CARNIVAL GRAND BAHAMA INVESTMENTS LTD.
ENVIRONMENTAL IMPACT ASSESSMENT
For
Carnival “Grand Port”

Freeport, Grand Bahama Island
The Bahamas

Prepared by:

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Rev. II April 2020

This document is a revised version of the January 2020 Submission and incorporates responses to comments received from the BEST Commission and the GBPA. All other Appendices remain unaltered; revisions are limited to changes to the main document.

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n.b: *This study including major review and revisions was substantially completed prior to the outbreak of the Covid19 global pandemic. At the time of the issuance of this document it is undetermined if this major disruption to The Bahamas and the world will result in changes to any element of this study.*

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EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) was prepared at the request of the Grand Bahama Port Authority (GBPA) and the Government of The Bahamas for the Carnival Grand Bahama Investment Limited (CGBIL) proposed project Carnival “Grand Port”. The Grand Port name is a working title and a permanent name has yet to be determined. CGBIL is a wholly owned subsidiary of Carnival Corporation, a Panamanian corporation. Over the 23-year time horizon, it is estimated that Carnival’s proposed development on Grand Bahama Island would boost Bahamian employment, income, GDP and government revenues by the following:

- A total investment of B$170 million
- More than 40 additional calls to Freeport annually, on average
- An estimated 500k incremental cruise passengers annually, on average
- 706 new Bahamian jobs during the development phase
- More than 1,680 new Bahamian jobs annually during on-going operations
- B$1.5 billion (in B$2019) increase in Bahamian GDP
- B$647 million (in B$2019) in income earned in The Bahamas
- B$363 million (in B$2019) increase in Bahamian government revenues, outweighing proposed concessions by a factor of 3.8.
- The proposed project includes plans for more than 250 calls by 2025, a 26 percent increase from current levels.

Freeport Passenger Counts by Carnival Brands per Bahamian Fiscal Year

Brands	July 2017- June 2018	July 2018 - June 2019
CCL	474,632	480,450
Costa	7,790	4,520
P&O / CAU / CUK	704	4,964
TOTAL	**483,126**	**489,934**

Post-Hurricane Dorian, the Carnival Grand Port will be significant in helping rebuild the economy of Grand Bahama. The adverse ecomonic impacts to Grand Bahama are significant, as many have lost everything and many businesses in the downtown area, including the Grand Bahama Airport, were impacted by flooding. While no one project can single handedly solve the economic woes of Grand Bahama the culmination of many projects, particularly high end investments like the Grand Port will have far reaching benefits which will aid in the economic recovery. Moreover, it will let the world know that Grand Bahama is back in a significant way as a tourist destination in the Caribbean region.

The proposed project encompasses the construction of a main pier to accommodate two cruise ships at a time, a Shore Excursion Dock (Shorex), a recreational facility onshore that will have restaurants, shops, transportation canal, water park and other amenities. The facility will primarily service Carnival Cruise Line ships but may also serve other Carnival Corporation brands operating in the Caribbean. Moreover, other branded ships will be able to call on the Grand Port. Carnival has similar facilities throughout the Caribbean, but this facility will be their Flagship destination. The CGBIL Grand Port will be a new Port of Entry for Grand Bahama exclusively operated by CGBIL

A site was selected based on the criteria of deep water close to shore, amount of developable land available, and surrounding environment. The Sharp Rocks Point site was selected, and a purchase agreement has been made for the property. The site location based on The Bahamas Government Topographic Map Sheet 8 Grand Bahama Island includes Silver Point and Sharp Rocks Point on the south shore of Freeport. The western boundary is just west of Sharp Rocks Point and eastern boundary is east of Tony Maura Point. The two parcels are identified as Parcel A and Parcel B. Parcel A is approximately 171 acres and Parcel B is approximately 158 acres giving a total of approximately 329 acres. Entrance to the site is located off the Grand Bahama Highway on Sussex Drive.

The current port in Grand Bahama is consistently among the lowest ranking ports in terms of guest satisfaction. Currently, five cruise lines visit the island; three of these – Carnival Cruise Line, Costa Cruises, and P & O UK – are Carnival Corporation brands. Over 80% of all guests arriving to Freeport on cruises will come from Carnival Corporation brands.

CGBIL proposes constructing a 1.6 mile canal primarily for the transportation of guest from east to west using electric boats and as a recreational area. As part of the EIA a Hydrogeological Study was undertaken to determine if a freshwater lens was present and the extent of any existing lens in the area, and to assess what impact the 1.6 mile canal would have on changes to any freshwater lens and to the Grand Bahama Utility Company's Wellfield W-6 located on the northside of the Grand Bahama Highway. To this end a total of fourteen observation wells were drilled in the project area. The observation well locations are presented in

Figure 6 of the Hydrogeological Report (**Appendix 4**). Two existing wells were used which are identified as Observation Wells OW-15 and OW-16.

Each observation well was drilled using a direct air drill rig. Starting at a depth of five (5) -feet below the water table and continuing at 5-foot intervals thereafter, water air from each borehole was tested for salinity and conductivity. Drilling was stopped when the salinity test results gave assurance that no freshwater was present. Freshwater being defined as having a salinity of 0.6 parts per thousand (ppt.), which is the Grand Bahama Utility Company (GBUC standard). The GBUC is the potable water supply company for Grand Bahama Island.

On completion of drilling, all observation wells were rested for between four and eighteen days to allow for stabilization of the water column. Salinity and conductivity measurements were recorded at one-foot intervals in all observation wells on three occasions; 1) June 18-19, 2) August 10 and 11, 2019, and 3) post Dorian in September 2019. The results are presented in Table 3 of the Hydrogeological Report.

Numerical modeling for this project was completed using Visual Modflow and the SEAWAT code. Modflow was developed by the US Geological Survey and is the standard for three-dimensional groundwater flow and transport modeling. SEAWAT couples the flow portion of the Modflow code with a mass/density-related flow transport model MT-3DMS. In addition to other solute transport projects, SEAWAT is specifically designed to simulate saltwater/freshwater interactions due to the density variations between salt and freshwater.
The study concluded for the following:

- Groundwater in the aquifer is tidally influenced and is in good hydraulic communication with the Northwest Providence Channel. There is very poor to negligible hydraulic communication between the surface water in the wetlands and the groundwater in the Aquifer.
- The excavation of the canal will slightly change the location and shape of the freshwater lens, moving the boundary between fresh and saltwater inland several hundred feet. The shape of the lens also illustrates a “bump” landward similar to the shape of the canal itself. Moreover, the change in the freshwater lens due to the canal construction would be relatively quick and the system would re-equilibrate shortly thereafter.
- The placement of dredge spoils and seawater based on simulations would not have a significant impact on the freshwater lens as most of the water would be returned to the sea.

- No impact was predicted for the freshwater lens in the landward portion of the Grand Port Property and points northward up to and including the W-6 wellfield. Also, there should be no or minimal impacts to Observation Wells, OW-9 and OW-12.
- The impacts from Hurricane Dorian on the freshwater lens in the vicinity of OW-9 and OW-12 was not affected. The previously degraded lens at OW-10 and OW-13 appears to have undergone further deterioration as did the salinity concentrations in the other observation wells.

It is noted the dredge spoils will be used to elevate the site to 13 ft mean low water for flood protection.

There is no water main for the distribution of potable water to the site. It is estimated that approximately 4 - 5 million gallons per month will be needed to support the facility at full capacity. The original plan pre-Dorian was to have the potable water supplied by the GBUC, which is responsible for city water in Grand Bahama. The GBUC water supply was intended to be used for the facility and for water bunkering of the cruise ships. However, as a result of Hurricane Dorian the W-6 wellfield has been adversely impacted. Conversations with GBUC indicate that, the GBUC will have a potable water supply available by late 2021 by combining water treated by reverse osmosis with water from the wellfield. If this is the case, then the Grand Port will utilize that supply. However, CGBIL will plan the project to include a Sea Water Reverse Osmosis System (SWRO) in the event that Grand Bahama is stricken by another hurricane or for some reason GBUC cannot meet the supply demand at the time of facility opening. The appropriate applications will be made to the Grand Bahama Port Authority and Grand Bahama Utility Company for approval of the SWRO.

The Terrestrial Resource Survey (TRS) found there were ten (10) different habitat types. It is important to note that the baseline terrestrial study was conducted prior to hurricane Dorian which has severely impacted vegetation on the site. Below in the table are the (Pre-Dorian) habitats and acreage. It is noted the Mangrove Wetland and Mangrove Forest calculations are integrated. The complete description of the habitats is provided in the Terrestrial Resource Survey.

Habitat Communities and Acreage

Habitat	Acres
Broadleaf Coppice Forest	25.48
Casuarina dominated Coastal Shrubland	26.43
Coastal Shrubland	13.98
Fire Impacted Coppice	3.96
Mangrove Forest and Wetland	155.18
Pine Woodland	21.61
Sabal Woodland	41.56
Semi Permanently Flooded Wetlands	20.23
Silver Palm-Bracken Fern Shrubland	13.44

Based on the TRS, the following acres of Habitat will be impacted for site improvements.

Habitat Impacts from Terrestrial Resource Survey

Habitat Class	Total Habitat Acreage	Total Impact (ac)	Total Impact (%)
Broadleaf Coppice Forest	25.48	14.78	58.01
Casuarina dominated Coastal shrubland	26.43	4.77	18.03
Coastal Shrubland	13.98	10.17	72.76
Fire Impacted Coppice	3.96	1.29	32.65
Mangrove Wetlands	155.18	54.60	35.19
Pine Woodland	21.61	5.76	26..66
Sabal Woodland	41.56	31.97	76.91
Semi permanently flooded wetlands	20.23	18.62	92.05
Silver Palm-Bracken Fern Shrubland	13.44	3.27	24.31

As part of avoidance for the project, approximately 103 acres of mangrove wetland habitat will be preserved. Additionally, a nature trail of approximately 55 acres will be situated at the northeastern corner of the property.

The coastal dune has an existing beach road which is near the top of the dune. The dune is dominated by Casuarina trees with native beach vegetation as noted in the Terrestrial Resource Survey. The setback for the dune will be variable which is outlined in green in the drawing on the accompanying thumb drive. The minimum width of the setback is 7 ft and the maximum width is 115 ft, the average set back is approximately 50 ft. Setback inspections will be performed during construction. There will be a gap in the dune where the pier meets the shoreline and transitions to the security center and Shorex Dock. The dune will be stabilized with native dune vegetation.

Waste generated at the Grand Port will be domestic waste. The waste will be collected by Sanitation Services Company Ltd. and disposed at the Pine Ridge Landfill. Reduction of garbage will be utilized using a trash compactor at the facility and other reduction technologies. Garbage collection schedule will be discussed with Sanitation Services as the port comes onstream. Additionally, a low volume of sludge from the wastewater treatment plant will be generated. The sludge may be dried and used in the nursery/landscaping purposes or disposed at the landfill.

Cruise ships calling Grand Port will strictly comply with MARPOL, governing waste disposal. There will be no discharge of black, gray, or treated wastewater from the ship to the sea while they are in port. The beach is a recreational area and therefore discharges will be prohibited. Moreover, cruise ships will not be allowed to off load waste at the Grand Port.

Relocating some of the vessels to the East of the existing port facilities will "spread" the vessel generated emissions, resulting in lower local ambient ground level concentrations at the current port and decreasing the local air pollutant concentrations there in proportion to the quantity of ships relocated. The introduction of vessel emissions to the new port will have a negligible effect on the local air quality at that location, considering that they are a fraction of the total originally generated at the existing port, and the total emissions showed no ambient air quality issues. The ability of the new port to accept the newer, LNG fueled vessels will further reduce emissions long term. All cruise ships flagged under countries that are signatories to the International Convention for the Prevention of Pollution from Ships (MARPOL) are required to strictly comply with MARPOL, IMO regulations.

As with any port operation it will be necessary to provide fuel services for ships stopping at the facility. This is similar to the bunkering operation that occurs at Lucayan Harbour in Freeport. While CGBIL will not store fuel or provide fuel services itself, it is important to the project that services can occur at the Grand Port. The fuel bunkering operations will be developed through a future arrangement between the cruise brand and the fuel provider.

As part of the Carnival Corporations sustainability program there is a transition from the use of traditional marine fuels to using Liquified Natural Gas (LNG) to reduce air emissions. The new XL Class ship, which can carry in excess of 6,000 passengers will be powered by LNG. Therefore, when the new class of Carnival brand ships arrive in North America there will be a need for LNG fuel bunkering and marine fuel as The Bahamas is added to the cruise itinerary.

While a Liquified Natural Gas-powered ship is docked, some LNG will continue to boil off from the ship storage tank due to the temperature difference between the liquified natural gas and the significantly higher ambient temperature of the environment. A portion of this boil off gas will be used to run the ship engine to produce power while docked. Any boil off gas generated beyond what is required for the engines is typically vented to the atmosphere. Natural gas (methane) is lighter than air and if unobstructed will rise away from the ship and disperse. The methane will have no impact on local ambient air quality. However, methane is many times more active as a "greenhouse gas" than carbon dioxide, and Best Management Practices should be used to minimize methane losses. The minimal methane discharge is more than offset by the reduction in carbon footprint associated with LNG fueled vessels. The operation of the cruise ships at the proposed port, the increase in cruise ship visits, and an increase in vessel size and the use of LNG fuel are all expected to have negligible impacts on the air quality of the region.

Electricity will be provided by the Grand Bahama Power Company. CGBIL has been in discussions with the power company on the use of solar power. Currently, there is no power to the property boundary. Given the impacts from Hurricane Dorian, CGBIL will further engage with G.B. Power on the provision of power to the facility and opportunities to meet this demand with renewable sources (namely, a solar power generation plant). An easement for power and utilities has been incorporated into the Sussex Drive design.

Marine Project Elements

Marine project elements include construction of two vessel berths, access pier and ancillary coastal structures. The berth excavation will involve the hydraulic excavation of approximately 1.1 million cubic yards of material from the dredge area footprint which covers 75.6 acres. The project also includes construction and stabilization of two coastal inlets associated with the proposed inland waterway. Material will be hydraulically dredged (after relocation of corals from the area of direct impact) and placed on proposed upland development portions of the property to raise grade elevation.

Key marine elements of the project are:

- Berth excavation (dredging)
- Upland placement of dredge spoil
- Pier construction
- Inlet excavation and stabilization
- Construction of ancillary coastal structures
- Construction of mitigation reefs to offset project impacts

The project will result in direct impacts to 75.6 acres of existing benthic habitat from berth construction. This area of impact is primarily associated with dredging of the berth to a nominal depth of 35 feet (MLW) and includes slope adjustment along the boundary of the dredge footprint. Existing resources within this area will be lost, unless they are relocated before construction.

A total of 27 stony coral species were identified within the project footprint and the relative densities of observed corals has been estimated. Three threatened coral species (as designated under the US ESA) are present within the area of direct impact. Relocation of reef substrate from the coral mound habitat and creation of additional mitigation reef substrate for coral transplantation is proposed as mitigative measures for coral impacts.

It is noted that marine field investigations conducted in support of this study were completed in the summer of 2019 prior to observations and subsequent reports of the presence of Stony Coral Tissue Loss Disease (SCTLD) in Grand Bahama including the project and study area. An additional field effort will be conducted to assess the prevalence of SCTLD within the project area. Currently, The Bahamas are under emergency orders due to the COVID-19 pandemic. Therefore, the borders and many businesses are closed, and physical distancing measures are in place. This precludes the conduction of additional field efforts at this time. This additional field effort will be in addressed as an addendum to this EIA upon completion of the work. As SCTLD may now be present in the project area, we have proactively engaged with SCTLD expertise to begin consideration of appropriate response measures should they be required and will address further within both the field effort and EIA addendum.

Summary of Direct Impacts from Berth Excavation

Habitat	Location	Area (acres)	Area (ft²)	Area (m²)	Percent
Land	Dredge	0.00	0.00	0.00	0.0%
Sand	Dredge	22.85	995,343.89	92,470.84	30.2%
Exposed Limestone	Dredge	0.00	0.00	0.00	0.0%
Macroalgal Hard Pan	Dredge	0.00	0.00	0.00	0.0%
Hard Pan	Dredge	40.77	1,775,875.44	164,984.89	53.9%
Ridge and Swale	Dredge	7.17	312,463.69	29,028.94	9.5%
Spur and Groove	Dredge	3.71	161,817.13	15,033.36	4.9%
Reef Mounds	Dredge	1.09	47,501.45	4,413.05	1.4%
Total		75.60	3,293,001.62	305,931.08	100.0%

The construction of two coastal inlets will result in direct impacts to 0.2 acres of intertidal hard pan (hardbottom) and macro hard pan (hardbottom) associated with excavation of the inlet channels and installation of inlet jetties. Construction will also impact approximately 3.0 acres of sand substrate. These two coastal inlets will connect to the planned interior waterway and introduce a tidal exchange from the waterway into the ocean. Numerical modeling of this exchange was conducted. This analysis suggests that induced currents within the waterway from natural process (tidal forcing, wind and waves) will result in mild current velocities, with maximum velocities in the inlet throat approaching 0.5 meters per second. Mechanical pumping is proposed, and the design and required system will be determined following further analysis during the design phase. Mechanical pumping will be utilized to reinforce natural flushing of the interior waterway.

The construction of the excursion dock will result in approximately 1.2 acres of impact to nearshore substrate consisting of intertidal hard pan (hardbottom) and macro hard pan (hardbottom, and sand substrate. As will the pier, these structures will be pile supported structures. Direct impacts will occur due to the installation of the structure piles and the shading impact of the structure decks. The resulting pile structure will provide additional (vertical) benthic substrate post construction.

Project construction represents a major perturbation in the marine environment in the vicinity of the project area. While the majority of anticipated impacts will be direct and predominant during construction activities, there is a potential for additional indirect and secondary impacts both during and post-construction. This risk is addressed through the adoption of Best Management Practices (BMPs) for project construction including the use of turbidity curtains and turbidity monitoring.

Berth construction will permanently alter the bathymetry in the project area, resulting in a modification of the local wave climate and resulting sediment transport system. The two coastal inlets will interrupt the transport of sand within the beach system. Numerical modeling of the wave and sediment transport system was conducted. This modeling suggests the following modifications to the current coastal sediment transport system:

- Changes in beach stability (erosion potential) will be primarily limited to interior portions of the property.
- Infilling of the eastern inlet channel is predicted suggesting that maintenance dredging may be required. This material can be beneficially used to address erosion to the immediate west of the inlet.
- The main areas of increased erosion potential occur adjacent and downdrift (to the west) of the proposed eastern canal inlet and immediately landward of the berth.
- Downdrift impacts as a result of the project outside of the property boundaries are not anticipated as the Sharp Rock headland already largely isolates the project site within its own littoral cell.
- Dredging of the berth will cause waves to refract and break closer to shore. These impacts in terms of increased wave heights at the shoreline and erosion potential are minor and limited to the study area.
- Increased wave energy seaward of the proposed jetties is possible due to wave reflection. This can be mitigated during design through mild sloping structures and/or the use of less reflective material.

Proposed mitigation for impacts from marine construction elements includes relocation of environmental resources from the area of impact where practicable, the protection in place of resources through the deployment of turbidity curtains, and the monitoring of resources throughout construction to ensure compliance and allow for corrective action if needed. The following mitigation actions are proposed to offset impacts to the marine environment:

- The dredge footprint includes approximately 1.09 acres of reef mound substrate. These structures are largely undercut discrete rock formations that can be dislocated and transplanted in large boulder sections utilizing lift bags or barge/crane equipment (similar to that proposed for pier construction operations). A 5.81 acres receiver site has been identified approximately 1.5 miles to the east of impact area which provides similar conditions as the existing site. The mound features will be placed randomly within the area leaving open sand areas between the mounds resulting in a habitat similar to that impacted by the project.

- A mitigation reef will be constructed on a 5.18 acres receiver site in the nearshore adjacent to the western property boundary. The reef will be constructed of limestone boulders of approximately 4-foot diameter in random groupings. This site will also serve as a receiver site for suitable coral colonies from areas of direct impact. The reef will provide additional substrate for both coral relocation and recruitment and will provide an additional nearshore amenity for visitor excursions and an alternative to natural reef resources.
- Mooring buoys will be installed in conjunction with the creation of the reef mound transplant reef and the nearshore mitigation reef. Installation of mooring buoys within Peterson's Cay National Park will be considered in coordination with The Bahamas National Trust.
- Removal of marine debris from the study area including Peterson's cay is proposed as a mitigative measure to offset marine project impacts.
- The presence of Lionfish (Pterois volitans) was also noted during the benthic field studies. This species is a non-native, invasive fish that competes with native species. Removal of specimens encountered during marine field efforts is proposed as a mitigative measure.
- CGBIL will explore efforts to increase education opportunities for guests regarding Grand Bahama's environmental resources through signage, pamphlets and excursion experiences.
- Beach conditions will be monitored post project and if there is a need the implementation of beach nourishment will be considered.
- A long term sea turtle nesting management and monitoring plan for property beaches is proposed as a mitigative measure for marine project impacts.
- In concert with The Bahamas National Trust, CGBIL will support the development of a long term management plan for the area. Support for plan development is proposed as a mitigative measure for project cumulative impacts to the marine environment.

Extensive oversight and monitoring is proposed throughout the construction process to minimize the potential for additional secondary impacts to terrestrial and marine environments. These efforts include daily turbidity monitoring and biweekly benthic surveys. Post construction monitoring is also proposed for a period of two years.

