

Attachment B: Supporting Research

April 6, 2021

Research Review Phase of the IRC Lagoon Management Plan: Update 3

1. Hydrology and Hydrodynamics

The hydrology and hydrodynamics of the Indian River Lagoon have changed over time as human influences have changed the natural flows of the system. According to the Indian River Lagoon National Estuary Program's (IRLNEP) Comprehensive Conservation and Management Plan (CCMP), hydrology is the study of the movement, distribution, and quality of surface and ground waters, and hydrodynamics is the study of the internal circulation of waters and effects on water quality. The creation of inlets, mosquito impoundments, drainage canals, filled wetlands, hardened shorelines, and other human development have all changed the movement of water throughout the Lagoon. As a brackish waterbody, the Lagoon requires inputs of salt water and freshwater to find a balance in the ecosystem and services it provides. The County's low sea level elevation combined with a high surficial aquifer table means the Lagoon is not only influenced by surface water runoff and ocean inputs, but also by groundwater flows and levels.

The County is unique in that it is bounded by two inlets, Sebastian Inlet to the north and Fort Pierce Inlet to the south. These inlets act as sources of ocean water into the Lagoon, and aide in faster flushing rates of the Lagoon's waters when compared to northern areas, such as Banana River Lagoon. According to the IRLNEP CCMP, water residence times for the County are 10 days for the Vero Beach area and 5 days for the Sebastian area. The Sebastian Inlet is a man-made inlet that was constructed in 1924, closed by natural forces in 1941, and reopened and stabilized in 1947. The Fort Pierce Inlet is a man-made inlet that was dredged and stabilized in 1921. The proximity of the inlets to the County means the Lagoon experiences more tidal-driven circulation than wind-driven circulation when compared to other portions of the Lagoon.

Sources of freshwater into the Lagoon include direct precipitation, surface runoff, groundwater seepage, St. Sebastian River, and discharges from point sources, such as the drainage canals. Precipitation rates into the Lagoon vary based on the dry season versus the wet season. Heavy storms and hurricane events bring excess freshwater into the system, not only through direct rainfall, but also through transport from the three main relief canals in the County. The salinity in the County's portion of the Lagoon does not respond as drastically to large inputs of freshwater when compared to salinities in the northern portions of the Lagoon due to the proximity of the inlets. These rainfall events also lead to surface runoff from lagoon-front properties, which can act as a source of excess nutrients into the Lagoon. The alteration of lands for development alter natural drainage patterns, increases runoff, removes natural buffers, and acts as a pathway for excess fertilizer, pet waste, car leaks, etc.

Human development plays a major factor in changing the Lagoon's natural flows throughout its watershed. The Lagoon's drainage basin continually changes based on urban, industrial, and agricultural uses. The addition of non-pervious materials to the land inhibits natural flow patterns and seepage into the ground. Previous updates have discussed the issuance of Environmental Resource Permits (ERPs) by state regulatory agencies whenever there is an alteration of natural water flow or an increase in the quantity of stormwater runoff in an area because of human uses and development. While the majority

of the Lagoon's drainage basin within the County is already developed, the rate of human influx into the County and the pressures that puts on creating new development will continue to alter the hydrology of the County. It is important for the County and other various entities to continue to purchase lands to revert back or keep in a natural state in perpetuity to maintain and encourage natural hydrology along the Lagoon when possible.

Groundwater plays an important role in the hydrology and hydrodynamics of the Lagoon. Based on the Spatial Watershed Iterative Loading (SWIL) model being used to evaluate nutrients into the Lagoon by the Florida Department of Environmental Protection (FDEP), groundwater accounts for 60% of nitrogen and phosphorus loadings into the Lagoon. Assuming the accuracy of these calculations, groundwater plays a significant factor in the hydrology and nutrient cycling within the Lagoon. Below the ground level, the County has a surficial aquifer system which interacts with the Lagoon. When water seeps into the ground, it generally migrates through the soil pore space along a path similar to the surface topography until it reaches conveyance systems to the Lagoon (i.e., drainage canals and tributaries). During the dry season, groundwater flow can be estimated based on the quantities of water observed in the three relief canals. Due to their depths, and with a lack of heavy freshwater input from rainwater, the water levels observed in the canals are what seep in from the surficial aquifer or free-flowing artesian inputs. The County would benefit from studying nutrient inputs in groundwater and the interaction of groundwater into the Lagoon within our part of the Lagoon, as these areas have not been greatly studied previously and currently act as large decision factors in FDEP's Basin Management Action Plan (BMAP) program. A model of nutrient inputs from septic systems using the ArcGIS Nitrogen Load Estimation Tool (ArcNLET) has been completed for some areas of the County and this model identifies the groundwater nitrogen impacts from septic system loading at the conveyance interface. The model should be expanded in areas of the County where septic system use is concentrated and/or in close proximity to conveyances. The model should be updated as new septic systems are installed, septic systems are upgraded for nutrient removal, or septic systems are connected to the central sewer system. ArcNLET provides the basis for nitrogen removal credit from septic system projects under BMAP.

Natural hydrologic flows into the Lagoon have been manipulated for many years to accommodate human development. One major example of this is through the creation of mosquito impoundments. Salt marshes along the Lagoon were once prolific producers of mosquitoes before humans intervened. Impoundments are areas of salt marsh or mangrove forest that have been diked to allow control of water levels for purposes of mosquito control. Within the dikes, perimeter ditches are flooded artificially to control breeding and reproduction of salt marsh mosquitoes without the use of pesticides. Along the Lagoon, organized mosquito control began in the 1920s, with the Indian River Mosquito Control District (IRMCD) established in 1925. During the 1950s and early 1960s, 2,600 acres of 4,500 acres of coastal marsh in the County were impounded by constructing low, earthen dikes around high marshes to prevent mosquitoes from laying their eggs. IRMCD provides mosquito control services in the eastern two-thirds of the County.

By the 1970s, over 40,000 acres of coastal wetlands were impounded Lagoon-wide. Most of these impoundments were constructed at mean high water level and flooded year-round, with no connection to adjacent waters. While this method was effective for mosquito control, it negatively impacted the

environment due to water quality degradation, isolation of important fishery species from critical nursery habitats, interruption of nutrient flow between wetlands and estuarine waters, creation of unnaturally high water levels, loss of vegetation, and hypersaline conditions when water in the closed impoundments evaporated. Experiments on an improved strategy for impoundments started in the mid-1960s, which involved flooding of impoundments during peak mosquito breeding season. For the remainder of the year, impoundments were opened via culverts so that water levels within the impoundment could fluctuate naturally with the tides. This technique, along with active water management, allowed for the retention of mangroves and other vegetation, and allowed the return of juvenile fishes to nursery areas. This management became known as Rotational Impoundment Management (RIM).

