily used for recreational activities such as sunbathing, volleyball, surfing, and other watersports. The proximity, diversity and aesthetic beauty of the natural reef system, as well as the presence of a shallow shipwreck in the nearshore waters of Delray Beach also offers opportunities for fishing, snorkeling, scuba diving and boating. Annual beach attendance has been on the rise since the early 2000's Figure CME-1 Beach Visitors per Year.

Figure CME-1
City of Delray Beach Visitors per Year



Source: Delray Beach Ocean Rescue as reported to The United States Lifesaving Association.



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Infrastructure

Public infrastructure facilities in the Coastal Planning Area include water and sewer systems, seawalls, stormwater inlets and outfalls and streets that serve the mostly built-out area. Future infrastructure improvements will be those to provide the Coastal Planning Area with a reasonable level of service in the future. On the barrier island, the existing infrastructure systems for potable water, sewer, and streets accommodate existing development. The City has completed projects to provide reclaimed water to a significant portion of the island and has capital improvements plans to continue to expand the system to most of the other potential residents.

The Coastal Planning Area experience increased seasonal flooding within certain areas, such as the Marina Historic District, Atlantic Dunes parking lots, and select residential streets. The City has recently completed a seawall improvement project at Veterans Park to address flooding by raising the seawall elevation. A Sea Wall Vulnerability Analysis is in the process of evaluating other flood prone areas. In 2018 seawalls, stormwater inlets, and outfalls along the Intracoastal Waterway and connecting canals were surveyed to inventory current conditions. These surveys identified that backflow prevention devices, such as flap gates, duckbills, and inline valves are installed on select, but not all, outfalls. In addition, varying levels of maintenance are required on these devices to optimize performance. This data will assist the Public Works Department in setting priorities for future installations.



Inline Valve, Image courtesy of APTIM 2018.



Duckbill Installed - Courtesy of APTIM 2018

Historic Resources

Two locally designated Historic Districts are within the Coastal Planning Area. They are the Nassau Street Historic District and a portion of the Marina Historic District. In addition, ten individually designated structures are on the local historic register. Those historic resources are shown on Map AD-17 (Coastal High Hazard Area and Historic Resources). The City has a Historic Preservation Ordinance that is administered by the Historic Preservation Board. That ordinance requires issuance of a Certificate of Appropriateness by the Board prior to modification or new construction on properties in Historic Districts and on individually designated sites. No conflicts between the Future Land Use Map and historically designated sites exist.



Historic Marker for the Orange Grove House of Refuge. Image courtesy of APTIM 2018



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Cultural Resources

The settling of Delray Beach began in the later part of the 19th Century. One of the first buildings constructed there was the Orange Grove House of Refuge No. 3 in 1876 that served as a safe-haven for victims of shipwrecks. Other refuge houses similar to the Orange Grove House were constructed up and down the east coast during this time after the federal government decided to require more aids to sailors, which also included the construction of more lighthouses. Unfortunately, the Orange Grove House burned down in 1927.



Photo Source: Historical Society of Palm Beach County (HSPBC).
<http://www.hspbc.org/>

In 1998, the Sandoway Discover Center opened in Delray Beach. The Sandoway Discovery Center is a coastal ecosystems and marine life center, which is open to the public. The Center presents educational exhibits and programs for locals, tourists, and visitors of all ages. The Center currently hosts field trips and offers educational outreach programs related to sea climate change, coral reefs, amphibians and birds, insects, plants and seeds, sea turtles, and reptiles. The Center represents early beach-front living, the lawn is thick with natural local beach dune vegetation. The Sandoway House Nature Center is a historic home built in 1936, where one can experience Delray's rich history through a self-guided tour. Palm Beach County owns the property and leases it to the City of Delray Beach, who in turn, sublet the property to the Friends of Sandoway Nature Center, inc. The City could coordinate with the Friends of Sandoway House to create and coordinate public education programs.

On September 11th, 1903 the S.S. Inchulva wrecked during a hurricane while transiting from Galveston, TX to Newport News, VA. Nine sailors were lost during the event and the remaining survivors found refuge at the Chapman house in Delray Beach. Following the wrecking, the S.S. Inchulva was heavily salvaged. During the 1920s and 30s the hull was dynamited to continue the salvage efforts and to alleviate the navigational hazard it had become. Masts and superstructure could be seen out of the water.

The S.S. Inchulva, also known as "the Delray Wreck", is located in about 20 feet of water offshore of the south end of the Municipal Beach. Currently, when exposed, the hull and boilers serve as a substrate for marine organisms. Over the years it has become a popular location for recreational SCUBA divers and snorkelers. Divers and snorkelers can view five different sections of the hull, one section associated with a barge that sank during the salvage efforts during the early 20th Century.