0 FOREWORD

During the preparation of this Environmental Impact Assessment (EIA) Hurricane Dorian struck the islands of Great Abaco and Grand Bahama. Dorian was a very strong Category 5 hurricane based on the Saffir Simpson scale with sustained winds of 185 mph and gusts up to 200 mph. The storm lasted from September 1 – September 3, 2019, on Grand Bahama. Dorian hit Great Abaco from the east and continued on a westward trajectory hitting east Grand Bahama on Sunday evening, September 1st. The hurricane moved across the settlements of Sweetings Cay, McCleans Town, Pelican Point, and High Rock before turning northward on to the Northshore of Grand Bahama. Dorian was a very slow-moving storm traveling at a rate of 1.3 mph and at times stalled while moving along Grand Bahama.

Dorian was the most devastating natural disaster to hit The Bahamas. It has adversely impacted the second and third largest island economies of The Bahamas. Dorian caused wide spread flooding on Grand Bahama, as the strong winds combined with a "king tide" resulted in waters from the Little Bahama Bank being pushed southward. Unprecedented flooding occurred from East Grand Bahama to Freeport and beyond. The storm surge was estimated to be 20 feet, the highest ever recorded on the island. This flooding also impacted the island's water supply, particularly wellfield W-6 operated by the Grand Bahama Utility Company (GBUC). The flooding resulted in loss of the city water supply for approximately two weeks and contamination of the wellfield with seawater. The GBUC criteria for salinity is based on a salinity of 0.6 parts per thousand (ppt). The salinity measured from a household post-Dorian was 4.9 ppt.

Since most of the field studies were completed before Dorian, we utilized that baseline data. Where appropriate, we describe in the individual reports the impacts from Dorian to some degree. The Carnival Grand Port was impacted by Dorian. Photographs are provided for visual representation of current conditions.

Photo 0.1. East Boundary Road (View to North)

Photo 0.2. Beach Road along Broadleaf Coppice Area (View to East)

Photo 0.3. Beach on Eastern side of Property (View to West)

Photo 0.4. Broadleaf Coppice Area

Photo 0.5. Aerial View from East Parcel (View to West)

Photo 0.6. View of Broadleaf Coppice at Observation Well 4 Location (View to North)

Photo 0.7. Eroded Beach Road - West of Sharp Rocks Point (View to North)

1 INTRODUCTION

This Environmental Impact Assessment (EIA) has been prepared at the request of the Grand Bahama Port Authority (GBPA) and the Government of The Bahamas for the Carnival Grand Bahama Investments Limited (CGBIL) proposed project Carnival "Grand Port." The Grand Port name is temporary; a permanent name will be provided by Carnival Corporation. CGBIL is a wholly owned subsidiary of Carnival Corporation, a Panamanian corporation.

The proposed project encompasses the construction of a finger pier to accommodate two cruise ships at a time and a recreational facility onshore that will have restaurants, shops, transportation canal and other amenities. The facility will primarily service Carnival Cruise Line ships but may also serve other Carnival Corporation brands operating in the Caribbean. Carnival has similar facilities throughout the Caribbean but this would be the Flagship destination. The CGBIL Grand Port will be a new Port of Entry for Grand Bahama exclusively operated by CGBIL.

The EIA is being submitted to two different jurisdictional agencies, the GBPA and The Bahamas Environment, Science and Technology (BEST) Commission since the project crosses two different governing boundaries. The proposed project requires approvals for environmental and building permits for the terrestrial side of the project from the GBPA. The Bahamas Government is responsible for approvals for the offshore side of the project including granting a seabed lease, environmental permitting, and construction permits for the dock facility, including a shore excursion dock.

A Terms of Reference has been submitted to the Building and Development Services Department of the GBPA and BEST providing information of the project and the proposed scope of work for the EIA including a list of Consultants (**Appendix 1**).

The proposed project will be located on the south shore of Grand Bahama Island between Sharp Rocks Point and Tony Maura Point within the Freeport/Lucaya city limits, which fall under the administration of the GBPA. This site was selected due to the closeness of deep water to shore, the size of land available, environmental surroundings, and that it is beach front property. The site is undeveloped and a lease for the property has been secured. The approximate location of the facility is presented in **Figure 1-1.**

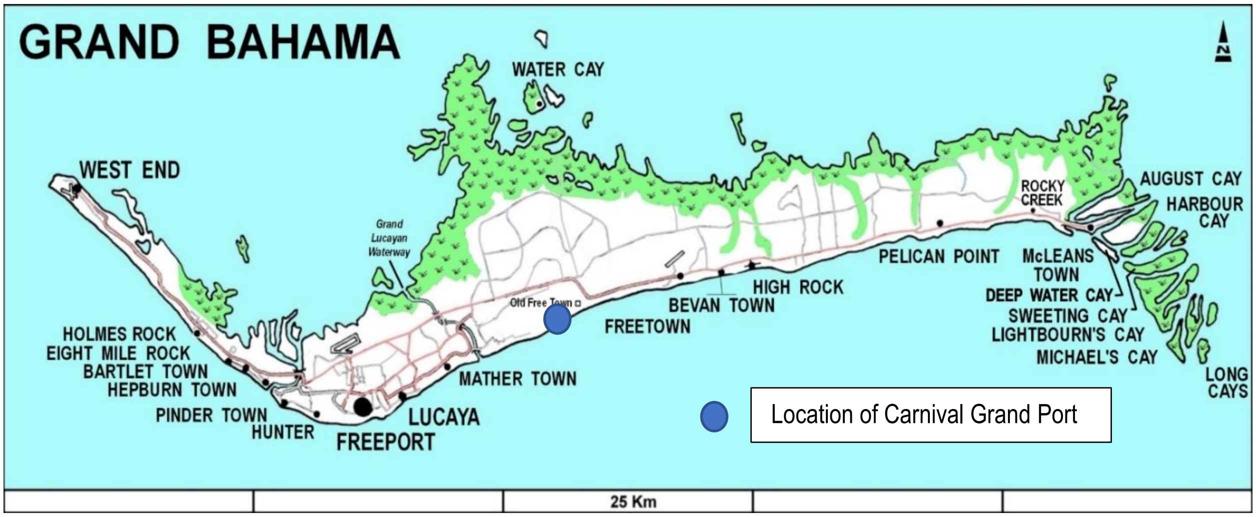


Figure 1-1. General Location of Project Site

2 HISTORY OF CARNIVAL CORPORATION AND CRUISE LINE

2.1 About Carnival Corporation & plc (CCO)

CCO is the world's largest leisure travel company and among the most profitable and financially strong in the cruise and vacation industries, with a portfolio of nine of the world's leading cruise lines. With operations in North America, Australia, Europe and Asia, its portfolio features Carnival Cruise Line, Princess Cruises, Holland America Line, Seabourn, P&O Cruises (Australia), Costa Cruises, AIDA Cruises, P&O Cruises (UK) and Cunard.

Together, the corporation's cruise lines operate 104 ships with 244,000 lower berths visiting over 700 ports around the world in over 130 countries, with 19 new ships scheduled to be delivered through 2025. CCO also operates Holland America Princess Alaska Tours, the leading tour company in Alaska and the Canadian Yukon. Traded on both the New York and London Stock Exchanges, CCO is the only group in the world to be included in both the S&P 500 and the FTSE 100 indices.

According to Carnival's website, "Carnival Corporation employs over 120,000 people worldwide and its nine cruise line brands attract nearly 11.5 million guests annually, which is about 50 percent of the global cruise market. Combining more than 225,000 daily cruise guests and 100,000 shipboard employees, more than 325,000 people are sailing aboard the Carnival Corporation fleet every single day, totaling about 85 million passenger cruise days a year."

CCO operates a variety of cruise ports around the world, each with its own unique arrangement including some via joint ventures with private entities and other cruise lines. These include:

- Puerta Maya, Cozumel, Mexico
- Grand Turk Cruise Center, Turks and Caicos Islands
- Mahogany Bay, Roatan, Honduras
- Amber Cove, Puerto Plata, Dominican Republic
- Half Moon Cay, The Bahamas
- Princess Cays, The Bahamas
- Long Beach, California, United States
- Barcelona (Terminals D and E), Spain
- Santa Cruz de Tenerife, Spain

- Marseille, France
- Civitavecchia, Italy
- Palacrociere, Savona, Italy
- Sasebo, Japan

The CCO brands and approximate number of ships are listed below:

- Carnival Cruise Line: Ships 26
- Princess Cruises: Ships 18
- Holland America Line: Ships 14
- Seabourn: Ships 5
- Cunard: Ships 3
- Aida Cruises: Ships 12
- Costa Cruises: Ships 15
- P&O Cruises (UK): Ships 7
- P&O Cruises (Australia): Ships 5

Carnival Corporation is in the process of expanding the existing fleet with the construction of a new class of ships named the “Excellence Class” also known as the “XL Class.” The XL Class ships are 180,000 gross tons (GT) cruise ships that are 1,130-feet-long (345 meters) with a 6,500-passenger capacity. This class ship is the largest in the Carnival Corporation fleet. The XL Class ship or Mardi Gras, named after the first Carnival cruise ship of the series, is scheduled to be completed in 2020 and will have Port Canaveral, Florida as its home port. The new class ship will be the first North American-based cruise ship to be powered by liquefied natural gas (LNG), part of Carnival Corporation’s “green cruising” design platform. An artist rendering of the new XL.Class ship is presented in **Figure 2-1**. on the following page.

Figure 2-1. Artist Rendering of Carnival XL Class Ship (Source: Carnival)

Carnival made history with the first ever cruise ships to use LNG, when they took delivery in 2018 of the first cruise ship able to be completely powered by LNG, the AIDAnova. They have an additional ten next-generation cruise ships on order that will also be powered by LNG (both in port and on the open sea) - an innovation that reduces carbon emissions to help protect the environment.

In support of the new LNG Carnival brand cruise ships, Carnival Corporation has partnered with Shell to fuel North America's next-generation LNG-powered cruise ships - the first of which, the Mardi Gras, will arrive in October 2020. As part of the agreement, the two ships, built with a next-generation "green cruising" ship design, will be fueled through Shell's Partner Quality LNG transport (Q-LNG) Bunker Barge (LBB) – a project that is part of Shell's strategic plan to develop a global LNG bunkering network. The ocean-going LBB, which is designed to support growing cruise line demand for LNG as a marine fuel, will be the first of its kind in the U.S. and will allow these ships to refuel with LNG at ports along the southern U.S. East Coast.

Carnival Corporation is in the forefront of advancing LNG as a fuel source for the cruise industry. One of the keys to establishing LNG as a standard for powering cruise ships is building extensive, safe and reliable infrastructure across the globe for this clean burning fossil fuel. Carnival Corporation is working closely with

Shell as they help to bring LNG to North America in what will be the first step in building a strong foundation for the future of LNG fuel supply for cruise ships in the region.

2.2 Carnival Caribbean Ports

Carnival Corporation has constructed a network of various cruise ports and shore facilities throughout the Caribbean. The facilities are listed below and aerial photographs (source: Google Earth) of each facility are presented in the following figures.

- **Mahogany Beach** - Dixon Cove, southwest coast of Roatan, Honduras (**Figure 2-2**)
- **Grand Turk Cruise Center** - Grand Turk, Turk and Caicos Islands (**Figure 2-3**)
- **Puerta Maya** – Southwestern part of Cozumel, Mexico (**Figure 2-4**)
- **Amber Cove** – Puerto Plata, Dominican Republic (**Figure 2-5**)

Carnival Corporation also owns two facilities in The Bahamas which do not have berthing areas but rely on tenders to transport passengers from ship to shore. They are **Half Moon Cay** (**Figure 2-6**) in Little San Salvador, operated by Holland America Line and **Princess Cays** (**Figure 2-7**) in Eleuthera, operated by Princess Cruises.

Figure 2-2. Mahogany Beach – Roatan, Honduras **(Source: Google Earth)**

Figure 2-3. Grand Turk Cruise Center - Grand Turk, Turks and Caicos Islands (Source: Google Earth)

Figure 2-4. Puerta Maya – Cozumel, Mexico (Source: Google Earth)

Figure 2-5. Amber Cove – Puerto Plata, Dominican Republic **(Source: Google Earth)**

Figure 2-6. Half Moon Cay, Little San Salvador, Bahamas

Figure 2-7. Princess Cays, Southern Eleuthera, Bahamas (Source: Google Earth)

Carnival brands contribute significantly to the tourism sector of Grand Bahama. Below is a table showing the number of passengers that have visited Grand Bahama on Carnival Corporation brands in recent years.

Table 2.1. Freeport Passenger Counts by Carnival Brands per Bahamian Fiscal Year

Brands	July 2017- June 2018	July 2018 - June 2019
CCL	474,632	480,450
Costa	7,790	4,520
P&O / CAU / CUK	704	4,964
TOTAL	**483,126**	**489,934**

2.3 Grand Bahama Shipyard

Along with Royal Caribbean and the Grand Bahama Port Authority, Carnival is also an owner in the Grand Bahama Shipyard (**Figure 2-8**) formerly the Lloyd Werft Grand Bahama Shipyard, which opened in 2000. The shipyard is located in Lucayan Harbour and within the industrial park of Freeport. The shipyard employs over 500 people and exceeds $250 million in investment. The shipyard is significant to the economy of Grand Bahama in terms of direct and indirect employment.

Figure 2-8. Aerial Photograph of the Grand Bahama Shipyard (September 2014) Source: Envirologic International

2.4 Health Environment Safety and Security (HESS)

Environmental affairs throughout the numerous Carnival brands are managed through their Health, Environment, Safety, Security (HESS) department.

As in all Carnival Ports in the Caribbean and Central America, Grand Port will have a Health, Environment and Safety Department (HES) integrated by qualified staff who will be trained by Corporate specialists and by the staff of the other ports, further enhancing this way the best practices in this field applied in the operation of all Carnival ports. As in the rest of Carnival ports, this HES department will have a fully equipped in-house laboratory. Grand Port HES department will manage solid wastes (including waste reduction and potential recycling), wastewater system, potable water, Public Health (potable water and food safety as well as pest management), coastal and marine environment (including but not limited to: beach water quality, benthic resources, coral reef restoration projects and beach management plan), terrestrial environment (including but not limited to: flora and fauna, mangrove restoration and reforestation) and will also implement a comprehensive environmental education program with the participation of key stakeholders, as well as other aspects of the operation of the port.

Below is the Carnival Corporation's HESS Commitment taken from the Carnival Corporation's Sustainability from Ship to Shore Report 2018. The Grand Port will follow the Corporate HESS Commitments and Policy.

"OUR HESS COMMITMENTS

Given our global reach and impact, we are committed to the following health, environment, safety, security (HESS) and sustainability core values:

Protecting the health, safety and security of our passengers, guests, employees and all others working on our behalf, thereby promoting an organization that always strives to be free of injuries, illness and loss.

Protecting the environment, including the marine environment in which our vessels sail and the communities in which we operate, striving to prevent adverse environmental consequences and using resources efficiently and sustainably.

Complying with or exceeding all legal and statutory requirements related to health, environment, safety, security and sustainability throughout our business activities.

Assigning health, environment, safety, security and sustainability matters the same priority as other critical business matters.

Our management ensures that the values and objectives stated in our HESS Policy are clearly understood by everyone in the organization and articulated on a regular basis. Senior management reviews the HESS Policy at least annually.

If changes are warranted, it will be updated; otherwise the policy remains unchanged. The full text of our HESS Policy."

The full text of the HESS Policy is found on the following page.

CARNIVAL CORPORATION & PLC.

HEALTH, ENVIRONMENTAL, SAFETY, SECURITY AND SUSTAINABILITY CORPORATE POLICY

Carnival Corporation & plc and its Operating Lines are committed to:

- Protecting the health, safety and security of our passengers, guests, employees and all others working on our behalf, thereby promoting an organization that always strives to be free of injuries, illness and loss.
- Protecting the environment, including the marine environment in which our vessels sail and the communities in which we operate, striving to prevent adverse environmental consequences and using resources efficiently and sustainably.
- Complying with or exceeding all legal and statutory requirements related to health, environment, safety, security and sustainability throughout our business activities.
- Assigning health, environment, safety, security (HESS) and sustainability matters the same priority as other critical business matters.

To implement this Policy, the management of Carnival Corporation & plc and its Operating Lines will:

- Ensure compliance with this Policy within each of Carnival's Corporate and Operating Line organizations.
- Identify managers who are responsible for HESS and sustainability performance and ensure that there are clear lines of accountability.
- Develop, implement and monitor effective and verifiable management systems to realize our HESS and sustainability commitments.
- Support a proactive framework of risk mitigation in the areas of HESS aimed at preventing, monitoring and responding to threats.
- Identify the aspects of our business that could negatively affect the environment and take appropriate action to minimize any adverse effects.
- Identify, document, assess and conduct periodic reviews of the principal HESS and sustainability risks affecting our business and implement practical measures to manage the identified risks effectively.
- Provide HESS and sustainability support, training, advice, and information, as appropriate, to passengers, guests, employees, and others working on behalf of the Company.
- Perform annual HESS audits and take prompt action on identified audit findings.
- Maintain an Ethics & Compliance reporting hotline to allow for anonymous reporting of HESS and compliance concerns.
- Promptly report and properly investigate all HESS incidents and take appropriate action to prevent recurrence.
- Establish and act upon goals and objectives to improve our HESS and sustainability performance.
- Promote industry best practices and publicly report to and maintain open dialogue and cooperation with key stakeholders on HESS and sustainability matters.
- Require business partners to know and comply with applicable legal and statutory requirements related to HESS, labor and human rights.
- Require that employees who become aware of any vessel or crew's inability to comply with Company, legal or statutory requirements report same to management and specifically require that Environmental Compliance reports from shoreside employees be made in writing to their Operating Line Compliance Manager.
- Prohibit retaliation against anyone who reports a violation of Company, legal or statutory requirements and establish that an employee's failure to notify regarding any such violation is grounds for discipline or dismissal.
- Conduct a Corporate senior management review of this Policy at least annually.

Approved by:

William R. Burke	Arnold W. Donald	Micky Arison
Chief Maritime Officer	President and CEO	Chairman of the Board

Original Issue: 10/15/07 | Revised: 10/18/17

Carnival Costa P&O P&O CRUISES PRINCESS CRUISES Holland America Line AIDA CUNARD SEABOURN fathom

2.5 Corporate Responsibility Objectives

Below is the Carnival Corporate responsibility statement:

"*We at Carnival Corporation & plc believe that sustainability is about preserving our environment, respecting our employees and communities, and returning value to our shareholders. Sustainability is not a cost of doing business; it is a way of doing business. As one of the largest vacation companies in the world, we have been committed since our inception to operating responsibly.*

We recognize that our success is tied to protecting the environment, safeguarding and developing our workforce, strengthening stakeholder relationships, enhancing the port communities that we visit and maintaining our fiscal strength. We also recognize that, in today's business climate, the viability of our business as well as our reputation depends on being more sustainable and transparent.

We know that the journey ahead will contain many challenges and opportunities for stronger stewardship, and recognize that our future success and delivery on our sustainability plans and goals are inextricably linked. As an industry leader, we are committed to and accountable for growing and operating wisely.

In addition, we have established a hotline telephone number and website to permit reporting of environmental concerns. The hotline can be contacted at:"

- 1-888-290-5105 (toll-free in North America)
- +1-305-406-5863 (from all other locations)
- www.carnivalcompliance.com

3 STATEMENT OF NEED

The Bahamas has always been an important destination for Carnival Corporation and the investment in the new port seeks to enhance the role of Grand Bahama as a major tourism center. Currently, ships arrive at the Lucayan Harbour in Freeport (**Figure 3-1**). The harbour itself is surrounded by industrial or commercial companies as it is located within the industrial park. Passengers have to be transported either by taxi or tour bus through the industrial park to the touristic sites. The Carnival Grand Port will allow Carnival's guests to forego the trip through the industrial setting. Passengers will arrive on the south shore of Freeport and will be able to go directly from the ship onto beachfront property.

Figure 3-1. Lucayan Harbour and Industrial Park (Source: Google Earth)

3.1 Current Status of the Cruise Industry in Grand Bahama

The current port in Grand Bahama is consistently among the lowest ranking ports in terms of guest satisfaction. Currently, five cruise lines visit the island; three of these – Carnival Cruise Line, Costa Cruises, and P & O UK – are Carnival Corporation brands. Over 80% of all guests arriving to Freeport on cruises will come from Carnival Corporation brands.

Carnival Cruise Line, the leader in short cruising from the southeast U.S. for decades, based on their passenger demands, and low ratings for the current cruise port in Grand Bahama, decided to take the extra step and create a new, spectacular port experience that their guests expect, in Grand Bahama. Successful transit ports satisfy two primary groups of people: 1) passengers who do not buy tours (about 70%) and 2) crew. The Lucayan Harbour does not adequately address either group. The harbour is far away from areas of interest for passengers and lacks activities as well as water-bound offerings originated from the current harbour.

The new port will allow opportunities, which include water based tours by recreational boats such as catamarans, glass-bottom boats, fishing trips, and nature tours by local operators. More tours and activities will be developed and contracted for directly with CCL.