RIM allows the Lagoon to retain many of its natural functions. Culverts remain open between the Lagoon and impoundments between October and May to allow for water exchange and movement of organisms. During the summer months, culverts are closed and impoundments are flooded to minimum levels necessary to prevent hatching of salt marsh mosquitoes. RIM has proven to minimize serious environmental impacts to the Lagoon while providing to be an effective strategy for controlling mosquito populations. IRMCD primarily utilizes RIM techniques within the controlled impoundments. As of December 2018, approximately 2,086 acres of the 2,668 acres of impoundments in the County utilize RIM techniques. IRMCD also uses an Integrated Pest Management (IPM) approach for control efforts, which uses a combination of source reduction, larviciding, and adulticiding to control mosquito populations.

As a whole, the County would benefit from studies looking into the hydrology and hydrodynamics of the Lagoon as it pertains to this specific area. The impacts the inlets have on the Lagoon's hydrology are relatively well understood, but the interactions as a whole, including the dynamics of all water inputs, could be further researched. These studies would act as guides for restoration strategies and help drive informed decisions about development within the County. The County would also benefit from better understanding surficial groundwater interactions and load estimates into the Lagoon. Since loading estimates are being heavily utilized by FDEP, with large implications for the County to reduce nutrient loadings, the County would benefit from better understanding how groundwater truly impacts this portion of the Lagoon and the concentrations of nutrient leeching into the aquifer before interacting and adding nutrients to the Lagoon. FDEP's BMAP will potentially cost the County millions of dollars in nutrient removal, so a better understanding is warranted before large quantities of tax dollars are invested. When able and feasible, the County should work with partner agencies to restore natural hydrologic connectivity throughout the Lagoon watershed.

2. Water Quality

Water quality is a major indicator of the health of the Lagoon. Degraded water quality negatively impacts the health and diversity of the Lagoon, which has been associated with widespread seagrass habitat die-offs and the triggering of harmful algal blooms. Not only does decreased water quality impact organisms within the Lagoon, it also impacts the Lagoon's economic contributions to its surrounding communities. Water quality is heavily monitored throughout the Lagoon, with multiple regulatory agencies and groups routinely collecting and analyzing water samples. Numerous parameters are measured by these organizations, with emphasis on nitrogen and phosphorus concentrations.

The collection and measurement of such water quality parameters is necessary to understand and maintain a healthy ecosystem within the Lagoon. Long term trends show that nutrients in portions of the Lagoon have been increasing from historical values. This increase has been linked to anthropogenic influences associated with increasing population growth and human development. Nitrogen and phosphorus often receive a bad reputation when it comes to water quality, but they are essential at the proper concentrations and ratios for organisms to survive in their habitats and to maintain certain life processes. Nutrient concentrations in the proper ratio create a balance in the system. While proper ratios of nitrogen to phosphorus are essential, too much of either can create algae blooms and result in low dissolved oxygen levels which harms plants, fish and other living organisms. Nitrogen found in water can come from a variety of sources, including phytoplankton, bacteria, fertilizer, sewage, erosion of soils, and stormwater runoff. The decomposition of aquatic life (die-offs of algae blooms) can also add to nitrogen levels in the water column. Phosphorus is an element that occurs naturally in soils, rocks, and organic matter. High concentrations in surface waters may indicate the presence of fertilizer runoff, discharge from wastewater treatment facilities or septic systems, or industrial chemicals. Most areas of the Lagoon are sensitive to sudden influxes of nutrients and other pollutants and reducing these influxes is paramount to maintaining a balanced ecosystem.

Nutrient cycling in the IRL is very complex and dynamic, as by definition an estuary is the area where freshwater and salt water mix along with the biological communities within these two different systems. Phosphorus exists in the water in several forms: organic phosphate, orthophosphate (inorganic, dissolved phosphorus), and polyphosphate (from detergents). Compared to nitrogen, phosphorus is relatively stable in the environment. Nitrogen in the environment exists as atmospheric or inorganic nitrogen (N_2), ammonia, nitrite, and nitrate. Atmospheric nitrogen makes up nearly 80% of the air we breathe and is not chemically available for organisms to use. Organisms, such as some bacteria and cyanobacteria (blue-green algae), perform a process called nitrogen fixation and convert inorganic nitrogen to ammonia, making nitrogen chemically available for uptake by organisms. The biotic community in the soil, sediment, and open water cycle the nitrogen from ammonia, to nitrite, to nitrate, and back again.