The SS Inchulva
Image courtesy of APTIM 2018



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Dredge and Spoil Disposal Sites

No dredge spoil disposal sites have been identified as needed within the city throughout the planning period. Three parcels in the city that are owned by Florida Inland Navigation District (FIND) are designated as spoil disposal sites for United States Army Corps of Engineers for maintenance dredging of the main Intracoastal Waterway channel. If the City has a need to conduct canal dredging activities, permission for temporary stockpiling of dredge spoils would have to be granted by the FIND board to utilize those parcels. Permission is unlikely to be granted for dredging of private canals. Ongoing coordination with FIND is recommended and should be expanded to discuss future needs as sediment accumulates in both public and private canals.

Natural Resources

Reef

Delray Beach is unique in South Florida in that it does not have any nearshore natural hard-bottom, but does have an extensive offshore reef in about 60 feet of water, located approximately $\frac{3}{4}$ mile from the beach. This reef is part of the Continental Southeast Florida Reef Tract that extends from southeast Miami to north of West Palm Beach. These reefs run parallel to shore and are made up of a ridge complex (closest to shore), an inner, middle and outer reef, all separated by sand deposits of varying thickness. Moving north, the nearshore ridge complex disappears under the modern shoreline at Hillsboro Inlet in Broward County and, continuing north, the Inner and Middle Reefs also disappear leaving only the Outer Reef just north of the Boca Inlet in Palm Beach County. This area is where the Delray reef is located and why only one shore parallel reef tract is just offshore of the City of Delray Beach.

The Delray Beach Reef is dominated by octocorals and sponges both in size and density. The most abundant octocorals include sea rods and sea whips, and giant barrel sponges are also very common among the benthic community making up a large part of the reef biomass (CPE, 1997, 2005; CB&I, 2013). There is also a complex

macroalgae community that supports a diverse assemblage of herbivores including reef fish and sea turtles. Although this reef is not a stony coral dominated community, it supports a large variety of stony corals, including the federally listed coral species of *Acropora*, as well as several other listed coral species.

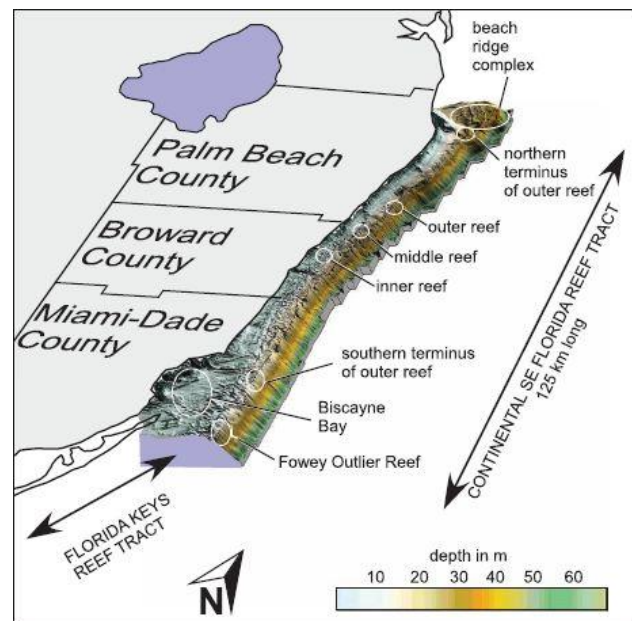


Figure Source: Banks et. Al. 2018



Reef image courtesy of APTIM 2018

The reef edge is often defined by a very clear ledge on the western boundary where the reef rises about 10 ft. and plateaus toward the east. Many schooling fish assemble along the edge



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where the change in relief is greatest. There are also areas where the edge is rather patchy and characterized by rock outcroppings (large and small) that also support benthic and fish assemblages characteristic of coral reef habitat.

Beach

The city has 2.7 miles of oceanfront shoreline, all of which are deemed critically eroded shoreline by the State (FDEP, June 2018). The beach is 100% publicly accessible and 51% of the ocean frontage is within two public parks: Delray Municipal Beach and Atlantic Dunes Park. The beach seaward of the Erosion Control Line (ECL) throughout the city is public land, jointly managed by the City, County, State and United States Army Corps of Engineers as the federally authorized Delray Beach Segment of the Palm Beach County Shore Protection Project. The beach nourishment project has successfully provided storm protection for upland property. Since 1973, no damage to upland property due to erosion or wave damage has occurred.



Municipal Beach, image courtesy of APTIM 2018



Municipal Beach, image courtesy of APTIM 2015

In addition to storm protection and recreation, Delray's beach provides habitat for many species of flora and fauna, including nesting and roosting shorebirds and nesting sea turtles. The primary nesting sea turtle in Delray is the loggerhead sea turtle; however, endangered leatherback turtles have also been documented to nest on the beach in Delray. The beach and nearshore marine habitat are designated as critical habitat to loggerhead sea turtles. Recognizing the valuable habitat that the beach provides to nesting sea turtles, the City began the Sea Turtle Monitoring and Conservation Program in 1984 and has monitored the beach for sea turtle nests annually since, whether required by permit or not.



Courtesy of APTIM

Another important resource for wildlife on the beach is present along the water line where



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beach wrack washes on shore and provides valuable food resources for many shorebirds. The wrack creates an energetic link between marine and terrestrial systems at this interface.