Future of the Cruise Industry in Grand Bahama

Carnival's new $100 million port development will have a substantial impact on the cruise industry in Grand Bahama, providing increased opportunities for tour operators, food and beverage service operators, and other cruise-related businesses. The Grand Port is projected to create over 1,000 jobs. CGBIL does not intend to operate any of the restaurants; local qualified businesses will be provided the opportunity to operate the food and beverage services.

The new facility will also allow more guests to pass through Grand Bahama with the new docking facility that accommodates two ships at a time. The facility is designed to allow for an estimated 10,000 -13,000 guests and crew on a daily basis. The Carnival Grand Port will also enable Carnival Corporation to build on its already established brand by enhancing its' guest experience while simultaneously improving the tourism product in Grand Bahama.

The new port is both strategically and operationally important to Carnival Corporation. The close proximity of Grand Bahama to Florida will be strategically advantageous since it presents more opportunities in scheduling ships from the east coast of Florida. The berth area will be designed to accommodate the new class of Carnival ships, the XL Class. Moreover, from an operational standpoint, the new port will allow flexibility in scheduling, especially during hurricane season when tropical storms may impact other Caribbean destinations or when other unforeseen circumstances arise.

Ultimately, cruise ship passengers will obtain a different perception of Freeport as a destination because they will be delivered onto a wide expanse of beach in a secluded area. The new port will also allow other Carnival Corporation brands that operate in the Caribbean region to use the facility. Another benefit is that this will free space at Lucayan Harbour for others interested in adding Grand Bahama as a destination.

Post-Hurricane Dorian, the Carnival Grand Port will be significant in helping rebuild the economy of Grand Bahama. The adverse ecomonic impacts to Grand Bahama are significant, as many have lost everything and many businesses in the downtown area, including the Grand Bahama Airport, were impacted by flooding. While no one project can single handedly solve the economic woes of Grand Bahama the culmination of many projects, particularly high end investments like the Grand Port will have far reaching benefits which will aid in the economic recovery. Moreover, it will let the world know that Grand Bahama is back in a significant way as a tourist destination in the Caribbean region.

4 INSTITUTIONAL AND REGULATORY FRAMEWORK

This chapter explains the unique framework under which the City of Freeport is administered and the rights that have been given to the Grand Bahama Port Authority under the Hawksbill Creek Agreement and Bahamas Government Acts.

4.1 Grand Bahama Port Authority (GBPA)

The GBPA was established in 1955 under the Hawksbill Creek Agreement (Hawksbill Creek Agreement – Deepwater Harbour and Industrial Area) and charged with the responsibility for the development, administration and management, and provision of services within the "Port Area." The Port Area is defined as the Freeport/Lucaya city limits. As a result, the GBPA was mandated to build a deep-water harbor, an industrial community, and the required infrastructure for Freeport. The GBPA licenses and regulates businesses in the Port Area and has the responsibility to enforce GBPA Building and Sanitary Code regulations. The GBPA has also adopted The Bahamas Government's Bahamas Building Code. New projects within the Port Area are approved after consultation with the GBPA's Building and Development Services Environmental Department and preparation of an EIA.

4.2 Legal Framework

Chapter 261 - Hawksbill Creek, Grand Bahama (Deep Water Harbour and Industrial Area)

The creation of the City of Freeport and Lucaya Harbour are a direct result of the provisions in the Hawksbill Creek Agreement. The GBPA has allowed for the expansion of the Lucayan Harbour and the development of businesses in the Port Area in accordance with Chapter 2, Paragraph 22, of the Hawksbill Creek Agreement which states:

> *"That subject to the provisions of sub-clause (10) of clause 1 hereof only the Port Authority shall have the sole right from time to time and at all times during the continuance of the Agreement to plan, layout, and vary the development of the Port Area in such a manner as the Port Authority shall in their absolute discretion deem fit and proper and that neither the Port Authority nor any Licensee shall have during the continuance of this Agreement require any building permit from the Government or any Department thereof for any excavation and/or for the erection or demolition of any building or structure in the Port Area, or for the installation, operation, maintenance, or removal of any machinery, plant equipment, or other apparatus in or about any buildings and/or structures within the Port Area."*

The GBPA was also encouraged to establish factories and other industries within the Port Area. Under Section 2 Paragraph 1 sub-clause (3) of the Hawksbill Creek Agreement, it mandates the GBPA to:

> *(3) Use their best endeavors to promote and encourage the establishment of factories and other industrial undertakings, and in particular factories, industrial undertakings, and industries which will make use of the natural resources and products available at Hawksbill Creek such as limestone rock and pine timber, within:*

THE GBPA UNDER THE FREEPORT BYE-LAWS ACT

Under this Act, the GBPA is allowed to make and enforce bye-laws for the purpose of maintaining proper standards of building, construction, sanitation and hygiene within the area of Grand Bahama Island known as the Port Area and other purposes connected with the orderly development of said area. Under Schedule (Clause 1) Paragraph 16 of the Freeport, Grand Bahama Act 1993, the GBPA was required to, "introduce additional environmental frameworks for development." The GBPA drafted environmental bye-laws which include the following:

- Freeport (Natural Resources Protection and Management)
- Freeport (Environmental Management and Protection)
- Freeport (Pollution Prevention and Waste Management)
- Freeport (Nuisances)
- Additional Clauses to Existing Bye-Laws

The GBPA also produced a Coastal Management Plan (2009) to be used as a guideline for the development of coastal areas including wetlands.

4.3 Ministry of Environment and Housing (MOE)

Under MOE, two departments are important for environmental management: The Department of Environmental Health Services (DEHS) and The Bahamas Environment, Science and Technology (BEST) Commission.

Department of Environmental Health Services (DEHS)

DEHS is the environmental regulatory department responsible for environmental control, solid waste collection and disposal. Also, DEHS is responsible for regulating and enforcing public sanitation and beautification of The Bahamas. DEHS is the regulatory agency responsible for enforcing the Environmental Health Services Act.

The Bahamas Environment, Science, and Technology (BEST) Commission

The BEST Commission was established in 1994 to serve as the government agency responsible for activities, agreements, and conventions that involve Bahamian natural resources and to advise the Government in a timely fashion on EIAs and environmental management plans of various development proposals submitted to The Bahamas Government. The BEST Commission also evaluates research permit applications for scientific investigations involving or affecting natural resources within The Bahamas.

Department of Marine Resources (DMR)

DMR is responsible for management of marine resources in The Bahamas and enforcing fisheries regulations as outlined in Chapter 244 Fisheries Resources (Jurisdiction and Conservation) Regulations. The removal of corals and research permits are issued by DMR.

4.4 Other Government Ministries and Departments

Other government agencies which have or may have responsibility for the oil releases to the sea are the Ministry of Transportation and Aviation, Port Department, National Emergency Management Agency (NEMA) and the National Oil Spill Advisory Committee.

Ministry of Transportation and Aviation

The Ministry of Transportation and Aviation is responsible for Road Traffic, Postal Department, Department of Civil Aviation, Department of Meteorology, and Port Department.

NEMA

The mission of NEMA is, “To reduce the loss of life and property within the Commonwealth of The Bahamas, by ensuring that adequate preparedness and mitigation measures and response and recovery mechanisms are established to counteract the impact of natural, man- made and technological hazards.”

National Oil Spill Advisory Committee

The purpose of the committee is to ensure that The Bahamas is in a state of readiness, as it pertains to oils spills in the territorial and archipelagic waters of The Bahamas.

4.5 Legislation

The Environmental Health Services Act, 1987 was published in the Extraordinary Official Gazette, The Bahamas on May 11, 1987. Under this Act, "The Minister makes regulations for the giving effect to or carrying out the purpose, intention and provisions of this Act, and without prejudice to the generality of the forgoing, such regulations may provide for -." To date few environmental regulations have been promulgated in support of the Act.

The Environmental Planning and Protection Act - Pollution Control and Waste Management Regulations was proposed in 2000 but has not been passed. This Act proposed freshwater and saltwater water quality standards.

4.5.1 Environmental Health Services Act 1987

An Act to promote the conservation and maintenance of the environment in the interest of health, for proper sanitation in matters of food and drinks and generally, for the provision and control of services, activities and other matters connected therewith or incidental thereto.

4.5.2 Fisheries Resources (Jurisdiction and Conservation) Regulations

This Act regulates fisheries resources in The Bahamas through DMR. This Acts states that no person shall uproot or take any hard or soft corals without written permission from the Minister. Additionally, permits for scientific research or experimental projects are regulated through DMR.

The project will comply with all Commonwealth of The Bahamas statute laws, Freeport bye-laws, GBPA building and sanitary codes and adhere to the environmental management plan (EMP). Moreover, the developer must comply with all environmental monitoring requirements and conditions prescribed by GBPA and The Bahamas Government if the project receives approval. CGBIL will apply for all the necessary permits required under the GBPA building and sanitary codes and building codes if the project is approved.

4.5.3 Conservation and Protection of the Physical Landscape of The Bahamas Act (2011)

This act includes provisions for the protection of physical landscape features including beaches and shorelines and provides for the regulation of excavation and landfill operations. The act further provides for conservation of protected trees.

5 PROJECT LOCATION

Carnival Corporation reviewed possible sites in Grand Bahama that would meet the need of the project. A site was selected based on the criteria of deep water to shore, amount of land available, and surrounding environment. The site location based on The Bahamas Government Topographic Map Sheet 8 Grand Bahama Island includes Silver Point and Sharp Rocks Point on the south shore of Freeport. The western boundary is just west of Sharp Rocks Point and eastern boundary is east of Tony Maura Point. The two parcels are identified as Parcel A and Parcel B. Parcel A is approximately 171 acres and Parcel B is approximately 158 acres giving a total of approximately 329 acres. The general location of the site is identified in the 2016 aerial photograph presented in **Figure 5-1**.

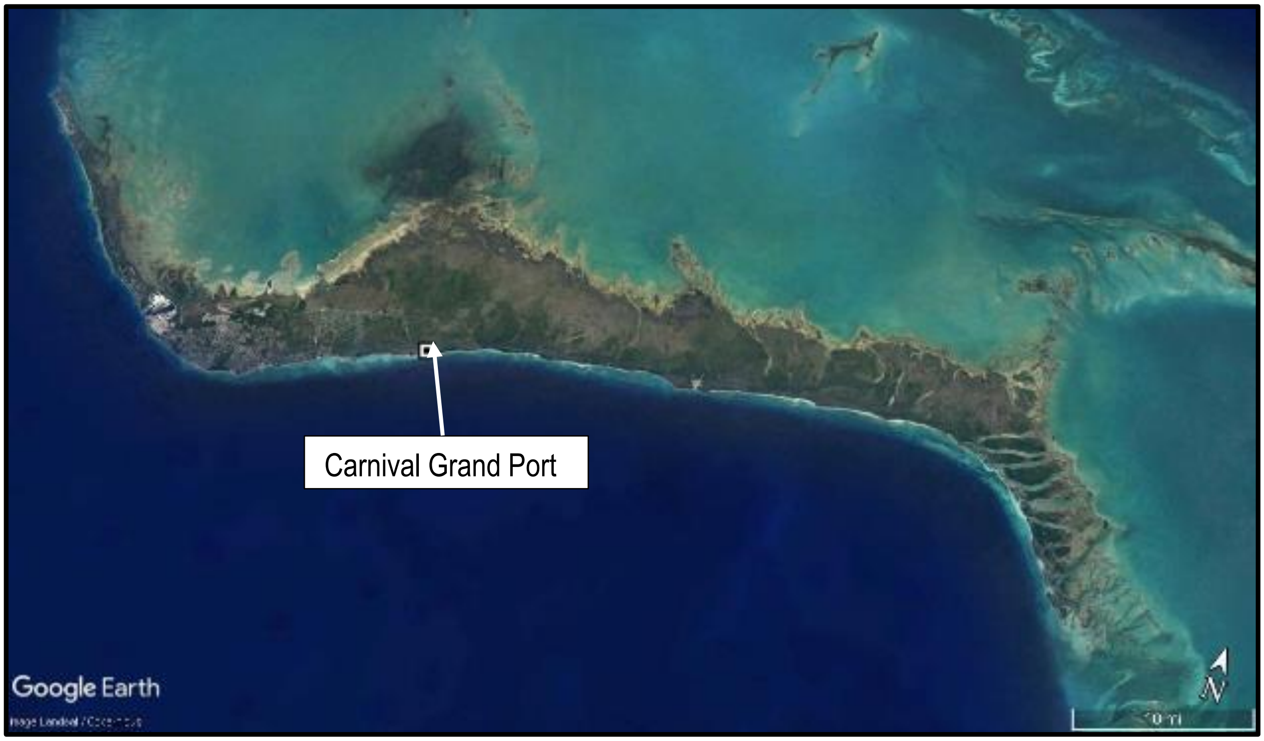


Figure 5-1. General Site Location of Carnival Grand Port **(Source: Google Earth)**

The boundary survey map is located in **Appendix 2 (electronic files)** section of this document. The property boundary lines are overlaid on an aerial photograph in **Appendix 2 (electronic files)**.

The site is undeveloped, which prior to the signing of the Hawksbill Creek Agreement, had a small settlement (Old Freetown) located to the east of the site. The only access to the site was a narrow track road (Heritage Trail) parallel to the shoreline exists. The beach entrance road is located 2.1 miles (3.4 kilometers) to the east the site. However, with the passing of Dorian this road is impassable. In order to conduct the

Hydrogeological Study and Terrestrial Resource Survey, it was necessary to construct an access road (Sussex Drive Extension) from the Grand Bahama Highway to the CGBIL property. Additionally, a temporary road network was constructed throughout the property, which allowed access for a drill rig. This clearing and temporary road works were approved by GBPA **(Figure 5-2)**.

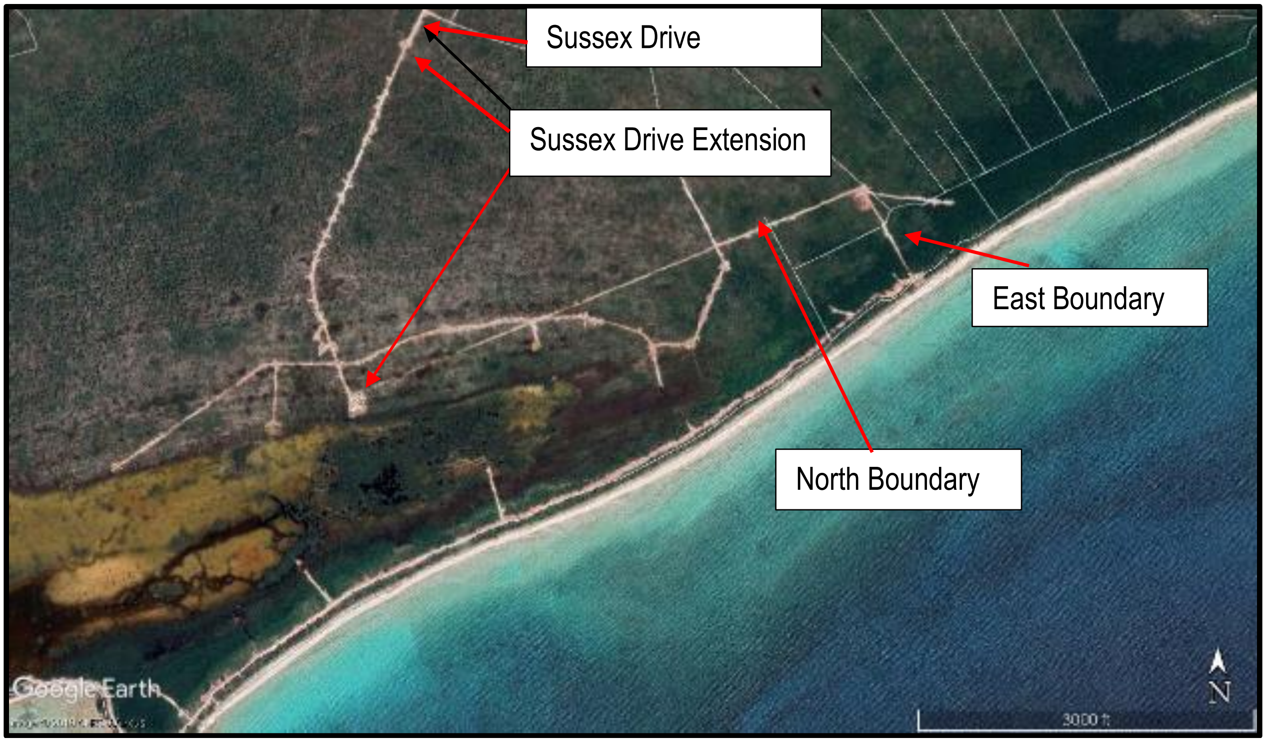


Figure 5-2. Temporary Site Roads (Source: Google Earth)

The proposed site is located in an undeveloped area of Freeport/Lucaya along the southern shore. Between the Grand Lucayan Waterway, located approximately 3.85 miles west of Sharp Rocks Point, and the site, there has been no development along the coast. The only development along this stretch of coastline is a small bone fishing lodge, which is located approximately 3 miles to the east. The site is bounded to the south by the Northwest Providence Channel, to the east by undeveloped land, to the west by undeveloped land, and to the north by undeveloped land. A single residence is located over 1.5 miles away in a northwesterly direction.

5.1 National Parks

In 1959, The Bahamas Government passed The Bahamas National Trust Act that established The Bahamas National Trust (BNT) as a statutory organization responsible for the conservation and preservation of places of historic interest and natural beauty. Paragraph 4 Clause 2 states the following:

> "*Subject to the provisions and for the purposes of this Act The Bahamas National Trust may acquire by purchase, gift or otherwise and may hold lands, buildings and hereditaments and submarine areas and any rights, easements, profits or interests therein or thereover and any other property of whatsoever nature and may maintain and manage or assist in the maintenance and management of lands as open spaces or wild life sanctuaries or places of public resort and recreation and of buildings for purposes of preservation, public recreation, resort or instruction and may maintain and manage or assist in the maintenance and management of submarine areas as marine life sanctuaries or places of public resort and recreation and may accept property in trust for any public purposes and may act in any trusts for, or as trustee of, any property devoted to public purposes and may do all acts or things and take all such proceedings as they may deem desirable in the furtherance of the objects of The Bahamas National Trust and they may upon or with respect to any property belonging to them or in which they have any interest do all such things and make all such provisions as may be beneficial for the property or desirable for the comfort or convenience of persons resorting to or using such property and may exercise full powers of ownership over their lands and property according to their estate and interest therein not inconsistent with the objects for which they are constituted including power to mortgage, loan, exchange or sell the same (subject to the provisions of section 14 hereof) and may apply their funds to all or any of such objects*."

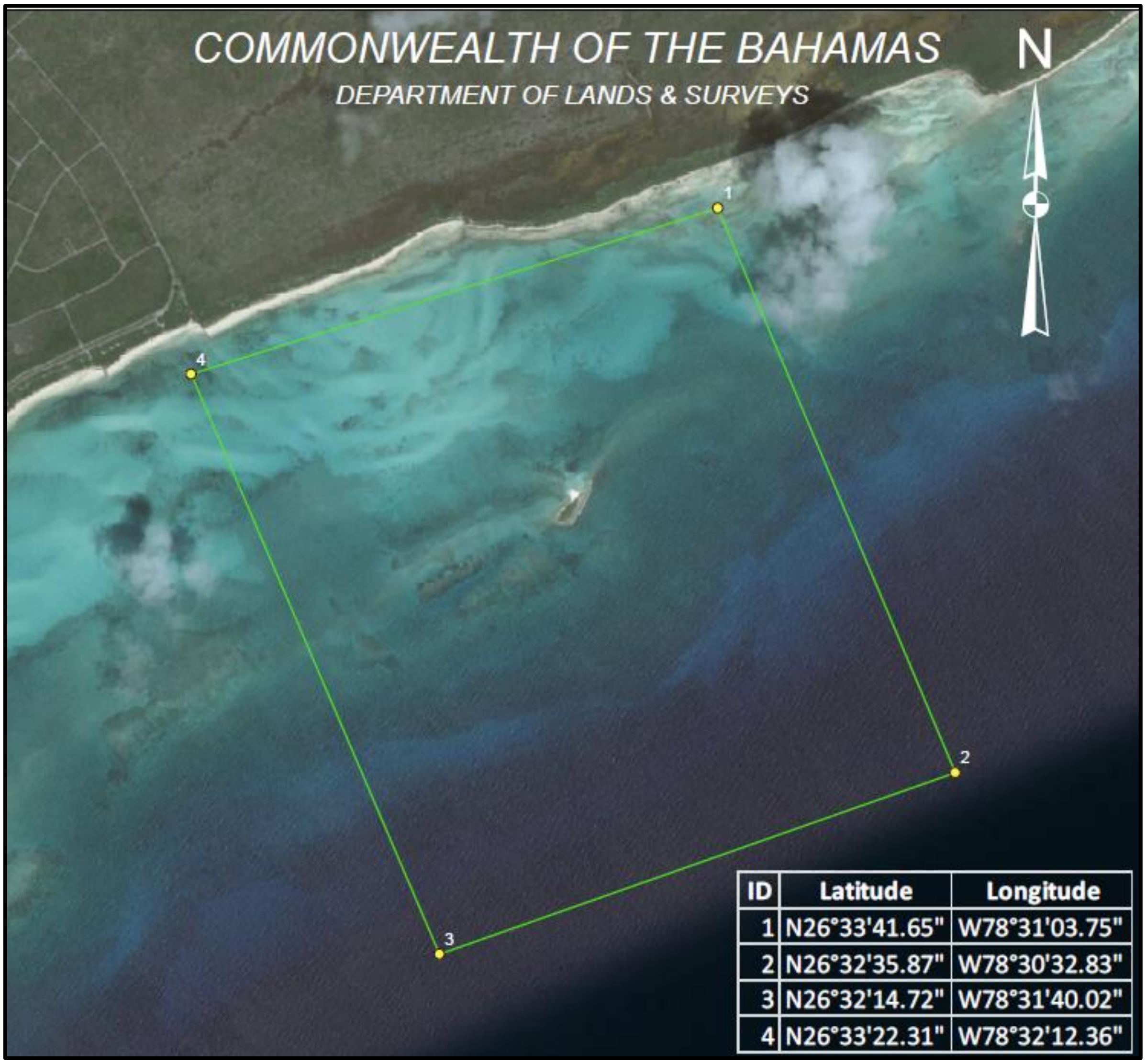
There are three national parks established by BNT in Grand Bahama:

- Rand Nature Center
- Peterson Cay National Park
- Lucayan National Park

The Rand Nature Center is located off Settlers Way and is where the BNT office is located. The Peterson Cay Park is located approximately 0.59 miles off the south shore of Barbary Beach. The Lucayan National Park is located off the Grand Bahama Highway approximately 2.14 miles west of the GBPA/Government Boundary in eastern Grand Bahama. The Lucayan National Park boundaries extend to the north and south of the Grand Bahama Highway and is the most visited park in Grand Bahama.