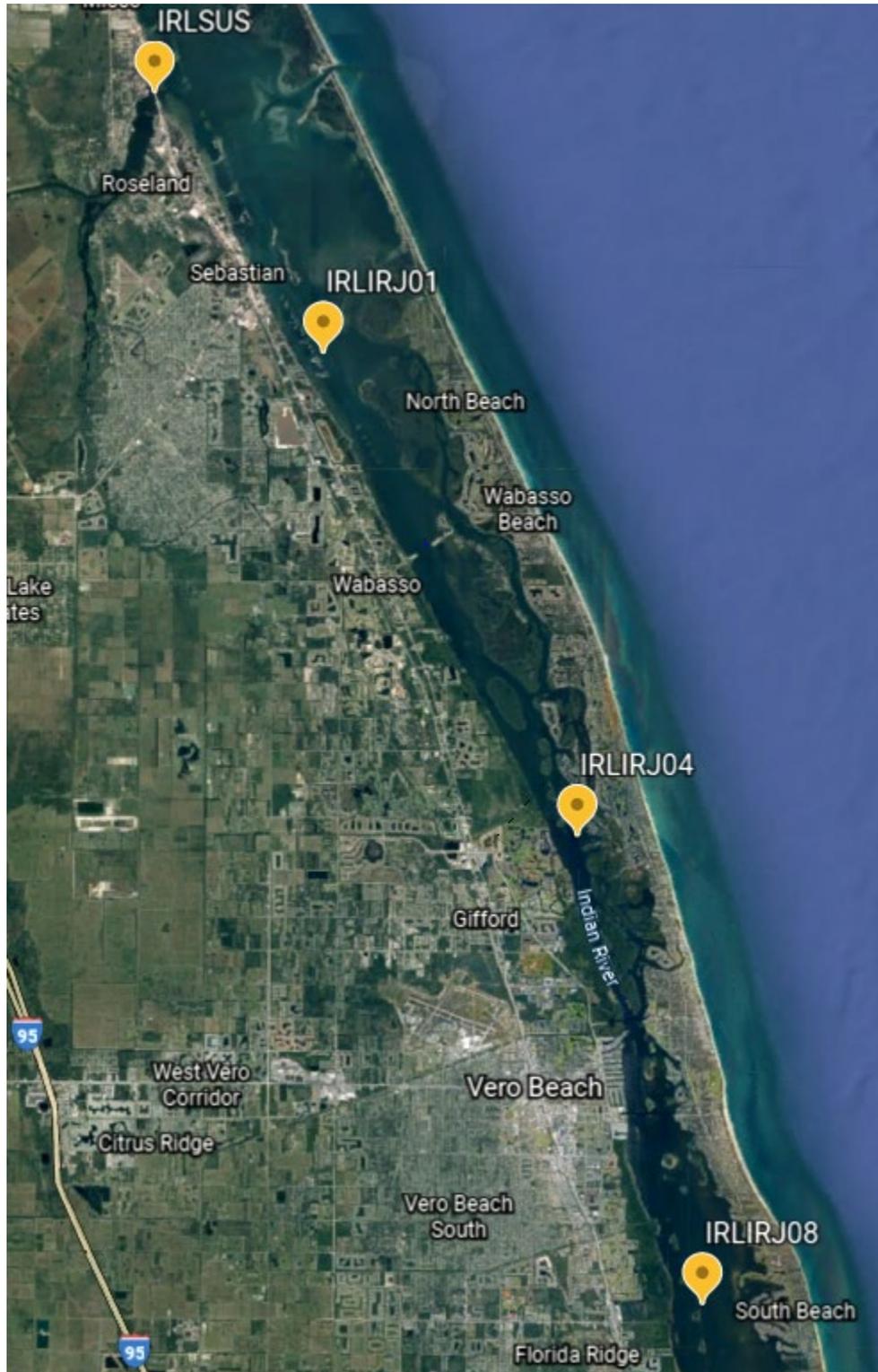
When the system is stable, the nutrient cycle and algal community can stay in balance with macro algae, cyanobacteria, and phytoplankton working together at relatively low concentrations to cycle nitrogen and provide a food source for fish and other species in the estuary. Inputs of nutrients or a shift in algal species communities can change the nutrient cycle, alter the nitrogen to phosphorus ratio, and create unbalance in the system allowing one algal species to out compete the others. One example would be an influx of phosphorus allowing for cyanobacteria growth. Because cyanobacteria can fix nitrogen, the limiting nutrient for their growth is the presence of phosphorus. As long as there is phosphorus present, cyanobacteria can fix atmospheric nitrogen to meet the nitrogen demand. At some point, the phosphorus in the system may be used, and the cyanobacteria may largely die off, sink to the bottom, and release the nitrogen and phosphorus back to the system. The process of decomposing the dead cyanobacteria biomass consumes oxygen in the water column and may cause low oxygen conditions and fish kills. This imbalance is difficult to bring back into balance as biological communities cycle between different dominant species.

Conversely, an influx of nitrogen may allow brown tide algae (i.e. *Aureoumbra lagunensis*) to dominate in a nitrogen limiting system. As the nitrogen in the system is consumed below the Redfield ratio, the brown tide species may rapidly die off, leading to a similar low oxygen environment as described above. If the salinity is low enough, this may also result in an algal community shift and resurgence of cyanobacteria bloom, which continues the harmful algal bloom cycle.

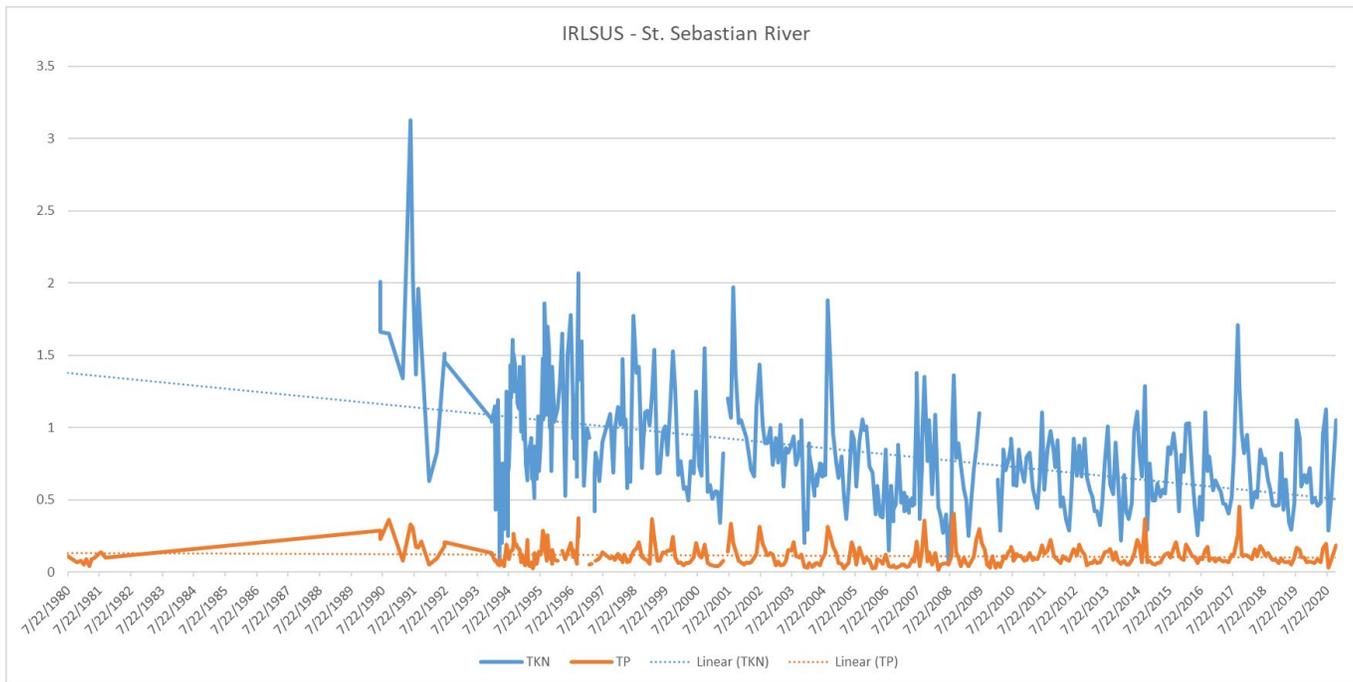
When algal concentrations are high in the open water, it creates turbid conditions, leading to loss of seagrass due to a lack of light penetration. This loss of seagrass is yet another imbalance, as a healthy seagrass community will take up a significant amount of nutrients. Nutrients, available oxygen, salinity, and the cycling of these factors are constantly changing in the Lagoon. These factors are in a constant state of flux and each play a role in water quality and the determination of the biological communities that dominate the system.