The intertidal habitat, or wet beach, in Delray is made of up softbottom substrate (sand) and serves as a feeding ground for many shorebirds and finfish. The infaunal community is generally comprised of polychaete worms, coquina clams and mole crabs, which are considered indicator species for the health of beach habitat by Florida's Comprehensive Wildlife Conservation Strategy. The surfzone and subtidal habitat is home to shellfish, foraging fish, predatory fish and the occasional offshore migratory predators (Greene, 2002).



Courtesy of APTIM

The softbottom substrate found in the intertidal and subtidal habitats, as well as the water column are designated as Essential Fish Habitat. The softbottom provides habitat for benthic organisms to live on and within and is an important element in the food web. The water column is that habitat where highly migratory species are found, such as king mackerel and sailfish. The beach is accessible to residents and visitors through a number of beach walkways throughout the two public parks. Mobi Mats® installed at the first access south of Atlantic Avenue, create a more stable surface for access by wheelchair, stroller, etc. The Ocean Rescue department also has four surf chairs available for the physically challenged to enjoy the beach, available on a first come, first served basis at the following lifeguard towers: South 1, South 3, South 5 and Atlantic Dunes Park. at Atlantic Dunes Park has over 100 parking spots and over 500 public parking spots are available within ¼ mile of the Municipal Beach. In addition to

personal car, beach goers can access the beach by the Downtown Roundabout Trolley or by bicycle and utilize one of the many bicycle racks.



Mobi Mats at Atlantic Avenue Access - Courtesy of APTIM 2018



Courtesy of APTIM 2018

Dunes

Starting from the western boundary of the beach, Delray boasts an extensive dune habitat. Early on, the City recognized the protection that a dune offers to the upland infrastructure and has maintained the vegetated dune since the initial dune restoration and planting in 1974. The City also



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recognizes that removal of exotic vegetation and planting native Florida dune vegetation promotes a healthy ecosystem and provides a protective barrier between the ocean and the upland infrastructure.



Courtesy of APTIM 2018

Coastal dunes serve a number of functions. The dune vegetation traps and stabilizes wind-blown sand, slowly growing in elevation into an important storm protection feature that can reduce flooding and wave damage during heavy storms. The success of this dune system can be measured by the large accumulation of wind-blown sand that has formed into a storm protective dune approximately 100-200 feet wide. The sandy dune also provides a habitat for over two hundred plant and animal species (Barron, 2015).

An important component of the Dune program at Delray Beach has been the rescue and relocation of a number of plants listed as endangered or threatened by the State and Federal governments. Plants such as Sea Lavender, Golden Creeper, Silver Palm, and Beach Clustervine have been grown from seed or transplanted from development sites or areas of neglected management, and reintroduced to the Municipal Beach to establish functioning populations, and preserve a genetic storehouse for future restoration efforts. This work has been conducted and supported by high school and college students, local native plant nurseries, and a Federal grant program.

The City's decision, years ago to allow access pathways to evolve naturally, rather than to build elevated structures, has proven prudent. The only evidence of harm from pedestrian load even at the access points nearest the most concentrated parking, is the fanning of the seaside of a few paths, such as at South 3/Sandoway path, which allows sand to blow and accumulate farther into the backdune.



Courtesy of APTIM 2018

Intracoastal Waterway

Technically, there is no estuarine environment in the approximately 21.4 miles of tidally influenced canals within the Delray Beach Coastal Planning Area. The Intracoastal Waterway has been channelized throughout the city, and most of the shoreline is protected by seawalls of varying age and structural condition. The natural areas that remain are not estuarine in a technical classification. Nonetheless, the City and other responsible agencies consider the waterway to be more than a transportation route and seek to protect its estuarine features.

The City does not have any significant areas that support manatees and the estimates of manatee sighting are relatively low. Even so, the City supports speed restrictions in the Intracoastal Waterway designed to protect this endangered species. The majority of the Intracoastal Waterway maintains a boating speed of 25-30 mph with slow speed and idle speed zones. The narrow canals



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and waterways off of the Intracoastal Waterway are "Slow Speed All Year" areas, as is the area from 300 feet north of the Atlantic Avenue Bridge to 500 feet north of the Knowles Park boat ramp. "Idle Speed All Year" zones are present between 300 feet north and 600 feet south of the George Bush Boulevard Bridge and from 500 feet north of the Knowles Park boat ramp to 300 feet north of the Linton Bridge.

Three publicly owned parcels that front the Intracoastal Waterway have potential as preservation areas. The sites include Florida Inland Navigation District Parcels MSA 645 and 650, and the City-owned Donnelly Tract. All three sites have conservation land use designations and are zoned as conservation or open space areas. One of the most significant activities to be undertaken along the Intracoastal Waterway involves the preservation of these sites. No known point sources of pollution exist along the Intracoastal Waterway, other than storm water discharge areas. Implementation of projects and programs under the National Pollution Discharge Elimination System (NPDES) permit, together with standards already adopted in the Land Development Regulations for new construction and reconstruction, keep the City compliant with state and national standards for the quality of storm water runoff.