The Peterson Cay National Park is located approximately 1.5 miles to the west of Carnival Grand Port and the Lucayan National Park is located approximately 5.11 miles east of Carnival Grand Port. The location of the three parks is presented **in Figure 5-3**. The Peterson Cay National Park had its boundaries extended in recent years to include the surrounding offshore area (**Figure 5-4**).

Figure 5-3. Location of the National Parks in Grand Bahama



ID	Latitude	Longitude
1	N26°33'41.65"	W78°31'03.75"
2	N26°32'35.87"	W78°30'32.83"
3	N26°32'14.72"	W78°31'40.02"
4	N26°33'22.31"	W78°32'12.36"

Figure 5-4. Boundary Limits of the Peterson Cay National Park (Source: Bahamas National trust)

6 PROJECT DESCRIPTION

Grand Port is a development project that includes a pier constructed to accommodate two XL Class cruise ships and a welcome center; a day dock for tour operators; a town plaza with shops and restaurants; and recreational activities including nature trails, a water park, beach cabanas and other amenities. Grand Port is based on a Bahamian cultural theme which includes the construction of a church as well as having Junkanoo. One of the core features of the facility is a 1.6-mile-long canal used for transportation of guests by water taxi. This canal will also have beach areas and cabanas for guests that are beneficial when there are rough sea conditions along the beach. A chair lift system will also be utilized to transport guests across the facility. The use of the water taxis and chair lift system greatly reduce the use of vehicles throughout the property. The day dock ("Shorex" dock) will be used by tour operators to pick up and drop off guests.

The facility is designed to accommodate approximately 11,000 guests and 2,000 crew. It is estimated there will be approximately 1,000 people working at the facility. It is forecasted that the facility will gradually phase in ship arrivals over a five-year period, when it will reach full potential. An illustration of the site plan is presented in **Figure 6-1** and in **Appendix 2 (electronic).**

The proposed development is located on 329-acres on the south shore of Grand Bahama. The western half of the 1.8-mile wide upland is comprised mainly of mangrove wetlands, while the eastern half is a mixture of semi-permanent flooded wetlands, broadleaf coppice, fire impacted coppice, and sabal woodlands, pine woodland and, silver palm-bracken shrubland.

Integrated into the development plan is a mangrove conservation area from approximately the center of the property to the western limits, which encompasses 100 acres more or less of the total 155-acres of mangrove wetlands. Additionally, a nature trail consisting of 55 acres will be created on the eastern side of the property, which will be used as a recreational area. Therefore, a minimum of 155 acres more or less will be set aside as conservation areas, which represents 47 percent of the total site. Other smaller parcels may additionally be set aside and will be identified in the EMP.

The access road connecting the site to the Grand Bahama Highway is Sussex Drive which meets the site near its midpoint between the two parcels. A temporary road was constructed for field studies, which extends from the Sussex Drive extension and heads eastward to the eastern property boundary and then southwards to connect to the existing beach road (which parallels the shoreline) to the western property boundary. However, due to impacts of Hurricane Dorian, the beach road was eroded away between Sharp Rocks Point and the western boundary. A large format print of the site plan is included in the hard copy report and within **Appendix 2.**

The main components of the proposed development are:

- **Undeveloped wetlands**, comprising about 30 percent of the site, which are set aside for conservation.
- **Undeveloped uplands**, comprising about 17 percent of the site, with a network of pedestrian paths and mountain-bike trails.
- A 1.6-mile long beach and related amenities, such as restrooms, lifeguard stations, beachside restaurants, and natural and enhanced vegetation leading up to the existing ridge road, which will be enhanced as a principal artery for pedestrians and occasional service vehicles.
- An approximately 1.6 mile-long, engineered saltwater inland canal that incorporates a variety of recreational activities and use primarily for guest transportation. The main inlet, immediately east of Sharp Rocks, serves to define the boundary between the beach and the Sharp Rocks nexus of activities. The transportation boats will be electric powered, especially constructed for Grand Port. In addition, a cable lift transportation system will be used for transporting guests. The canal shoreline will primarily consist of replanted mangrove fringe. Additional shoreline stabilization with riprap or other appropriate structures will be utilized where needed around structures such as bridge abutments. The ocean inlets associated with the waterway will be stabilized with rock jetties.
- The upland development includes a mix of commercial and resort oriented amenities including a water park on the eastern portions of the property. This water park includes several pools and a lazy river water feature. There is no output/input from the “Active River” or any other pool amenities to the waterway. The pools will be freshwater. The pool design has not been completed; therefore, the filtration system has not been finalized. Backwash from the pools will be disposed through the deep injection well. The disposal of the backwash water from the pool amenities and filtration system will be addressed in the EMP. Upland amenities include a miniature golf course. The golf course will utilize artificial turf and will have no nutrient runoff or fertilizer.

- The dune does not extend into the ocean. There are jetties that are associated with the inlets and these are represented within the master plan.

An approximately 3.5-acre nexus of activities at Sharp Rocks Point, grounded literally and figuratively by an elaborate "historical-mythical found ruin" in the shape of a star fort (**Figure 6-2)**. An eclectic series of structures will be built on or above the fort's stone foundations including a performance plaza, an "antiquated" lighthouse, water-taxi station, restaurant, history museum, zipline or ski-lift "towers", and walkways and terraces, including a (safe) jumping platform, jutting past the rocky outcropping and over the sea.

- An approximately 14-acre arrival plaza and town center forms the core of the development and is the only "urbanized" zone where natural vegetation is removed, the ground will be elevated to +13-feet and paved, lushly landscaped (native vegetation), and built upon. At the arrival plaza, guests are greeted and informed about the different transit modes, including ski-lifts up and down the beach (and beyond); pedestrian streets and pathways; and water-taxis plying the length of the canal. Further in, the town center features quaint shops and cafes, shaded open spaces, sidewalk-lined canals, footbridges, and distinctly Bahamian cultural icons such as a police station, post office, and Anglican chapel. Our Junkanoo parade will wind its way through the center, over footbridges ending at the arrival plaza, where guests also funnel back to the ships.
- An approximately 12-15-acre "water amenity" featuring a lazy river, various waterslides, food and beverage outlets, and related amenities.
- An approximately 5-acre, 50-foot high manmade hill to support recreational activities such as ski-lifts, ziplines, and waterslides, dotted with hillside cabanas.
- An approximately 4.5-acre ground transportation area for making connections to and from points of interest on Grand Bahama Island.
- An approximately 6-acre crew area with useful facilities for their transactions, recreational and sports amenities, including volleyball and soccer, and a 600-foot beach at the eastern end of the site.
- A pier capable of accommodating two XL Class ships and excursion dock for tour operators.

Figure 6-1. Illustration of Site Development Plan

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

Figure 6-2. Canal Description

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

The canal (**Figure 6-3**) is an integral feature of the project. Its three main purposes are: to move guests east and west to various points along the 1.65-mile wide beach and recreational amenities; to provide safe, shallow water recreational opportunities complementing the ocean beach; and to provide a visual focus and Bahamian-landscaped backdrop to most of the activities on the site. While the canal will have two inlets, no boats are allowed to enter the canal system from the sea. A barrier will be placed at both inlets to restrict the movement of vessels entering the inlet while allowing the water to exchange. This barrier is also a protective measure for the guests that utilize the canal recreational areas free from large marine species. This will most likely be a floating line barrier and will not impede flow or pose an entanglement risk to wildlife.

The shape of the canal is designed to appear natural and only has a hard-edge, manmade character at the Village Center. Over the 1.65-mile long system, the width of the water body varies from 100 feet at the narrowest point to more than 250 feet at the three crescent-shaped “lagoon beaches.”

The navigational channel for the water taxis is 50 feet wide for two-way boat traffic and is marked by wooden pole markers, buoys, and heavy netting affixed to the poles to prevent guests from accidentally crossing into the channel. The channel depth will be between 4 to 8 feet, depending on the water taxi vessels ultimately purchased, while the depth of the recreational areas and beaches will be 42 to 48 inches.

Figure 6-3. Canal for Transportation of Guest

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

6.1 Water Taxi Stations

There are seven water taxi stations (**Figure 6-4**) spaced throughout the canal system. The aluminum or wood docks are floating and ride up and down with the tide, grommeted to fixed wooden piles. A scissor-type aluminum ramp system connects the fixed shore to the floating dock; self-adjusting for the changing vertical distance, based on the tides. Each station has power for recharging the electric water taxis, lighting, and an architectural roof covering for the waiting passengers, made of wood and metal in a contemporary tropical style. At the Village Center Station, there will also be approximately 20 boat charging stations lined along the adjacent sea wall/waterfront. At the east end of the canal system will be a metal building for boat storage, where the fleet of 20 water taxis can float directly inside the building for repair or safekeeping during a storm.

Figure 6-4. Water Taxi Station Locations

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

6.2 Lifeguard Stations and Beach Cabanas

A series of lifeguard stations and beach cabanas will showcase the uniquely Bahamian/Lucayan culture of Grand Bahama Island - functional designs and light-hearted, bringing a smile to our beachgoers experience. The upper part of the station will sit approximately 7 feet above the beach sand elevation. The area under the station will be used for storage. The lifeguard station locations are presented in **Figure 6-5.**

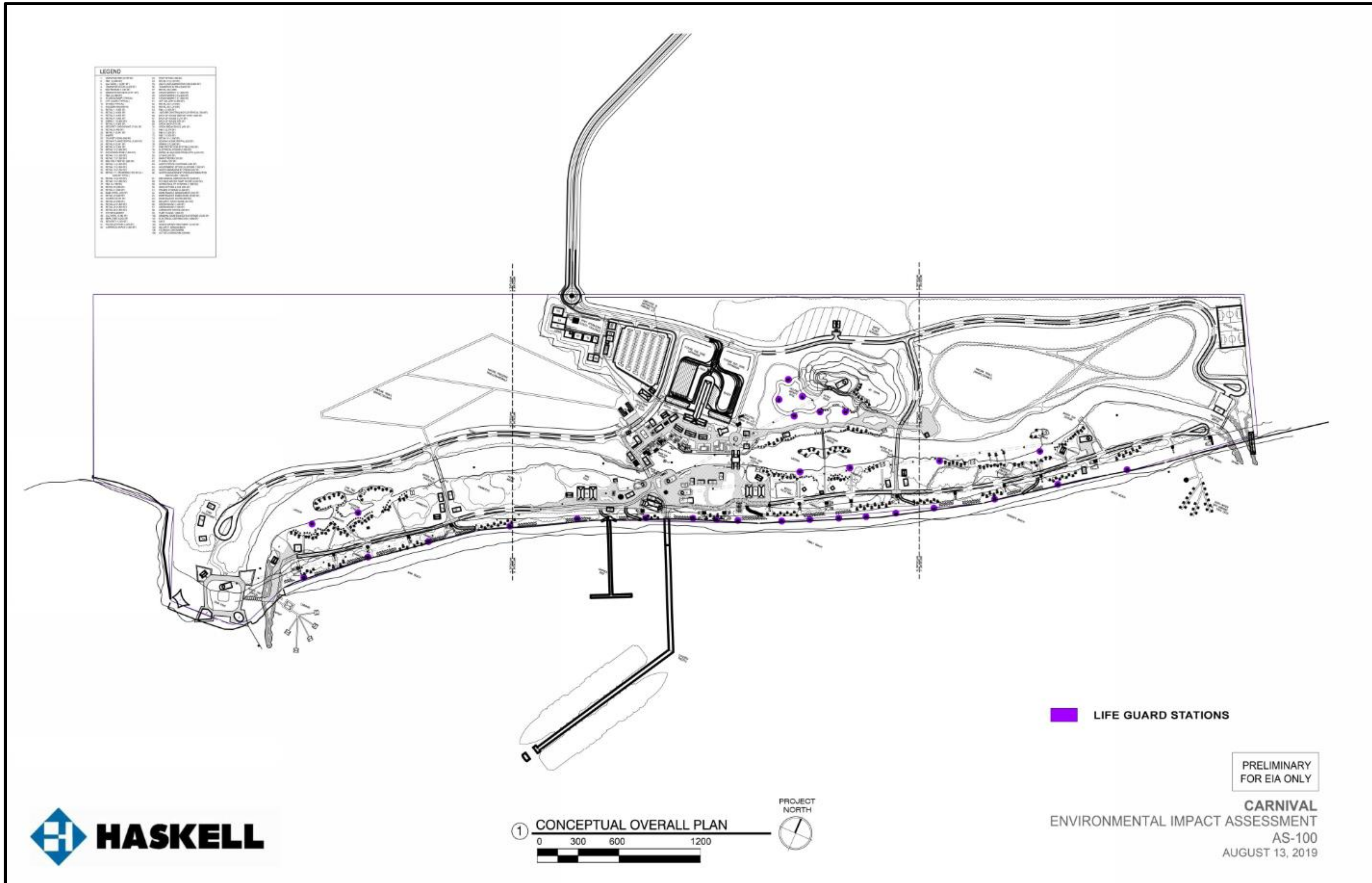


Figure 6-5. Lifeguard Station Locations

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

6.2.1 Lifeguard Stations

Figures 6.6 and 6.7 provide illustrations showing the design of the lifeguard structures.

Figure 6-6. Illustration of Lifeguard Station

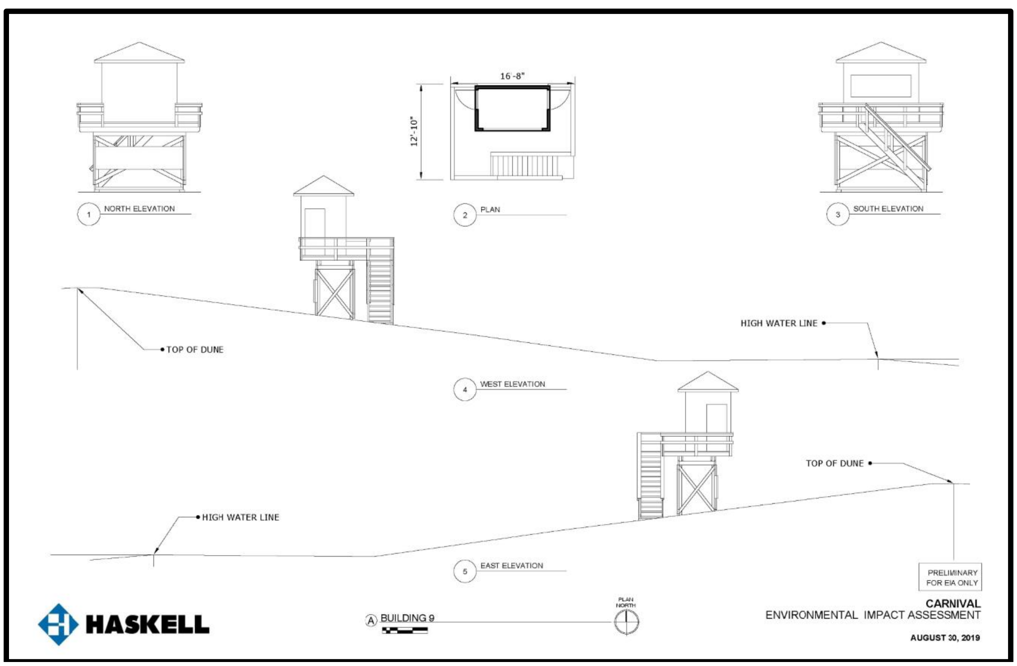


Figure 6-7. Design of Lifeguard Station

6.2.2 Beach Cabanas

Illustrations of the beach cabanas are provided in **Figures 6-8 and 6-9**.

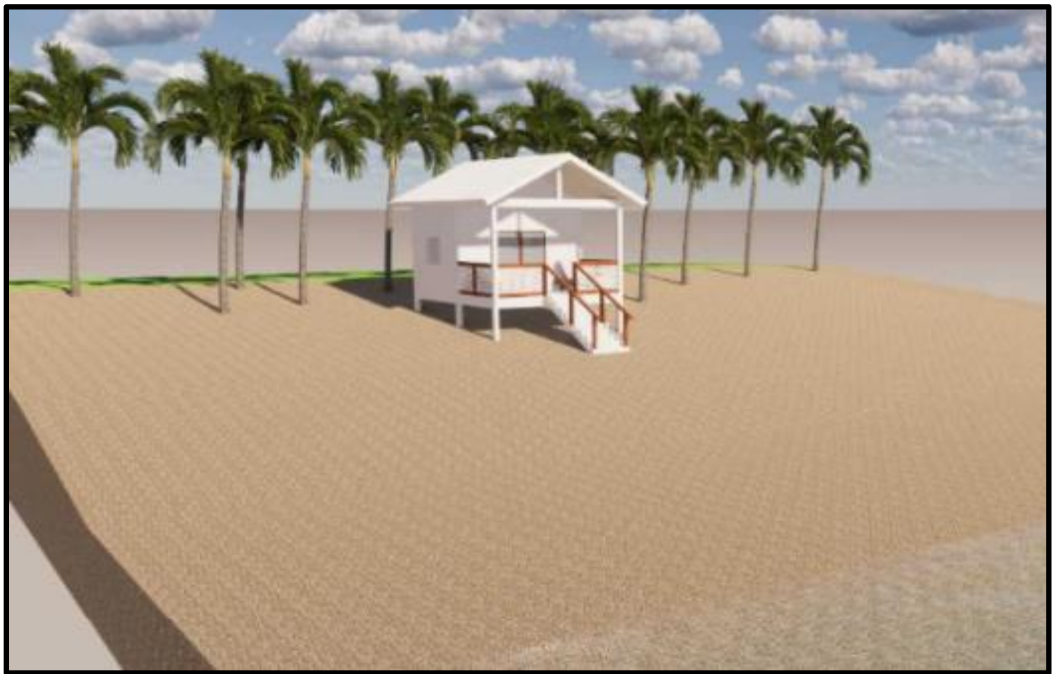


Figure 6-8. Beach Cabana

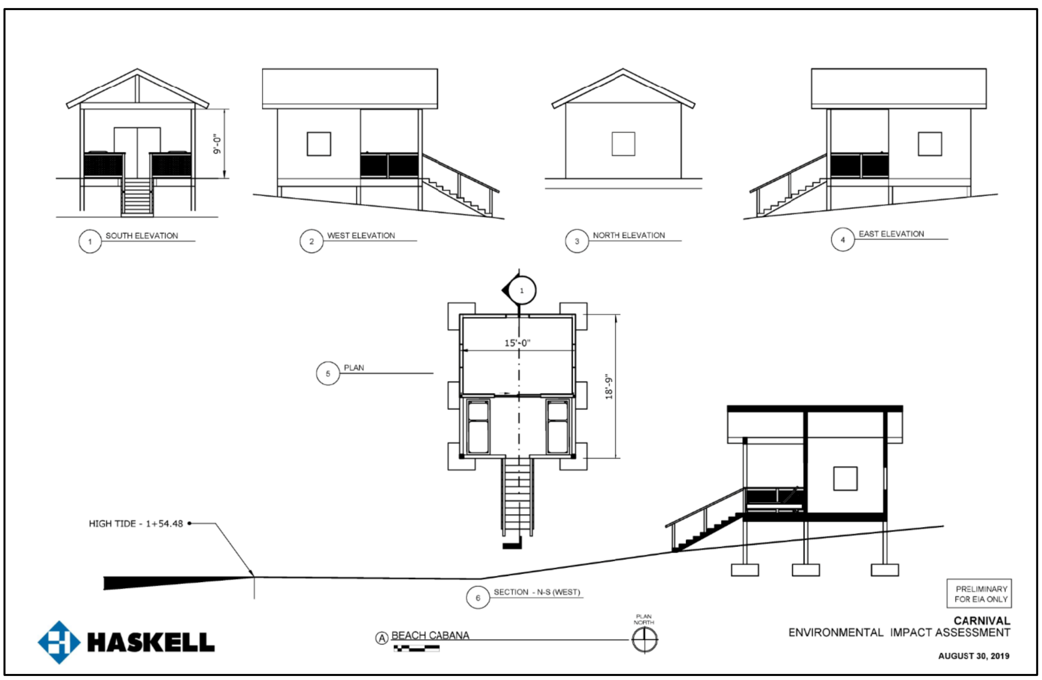


Figure 6-9. Beach Cabana

6.3 Wetland Conservation

Integrated into the plan are conservation elements to comply with the spirit of the GBPA Coastal Zone Management Plan. The development of the facility will involve the excavation and/or filling of some mangrove areas for the canal, town center, and back of house operations. Approximately 52 acres of the 155 acres more of less of mangrove wetlands will be impacted due to the overall site development, including filling the site with dredge spoils to elevate the site to +13 ft. Approximately 103 acres of the 155 acres more or less of mangrove wetlands will be conserved. Protective and mitigative measures will be put in place for the preservation of the wetland areas and mitigation of the impacted mangrove habitat, which will be addressed in detail in the Environmental Management Plan. The mitigation will involve a mangrove restoration project similar to that implemented at the Carnival Roátan Cruise Terminal. The wetland areas will not be hydraulically linked to the new waterway. Modifications to the site will have negligible impact to the mangrove systems adjacent to the property which extend approximately 1.5 miles to the west of the western property boundary. Pre-Hurricane Dorian salinity measurements of the wetlands ranged from 8.3 to 11.4 part per thousand (ppt) from the central to western part of the property. Further east salinity values were lower. Seawater has a salinity of approximately 35.0 ppt. A boardwalk will be constructed through the wetlands, similar to that as the one at the Lucayan National Park.