Various entities throughout the Lagoon monitor water quality at different locations throughout the watershed such as the St Johns River Water Management District (SJRWMD), the Florida Department of Environmental Protection (FDEP), Florida Fish and Wildlife Conservation Commission, Indian River County and an assortment of other stakeholders and research groups. The County's Utilities Department and Stormwater Division monitor water quality at their respective project sites, generating data of known quality in accordance with the FDEP's Standard Operating Procedures for sample collection and analysis. SJRWMD has sampling stations within the Lagoon that span from the St. Sebastian River in the north, south to the County's boundary. Available Lagoon data goes back to the 1980s and 1990s, depending on the location, with many sites still actively collecting and publishing data. Staff queried SJRWMD data from the St. Sebastian River (IRLSUS), northern County Lagoon (IRLIRJ01), central County Lagoon (IRLIRJ04), and southern County Lagoon (IRLIRL08). Available data from all sites showed decreasing trends overtime of Total Kjeldahl Nitrogen (TKN) and total phosphorus (TP). Spikes in data can be correlated to the wet season and times of extreme weather events (i.e. hurricanes).

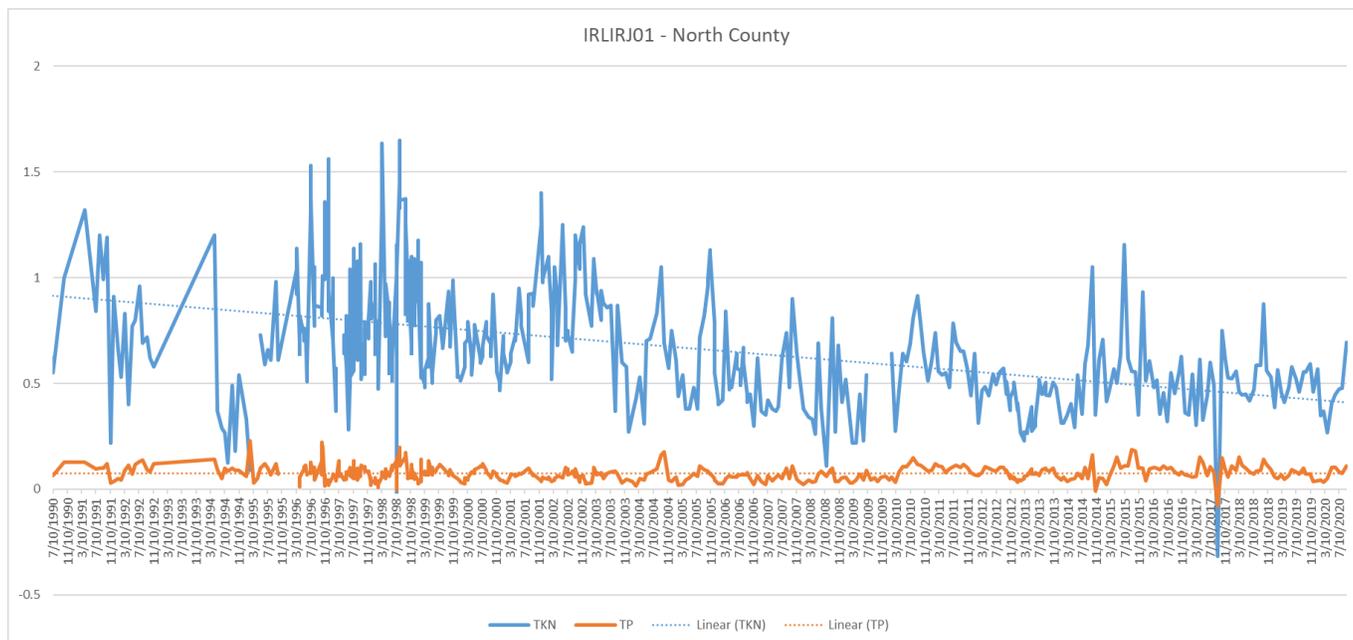
Image 1: SJRWMD Water Quality Stations Referenced



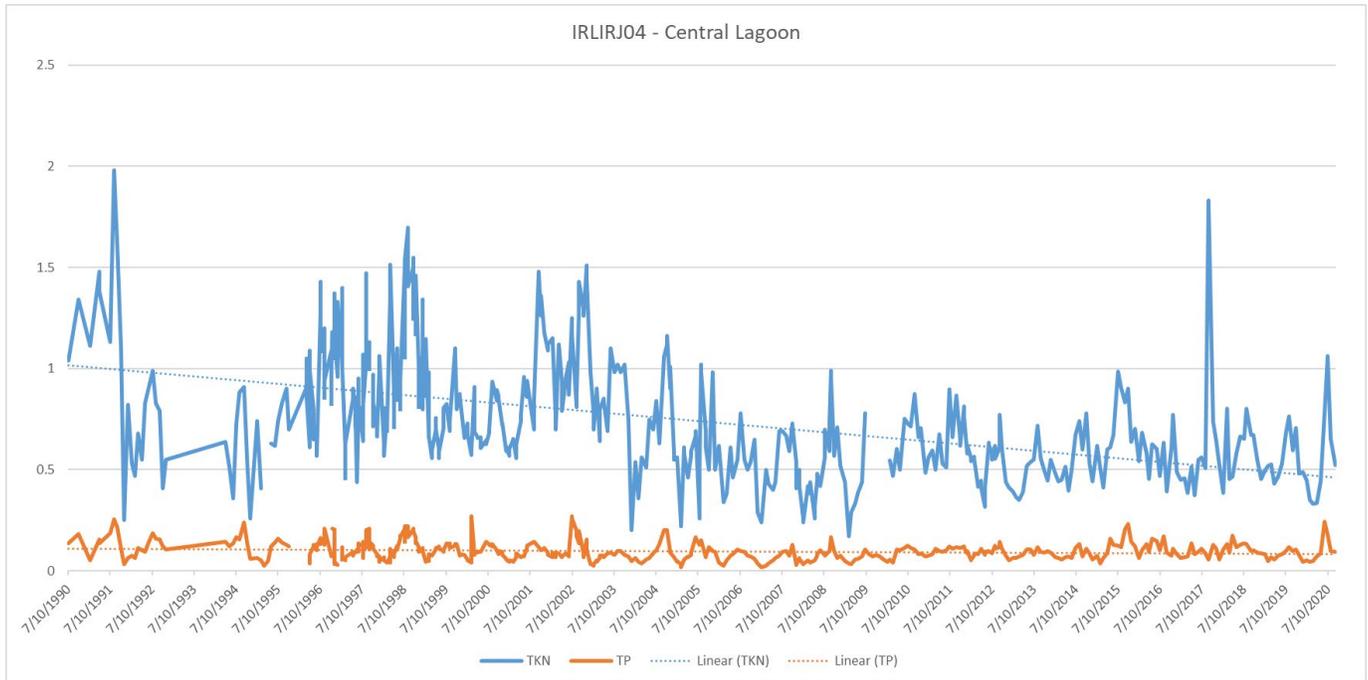
Graph 1: TKN and TP Levels from SJRWMD's IRLSUS Station