Offshore Sand

Between the reef and shore is sand bottom, there are no hardbottom areas or outcrops of reef or rock. The City of Delray Beach has proactively managed their coastal resources by implementation of a Beach Nourishment Program since 1973. To date, this program includes an initial nourishment, five periodic nourishments, and two

storm damage repair projects all built with beach compatible sand dredged from permitted borrow areas directly offshore of the City.



Courtesy of APTIM 2016



Courtesy of APTIM 2016



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HISTORY OF MANAGEMENT OF COASTAL RESOURCES

Reef Monitoring

Monitoring of biological communities on the barrier reef occurred from 1993 through 1996 in conjunction with the 1992 renourishment project. The post-construction monitoring report describes the reef community observed offshore of the borrow areas as typical of the southeast Florida coast, with octocorals and sponges being the dominant fauna both in size and density (CPE, 1997). Reef surveys were again conducted in conjunction with the 2005 Storm Damage Repair Project and similar flora and fauna assemblages were reported (CPE, 2005). As of 2008, the reef offshore of Delray was designated as critical habitat for the threatened coral species *Acropora* spp. Prior to the 2013 5th Periodic Nourishment, the reef was surveyed for *Acropora* by implementation of the NMFS Recommended Protocol (CPE, 2011).

During dredge and fill activities, all vessels are required to remain at least 400 ft. from the reef at all times and must travel to and from the beach

through the gap in the reef, which is about 1,800 ft. wide. The borrow areas directly offshore of Delray's beach have been used multiple times since program inception in 1973. The short distance and direct route from the borrow area to the beach also minimizes risk for incident during dredge and fill operations.

Due to the distance of the reef from the beach and borrow areas, the gap in the reef allowing safe ingress and egress of vessels, and the nearby proximity of the borrow areas to the fill area, monitoring has not been required by regulatory agencies since the 2005 project, except for *Acropora* surveys. Even so, the City has adopted a proactive approach to ensure protection of the reef by mapping at a minimum, the reef edge before and after project construction in order to document conditions (CPE, 2013).





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Infauna Monitoring

Monitoring of infaunal communities, the critters that live in the sand, took place in the borrow areas and on the beach for the 1992 renourishment project. The benthos is an important element in the food web, providing food for wading birds, shorebirds and fish. The post-construction monitoring report compared pre-construction, mid-construction and post-construction infauna data and documented that annelids were most abundant, with arthropods, nemerteans and molluscs the second, third and fourth most abundant groups (CPE, 1997). Based on comparisons of community structure, species composition, infauna densities and species diversity, the report concluded that dredging of the borrow areas had little or no long-term effect on the associated infaunal communities or the mean grain size and silt/clay or organic content of the sediment. This type of monitoring has not been required since.

Beach Nourishment Projects

In the 1960's and 1970's severe coastal erosion threatened AIA and upland infrastructure in the city. The Delray Beach Restoration Project, covering the entire City limits, was federally authorized by the United States Army Corps of Engineers (USACE) and initially constructed in 1973. Delray Beach's beach nourishment

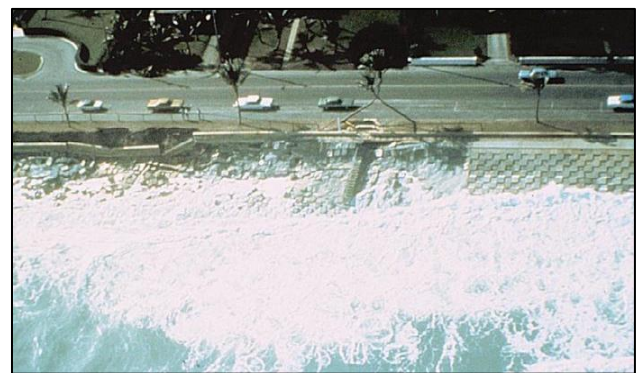
program is one of the longest and most successful programs in the country and is often used as an example throughout the field of coastal engineering and management.

To date, the City has participated in eight beach nourishment projects. Approximately 7.9 million cubic yards of sand from offshore borrow areas have been placed as a result of the City's and United States Army Corps of Engineers beach preservation efforts. Since the initial nourishment of 1973, the City has maintained the beach through planned, periodic beach renourishments on five occasions, including 1978, 1984, 1992, 2002 and 2013. Storm damage repair projects were constructed by the United States Army Corps of Engineers in 2005 in response to losses from the active 2004 hurricane season and in 2014 to repair damages from Hurricane Sandy (October 2012).

Physical monitoring in the form of beach profile surveys on the R-monuments, and engineering analysis, are conducted annually to assess the conditions of the beach. These surveys and analysis are used to satisfy pre-construction and post-construction State and Federal permit requirements, as well as document beach conditions before and after storm events.