6.4 Nature/Recreational Trail

The second element is a 55-acre nature trail. This nature trail is located in the northeast section of the site. This area will be used as a light recreational area with a series of curved trails made from crushed gravel or packed soil for pedestrian, Segway PT, and bicycle use. The trail will only be 5 to 8 feet wide. Only 30 acres of the nature trail will be available to the guests Post-Hurricane Dorian some planting of like habitat species may occur.

6.5 Roadways – Access Road (Sussex Drive) and Parking Lot (Taxis and Buses)

The 2.3 miles of access road (Sussex Drive) from the Grand Bahama Highway to the port will be included in this design as per following drawings (**Figures 6.10 – 6.12**). Sussex Drive is currently an unpaved road and will have to undergo widening, pavement preparation, and paving.

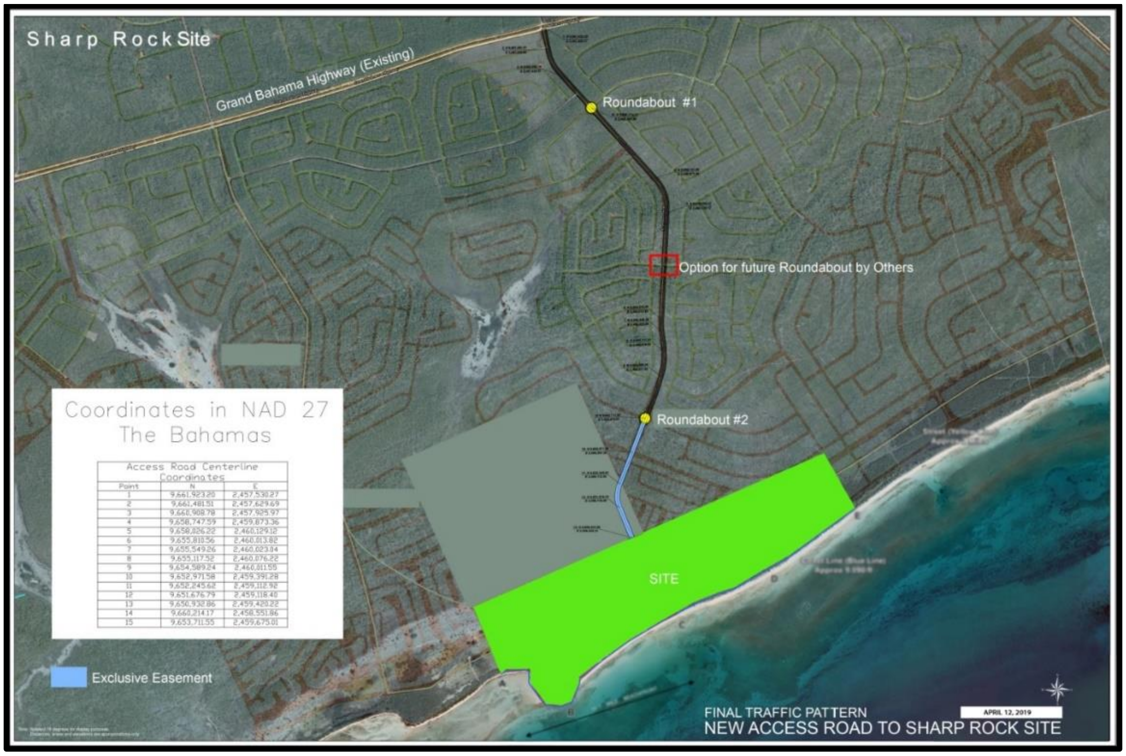


Figure 6-10. Sussex Drive and Extension Road

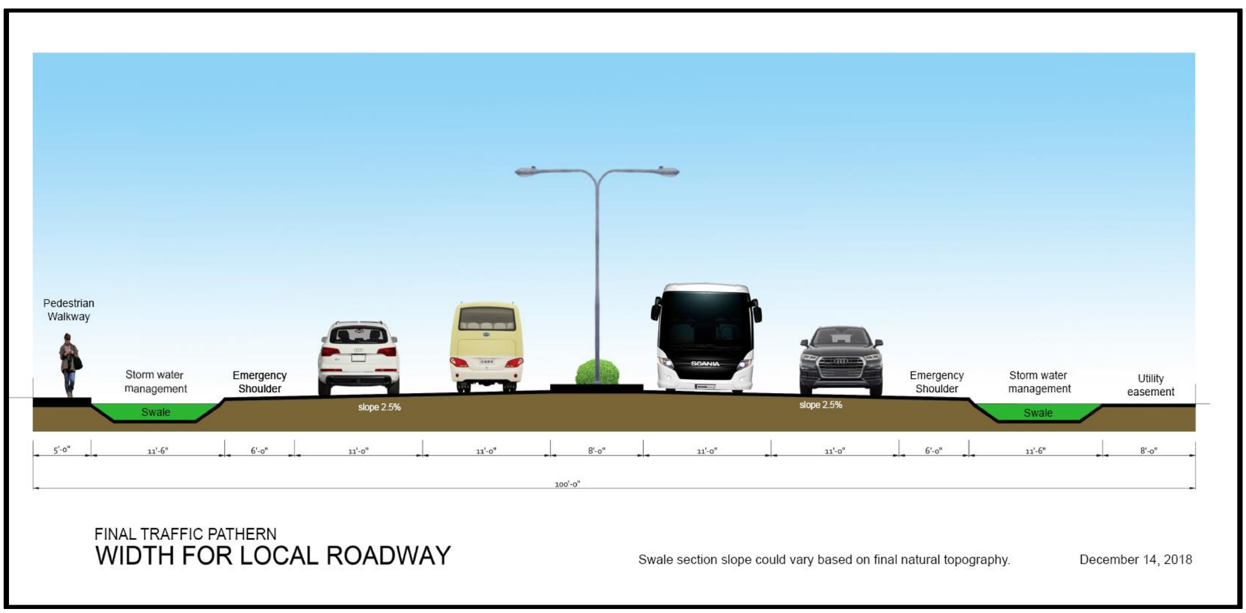


Figure 6-11. Illustration of Road Width

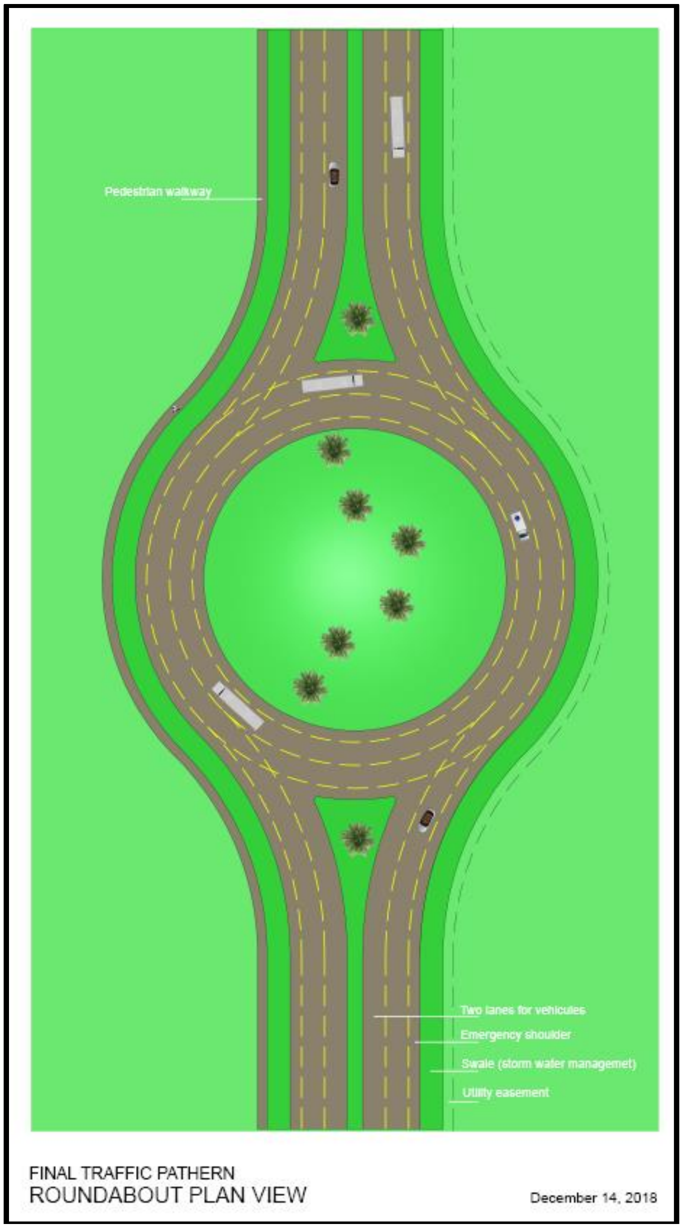


Figure 6-12. Illustration of Traffic Circle

Sussex Drive will be converted to a dual lane road with an emergency shoulder. One swale on each side of the road will manage the stormwater received in the street. Only one pedestrian walkway is needed and will be located on one side of the road. Vehicular roadways located out of the transportation hub will be finished with 2 inches of asphalt.

A utility easement will be located on the east side of the access road. Two roundabouts are included in the design.

Vehicular signage inside the port (after first guardhouse) will be designed in accordance with local and international codes, consistent with the theme (look and feel) of the destination. Main utilities will be installed along an easement on the eastern side of Sussex Drive.

6.6 Back of House (BOH) Operations

BOH operations for Grand Port are co-located at the access road entry point near the site's east to west parcel centerline. A complex of 12 to 15 buildings is planned around a large central paved area which serves as vehicle turning space and parking. The wastewater treatment plant is the furthest removed from the paved court and sits directly behind the entry roundabout. On the west side are larger warehouses for cold and frozen storage and maintenance, both of which have loading docks with additional parking for tractor trailers between them. The south flank of the service yard contains facilities for maintenance shops, mechanical service bays, electrical generators (Item 78 Figure 6-13) and diesel fuel storage (Item 79 Figure 6-13.). The fire protection system and potable water pump are located at the south end of a finger extending southward from the service yard – being closest to the development. The eastern flank on the BOH contains the waste management facilities – conveniently close to the entrance off the main access road and contain space for recycling and waste storage. Ship agents and Customs offices, with parking, and a series of operational offices for information technology, water quality, health and security are also located close to the entrance off the main access road. An illustration of the BOH area is presented in **Figure 6-13**. The specific identification of the buildings for the BOH area are on the site plan included in this report.

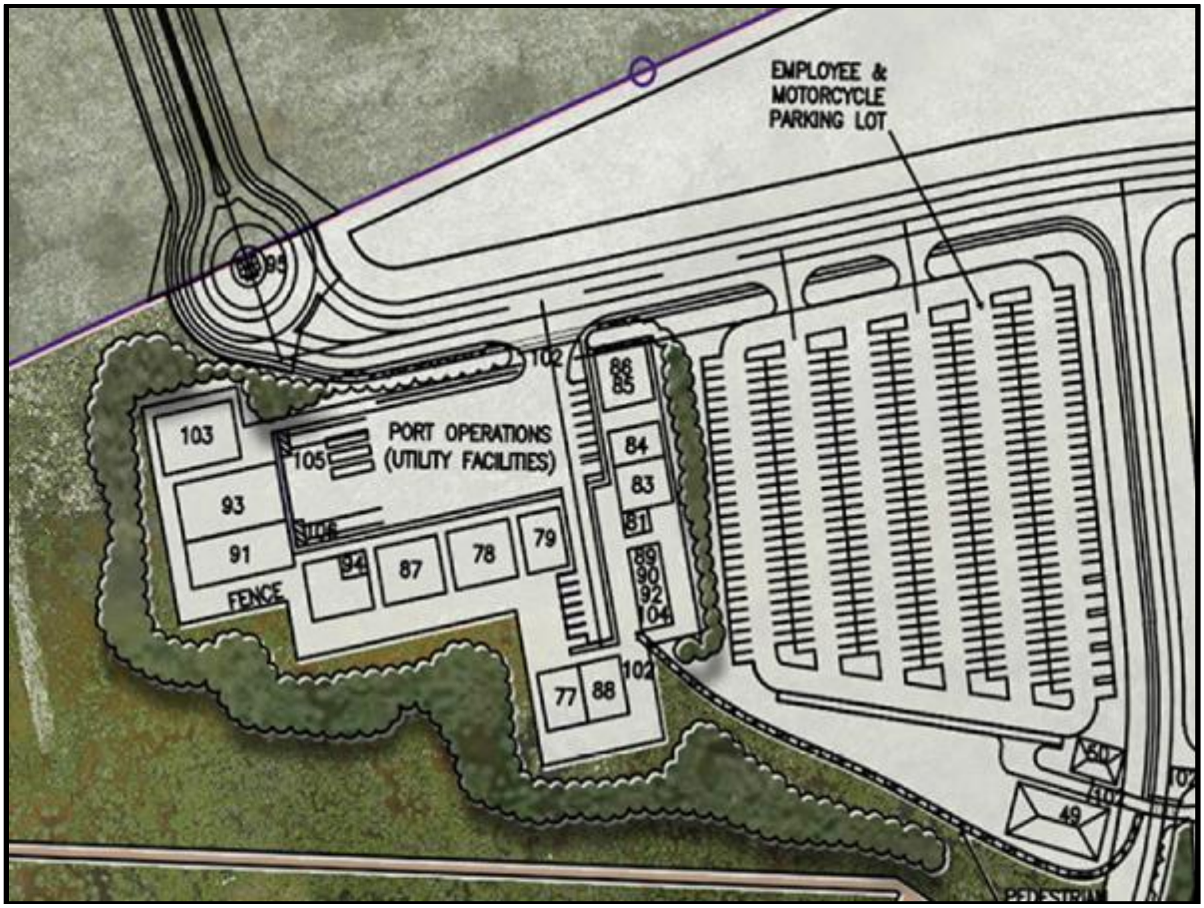


Figure 6-13. BOH Operations. Electrical Generators are in area 78 and Diesel Fuel Storage are in area 79.

6.7 Electrical Demand and Emergency Generator

An estimated 2 MWh electrical demand will be needed when development reaches full capacity. The primary power line will be provided by the Grand Bahama Power Company (G.B. Power). The facility includes the interconnection between local electrical connection point to the first transformer and the rest of the electrical system within the facility. All incoming power to the terminal's substation will be buried. G.B. Power has authority over the relevant electrical utilities for the development and discussion regarding the proposed development are ongoing. The applicant is supportive of the use of green technologies; however, G.B. Power is the relevant governing body regarding this issue. With the extensive damage to the electrical infrastructure due to Hurricane Dorian, G.B. Power may not have the capability to provide solar power for the project. Grand port will continue discussions with G.B. Power to determine if it is possible for Grand Port to construct and operate its own solar farm given that the power company has a monopoly on supplying power in Freeport, Grand Bahama Island. Wherever there is an opportunity to use solar powered lighting those opportunities will be taken advantage, in keeping with Carnival's sustainability program.

The facility design considers the amount of load required to operate 100% of the facility, including tenant occupied space, to determine size of electrical generators required during periods of blackouts by the local electrical company. Full redundancy of the emergency generators is needed.

The facility design will consider the electrical connection coming from the main pier and Shorex dock to landside distribution grid. The electrical connections from the pier at the landside interface are to be sized to accommodate electrical power, data, CCTV, and future needs/redundancy conduits (at least 2-inch conduits) and will be located upon coordination between the marine and landside design professionals.

The port will operate during nighttime hours; therefore, lighting will be sufficient around the destination with LED lights around the entire port.

6.8 Bathroom Facilities

The facility will have a number of public bathrooms placed throughout the property as shown in drawings provided in **Appendix 2**. The bathrooms are divided into three categories:

Large Public Restrooms (Quantity 10)

- Men's Urinals 5
- Women's WC 11
- Men's Lavatory 3
- Women's Lavatory 4

Small Public Restrooms (Quantity 9)

- Men's WC 1
- Women's WC 1
- Men's Lavatory 1
- Women's Lavatory 1

Crew Restrooms (Quantity 3)

- Men's WC/Urinals 3
- Women's WC 4

- Men's Lavatory 2
- Women's Lavatory 2

6.9 Telephone

Telephone lines for owner's service will be connected to main distribution frame (MDF) #1. Telephone access is needed in all the offices in the main executive office and in other remote offices such as maintenance, HESS, landscaping, recreation offices, etc. The telephone system for vendors and tenants will be connected to MDF #2. Each vendor/tenant will acquire (if needed) the system directly from the service provider previously selected by the owner. Several intermediate distribution frames (IDFs) will be installed as needed.

6.10 Internet

Data lines for owner's service will be connected to MDF#1. Data is needed in all the offices in the main executive office and in other remote offices such as maintenance, HESS, landscaping, recreation offices, etc. as well as utility rooms such as the wastewater room. Regulated plugs for computers and servers will be installed in offices and utility rooms as well.

The data system for vendors/tenants will be connected to MDF #2. Each vendor/tenant will acquire (if needed) the system directly from the service provider previously selected by the owner. Design professionals will consider that the port must have Wi-Fi for passengers; therefore, the reach of antennas will be considered to identify the location of IDFs as well. Several IDFs will be installed in the property as needed.

6.11 Fuel Storage Tank

An above-ground diesel fuel storage tank (Item 79 Figure 6-13) with a capacity of 15,000 gallons will be needed to fuel the emergency generator. The capacity of the fuel tank is based on providing power for 12 to 15 days (full operation). Secondary containment is 110% of full capacity and the tank itself is double walled. The diesel tank is located next to the emergency generator. Currently, there is no alternative location as it must be located adjacent to the generator. The secondary containment structure will comply with GBPA Building codes.

6.12 Pier Design

The design will accommodate two 1,130-foot (345 m) XL Class ships, one on each side of the pier. The pier structure will be on steel pipe piles as the foundation and braced with cast in place concrete bent caps with a concrete deck as a walking surface. These structural components will be constructed simultaneously with the dredging operation. The pier area (dredge box) will be dredged to a depth of – 35 feet (MLW) to allow safe navigation to the pier structure and docking. It is calculated that approximately 1,100,000 cubic yards of material will have to be excavated. The trestle will extend approximately 1,024 feet with a width of 32.8 feet from the land plaza to the pier berthing structures. From the end of the trestle area it will extend 1,347.1 feet to the end dolphin, which is the capable berthing length. The entire berthing length is divided in three different wide sections: 1) 304.1 lineal feet by 33.8 feet wide 2) 846 lineal feet by 55.75 feet wide and 3) two dolphins 55.75 feet wide. To achieve the total structure length there will be 35 bent caps at the trestle section, 22 bent caps at the pier section and two berthing dolphins, one intermediate between the deck and one end dolphin with their respective fenders. See **Appendix 2** for pier drawings and dredge box.

To achieve construction of the pier structure, the following means and methods for construction will be utilized:

1- Dredging: To achieve the design depth, a cutter suction dredge will dig the natural bottom until design elevation has been achieved. The dredge spoils will be pumped ashore and used as fill material for raising the site elevation.
2- Pile driving: Floating barges will be used with heavy mechanical equipment capable to lift all required elements and equipment to drive each pile at the design location and elevation using template frames to hold in place each pile pocket.
3- Cast in place concrete elements: After the pile driving advances, a concrete crew will follow with the bent cap wood forms and designed reinforced rebar. After this rebar is installed and passed QA/QC, the contractor will place the concrete into the forms utilizing a mechanical bucket or concrete pump to bring the fresh concrete to the designated location. This concrete will be cured as per American Concrete Institute (ACI) specifications to strip it and place load. After certain bent caps has been placed, the contractor will follow placing the precast slabs in between each bent cap and then place the topping deck rebar. After this rebar passes inspection the contractor will place the topping concrete with a broom finish.