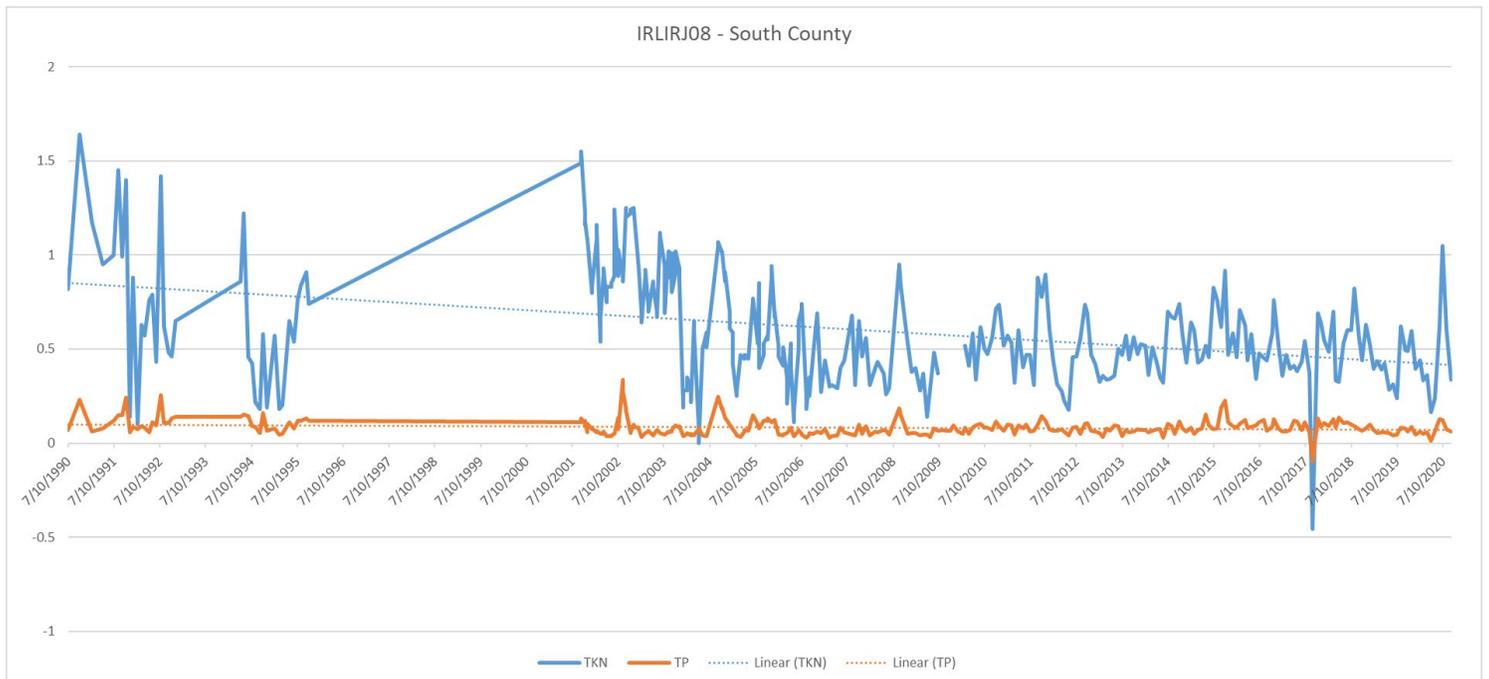
Graph 2: TKN and TP Levels from SJRWMD's IRLIRJ01 Station



Graph 3: TKN and TP Levels from SJRWMD's IRLIRJ04 Station



Graph 4: TKN and TP Levels from SJRWMD's IRLIRJ08 Station



Salinity and rainfall are also two important parameters when discussing water quality within the Lagoon. These two parameters often go hand-in-hand, as the amount of rainfall and freshwater runoff the Lagoon receives will influence the salinity levels in that area. Salinities vary based on the type of water. Seawater has a salinity of around 35 parts per thousand (ppt). Freshwater bodies have an average salinity between 0 to 0.5 ppt. Since estuarine waters are formed from the mixing of salt and fresh waters, their salinities fluctuate based on tidal influences and freshwater inputs. Brackish waters typically range from 0.5 to 30 ppt. Salinities in the County's boundaries of the Lagoon typically range on the saltier side, with averages in the mid-20 ppt. Due to the proximity to the inlets, salinities in the County's portions of the Lagoon are typically higher when compared to areas in the northern Lagoon. Organisms that live in estuaries are adapted to variations in salinities, but extremes in either freshwater inputs or seawater are detrimental to their survival. For instance, oysters typically prefer salinity ranges between 14 to 28 ppt.