Pre-nourishment conditions.
Photos provided by Paul Dorling in 2014



Pre-nourishment conditions.
Photos provided by Paul Dorling in 2014



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TABLE CME-B Chronology of Beach Nourishment Events				
Project	Construction Date	Placed Volume (CY)	Location	State Permit Number
Initial Nourishment	1973	1,634,500 ¹	R-175 to R-188	BBS 72-24
1 st Periodic Renourishment	1978	701,300 ¹	R-176 to R-182 and R-186 to R-188	BBS 75-10
2 nd Periodic Renourishment	1984	1,311,000 ²	R-175 to R-188	BBS 75-10M1
3 rd Periodic Renourishment	1992	1,196,500 ³	R-180 to R-188.5	DBS890242 and 501662809
4 th Periodic Renourishment	2002	1,230,000 ³	R-179 to R-188A	0178582-001-JC
USACE FCCE SPP ⁷	2005	250,000 ⁴	R-175 to R-188	0178582-003-EM
5 th Periodic Renourishment	2013	1,158,500 ⁵	R-179 to R-188A	0303553-001-JC and 0303553-002-BV
USACE FCCE SPP	2014	381,200 ⁶	R-175+300 to R-180	0303553-001-JC
	Total to Date	7,863,000	R-175 to R-188.5	-
References: (1) 1990 LRR (USACE, 1990), (2) 2001 LRR (USACE, 2001), (3) 2002 Post-Construction Report (CPE, 2003), (4) 2005 Post-Construction Report (CPE, 2006) (5) 2013 Post-Construction Report (CPE, 2013), (6) 2014 FCCE Post-Construction Report (CB&I, 2014). (7) USACE FCCE SPP = U.S. Army Corps of Engineers' Flood Control and Coastal Emergencies Shore Protection Project				



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2017 photo from GoogleEarth. 1973 photos courtesy of APTIM.

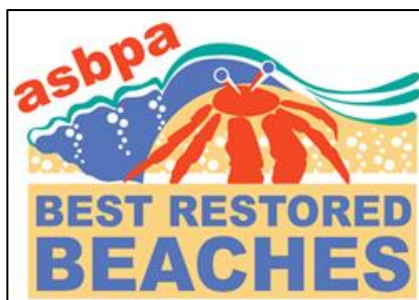
Physical monitoring in the form of beach profile surveys on the R-monuments, and engineering analysis, are conducted annually to assess the conditions of the beach. These surveys and analysis are used to satisfy pre-construction and post-construction State and Federal permit requirements, as well as document beach conditions before and after storm events.

Coastal Awards:

2013 ASBPA Best Restored Beach award

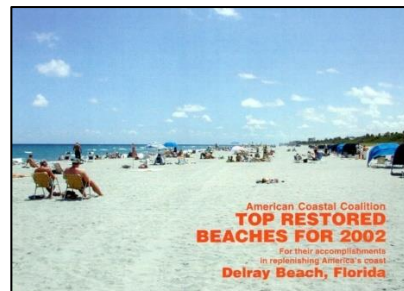
2005 ASBPA Project Award

2002 American Coastal Coalition Top Restored Beaches



2013 Award Winner!

"The beach has performed better with every project and is the quintessential example of a beach nourishment success story."





COASTAL MANAGEMENT ELEMENT

Dunes

The coastal dune is almost entirely man-made, installed and enhanced through several dune planting projects that began as an effort to solve the problem of sand blowing into the street after the first major beach nourishment in 1973. In 1995, the City conducted the first of several projects to remove the invasive exotic scaevola hedge, prune seagrape trees, and revegetate with native dune species. At that time, eight native species had planted and about 25 native and ruderal species had voluntarily recruited to the renourished dune.

In 2015, an analysis of the dunes was completed again. A total of fifty native species had planted, including several listed as endangered or threatened by the State of Florida or the U. S. Fish and Wildlife service. Another 73 native plant species had recruited as volunteers into the system. The Floristic Inventory appendix to the Dune Management Plan, identifies an additional 40 nonnative species of a few individuals or small populations.

In 2015, the City completed a program of contracted removal of the six most common invasive exotic species at the Municipal Beach. Populations of those six invasive species were mapped for Atlantic Dunes Park as well as for the private areas within the City limits to facilitate control efforts and as part of the City's Dune Management Plan (Barron, 2015).



Example of Dune Replanting Event – Courtesy of APTIM



1973 Initial Plantings to Prevent Wind Blown Sand



2018 Dune Conditions – Courtesy of APTIM

Atlantic Dunes Park, which has been managed by the City since the 1970's, is one of the few remaining coastal ecosystems in South Florida with a full transverse section of Beach/Dune, Coastal Strand and Maritime Hammock communities. The species diversity of the Park has



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been on the decline over the past thirty years, likely due to overshadowing by exotic plants. More than a dozen of the native species that used to exist in Atlantic Dunes Park, have been lost. (Barron, 2015)

In 2017, the City performed a crown reduction and pruning event of sea grape trees in the central portion of the Municipal Beach (from The Marriot to Dover House), and supplemental pioneer zone and strand zone replantings to comply with Federal Department of Environmental Protection (FDEP) permits for sea grape pruning. The City currently holds FDEP field permits for dune prunings that are contingent upon performance of continued exotic removal and compliance to lighting protocols.