DESIGN CRITERIA:

During the pier design, professionals took into consideration following ships for tonnage and berthing requirements:

ROYAL PRINCESS:

Length Overall:	330m
Beam at Waterline:	38.4m
Draft:	8.5m
Gross Registed Tons	139,000
Displacement @ Design Draft:	68,146 metric tons
Displacement @ Maximum Draft:	70,833 metric tons

CARNIVAL XL:

Length Overall:	344.5 m
Beam at Waterline:	42 m
Draft:	8.6 m
Gross Registed Tons	180,000
Displacement @ Design Draft:	84,227 metric tons
Displacement @ Maximum Draft:	86,963 metric tons

The pier is designed to accept smaller ships within the fleet including **Carnival** Fantasy, Destiny, Triumph, Conquest, Spirit, Splendor and Dream Classes, **Holland America** Nieuw Amsterdam, Eurodam, Prinsendam, Vista Class, R-Class, and S-Class, **Princess** Sun, Explorer, Grand and Royal Classes, **Costa** Marina, Allegra, Victoria, Spirit, Destiny, Classica, Vista, and Conquest Classes, and **Aida** Acara, Avita, Adiva, Ablu Classes and Newbuild (300m LOA, 37.6m beam, 8.1m draft).

The designer/builder shall adhere to all applicable environmental regulations, permitting requirements and provisions. The designer/ builder shall conform to the design codes of The Bahamas, including but not limited to the following industry standards including the applicable requirements of:

1- International Building Code, latest edition
2- American Institute of Steel Construction, AISC, Steel Construction Manual, (Latest Edition)
3- American Concrete Institute, ACI, publication ACI 318, “Building Code Requirements for Structural Concrete” and ACI 301-05, “Specifications for Structural Concrete”. (Latest Edition)

4- American Association of State Highway Transportation Officials, AASHTO, "Standard Specifications for Highway Bridges", HB-17.

5- Unified Facilities Criteria, UFC,

"Design of Piers and Wharves", UFC-4-152-01

"Mooring Design", UFC-4-159-3, 07-02

- U.S. Army Corps of Engineers, "Coastal Engineering Manual", latest edition
- Welding - American Welding Society, AWS, "Structural Welding Code – Steel" D1.1, (Latest Edition)
- PIANC: "Guidelines for the Design of Fender Systems: 2002"

Design Life: 50 years based on regularly scheduled inspection and maintenance. Items not covered will be lighting, anodes, fenders and related fender hardware which shall have a design life of 10 years minimum.

Pier Deck: Width 10 m to 17 m depending on the section edge of concrete to edge of concrete. Elevation along edges of pier deck and dolphins shall be +2.8 m MLLW. Concrete top surface shall have uniform heavy broom finish. Slope deck surfaces a minimum of 0.84 percent to edges for drainage. No curbs on ship side of pier. Provide concrete curbs a minimum of 300 mm wide and 255 mm high on other walking sections and on pier ends except at connection to access bridge and catwalk to dolphins.

Dolphins: Provide two mooring/breasting dolphins with their respective bollards. Concrete top surface shall have uniform heavy broom finish. Slope deck surfaces a minimum of 0.84 percent for drainage.

Catwalks: Catwalks bridging the new pier with the dolphins will provide side rails with a minimum top of top rail of 1m. All structural components including railing and deck grating shall be type 6061 aluminum. Provide sliding connections to allow for thermal movement and movement of deck and dolphins under berthing, mooring, seismic and wave loading.

Piling: For the pier and trestle, the piles will be steel pipe. Steel shall be a minimum of 16 mm thick. Pipe piles shall be filled with concrete from pile cap to elevation –1.2 m or lower. Steel piles shall be coated with an approved system of Coal-Tar-Epoxy with a minimum thickness of 16 mils from 100 mm into concrete cap to 1.2 m below dredged depth. Each pile shall be provided with sacrificial anode cathodic protection with anode design life of 12.5 years allowing for 5 percent initial defects in coating system and 2 percent loss of coating area per year. Piling for new deck construction and for reinforcement of the existing pier deck shall be designed to limit lateral movement of pier deck to 75 mm at design ship impact or design mooring loads. Piling shall be designed to limit lateral movement of dolphins to 125 mm at design ship impact or design mooring loads.

Ladders: Type 316 stainless steel ladders from -0.6 m to top of deck at a maximum spacing of 75 m on alternating sides of pier deck and access bridge. Provide one ladder at each dolphin.

Concrete: Design in accordance with the latest edition of ACI 318. Cast-in-place concrete shall have minimum compression strength of 27.6 MPa (4,000 psi) at 28 days. Pre-stressed concrete shall have minimum compression strength of 47.4 MPa (6,000 psi) at 28 days. Minimum concrete cover over reinforcing steel shall be 100 mm for cast in place concrete and 75 mm for precast, pre-stressed concrete. Deck surfaces shall have a uniform rough broom finish. All other surfaces shall have a smooth formed/float finish with fins removed and holes filled and rubbed. Chamfer all exposed edges 19 mm x 19 mm minimum. Verify that all materials used in the concrete mix are suitable for the work and compatible. Alkali reactive aggregates shall not be allowed. Provide testing of coarse and fine aggregates per ASTM C289 to determine potential reactivity of aggregates with alkalis in cement. Provide certificates confirming suitability. Only potable water shall be used for mixing and curing concrete.

Miscellaneous Steel: All exposed steel including bolts, nuts, washers, plates, and angles shall be heavy hot-dipped galvanized or Type 316 stainless steel. All bolts embedded in concrete shall be Type 316 stainless steel.

Testing Laboratory: Designer/builder shall arrange with a local laboratory to carry out tests needed to control the works. Quality certificates shall be provided by a qualified laboratory technician. The owner shall be given reasonable notice of all calibrations and testing and shall be provided with opportunity to witness all tests.

Shrinkage Cracks: The designer/builder shall execute the work so as to avoid the incidence of shrinkage cracking of the concrete. These cracks include plastic shrinkage cracks that occur during curing of the concrete and cracks that occur after the curing of the concrete has terminated and the long-term shrinkage process starts. Designer/builder shall introduce methods to avoid shrinkage cracks including but not limited to curing methods, concrete mix design, limiting water/cement ratios, admixtures to the concrete mix, and concrete placement procedures and sequencing. Contractor shall implement a monitoring regime to determine the extent of cracking on all surfaces and shall measure on a minimum of three-month cycles throughout the contract period and the maintenance period to ensure that the behavior of the concrete performs as required.

Pre-stressed Concrete: Design for a maximum allowable tension in the extreme fiber of the composite concrete section of 0.0 MPa (0 psi) under design working load. Precast elements that have visible cracking or excessive camber at the time of placement will be rejected.

Fenders: Cell or cone type fenders with closed box steel fender panels and UHMW-HDPE pads, with color to match existing. Locate at not more than 24.4 m. centers along face of pier and at each mooring dolphin or as determined by mooring analyses. All bolts or anchors imbedded in concrete shall be Type 316 stainless steel. All other chains and hardware shall be heavy hot-dipped galvanized. Support chains shall be equipped with adjustable links to eliminate slack in chains.

Fenders shall be designed in accordance with the latest PIANC recommendations. Minimum design vessel berthing speed shall be 0.14 m/s at a berthing angle of 10 degrees for interior fenders and 15 degrees for end fenders and dolphins. Maximum design hull pressure shall be 240 kN/m2. Berthing speeds shall be increased per PIANC recommendations for smaller vessels. When fender face panels are provided, they shall be beveled at top edge to accommodate belting on ship sides. Top elevation of fender panels shall not protrude above top of pier deck elevation to minimize blockage of ships service doors at low water levels.

Bollards: Mooring bollards shall be provided based on mooring analyses considering vessel projected wind areas and maximum design operating wind speed of not less than 40 knots/hour plus maximum current velocity for the full range of ships to be accommodated at the berth. Minimum bow and stern bollard capacity shall be 150 ton. For ships from 260 m LOA up to 339 m LOA, mooring bollards shall be positioned to provide a minimum of five each 150+ ton bollards at the bow and stern lines with bollards spaced approximately uniformly from 20 m beyond bow and stern locations to approximately ¼ length of vessel. Bollard spacing may be doubled when mooring dolphins are provided with bollards doubled on dolphins. Provide bollards on access bridge as needed to provide adequate moorings for design ships. Within the mid ½ of the vessel length, minimum bollard size shall be provided at 24 m maximum spacing and 100-ton minimum capacity. Bollards shall be filled with grout and shall be sandblasted to near white finish and coated with a three part coating system consisting of 2 to 3 mils DFT minimum of inorganic zinc rich primer, 8 mils DFT minimum of marine epoxy and 4 mils DFT minimum marine polyurethane finish for a total minimum dry film thickness of 16 mils. Color to be selected by owner.

Lighting: Provide LED curb lights (1 watt each) at not less than 12.2 m centers along inside of access bridge side curbs, both sides of deck. Provide LED marker lights (2 watts each) at approximately 24 m to 25 m centers along all outer sides of pier deck and access bridge, plus the two per lateral side at each intermediate dolphin and two on each of three sides of end dolphin. Provide buoy light on end dolphin and pole light at end of pier. Lights shall be equal to:

- Curb lights HADCO RSS2-A-K5-D5-E, concrete pour kit MAKM
- Marker lights OGM EWB4070MH LX2-ST, concrete pour kit MAKM
- Pole light at end of pier deck, 2 lamp type MH, 250 watts, HADCO PA3 with 2 heads, curved arms, on 7.6 m (25 ft) fiberglass pole designed for 108 knot, 3 second gust with fixture attached, white finish.

Design Loads:

Wind – 40 knots, 30 second duration, on ships or threshold category 5 hurricanes (155 mph fastest mile) on structure without ships.

Waves – Waves from 1 in 100 years – assuming depth limited waves and surge of 1 m, design significant wave shall be 5.8 m at the southwest end of the pier, 7.6 m at the northeast end of the pier, and 3.4 m at the shoreline with a period of 14.47 seconds in accordance with the wind and wave study prepared by Applied Technology & Management (ATM). Design wave forces on piles, vertical and horizontal projected areas of deck, pile caps and fenders shall be computed based on methods in the U.S. Army Corps of Engineers Coastal Engineering Manual. Uplift loading on pier and trestle deck shall not be less than 300 kN/m2 (6.3 ksf) on any area of 1.5m x 4m together with 44 kN/m2 (0.92 ksf) on the balance of the structure. Alternate span loading shall be considered for deck design. Piles shall be designed for a uniform uplift of 54 kN/m2 (1.13 ksf).

Deck live load – 1340 kg/m2 (275 psf) or HS20-44 ASSHTO loading Pier Deck.

Work Schedule:

For the three main activities, Carnival Corporation estimates the following durations based on previous port facilities construction events:

- Dredging: seven months.
- Pile driving: 12 months starting around the third month of dredging.
- Concrete works: 18 months.

The above durations have overlaps which means that some activities could occur simultaneously. The goal is to finish all maritime works in 18-20 months.

6.13 Shore Excursion (Shorex Dock)

The Shorex dock is for use by tour operators to pick up of guests for shore excursions. The Shorex dock is necessary since the canal will be closed to boats entering from the sea. The tours will be sold onboard the cruise ships to approved operators who can meet the Carnival Corporation's standards. The Shorex dock is a 20-foot wide T-shaped structure that extends 594 feet from the shoreline. The end of the dock will be 300 feet in length and 20 feet wide. The dock will be constructed of wood deck founded in steel pipe piles. A diagram of the Shorex dock is presented in **Figure 6-14**.

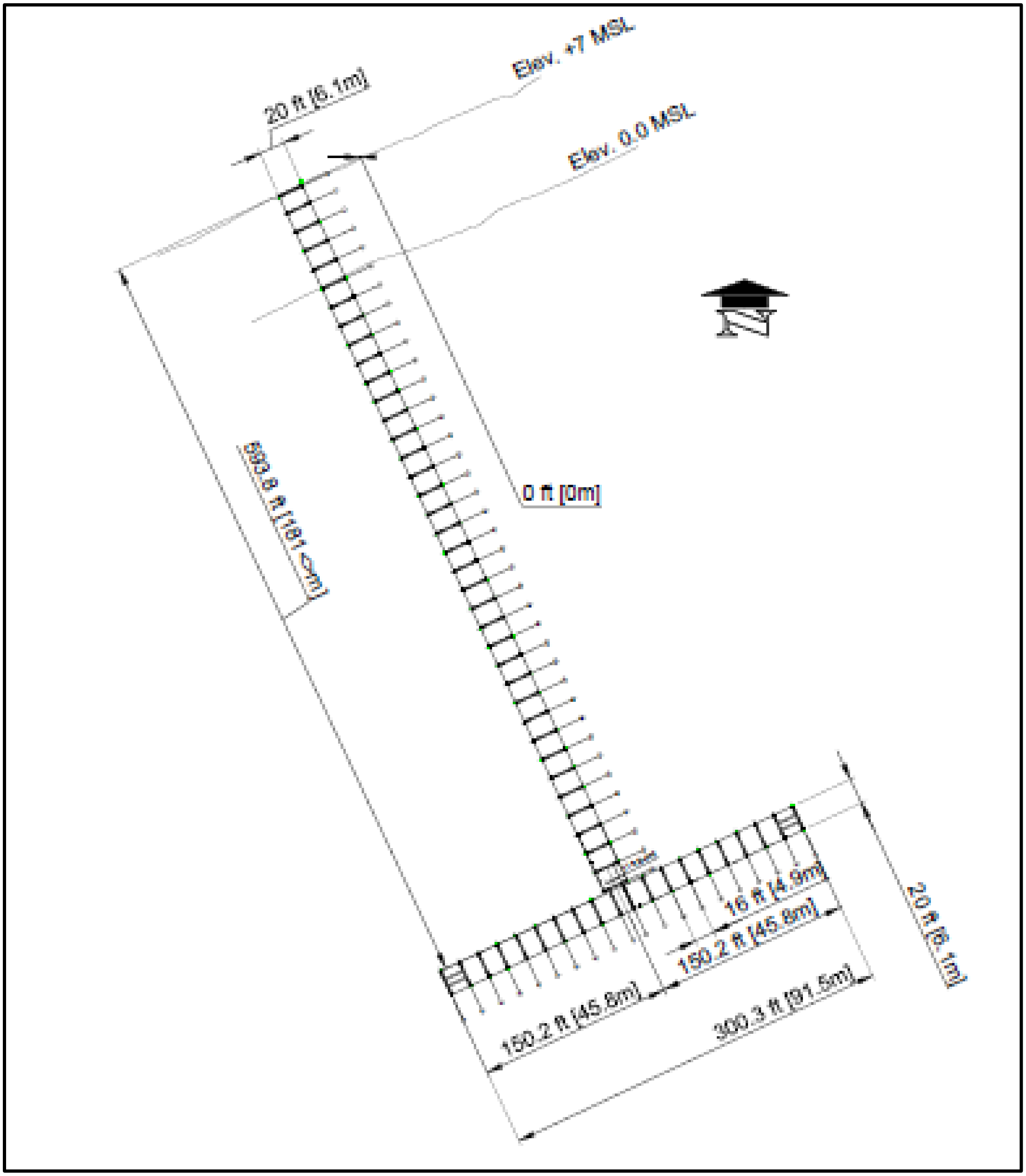


Figure 6-14. Diagram of Shorex Dock

6.14 Water Supply, Fire Protection, Wastewater, Irrigation and Stormwater

Principles for Water Management at Grand Port

Water sources for Grand Port

Potable water was to be supplied fully by Grand Bahama Utility Company (GBUC). However, considering the impacts of Hurricane Dorian on GBUC's well fields, particularly wellfield W-6, Carnival Corporation has decided to invest in an onsite sea water reverse osmosis (SWRO) desalination system. Hurricane Dorian hit Grand Bahama September 1 to September 3, 2019 and caused widespread flooding across the island. The island was subject to an approximately 20-foot storm surge which resulted in the flooding of W-6 with seawater. This flooding increased salinity levels in the city water supply resulting in an order to not drink the city water. The SWRO system will be sized to supply Grand Port's total demand of potable water. The SWRO system will be the responsibility of Grand Port.

Carnival Corporation is committed to preserving Grand Bahama's natural resources. A water conservation program will be implemented, which will include the use of alternative sources for certain non-potable uses: rainwater harvesting and high quality permeate (treated effluent) of the SWRO system with membrane bioreactor technology (MBR)[1]. This water conservation program will likely contribute to important operational costs savings.

Water management will be based upon assigning the source of water to each use by appropriate water quality, preserving for the highest quality requirements for the desalinated water.

Designated water uses for each source

The designated uses for the water sources are:

1. Desalinated water: Drinking, ice production, hand washing and recreational water facilities.
2. Rainwater harvested from the roofs of the buildings: Toilet flushing and firefighting. Could be also utilized in certain areas for irrigation.
3. MBR permeate: Irrigation in areas with less potential of contact with guests and staff.[2]

[1] MBRs wastewater treatment systems have been installed in three GPDDG ports: GTCC, PM and AC.

[2] Although the quality of the MBR permeate is safe for irrigation in all areas, GPDDG has established stricter guidelines avoiding the risk of contact between guests/staff and permeate. This risk could be minimized by using appropriate irrigation technologies.

The distribution system for each type of water will be color coded to prevent cross-contamination. The designer shall submit for approval a coloring code. This code must be available for all commercially manufactured pipe. **Appendix 3** contains drawings of all the utilities described in this section.

6.14.1 Storage Management

These three different quality water sources will be stored in completely separate tanks/cisterns within the property and will never be blended in the same tank except at the point of use, where potable water may be needed to supplement lesser quality water.

6.15 Potable Water Systems

This sub-section describes the basic public health guidelines for Grand Port's potable water systems to ensure the safety and acceptability of drinking water in Grand Port. For aspects not included in these guidelines, the designer must follow the Florida Building Code or The Bahamas Building Code (whichever one is stricter).

6.15.1 Water Supply

Drinking water supplied to Grand Port must be from a potable source that meets World Health Organization (WHO) standards for potable water and the standards provided in **Table 6.1**, whichever are more restrictive standards shall apply.

Table 6.1. Water Quality Requirements

Parameter	Potable Water Concentrations
Calcium, mg/l as Ca	<50
Magnesium, mg/l as Mg	<20
Total Hardness, mg/l as $CaCO_3$	80 - 120
Chloride, mg/l as Cl	<150
Total Alkalinity, mg/l as CaCO3	80 - 120
Turbidity, NTU	0 – 2.5
Iron, mg/l as Fe	0.05 – 0.10
Sulfate, mg/l as SO4	<50
Nitrates, mg/l as NO3	<10
Copper, mg/l as Cu	<1.0
Phosphates, mg/l as PO4	<0.10
pH (Field Measurement, pH units)	7.2 – 7.8
Conductivity, µS/cm	<500
Total Dissolved Solids, mg/l as TDS	<250
Sodium, mg/l as Na	<100
Saturation Index, -0.1-+0.5	-0.1 to +0.5
Free Chlorine, mg/l as OCl	2.0
Total THM, ug/l	<50
Hydrogen Sulfide, mg/l as H_2S	<0.01
Color, PCU	<0.1

6.15.2 Potable Water Treatment

1. Potable water treatment systems will be designed to achieve drinking water quality in compliance with **Table 6.2** The microbiological quality of the treated water entering Grand Port's distribution system, the treated water in Grand Port's distribution system and all water directly intended for drinking in Grand Port, will fully comply with the WHO standards for microbiological quality. These standards require that *E. coli*, must not be detectable in any sample, as detailed in **Table 6.2**:

Table 6.2. WHO Guideline Values for Verification of Microbial Quality[3]

Organisms	Guideline value
All water directly intended for drinking *E. coli* bacteria	Must not be detectable in any 100-ml sample
Treated water entering the distribution system *E. coli* bacteria	Must not be detectable in any 100-ml sample
Treated water in the distribution system *E. coli* bacteria	Must not be detectable in any 100-ml sample

2. Potable water treatment systems will be designed specifically according to the characterization of the quality the water source[4]. Those treatment systems will be approved by the Global Port Development and Destination Group. Water sources from different qualities will not be blended in the same tank/cisterns. More specifically, harvested rainwater (even treated) and other potable water sources will never be blended except at the point of use, where potable water may be needed to supplement lesser quality water.
3. Potable water must be continuously chlorinated to at least 2.0 mg/L (ppm) free residual chlorine where it enters the Grand Port site or during production at Grand Port with an automatic chlorination device. The water pH must be adjusted so it does not exceed a level of 7.8 or go below 7.0. Potable water will be brought directly to the central storage tank and provided both pre- and post-storage chemical treatment in this area.
4. GBUC will implement an analyzer controlled, automatic chlorination system. Install the analyzer probe sample point at least 3 meters (10 feet) downstream of the chlorine injection point and piping and include a static mixer or other approved device to insure proper mixing.
5. The system will utilize probes to measure free chlorine levels and link them to the analyzer/controller and chemical dosing pumps.
6. The system will include a back-up chlorination pump with an automatic switchover that begins pumping chlorine when the primary (in-use) pump fails or cannot meet the chlorination demand.
7. The system will include automatic pH adjustment equipment. Install analyzer, controller, and dosing pumps that are designed to accommodate changes in flow rates.

[3] Adapted from Table 7.10 Guideline values for verification of microbiological quality. Guidelines for Drinking-water quality. Fourth edition incorporating the first addendum. WHO, 2017.