Low freshwater inputs creating higher salinities combined with reduced nutrient inputs can stress or kill plants and animals. High freshwater inputs creating lower salinity levels combined with high nutrient inputs can contribute to the creation of harmful algal blooms. Increased freshwater inputs stemming from heavy rains can also increase inputs of sediment to the Lagoon, which can smother seagrasses and oysters and add phosphorus to the system. As discussed in Update 1, the Lagoon as a whole receives approximately 50 inches of rainfall per year on average. The County's portion of the Lagoon receives slightly more rainfall, averaging approximately 52 inches per year. However, trends indicate a 0.27 inch decrease of rainfall per decade has been observed throughout the area. As droughts become more frequent and more intense in the future, rain levels are expected to continue to decrease with implications on future salinity levels increasing.

Copper is another example of an important water quality parameter being monitored within the Lagoon. Copper is a fundamental micronutrient element for all forms of life, but in excessive amounts may become toxic to organisms. A trace metals study conducted by Dr. John Trefry of the Florida Institute of Technology (FIT) found that excessive leaching of copper from anti-fouling paints used on boat hulls poses an ongoing environmental threat to poorly flushed waterbodies such as the Lagoon. Dr. Trefry's research indicated that copper concentrations in Lagoon sample locations within the County (Sebastian Inlet, Wabasso, Vero Beach) were within normal limits. Since Dr. Trefry's study, copper concentrations in the Lagoon have increased to the point of FDEP potentially listing the section of the Lagoon south of State Road 60 within the County as impaired. A joint publication from SJRWMD and IRLNEP in 2007 states that copper was been found in isolated areas of the Lagoon, and high copper levels were found in sediments within the St. Lucie Estuary. In addition to anti-fouling paint, sources of copper (along with other heavy metals) are often present in stormwater runoff and can be toxic to plankton, fish, and other aquatic organisms, with a direct impact on their ability to reproduce. Elevated copper concentrations have been noted in muck deposits at several locations throughout the Lagoon. Educating the community on proper best management practices for scraping, sanding, and painting of boat bottoms is critical to control of this contaminant, as these activities often occur within or immediately adjacent to the water.

Water quality is an important factor in the restoration efforts for the Lagoon. The County falls within numerous state and federal agency oversights when it comes to the established water quality parameters for our portion of the Lagoon. One major example of this is FDEP's Central Indian River Lagoon

BMAP. The BMAP was originally adopted in February 2013 and did not include allocations to the stakeholders in the Central Indian River Lagoon. However, the BMAP was updated in 2020 and adopted in February 2021 to include nutrient load allocations and required nitrogen and phosphorus reductions for all stakeholders within the basin. These allocations and reductions were based on a model that FDEP plans to update so the County's requirements may change in the future.

However, water quality is a complicated topic in this portion of the Lagoon. Nitrogen and phosphorus data from the Lagoon within the County indicates that non-detrimental concentrations of the nutrients are currently present throughout much of the County's portion of the Lagoon. Water quality restoration is an important component for many areas outside of the County's boundaries, but with the reliable flushing of the inlets and observed reductions in concentrations of nutrients carried to the Lagoon, the County does not experience many of these detrimental concentrations observed in other stretches of the 156 mile long Indian River Lagoon. Restoration efforts to bring back seagrass beds and healthy ecosystems may require the County and regulating agencies to look beyond the normal focus on nitrogen and phosphorus if these allocated levels have been achieved with continued degradation to the system. It is not realistic to strip the Lagoon of both nutrients, as they are necessary for life forms. FDEP's Central Indian River Lagoon BMAP states: "The goal of the IRL Basin total maximum daily loads (TMDLs) is to recover the deeper seagrass habitats. The seagrass response is the most important factor in evaluating the success of nutrient TMDLs. Even if the relationship among nutrient loads and seagrass recovery is not as predicted by the regression model, the load reduction requirements themselves will not determine TMDL success. The assessment of success is based on whether the seagrass grows at sufficient depths." The County should continue to maintain and run its regional scale nutrient-reducing projects to maintain healthy nutrient levels, and work in coordination with outside agencies on collecting and analyzing water quality samples throughout the Lagoon. The County would benefit from continuous monitoring efforts on the health and vitality of the Lagoon's ecosystem and organisms to understand the levels of restoration achieved based on these nutrient targets.

3. Organic Materials and Sediments

Muck is classified as a black, organic-rich, mud-rich, high water content sediment that has a high nutrient content. Muck sources are fine sediments and fine biological particles that are carried to the Lagoon via tributaries, canals, and stormwater systems. Throughout the Lagoon system, muck is prevalent in the mouths of creeks, channel bottoms, Intracoastal Waterway (ICW), and in deeper pockets of water near tributaries. Muck is detrimental to the health of the Lagoon because it increases turbidity, depletes oxygen in sediments and the water above, stores and releases nutrients creating muck fluxes, covers the natural sandy bottom, and destroys healthy communities of organisms by blocking out light and smothering the environment. Studies from Brevard County in 2016 showed that decaying muck contributes almost as much nutrients as the annual loading from stormwater and groundwater baseflow combined.

The Lagoon bottom is naturally and historically composed of sandy sediments with minor accumulations of organic matter from erosion of shorelines and the breakdown of vegetation. However, the encroachment and accumulation of muck on the bottom of the Lagoon has caused troubles for the health of the system as a whole. Muck forms from the accumulation of various factors, with coastal

development and nutrient runoff encouraging the formation and settlement of muck on the Lagoon bottom.

Within the County's boundaries, there does not seem to be a wide-scale understanding of how much muck is present in the Lagoon. Small-scale mapping has been completed as it pertains to specific projects, but a consistent source of muck mapping of the entire County was not found. However, during a 2020 presentation to interested County residents about the potential Bethel Creek project, Dr. Duane De Freese of the Indian River Lagoon National Estuary Program (IRLNEP) stated that the County's waters contained less than ten percent of muck cover as a whole. Brevard County has taken substantial efforts to dredge muck from their portions of the Lagoon. In 2018, Dr. Trefry of FIT found that the average muck flux rates were estimated at 150 pounds of TN and 20 pounds of TP per acre per year within Brevard County. In 2017, Dr. Trefry estimated nutrient flux from the St. Sebastian River South prong to be 184 tons of TN and 57 tons of TP.

The dredging of muck in the Lagoon is an expensive undertaking. Mapping needs to take place to understand the depth and expanse of muck present in the focus area. Permits are required before a project is able to start. Bringing dredgers out into the Lagoon requires mobilization and equipment operating costs. Once the material is dredged, areas on land need to be established to act as dredged material management areas. The Florida Inland Navigation District (FIND) has established dredged material management areas throughout Florida, and using their upland sources for County projects requires partnership agreements. Settling ponds are present in these areas where the dredged muck is settled out and the overflow water captured is returned to the Lagoon. This overflow water should be treated to decrease the amount of nutrients returned to the Lagoon. Finally, a disposal site for the dredged muck would need to be found or established with minimal fiscal, environmental, and social implications.