Sea Turtles

The City has had an on-going sea turtle conservation program since 1984. This program includes nest monitoring and protection, and data collection such as nesting and hatching success, provided in Table CME-C, Delray Beach Turtle Nesting Data (2017). Artificial lights can deter females from nesting and disorient hatchling turtles; therefore, the City adopted Ordinance 11-14 in May 2014, setting requirements for new and existing beachfront lighting. Lighting inspections are conducted by the City's Code Enforcement staff to confirm compliance. Most recently, the City has made efforts to educate and guide coastal residents on sea turtle conservation and lighting requirements through mailing of sea turtle brochures prior to the start of nesting season on March 1, 2018.

TABLE CME- C Delray Beach Turtle Nesting Data (2017)				
	<i>C. caretta</i> Loggerhead	<i>C. mydas</i> Green Turtle	<i>D. coriacea</i> Leatherback	Total Species
Total # of Nests	252	46	6	304
Total # of False Crawls	900	120	2	
Date of First Nest	04/23/17	05/30/17	04/13/17	
Date of Last Nest	08/19/17	08/25/17	05/11/17	
Source: Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Annual Report for the Statewide Nesting Beach Survey, 2017.				

Intracoastal Waterway

Delray Beach has experienced more frequent and increased seasonal flooding within its coastal communities, streets, parks, and other facilities that border the Intracoastal Waterway in recent years. These seasonal flooding events have been primarily caused by inundation from the Intracoastal Waterway during elevated water levels. Similar to other coastal Florida communities, the City seeks to assess its

vulnerability to future seasonal flooding and to identify potential options to protect its infrastructure and citizen's property. The City has started this assessment with the 2018 Intracoastal Waterway Water Level & Infrastructure Vulnerability Study.

The study included review of available water level data, analysis of return periods of extreme events, and consideration of sea level rise guidance to



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determine water level projections for 30-year and 75-year planning horizons. Field investigations were performed to catalogue existing conditions of seawalls, stormwater inlets and outlets, and backflow prevention devices along 21.4 miles of canals within the City's study area in early 2018. The analysis is in progress and will result in a 30-year projected water level and both public and private recommended actions to improve the city's resistance to tidal flooding events.

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APTIM Performing Outfall Inspections - Spring 2018



Flooding within the City of Delray Beach, October 5, 2017 – Courtesy of APTIM



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EXISTING AND POTENTIAL COASTAL THREATS

Beach Nourishment Funding

The beach nourishment program is largely funded by federal, state and county funding partners. In order to maintain these funding partners, the City must comply with the conditions of the agreements and pursue reauthorization prior to expiration of existing agreements.

Depletion of Nearby Sand Resources

There is a finite amount of beach compatible sand within the existing offshore borrow areas. These areas do not quickly recharge with sand due to their offshore distances and depth. The City is to conduct an offshore sand search to identify and permit borrow area(s) for future renourishment events.

Flooding

Map AD-15 (FEMA Flood Zones) depicts the flood zone designations of the areas within the Coastal Planning area and include Zones VE, AE, and X. While the city is at a slightly higher elevation than other urbanized areas in Miami Dade and Broward County, flooding associated with King Tides has been documented along Marina Way, Veteran's Park and other low-lying areas on either side of the Intracoastal for years. The Rising Waters Task Force identified three types of flooding:

- 🌊 Coastal flooding due to tides
- 🌊 Flooding due to inundation of the stormwater management systems and diminished capacity
- 🌊 Flooding due to rising water tables, leading to flooding in low lying inland areas.

Addressing these impacts is a priority for the City.

Sea Level Rise

The City of Delray Beach is a member of the Southeast Florida Regional Compact for Climate Change (SFRCCC) and is committed to collaborating with the Compact members to foster sustainability and climate resilience at a regional scale. Map AD-18 (Sea Level Rise)

depicts the properties impacted at 1 foot, 2 feet, and 3 feet of sea level rise.

Invasive Exotic Pest Plants

The Florida Exotic Pest Plant Council designates certain plant species as Category I and II Invasive Exotic Pest Plants, generally when the species is known to crowd out native plants and produce a profusion of seeds which are spread by wildlife and wind, contaminating other areas. The problem of exotics on Delray Beach are also shallow rooted, compared to native dune species, and more likely to uproot or wash out in a storm. (Barron, 2015)

Light Pollution

All of Delray's beach is nesting habitat for sea turtles. If light illuminates the nesting habitat it may discourage nesting females or cause disorientation of sea turtle hatchlings as they instinctually use the light of the moon to guide them to the ocean.

Saltwater Intrusion

Due to a dense population and the permeability of the Biscayne Aquifer, Southeast Florida is at a high risk of saltwater intrusion – higher than other areas in the state. An aquifer is defined as a geological formation containing or conducting ground water, especially one that supplies the water for wells, springs, etc. The Biscayne Aquifer extends from Monroe County to Palm Beach County and provides nearly all the water used by South Florida residents and businesses.