[4] In all GPDDG ports in the Caribbean and Central America potable water is disinfected by a CULLIGAN analysis/dosing/recording system comprised of Shipboard-style equipment. Additional potable water treatment may be required depending on the specific water quality of the source

8. The chemical feed/storage room will include provision for proper ventilation. This may include exhaust hoods above all chemical storage and/or feed equipment. Locating chemical storage in a secure area outside of the chemical feed room is acceptable.

6.15.3 Potable Water Tanks/Cisterns

1. The size of the potable water storage tank will provide a minimum of two days of potable water storage in addition to the required fire protection storage. Based on 15 gal-passenger/day with a max facility capacity of 2 ships x 6,000 passengers+2 ships x 1,500 crew= ~15,000 x15 = 225,000 gallons per day (gpd). A storage tank capacity of 450,000 gallons plus fire flow, is required.

2. The size of the potable water storage tank does not include the volume needed for bunkering at this port. Corporate vessels will require bunkering, but Grand Port will not be responsible for supplying potable water for the ships. This will be a direct agreement between GBUC and the cruise lines. The location of the bunkering potable water supply line will be designated in the site plan, but conveyance, storage, treatment, etc., will be designed and built by GBUC and located outside the property.

3. The interior surface/coating of all potable water storage tanks must be approved for potable water contact by NSF/ANSI Standard 61. Any proposed coating must be submitted during design for approval. In addition, all items that penetrate the tank (e.g., bolts, pipes, pipe flanges) must be coated or lined with the same product used for the tank's interior.

4. All supplier or manufacturer's recommendations for applying, drying, and curing the tank coatings will be followed. In addition, the following records must be held onsite for the potable water tank coatings:

    a. Written documentation of the approval from the certification organization (independent of the coating manufacturer).
    b. The manufacturer's recommendations for applying, drying, and curing.
    c. Written documentation that the manufacturer's recommendations have been followed for applying, drying, and curing.

5. All suction lines within potable water storage tanks will be located at least 150 millimeters (mm) or 6 inches from the tank bottom or sump bottom. Any suction pipe greater than 200 mm (8 inches) in diameter must include anti-vortexing device.

6. An access hatch for entry into the tanks will be installed. This hatch will include a secure waterproof seal to protect the tank from contamination.

7. No storage tanks or pipes containing non-potable liquids (for example waste or gray water) will be installed directly over any potable water tanks.

8. Potable water pumps will be sized to meet the Grand Port facilities maximum capacity service demands. These potable water pumps will not be utilized for any other purpose. All pumping systems shall incorporate variable speed drives with capabilities for PID loop pressure control. All pump controls will include provisions for remote control from the main control room.

9. Potable water pumps and distribution lines will be properly sized so that pressure will be maintained at all times and at levels to properly operate all water outlets and equipment.

10. All potable water tanks will be disinfected and flushed before being placed in service.

11. All cisterns will be equipped with level transducers that can provide an analog signal to the main control room.

6.15.4 Potable Water Distribution System

1. The water distribution system will have a loop-network topology with no dead ends. Five complete loops are envisioned with a recirculation pump in each primary loop. The exact location of these recirculation pumps will be determined when a more detailed site plan is available.

2. Valves allowing periodic disinfection of the entire water distribution system will be installed in several points of the network.

3. A detailed diagram of potable water distribution system showing all locations and potable water equipment/installations positions will remain readily available.

4. Potable water lines will be laid at least 10 feet (3 meters) horizontally from any sewer. This distance will be measured from edge to edge. Vertical separation from the bottom of the potable water line and top of the sewer will be 12 inches. Any deviation from these guidelines will be reviewed and approved by the Global Port Development and Destination Group on a case-by-case basis.

5. All pressure mains shall be HDPE DR11.

6. All pipes will be cleaned and pressure tested. Once approved, disinfection and flushing of all parts of the water distribution system will be completed before the system is placed in service.

7. No lead, cadmium, or other hazardous materials will be utilized for pipes, fittings, or solder.

8. Potable water piping and fittings will be painted with a blue stripe at 5-meter (15-foot) intervals.

9. Chlorine analyzer(s) will be located in the vicinity of the recirculation pump(s).

10. A visual alarm will be installed in the control room to indicate low or high free chlorine readings at the distant point analyzer.

11. All valves will be non-metallic. Epoxy coated valves and parts will not be accepted. All ball valves shall be true union for servicing with EPDM elastomers. To the greatest extent, all valves shall be from the same manufacturer. All isolation valves for filling tanks need to include electric actuators with the ability to be controlled from the main control room.

6.15.5 Backflow Prevention and Cross-Connection Control[5]

1. Appropriate backflow prevention will be installed at all cross-connections including any outlets or connections to the potable water system where there is a potential health hazard. This may include non -mechanical protection such as an air gap[6] or a mechanical backflow prevention device. Air gaps will ideally be used where feasible and when water under pressure is not required.

2. In particular, if any of the following items are connected to the potable water system then it must be protected against backflow (back siphonage or backpressure) with either air gaps, or mechanical backflow prevention devices:

[5] Cross-Connection Control Manual. USEPA. 2003

[6] An air gap is a physical separation between the potable water outlet and the surface of non-potable water. It must be 2 times the inside pipe diameter or a 25mm (1") minimum distance

a. Any connections to waste water (sewage or gray water) systems. Note: An air gap only must be used for these connections.
b. Pumps that require priming.
c. Boiler feed water tanks.
d. Decorative water features and fountains.
e. Food service equipment such as ice machines, coffee machines, some beverage dispensers, combination ovens and similar equipment.
f. Any hose-bib connections, hose lines used for cleaning and kitchen pot wash spray hoses.
g. Mechanical ware washing machines.
h. Swimming pools and any other recreational water facilities.
i. Public toilets, shower heads and water fed urinals.
j. Detergent dispensers.
k. Any water softener and mineralizer drains.
l. Fire systems.
m. Any other connection to the potable water system where contamination or backflow can occur.

6.15.6 Water Distribution System Components

All the components of the water distribution system will be non-corrosive and must comply with NSF/ANSI Standard 61: Drinking Water System Components[7]. These components include but are not limited to:

1. Protective barrier materials (cements, paints, coatings)
2. Joining and sealing materials (gaskets, adhesives, lubricants)
3. Mechanical devices (water meters, valves, filters)
4. Pipes and related products (pipe, hose, fittings)
5. Plumbing devices (faucets, drinking fountains)
6. Process media (filter media, ion exchange resins)
7. Non-metallic potable water materials

Any exceptions must be approved by the Global Port Development and Destination Group.

[7] http://www.nsf.org/services/by-industry/water-wastewater/municipal-water-treatment/nsf-ansi-standard-61

6.16 SWRO Desalination System

The SWRO desalination plant will be located at the BOH area. Feed water will be supplied by a well located within the property and the concentrate will be disposed by a well that will be sized to accommodate disposal of both concentrate and the effluent from the wastewater treatment plant. The proposed location of both the feed and the disposal wells will be finally determined based upon the results of the hydrogeological study. Well construction details will be presented to GBUC and GBPA with the permit application.

6.17 Rainwater Harvesting

Sources of water for toilet flushing and other non-potable uses such as irrigation for certain areas: Rainwater supplemented with potable water when required.

Catchment areas considered for these guidelines: The roofs of buildings only.

Collection, storage, distribution and treatment

1. Rainwater will be stored in independent tanks/cisterns completely separate from the potable water tanks/cisterns. Due to Grand Port's significant area and dispersion of facilities and to maximize collection, multiple rainwater tanks/cisterns will be located as close as possible to the associated catchment areas and the facilities using rainwater harvesting: mainly bathrooms. In general, the use for irrigation will not define the location of rainwater tanks/cisterns. It is suggested in general to use the tanks/cisterns designated for toilet flushing for the irrigation of close-by landscape areas using portable submersible pumps and hoses.

2. Equipment to minimize organic matter input into the rainwater tank, such as gutter screens, first flush diverters, pre-filters, downspout filters, pre-tank filters and others will be conveniently installed in the collection system.[8]

3. The rainwater tanks/cisterns will be equipped with a calming inlet and an overflow conveyance siphon. Evaluate the feasibility of using a floating inlet filter[9].

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[8] See examples in: http://www.smartwatersolutions.net/RainStore-RWH-Product-Catalog.pdf

[9] Idem

4. Automated potable water make-up water connections (to supplement rainwater when required) will be provided and will always have an air gap.[10] Automated connections need to include the ability to be controlled from the main control room.

5. Pipelines supplying water for toilet flushing will be independent from potable water lines.

6. The rainwater distribution pipework will be separate from potable water piping and not installed above potable water tanks or piping.

7. Paint or stripe rainwater water piping and fittings safety gray only at 5-meter (15-foot) intervals.

8. If the pipes conveying rainwater have to be installed in parallel with potable lines, they will be installed in separate trenches.

9. All buildings shall have dual plumbing systems to allow non-potable water use for toilets and localized irrigation systems.

10. The disinfection system (by chlorination) will be designed to guarantee that rainwater is free from *E. coli.*

6.17.1 System Components for Rainwater Harvesting

Although system components are not required to comply with NSF/ANSI Standard 61 (Drinking Water System Components), it is recommended to be guided in the selection of the system components by the NSF Rainwater Catchment System Components Program.[11]

6.18 Irrigation Systems

1. Grand Port's irrigation system will be divided in two independent sectors which will be further defined as the site plan is further developed:

[10] The air gap must be 2 times the inside pipe diameter or a 25mm (1") minimum distance

[11] This program establishes testing guidelines for products such as roofing materials and coatings to confirm that they do not impart contaminants into the water at levels that exceed U.S. Environmental Protection Agency (EPA) health guidelines. See: http://www.nsf.org/consumer-resources/environment/rainwater-collection ; http://info.nsf.org/Certified/Protocols/Listings.asp?TradeName=&Standard=P151 and https://www.nsf.org/newsroom_pdf/water_rainwater_catchment.pdf

SECTOR 1. Landscape Areas of Main Guests Activities. Source of water: Rainwater supplemented with potable water when required or by potable water in zones where rainwater catchment is not feasible and irrigation is required.

SECTOR 2. Landscape Areas Surrounding Areas with Less Interaction with Guest Activities (mainly BOH): Treated wastewater (permeate) from the MBR wastewater treatment system. If supplemental potable water is needed, it will be provided through an air gap connection to the effluent holding tank.

2. Connections between both systems will be avoided and exceptions approved by the Global Port Development and Destination Group.
3. The landscaping contractor shall be responsible for designing the irrigation piping and pumping systems and coordinating these with the rainwater catchment systems, potable water lines and back of house reuse water lines.
4. Landscaping shall be designed around native species to limit water requirements and issues with salinity.
5. The use of drip irrigation and/or subsurface irrigation systems will be used where feasible to avoid spraying surrounding areas with irrigation water and to minimize water consumption. Sprinklers will be utilized in the areas with less interaction with guests and staff. Sprinklers will be avoided in pool areas.
6. Treated wastewater permeate water piping and fittings will be stripe painted purple at 5-meter (15-foot) intervals.

6.19 Wastewater Systems

The following sub-section describes basic design guidelines for Grand Port's wastewater systems. For aspects not included in these guidelines the designer must follow the Florida Building Code or The Bahamas Building Code (whichever one is stricter).

6.19.1 Wastewater Collection Lift Stations

1. Wastewater collection systems will be designed utilizing grinder pumping systems fitted with duplex pumps and automated level controls.
2. A telemetry system shall be provided that allows remote monitoring and alarming of each station.
3. Pumping stations will be located so as to minimize the potential for stormwater infiltration. The top of tank will be a minimum of 6 inches above the surrounding grade.
4. Due to the high groundwater table, pumping stations will be designed to assure water tightness and buoyancy calculations shall be based on the 100-year flood elevation.
5. Pumping stations shall be designed using the minimum volume required for pump cycling and gravity inlets to avoid holding sewage any longer than necessary.
6. Gravity collection of waste is preferred where feasible to minimize the number of lift stations required. However, given the high ground water table, deep manholes will be avoided. It is anticipated that small localized grinder stations will be required.

Pipelines:

1. Force mains and gravity collection mains shall be HDPE or Schedule 80 PVC. Ductile iron piping will not be permitted.
2. Wastewater collection piping and fittings will be stripe painted brown at 5-meter (15-foot) intervals.

Grease traps:

1. Grease traps will be provided at every restaurant; no toilets or floor drains shall connect with the grease traps. Only food preparation sinks shall be connected.
2. Kitchen facilities will not have in-sink grinders. Food waste will be collected in bins and all restaurants will have a small concrete solid trap. These solid traps will be cleaned simultaneously with the outdoors grease trap.
3. Grease traps will be located just outside the restaurant or kitchen in an easily accessible location out of the way of normal traffic. The trap must not be located in flood prone areas. The grease trap will be located downstream of the solid trap.

4. Even when under-sink grease interceptors are installed near kitchen fixtures, each restaurant must have an outdoor grease trap to prevent fats, oil and grease to enter into the collection system.

5. The selection of under-sink grease interceptors will be carried out by the restaurant lessor once the internal plumbing of the restaurant is designed. This selection must be approved by the Global Port Development and Destination Group.

6. Schier (http://www.schierproducts.com/) provides a wide range of products and clear methodologies for the right selection according to the conditions of each application.

7. Prohibited Discharges into the Grease Traps

7.0 Sanitary wastewater (blackwater) shall connect to the drain line downstream of the grease trap.

7.1 As stated above, garbage grinders are not permitted.

6.20 Wastewater Treatment

1. It is Carnival's policy to utilize membrane bioreactor (MBR) technology to treat onsite wastewater. While the Bahamian standard is less stringent, the treatment requirements set forth by Carnival are intended to exceed the standard set in the U.S.

2. A single wastewater treatment plant will be provided in the BOH area.

3. The wastewater treatment plant will include an equalization tank sized to store the peak day flow, or a minimum 30,000 gallons, whichever is greater.

4. A telemetry system shall be provided that allows remote monitoring and alarming of the wastewater plant.

5. A dual sludge dewatering box system[12], similar to that provided to other Carnival ports, will be provided.

6. Access to the wastewater plant will be designed to facilitate truck access to the sludge boxes.

7. Effluent disinfection will include sodium hypochlorite and ultraviolet.

[12] Dewatering sludge boxes are heavy duty carbon steel containers dewatering boxes with permanently mounted plastic filter media. A polymer system precedes the boxes for flocculation.

8. Influent fine screen shall be a perforated drum, self-cleaning rotary screen.

9. Per Bahamian requirements, a deep disposal well will be required. The necessary approvals for design, construction and operation will be obtained from (GBUC/GBPA).

10. The disposal well will be sized and located to accommodate disposal of wastewater effluent, concentrate from the onsite SWRO plant, and backwash from the pool amenities. The proposed location of this well will be finally determined based upon the results of a hydrogeological study.

11. The proposed location of the injection well is preliminary and subject to relocation pending hydrogeologic investigation. The injection well will be double cased with surface casing and injection casing. The permeate from the treated wastewater will be high quality and used for irrigation in the dry season. The Hydrogeologic Report determined that there is, "lack of hydraulic communication between the surface water in the wetland area and the groundwater flow system in the Lucayan Limestone Aquifer (LLA)" (Hydrogeologic Report page 11). Based on a review of the lithologic logs for the two deep wells in Freeport, information obtained from the hydrogeologic study, and well design criteria; there will be no mixing of the effluent from the water injected into the deep well and the wetlands. The well will be permitted through the Grand Bahama Port Authority and the Grand Bahama Utility Company.

6.20.1 Effluent Storage Tanks

1. Effluent storage will be provided to facilitate reuse of effluent for irrigating the BOH area.

2. Effluent storage will be covered to limit algae growth.

3. A minimum of one day of storage shall be provided.

4. All supplier or manufacturer's recommendations for applying, drying, and curing the tank coatings must be followed. In addition, the following records must be held on site for the tank coatings:

   a. The manufacturer's recommendations for applying, drying, and curing.
   b. Written documentation that the manufacturer's recommendations have been followed for applying, drying, and curing.

5. All suction lines within storage tanks will be located at least 150 millimeters (mm) or 6 inches from the tank bottom or sump bottom. Any suction pipe greater than 200 mm (8 inches) in diameter must include anti-vortexing device.

6. An access hatch for entry into the tanks will be installed and will include a secure waterproof seal to protect the tank from contamination.

7. No storage tanks or pipes containing non-potable liquids (for example waste or gray water) will be installed directly over any potable water tanks.

8. Reuse pumps and distribution lines will be sized so that pressure is maintained at all times and at levels to properly operate all water outlets and equipment.

9. All cisterns will be equipped with level transducers that can provide an analog signal to the main control room.

6.21 Fire Protection

1. Designer/builder will be directed to design the fire system to comply with Florida Fire Protection Code (6^{th} edition) and the Bahamian building code, whichever is more restrictive.

2. Designer/builder shall designate an engineer-of-record for the fire protection system who is qualified to design a compliant system.

3. System shall, at a minimum:

   a. Include fire hydrants spaced no further apart than 300 feet and no further than 300 feet from any structure.
   b. Potable water distribution piping will be sized to accommodate fire flow. As minimum, a 6-inch distribution pipe will be provided anywhere where hydrants are placed.
   c. Building sprinkler systems shall be provided where required by Florida Building Code or Bahamian Building Code.
   d. Fire extinguishers will be installed in all food and beverage areas, shops, office spaces, warehouses and other occupied facilities.
   e. A dedicated, diesel driven fire flow pump shall be provided to supplement distribution pumps to provide the higher flow necessary for fire protection.
   f. The potable water storage tank shall provide dedicated storage for fire flow based on the referenced codes. An initial estimate of 100,000 gallons shall be considered based on 2,500 gallons per minute (gpm) for 40 minutes.

6.22 Stormwater Management

1. The use of swales and "ponds" is not desirable as they will become mosquito breeding areas. Swales are acceptable for conveyance of storm water, but it should be conveyed, not held.

2. Given the geometry of the site, the following will be considered:

a. For the impervious areas north of the lagoon (BOH, parking area, shops, etc.) all of the stormwater shall be directed to flow to storm drains per GBPA Building and Sanitary Code 2010 Supplement. The GBPA code stipulates the following:

> "Drainage wells to be constructed using an approved drilling contractor, with adequate measures to retain spill water on site. Well to have a minimum diameter of 9-inches and drilled to a minimum depth of 150 ft and verified by Inspector/Engineer of Building & Development Services of the GBPA prior to installation of well casing.
>
> Casings to be installed and grouted to a minimum depth of 40 ft below the fresh water/ saltwater interface. Building & Development Services of the GBPA to ensure protection of the freshwater table, with an upstand of 6 inches and covered with a mesh basket.
>
> Catch-pits for the well head to be constructed with concrete of strength 3,000 psi, poured in place, with a minimum dimension of 2-ft width, 3-ft length, 2-ft depth. Frame and covers for catch-pit and wellheads to have a minimum load rating of H-20, and to be of Neenah Foundry, U.S. Foundry or equivalent approved by Building & Development Services of the GBPA."

b. In the portion of the site between the mini golf and beach volleyball areas, where there is fairly extensive impervious area:
   a. Grade to storm drainage collection structures and direct flow to shallow drainage wells.
   b. If soils and elevation permit, utilize subsurface drain fields.

c. Investigate adapting the exploratory borings for drainage wells.

d. For the entire site, utilize pervious materials for paths and non-traffic areas wherever feasible.

e. For the roads and paths that are not large impervious areas, swales will direct excess water away from paths and allow percolation where soils and elevation are appropriate. Where soils and elevations are not appropriate, overflow will be directed to drainage structures and wells.

f. Drainage will be coordinated with landscape designer to avoid ponding and maximize use of stormwater for irrigation. Again, where soils and landscaping do not allow, subsurface drain fields and/or drainage wells will be utilized rather than ponds.