Another alternative to muck dredging would be muck capping. Muck capping involves placing a thick layer of sand over areas of muck to restore the area. Palm Beach County has utilized muck capping within the Lake Worth Lagoon, and Brevard County is currently evaluating this in the City of Cocoa Beach. These capped areas reduce turbidity and improve water quality, and can also be utilized for restoration through the planting of seagrasses. This prevents the re-suspension of muck while providing a clean substrate for the natural recruitment of seagrass. Shallow water conditions are the ideal environment to complete muck capping projects. However, long-term evaluations on the longevity of the sand cap need to be conducted to ensure that it is not silted over with new muck sediments or carried away to expose the underlying muck.

More research is needed to fully understand the dynamics and interactions of muck within the Lagoon. Muck flux is a complicated biogeochemical process, and the County should encourage and partner with other agencies to study this process. The County should also undertake a County-wide muck mapping survey to better understand the extent of muck within the portions of the County's Lagoon. Discussions of potential muck removal projects cannot occur until we better understand and quantify the impacts from muck in the County. A cost-benefit analysis should take place to compare nutrients removed versus the expensive costs of completing a project. Cost-benefit analyses should also be conducted to compare opportunities for muck capping versus dredging. Priority should be placed on preventing the

upland input of muck components to prevent muck formation in the Lagoon. The County should continue to educate homeowners on the proper disposal of grass clippings and other yard plants. The County should also continue educating homeowners on reducing the amounts of nutrients that runoff from their homes, including following the fertilizer ordinance. Finally, the County should continue to encourage Lagoon-front homeowners to naturally stabilize their yards using living shorelines to discourage erosion into the Lagoon. Stopping the sources of muck before they reach the Lagoon is one of the most beneficial acts homeowners and businesses can do to help the Lagoon.

4. Marinas and Boat Ramps (Part 1)

The Lagoon is heavily used by the local community and visitors for boating purposes, whether it be fishing in the Lagoon or to access the Atlantic Ocean through one of the inlets. Various marinas and boat ramps, both public and private, for boaters to access the Lagoon and store their boats are found throughout the County. It is up to boaters to maintain their vessels and be responsible operators to protect the Lagoon ecosystem and create an environment that is enjoyable for all that use this waterbody.

Marinas and boat access ramps can be found on the Lagoon and St. Sebastian River. Most boating that takes place on the Lagoon is recreational boating as opposed to commercial boating. Commercial boats typically only use the ICW portion of the Lagoon, whereas recreational boaters will use inside and outside the ICW. Access to the Atlantic Ocean takes place in this region through the Sebastian Inlet or the Fort Pierce Inlet. Boats can also access the Lagoon and surrounding waters from private lifts or storage areas. There are ten public access boat ramps on or leading to the Lagoon. Two are owned by the City of Sebastian, two are owned by the City of Vero Beach, one is state owned, and five are owned by the County. There are also five marinas within the County that residents and visitors may pay to store their boats.

While most boaters properly maintain their boats and follow boating regulations, some vessels do impact the health of the Lagoon. Boats greater than 26 feet in length are required to have some form of marine sanitation device (MSD) on board for septage treatment/disposal. Improper discharging of MSDs into the Lagoon can be detrimental to the surrounding water quality. There are three types of MSDs, with types I and II requiring United States Coast Guard approval. MSDs are subject to inspection by local and state officers who can issue violations if proper standards are not maintained. The Clean Vessel Act, authorized in 1992, sets a precedence to establish pumpout and dump station facilities to ensure the proper disposal of human sewage from recreational boats. FDEP administers the Clean Marina and Clean Vessel Act grant program, which awards funds to establish pumpout facilities throughout Florida. Types I and II MSDs treat sewage onboard the vessel and may discharge the treated waste overboard into the water or contain it for pumpout. No Discharge Zones may be approved by the United States Environmental Protection Agency (EPA) in which no treated or untreated sewage may be discharged. There are only three currently established areas in Florida (Destin Harbor, Florida Keys Marine Sanctuary, and City of Key West), none within the Lagoon. These three areas in Florida are Destin Harbor, the Florida Keys Marine Sanctuary, and the City of Key West. According to FDEP's Map Direct application, there are 14 pumpout facilities located within the County. <https://floridadep.gov/rcp/cva>

Established in 2001, the Clean Boater Program works to involve boaters in protecting waterways through education about native vegetation, wildlife, and the natural environment. This program was

established as part of FDEP's Clean Vessel Act pumpout grant program and it works in collaboration with the Clean Marina Program. The Clean Boater Program provides guidance on adopting environmentally friendly practices, which include proper trash management, using bilge socks and fueling collars, EPA Safer Choice products, and practicing good recycling habits. There is a booklet that provides information on how to properly inspect equipment, cleaning techniques for boats and trailers, and educational materials on invasive plants. There is also a Clean Boater Pledge that boaters can take to promise to protect the environment. <https://floridadep.gov/CleanBoater>

The Clean Marina Program was established by FDEP in 2000 and assists in the implementation of best management practices that focus on sensitive habits, waste management, stormwater control, spill prevention, and emergency preparedness. All marinas, boatyards, marine retailers, yacht clubs, and military marinas throughout Florida are able to participate. In order to obtain this designation, interested facilities must submit a Clean Marina Application and Pledge, complete a Clean Marina Action Plan, and carry out an environmental review with a Clean Marina Coordinator. A facility must meet all environmental criteria outlined in the Clean Marina Program Guidebook. Facilities that take part in the Clean Marina Program pledge to maintain and improve waterways by reducing or eliminating the release of harmful substances and phasing out practices that can damage aquatic environments. This designation follows an annual renewal schedule, with a site visit from a Clean Boating coordinator every five years. There are 13 marinas throughout the County that are part of the Clean Marina Program. <https://floridadep.gov/rcp/clean-marina/content/clean-marina-program>

The implementation and compliance with these programs is crucial to preserving healthy waterways. Improper boating practices can be detrimental to a healthy environment. Discharges from MSDs, pollutants generated by fueling and operating boat motors, detergents from boat cleaning, and metals or other material leaching from bottom paints can affect water quality. If a boater does not properly dispose of trash and it becomes litter in the Lagoon, this can be extremely harmful, and possibly fatal, for the organisms that use the Lagoon, such as manatees, sea turtles, dolphins, fish, and birds. Boat traffic itself can also cause damage to the Lagoon if a boater is not smart and educated about their responsibilities. Boat wakes may erode shorelines, damage seagrass beds, and break up oyster reef if they are constant and high energy. The Lagoon is a shallow waterway, and an uneducated boater that does not stay within the ICW or channels can harm seagrass beds and/or benthic habitat if care is not taken to avoid shallow areas. Irresponsible boaters can also harm animals in the Lagoon if speed markers are not observed. These markers designate areas where manatees may be present, and not following these zones is a ticketable offense by officers and may result in harmful or fatal boat strikes for organisms such as manatees, sea turtles, and dolphins.