Saltwater intrusion occurs when large amounts of saltwater infiltrate an aquifer's fresh water supply, creating brackish water. This typically occurs when an aquifer's water supply is depleted at a faster rate than it is replenished. As non-permeable surface area increases due to development, the permeable areas that allow for rainfall to infiltrate the ground and recharge the aquifer decrease. Furthermore, increased development creates an increased withdraw demand, and a decrease in recharge potential. As the well fields draw inward, saltwater replaces freshwater. Intrusion



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of this nature is problematic, as it makes the water undrinkable – requiring expensive technology, such as reverse osmosis to make the water potable again.

Nearshore Artificial Nearshore Reef

During Community Workshops, residents expressed interest in creating a nearshore artificial reef as a recreational amenity. Incorporating a nearshore artificial reef is complicated for Delray Beach because of the city's unique geology. Although neighboring cities have swimmable nearshore reefs, the nearshore ridge complex doesn't exist in Delray Beach. Without a naturally occurring hard substrate underlying the sand, boulders deployed in the nearshore would eventually subside into the sandy bottom.

However, engineered materials such as a marine mattress could be incorporated into a design that would support boulders, prevent reef subsidence and allow deployment within a swimmable distance from the beach. Additionally, the potential artificial reef would need to be located in such a way that it is not affected by the City's federally authorized Shore Protection Project.

With proper field investigation, design and permitting coordination, it is possible for the City to locate an acceptable site for a recreational artificial reef. It is important to properly set expectations of the ecosystem that may colonize the artificial reef. Once installed the reef will attract fish, and it is likely that flora and fauna such as opportunistic species of macroalgae, tunicates and sponges will colonize the reef, however, it is less likely that coral colonies will naturally recruit. If corals are important to the public's goals, there may be opportunities to participate in coral transplantation programs. Transplanting corals will require coordination with regulatory agencies and may include monitoring to coastal flooding from tropical storm events, specifically the area below the elevation of the category 1 storm surge line as established by a

ensure certain levels of success are met. The level of effort or scope of these tasks are unknown at this time.

The City coordinates with Palm Beach County's artificial reef program. The County is currently in the process of permitting a new artificial reef site offshore of Delray Beach. This project does not have funding or a vessel identified for use, and will require access from boats, yet within a matter of a few years, the City may have an additional recreational dive site.

NATURAL DISASTER PLANNING

Natural disaster planning in the Coastal Planning Area involves all disasters, including hurricanes, tornadoes, floods, freezes and droughts. Due to the City's geographic location, the emphasis is directed toward hurricane response, including hurricane preparation and evacuation, post-storm evaluation and clean up, and long-term post disaster redevelopment. As flooding is a key issue in the city associated with these Natural Disasters and can cause serious damage and potential loss of life, the City will continue to look for mechanisms to better monitor the "Peril of Flood" strategies as noted in F.S. 163.3178(2)(f).

Hurricane response plans are fully discussed in the City of Delray Beach Comprehensive Emergency Management Plan. The City has designated the Natural Incident Management System (NIMS) as the City's incident management standard for emergencies (including hurricanes) occurring within the city (Resolution 51-05). City personnel training is regularly updated through annual and pre-storm briefings, as tabletop exercises.

Coastal High Hazard Area

This area, as defined in F.S. 163.3178(2)(h), is particularly vulnerable to the effects of

Sea, Lake, and Overland Surges from Hurricanes (SLOSH) computerized storm surge model.



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Evacuation Planning

The evacuation area in Delray Beach consists of the entire barrier island, together with mobile home parks, as directed by the Palm Beach County Division of Emergency Management. These areas are evacuated more because they can be isolated from emergency services than the threat of flooding.

Planning for evacuation is accomplished under the auspices of the Palm Beach County Division of Emergency Management. A coordinated program exists between that agency and the City, based on the Hurricane Evacuation portion of the Palm Beach County Comprehensive Emergency Management Plan. In Delray Beach, all of the barrier island would be evacuated in a category 1 hurricane, together with mobile home parks. In the case of more intense hurricane categories, the evacuation area would be expanded as stated in the City of Delray Beach Comprehensive Emergency Management Plan.

Map AD-12 (Evacuation Routes) depicts the three evacuation routes off of the barrier island, all of which provide bridges over the Intracoastal Waterway. Bridge operations are directed by the Coast Guard and Palm Beach County Emergency Management Division to assure safe evacuation. The evacuation routes are:

- 🌈 George Bush Boulevard to I-95, via Swinton Avenue and Atlantic Avenue
- 🌈 Atlantic Avenue to I-95
- 🌈 Linton Boulevard to I-95

In summary, the significant aspects of hurricane evacuation planning are:

- 🌈 5,403 residential units are located within the City of Delray Beach Coastal High Hazard Area, (source: Palm Beach County Information Services, 2018)
- 🌈 Based upon Census data from Tracts 7410, 7412, part of 64.02, and part of 64.01, the estimated population in the Coastal High

Hazard Area is 7,552 people, 2860 of whom live on the barrier island.

- 🌈 Evacuation routes can accommodate the population of the Coastal High Hazard Area with an evacuation time of 7-10 hours.
- 🌈 One designated hurricane shelter (Atlantic Community High School) is located within the city limits, with a total capacity of 5,760 based upon a standard of 20 sq. ft. per person.
- 🌈 There are no constraints to evacuation other than localized street flooding along evacuation routes and backlog traffic on I-95 and the Florida Turnpike, the regional evacuation routes.
- 🌈 There are no hospitals or facilities for groups with special needs in the Coastal Planning Area, except for a life care retirement community with a nursing home component on Linton Boulevard, on the west side of the Intracoastal Waterway. CM - 9
- 🌈 No significant changes in these conditions would be created through development allowed by the Land Use Map.

Long-Term Post Disaster Redevelopment

Post disaster redevelopment will replicate the existing land use pattern and character in the Coastal Planning Area. The Coastal Planning Area will remain primarily residential with a high level of public access to the beach. Commercial uses are restricted to the area along Atlantic Avenue and its intersection with SR A1A. Except as provided for post-disaster reconstruction, all redevelopment will be required to conform to existing criteria as described in the Land Development Regulations. In addition to local regulations, the rules and regulations of the Florida Department of Environmental Protection regarding shoreline development (i.e. Erosion Control Line, Coastal Control Line, etc.) have been incorporated by reference in the Land Development Regulations.



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RECOMMENDATIONS

The following needs and recommendations comprise tasks are needed to comply with existing state and federal permits, to execute

currently planned improvements to environmental systems within the Coastal Planning Area or reflect community desires.

Reef Recommendations:

- 🌈 Monitor and protect the offshore reef in compliance with state and federal permits.
- 🌈 Follow NFWF Acropora monitoring protocols
- 🌈 Conduct turbidity monitoring during beach construction events in compliance with state and federal permits
- 🌈 Continue coordination with Palm Beach County Artificial Reef Program to plan for future offshore artificial reef
- 🌈 Continue monitoring of the reef pre and post-renourishment events regardless of permit requirements
- 🌈 Study the possibility and cost of creating a near shore artificial reef.

Dune Recommendations:

- 🌈 Perform annual maintenance of sand fencing, removal of exotic plants, replantings with native species, and pruning as prescribed in the City's Dune Management Plan (Barron, 2015)
- 🌈 Scarp repair with sand and plantings as needed
- 🌈 Lighting surveys in compliance state and federal permits and continued public education on light pollution
- 🌈 Prune seagrasses in height and trim radially in compliance with permits
- 🌈 Implementation of detailed dune management recommendations included in the Dune Management Plan (Barron, 2015)
- 🌈 Increase public awareness associated with exotic contamination, provide maps and encourage their participation to eradicate non-native species.
- 🌈 Coordinate with FDEP to develop and carry out a plan for remedial reduction of the seagrass footprint to predefined permit limits and replant with pioneer zone species.
- 🌈 Review pruning methods and train Parks Staff in recognition and appropriate care of special dune areas, and rare species.



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Beach Recommendations:

- 🌈 Continue implementation of periodic beach renourishment program
- 🌈 Conduct an offshore sand search investigation and pursue permit modifications to incorporate the identified beach compatible borrow area(s)
- 🌈 City to pursue federal reauthorization prior to the expiration of the current project authorizations in 2023
- 🌈 Maintain 1 MCY of sand within permitted borrow areas so that the City is able to be resilient and respond to storm impacts swiftly if they are to occur.
- 🌈 Investigate new technologies such as in-line screening equipment to allow for use of borrow areas that may be considered marginal in quality due to rock or shell content
- 🌈 Survey the beaches at least annually regardless of permit requirements
- 🌈 Dependent upon impending storm and relative timing of the most recent monitoring beach survey, consider having additional pre-storm or post-storm beach surveys done
- 🌈 Continue to submit Local Government Funding Requests to the State for cost-sharing on permit required beach renourishment tasks
- 🌈 Monitor sea turtle nesting activities annually regardless of permit requirements as this information is useful data for future permitting and comprehensive dataset.
- 🌈 Conduct pre-turtle nesting season nighttime surveys, taking geotagged photographs of all point source illuminants visible from the nesting beach, allowing Code Enforcement time to proactively engage property owners and suggest resolutions before nesting begins.

Intracoastal Waterway Recommendations

- 🌈 Install backflow prevention devices on vulnerable stormwater outfalls
- 🌈 Complete Seawall Assessment, adopt standards, and prioritize seawall improvements on publicly owned lands
- 🌈 Preserve City-owned parcels
- 🌈 Create new Street end park improvements
- 🌈 Improve water quality and facilitate oyster beds
- 🌈 Maintain boating speed restrictions

Natural Disaster Planning Recommendations:

- 🌈 Continue to prohibit changes in future land use or zoning that would increase density or intensity within the Coastal High Hazard Area/Coastal Planning Area.
- 🌈 Continue to provide public outreach regarding storm preparedness and evacuation procedures and routes.

Climate Change & Peril of Flood Recommendations:

- 🌈 Create a Sustainability and Climate Action Plan.
- 🌈 Designate vulnerable areas based on the Sustainability and Climate Action Plan.
- 🌈 Update to the land development code to respond to climate change impacts, such as accommodating freeboard
- 🌈 Seawall and other infrastructure updates.



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