The County should continue to promote boater education and engagement programs so that boaters responsibly use the Lagoon. The County should also continue to utilize all the various boating programs offered by FDEP, when applicable. Marinas should be encouraged to utilize the funding offered by the Clean Vessel Act to establish pumpout stations on the Lagoon so that the boating community has areas to safely remove the waste off their boats. It would be beneficial for the County to continue monitoring the marinas to provide information on the services they offer and any designations they may have. The Lagoon is an important resource to the local economy, bringing in visitors and residents alike to use all

that it has to offer. It is extremely important for boaters to be educated on boating practices that do not damage the environment so that others can continue to enjoy the Lagoon into the future. This is the first update on this topic, and the second update will focus on the rules, regulations, and extent of derelict vessels and mooring within the Lagoon.

5. Sustainability and Resiliency (Part 1)

Sustainability and resiliency are measures taken to ensure the future of the Lagoon, its shoreline, and the surrounding infrastructure within the watershed. Sustainability and resiliency are not only possible factors influencing the Lagoon's health like previous topics, but are mainly approaches and proactive steps the County should factor in when creating new projects and updating existing infrastructure. While the County will have more of a regional-scale presence in this movement, homeowners can also take steps to ensure they are doing their parts to maintain a resilient and sustainable future for the Lagoon with smaller-scale approaches they can make to their homes and everyday lives.

As major storms and hurricanes are predicted to increase in frequency and intensity in the coming years, the resiliency of the Lagoon and surrounding shoreline will be tested. Natural forms of protection should be used to soften the impacts felt. One natural form of protection includes the creation of living shorelines along properties bordering the Lagoon, as living shorelines are shown to absorb wave energy and reduce the rates of erosion. Homeowners can also use mangroves to protect against high winds and aid in energy absorption. The County's measures of purchasing Lagoon-front property and keeping it in a natural state increases the resiliency of those areas. This is especially true when it comes to projects created that use the natural environment and protections, such as the creation of a living shoreline and maintenance of natural areas at the Jones Pier Conservation Area. The County also uses natural resilience in the maintenance of their spoil islands. Projects like the Lost Tree Island project strengthen the island by removing invasive vegetation and replanting it with native vegetation. Invasive vegetation does not have the root structures in place to stand up to intense winds and are more likely to topple over and contribute to erosion when compared to native vegetation.

Lagoon resiliency must also focus on infrastructure within the Lagoon watershed, even if said infrastructure does not border the Lagoon itself. The County should continue to plan for and design resiliency in all new projects and any updates on existing projects to ensure the success and longevity of all projects. Coastal areas are at greater risk for potential flooding and inundation from high waters. The infrastructure for services we rely on to transfer water, such as stormwater outfalls, wastewater collection systems, and potable water distribution systems should be designed and built to take the changing environment into consideration. Dated systems should be retrofitted to protect the Lagoon from any potential spills of nutrient-rich waters, as well as protect the collection or transmission systems from being inundated with water and damaged. Resiliency and sustainability can also be referenced in regard to emergency response measures. As a coastal county in Florida, the County faces threats of hurricanes and tropical storms every spring and summer. Threats posed by these storms can impact energy and transportation measures throughout the County, as well as other critical infrastructure. With a substantial increase in new residents moving to Florida on an annual basis, roads are prone to more traffic congestion which can hinder safe hurricane evacuation routes. Energy systems are affected during heavy storm events if high winds, falling debris, or high water tables damage powerlines or backup generators.

Outages can leave projects put in place to protect the Lagoon in jeopardy if they do not have the energy needed to run mechanical systems, or if too much water puts a stress on the efficiency of nutrient removal techniques. The County would benefit from continuing to use new techniques as they appear in these types of risk-based adaptations.

Once resiliency for an area is established, it is important to make sure these resilient-minded endeavors maintain a level of sustainability so that they can adapt overtime. The City of Satellite Beach is one example of a municipality taking great strides to identify ways to become a more resilient and sustainable community. In 2017, they adopted their Sustainability Action Plan. This plan is broken into five categories, covering the built environment, land and water systems, energy and transportation, community outreach, and quality of life. They set twenty Green Achievement Targets, with implementation periods from 2017 to 2022. This plan sets a good example for the County on ways a municipality can spearhead steps towards a more resilient and sustainable community for the future.

While the Lagoon is one area to focus on in the sustainability and resiliency initiative, there should be a holistic approach across the County to ensure the continued productivity and success of projects. Factors such as the environment, economy, community well-being, and social equity should all be considered when moving forward. The Lagoon is one important factor, but the Lagoon itself impacts numerous factors within the County, from the environment to the infrastructure to the economy. Future sustainability and resiliency of the Lagoon will impact more than Lagoon waters, and the County should continue to create proactive projects that will adapt over time to challenges experienced. These improvements and planning have the potential to incur large costs, so the County should continue to find and apply for applicable grants to help costs associated with future projects and retrofits. One example of this is the Building Resilient Infrastructure and Communities (BRIC) grant offered through the Federal Emergency Management Agency (FEMA). This grant supports states, local communities, tribes, and territories as they undertake hazard mitigation projects that reduce the risks from disasters and natural hazards. This grant is a pre-disaster mitigation program which focuses on proactive approaches to resiliency and sustainability in communities. The long-term health of the Lagoon requires planning and actions, and the County should continue to educate homeowners on ways to naturally protect their properties, and actions that can be taken to benefit the long-term improvement of the Lagoon. Sustainability and resiliency are community efforts, and the County should continue to work with various agencies and municipalities to continue adaptive management and planning for the long-term success of the area.