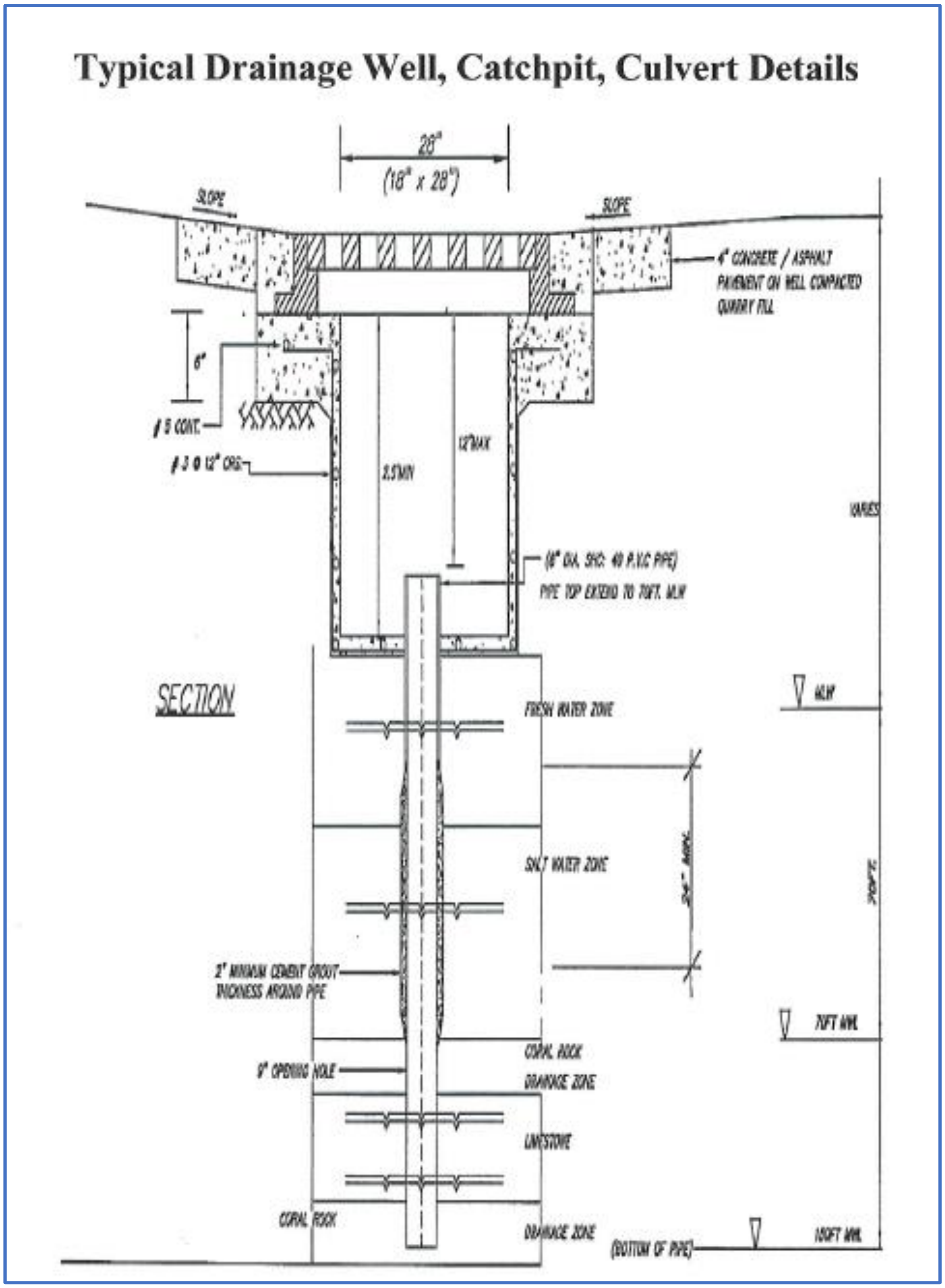

Figure 6-15. GBPA Typical Storm Drain Drawing

3. Oil traps associated with storm drains are not deemed necessary at every location as this is a touristic development. However, in the maintenance area interceptor traps may be required based on building codes of GBPA. It is noted the ferry boats will be electric powered and not require the traditional maintenance of internal combustion engines. The EMP will guide the operation of the facility to eliminate the release of any contaminants and to contain accidental spills. The GBPA Building and

Development Services department will review all site plans in the building permit approval process including the site drainage plan and the proposed location of the interceptor traps in the design and will advise if any modification will be required.

6.23 Ship Fuel Bunkering

As with any port operation it will be necessary to provide fuel services for ships stopping at the facility. This is similar to the bunkering operation that occurs at Lucayan Harbour in Freeport. While Carnival Corporation will not store fuel or provide fuel services, it is important to the project that these services can occur at Grand Port.

As part of Carnival Corporation's Sustainability Program, there is a transition from the use of traditional marine fuels to using LNG to reduce air emissions as discussed in **Section 2.1**. The new XL Class ship will be powered by LNG. Therefore, when the new class of Carnival brand ships arrive in North America there will be a need for LNG fuel bunkering as The Bahamas is added to the cruise itinerary.

6.23.1 Liquefied Natural Gas

Below is information on LNG provided by Shell Corporation.

"*Natural gas is one of the cleanest burning fuels available today with negligible sulphur or ash content. When burned in an engine or boiler, it can produce low levels of NOx (depending on engine type) and less CO2 than petroleum-based fuels. Worldwide reserves of natural gas are thought to be significantly higher than for petroleum and the International Energy Agency estimates there is enough supply for 250 years of consumption.*

Natural gas is a colourless mixture of several gases, but is principally composed of methane (CH4) with a typical concentration of 70 to 99 percent by mass, depending on the origin of the gas. Other constituents commonly found in natural gas are ethane (C2H6), propane (C3H8), and butane (C4H10). Small amounts of other gases, such as nitrogen (N2), may be present. When lowered to a temperature of about -162°C at atmospheric pressure, methane vapor becomes a liquid (LNG). At 162°C, the volume is reduced to about 1/600th of the volume needed for methane vapor. As a result, methane is typically transported as a cryogenic *liquid. The density of LNG is less than half of water, which means LNG will float. Further, the methane vapor from LNG will at first be heavier than air. As such, a vapor release from an LNG tank will hover close to the water surface, ground or deck. When the vapor warms to above about -100°C, it will be lighter than air and begin to further dissipate.*

LNG has roughly half of the density of traditional heavy fuel oil, but its calorific value is roughly 20 percent higher. Considering both its lower density and higher heating value, on a volumetric basis (m3) roughly 1.8 times more LNG needs to be bunkered to achieve the same range compared to bunkering heavy fuel oil. Due to heat leakage through the insulation of the fuel tanks, LNG in storage will be evaporating and giving off natural gas constantly. If the boil-off gas is consumed in the engines or boilers of the ship, the temperature and pressure of the LNG in the fuel tanks will be maintained. If the boiloff gas is not consumed, the pressure and temperature in the fuel tanks will rise.

Natural gas, like other combustible liquids, is not flammable in the liquid phase and cannot ignite. However, in the vapor phase it is highly flammable and will readily burn when there is a 5 to 15 percent by volume mixture with air. Although methane is colourless, cold methane vapours cause the moisture in air to condense resulting in what appears to be a white cloud. A general guide is that within the visible cloud, the methane concentration is still within the flammable range. Therefore, it is critical that equipment and procedures are in place to prevent a flammable mixture from occurring, and that sources of ignition are non-existent in and around areas where a flammable mixture is likely to occur."

Carnival Corporation and Shell Corporation

Carnival Corporation provides LNG training using simulators specifically for the XL Class ships at the Arison Maritime Center CSMART Academy in Almere, Netherlands. The CSMART Academy is a world-class training center for safety, sustainability and operational excellence in maritime operations. Therefore, Carnival branded staff are properly trained in the use and safety of LNG and to carry out bunkering operations.

Carnival Corporation has partnered with Shell Corporation for the provision on fuel bunkering services. Both the LNG and marine fuel services for Grand Port will be provided by Shell. Shell may contract the fuel bunkering services through others. However, Shell is ultimately responsible for the operations and conducting the necessary risk management. The risk management process used by Shell is provided below.

> "RISK MANAGEMENT It is critical to ensure that all credible hazards are identified and associated risks eliminated or mitigated to ensure the risk of LNG bunkering is As Low As Reasonably Practicable (ALARP). Typical Risk Management activities include the following and will be applied for the bunkering operation and location:
> 1. Hazard Identification Studies (HazID)
> 2. Hazard Operability Studies (HazOP)
> 3. Failure Mode and Effect Analysis (FMEA)
> 4. Qualitative Risk Assessment (QRA) for the quantification and establishment of Safety distances, if applicable"

The risk assessment process will identify critical hazards resulting from both design and operational practices and identify appropriate mitigations. To ensure safe bunkering operations at the relevant location and demonstrate that to the appropriate and relevant authorities it is proposed that a joint HAZID at those locations is carried out. Additionally this will ensure, if applicable, that the risk associated with simultaneous operations (SIMOPS) are captured and identified during the risk management process. **Figure 6-16** shows LNG of bunkering of the AIDAnova cruise ship while in port.

Shell will supply LNG to marine customers in the southeast U.S. and Bahamas from Shell's LNG capacity position at Elba Island in Savannah, Georgia, a Kinder Morgan facility operated as Southern LNG (SLNG), with a throughput of 2.5 Mtpa of LNG production. Shell is the 100% capacity holder for all liquefaction volumes and the sole import capacity holder. SLNG received Federal Energy Regulatory Commission (FERC) approval for export and is currently constructing the facility, expected to be ready for export in 2019.

Figure 6-16. LNG Bunkering of Carnival Branded Ship

Shell has signed a long-term charter agreement with Q-LNG Transport, LLC. for a 4,000 m3 articulated tug barge for delivery in 2020. Q-LNG will build, own, and operate the LNG Bunker Barge, which is intended to be used to supply LNG to vessels along the southern U.S. east coast. Additionally, Shell is currently reviewing additional delivery options using larger LNG vessels in the region.

The marine fuel bunkering operation will be conducted similarly as at the Lucayan Harbour utilizing similar protocols. According to Shell, arrangements will have to be made to secure a second vessel that would service the Grand Port and other cruise ports in The Bahamas. They are currently evaluating adding the fuel bunkering to the Grand Port location.

The fuel bunkering of the ships at Grand Port is strictly an arrangement between the Carnival branded ships and Shell. This is not a service provided by at Grand Port. However, Grand Port will assist wherever possible to make sure the bunkering operations are conducted in a safe manner.

6.24 International Ship and Port Facility Security (ISPS) Code and Security Measures

The ISPS Code is a comprehensive set of measures to enhance the security of ships and port facilities developed in response to the perceived threats to ships and port facilities after the attack on the U.S. on September 11, 2001. To achieve the objectives and functional requirements of the Code, steps include:

- Gathering and assessing information regarding security threats and exchanging such information with appropriate CGs
- Requiring the maintenance of communication protocols for ships and port facilities; preventing unauthorized access to ships, port facilities and their restricted areas; preventing the introduction of unauthorized weapons, incendiary devices or explosives to ships or port facilities
- Providing means of raising the alarm in reaction to security threats or security incidents
- Requiring the ship and port facility security plans based upon security incidents
- Requiring training, drills, and exercises to ensure familiarization with security plans and procedures.

The CGBIL Grand Port will develop its own Port Facility Security Plan (PFSP). The PFSP will ensure the application of measures to protect the port facility and ships, persons, cargo, cargo transport units, and ship's stores within the port facility from the risks of a security incident. This plan will be drafted and implemented before the opening of the port.

6.25 Project Description – Marine Elements

Marine elements include construction of two vessel berths, access pier and ancillary coastal structures. The project also includes construction and stabilization of two coastal inlets associated with the proposed inland waterway. Material will be hydraulically dredged (after relocation of corals from the area of direct impact) and placed on proposed upland development portions of the property to raise grade elevation.

Key elements of the project are:

- Berth excavation (dredging)
- Upland placement of dredge spoil
- Pier construction
- Inlet excavation and stabilization
- Construction of ancillary coastal structures

Berth Excavation (Dredging)

The berth excavation will involve the hydraulic excavation of approximately 1.1 million cubic yards of material from the dredge area footprint which covers 75.6 acres. The dredging operations will not commence until the coral mitigation has been completed. This material will consist primarily of sand and limestone rock. The nominal daily production rate during active dredging will be approximately 5,000 cubic yards per day requiring an estimated 220 days of active dredging to complete berth excavation. Dredging will occur on a 24 hour/ 7 day a week basis until completed. The post-dredge condition will consist of a deepened berth of consistent depth of -35 feet (MLW). A prominent limestone slope/ledge system will be formed at the boundary of dredging transitioning into the berth. This new ledge system will be most prominent along the landward (northern) boundary of the dredge area where the change in depth will be greatest, approaching a maximum height from the berth bottom on the order of 15 feet. The post-dredge berth bottom will primarily consist of limestone rubble overlaying base limestone substrate.

Excavation will be conducted utilizing a large, ocean going hydraulic cutter/suction dredge, adopting the same processes utilized for the construction of similar cruise pier facilities. This method of construction is preferable to mechanical excavation methods given the rate of production and the efficiencies of both excavation and hydraulic material placement where needed on the upland property. Hydraulic excavation is also warranted given that the hydraulic suction of the dredge tends to remove finer fractions of material from the marine environment and place it within the upland disposal area where it can be more effectively contained.

The dredge will be deployed from the ocean side facing landward and will excavate the berth from offshore to inshore. The dredge will advance landward excavating material in a series of passes of the cutter head to the required depth. Where practicable turbidity curtains will be utilized to contain fine material within the active dredge area and a turbidity monitoring protocol will be implemented to ensure that turbidity within the adjacent environment is within acceptable standards (turbidity monitoring and protocols will be addressed within the EMP). During excavation, the cut material will be transported by pipeline in a slurry to the upland disposal areas. The water and spoil slurry will be discharged into the disposal area that will consist of a series of contained, diked settling ponds. Solid material from the slurry will settle within the discharge ponds. Runoff water from the discharge ponds will be routed through a series of containment areas to allow sufficient settlement of solids. Return water will eventually be discharged back into the ocean. The discharge ponds will be temporary features composed primarily of dredge spoil formed into temporary dikes to retain hydraulically discharged material. Containment features will be implemented by the contractor to retain material on an as needed basis within the footprint of the material placement area. Containment will be addressed within the EMP. Details regarding the means and methods of containment are contingent on the contractor which has yet to be selected. This information will be provided upon selection of the dredge contractor. The proposed inland waterway areas will be utilized to route water back towards the ocean and the two new inlet areas will be utilized for water discharge back into the ocean to minimize beachside impacts. Canal excavation will occur in conjunction with hydraulic fill placement. Where practicable turbidity curtains will be utilized to further reduce turbidity discharge and a turbidity monitoring protocol will be implemented to ensure that turbidity within the adjacent environment is within acceptable standards and will be an element of the EMP. The dredged material will be beneficially utilized to raise the grade of upland areas that will be further developed as part of the facility. The dredged material is well suited for this purpose as the resulting discharged material will consist of limestone rock material, sand and limestone marl (due to the pulverization of limestone rock in the dredge process). As containment cells are raised to design elevation, additional cells will be opened to spoil placement and the site will be raised to design elevation (+ 13 ft relative to MLW) one containment cell at a time. Disposal containment areas will be constantly monitored and manipulated with mechanical equipment to entrain placed material and attain the desired upland final topography. The use of turbidity curtains will be employed to help contain fine material released into the environment through dredging activities and dewatering. Turbidity curtains will be positioned around active dredging areas and along the south side of the pier to reduce the spread of fine particulates in the nearshore. Additional curtains will be installed around the de-watering return pipe to further reduce and contain fine particulates from being released into the nearshore. The contractor will be required to implement sufficient turbidity curtain to contain active work areas. No minimum extents have been specified as the contractor will be required to meet this performance standard regardless of the extent of turbidity curtain required. Turbidity will be monitored at both sites and is discussed further in **Section 10**. Access to the dredge site will be by sea and staging of equipment will only occur within the dredge footprint. The port at Freeport will provide support services for all waterborne equipment including the dredge and will serve as the primary safe harbor for inclement weather.

Construction will occur within the boundaries (marine and upland) of the proposed facility and security perimeter. Construction will be conducted under the oversight of Carnival Corporation including site security. Lighting will be required during construction. The required navigation lighting will be addressed within the EMP and will conform to accepted international standards. Security will be maintained by existing Carnival Corporation staff and procedures. The dredge contractor has not yet been selected. Upon selection the contractor will provide a navigation and lighting plan based on the equipment that will be utilized for the work.

At a minimum, the dredge, all floating equipment, and pipelines will be lighted as per international standards. All fuels and hazardous substances will be subject to BMPs (which will be addressed in EMP). Temporary, mobile fuel tanks utilized by construction equipment will be double walled to prevent leaking into the environment, equipped with fire extinguishers and subject to regular inspection as part of the EMP. The contractor will be required to prepare an emergency management and spill prevention plan for review and concurrence by project management. This will include, at a minimum, training of staff, oversight of critical operations, onsite cleanup, and response equipment onsite. The site will be maintained in a professional manner, with regular observations for spills by the contractor with independent oversight by project management.

Photo 6.1. Representative photo of hydraulic dredging (Grand Turk Cruise Facility construction)

Photo 6.2. Representative photo of upland discharge of dredge material (Grand Turk Cruise Facility construction)

Pier Construction

The arrival pier will be constructed following completion of the berth excavation. This structure will be an open pile supported structure extending from the upland into the dredge area to allow for two vessels to berth on either side of the pier. The general layout of the pier and detailed drawings are provided in **Appendix 2**. Pile installation and deck construction will be performed with floating barge-mounted pile-driving equipment. Piles will be driven using a crane-mounted pile driver on the barge (**Photo 6.3**).

Pier construction operations will require, at a minimum, the following major equipment:

- Ocean-going [American Bureau of Shipping (ABS) rated] barge(s)
- Ocean-going tug(s) sufficient for barge movement
- Crane with pile driver and jig assembly
- Pier Piles (dimensions to be determined)
- Pre-fabricated concrete deck sections
- Concrete production and placement equipment
- Earth-moving equipment (dozers, etc.) (within the upland pier connection area)

Access to the pier will be by sea, and staging will be provided by barge within the berth footprint. Pier construction will be initiated upon completion of all dredging tasks. Pier construction activities will occur only during daylight hours on a 7-days-a-week schedule. Turbidity curtains will be deployed around all barge, pier and pile-driving operations, with specific emphasis on protection of existing resources (corals). Daily turbidity monitoring will be conducted during active construction and will be an element of the EMP. All on-water vessels will operate under accepted vessel standards, including no active discharge of materials. Vessels will stage from port facilities in Freeport, Grand Bahama.

Photo 6.3. Representative photo of pile driving (Grand Turk Cruise Facility construction)

Inlet Excavation and Stabilization

The project will include excavation of the approach to both the eastern and western inlets to a nominal depth of – 7 feet (relative to MLW). Excavation will be conducted utilizing barge mounted excavation equipment (depths in this area are too shallow to allow for hydraulic dredging with the main project dredge). Material will be excavated within a turbidity containment area and all material will be utilized within upland disposal areas. A turbidity monitoring protocol will also be implemented throughout excavation. Following excavation of the inlet throats, rock jetty structures will be constructed on either side of both inlets to stabilize the inlet and limit deposition of adjacent beach sand into the inlet throat. Jetty construction will be completed using both land-based and barge-mounted equipment.

Construction of Ancillary Over-Water Structure

The project master plan includes one additional ancillary over-water structure, an excursion dock to the west of the main pier. The excursion pier will be utilized for ingress/egress of visitors to smaller excursion vessels and if needed on-water emergency access. The structure will be open pile and concrete deck supported. Construction will utilize the same methodologies as the main pier though the excursion pier will be dimensionally smaller.

Reef mound relocation and mitigation reef construction

In support of benthic mitigation efforts (further described in **Section 10.6.3**) coral mound structures within the dredge footprint will be relocated to form a new reef. An additional nearshore mitigation reef will be constructed from limestone boulders as a receiver site for relocation of individual coral colonies. The parameters utilized to select the receiver site for the reef mounds is further described in **Section 10.6.3**. The site was selected based on its proximity to the project area, similarity in depths, acceptable bottom substrate, presence of similar structures and habitat adjacent to the receiver site. Both construction efforts will utilize water-based barge and crane equipment similar to that required for dock and pier construction.

7 PROJECT SCHEDULE

There are many businesses that were impacted by the flooding on the island. The plan is to move as quickly as possible to obtain the necessary approvals and prepare the necessary drawings for the building permit phase. To this end, CGBIL will be moving as fast as possible to obtain all of the necessary approvals and construction permits from both GBPA and Bahamas Government. Below is the proposed project schedule:

Maritime Approval/Permit & Construction Schedule

Receive Terms of Reference BEST Commission	7/5/2019
BEST & Team Dive Inspection (Benthic Overview)	8/6/2019
Execute the HOA & Sea Bed Agreement	9/25/2019
Receive BEST approval for In-Water Borings	11/5/2019
Submit the Environmental Impact Assessment	11/15/2019
Submit Planning & Excavation Application	1/20/2020
Docks Committee Meeting	1/29/2020
Design Development of Maritime Structures (Calculations)	3/20/2020
Resubmissions-Final EIA & EMP	3/23/2020
Receive BEST approval	4/3/2020
Building Permit Port Department & Ministry of Public Works	4/23/2020
Engage Coral Transplant Team	5/1/2020
Engage International Dredge Contractor	6/1/2020
Engage Design Build Pier Contractor	7/1/2020
Complete all Maritime Work	11/1/2021

8 BASELINE ENVIRONMENT

8.1 Project Environment

The project site is located in central Grand Bahama within the Freeport/Lucaya city limits. The property consists of two parcels of land known as Parcel A and Parcel B encompassing 329 acres. Parcel A is approximately 171 acres and Parcel B is approximately 158 acres. The site is undeveloped and consists of ten (10) different habitat types.

The site is bounded to the north by undeveloped land, to the south by the Northwest Providence Channel, to the east by undeveloped land, and to the west by undeveloped land, specifically mangrove wetlands. An aerial photograph of the site is provided in **Figure 5-2 in Section 5.**

The site was impacted by Hurricane Dorian which is discussed in the foreword of this EIA.

8.2 Climate

The climate of Grand Bahama is subtropical with a mean temperature range of 70°F (21°C) in January to 83°F (28°C) in August. The island is generally characterized by warm moist summers and drier cooler winters. Summer trade winds from the east bring warm humid air to the area. Winter high pressure cells arriving from the North Atlantic and North America bring periods of cold, sometimes precipitating fronts. Summer rainfall peaks in June through September, with a year total averaging approximately 60 inches. For most of the year Grand Bahama Island remains sunny. Cloudiness often indicates isolated rain showers and sustained overcast days are rare. A fairly constant breeze helps to alleviate the effects of the high humidity, yet most businesses and homes use air conditioning, especially in summer. Frost is unknown because any invading cold air mass must cross over the warming influence of the Gulf Stream.

8.3 Geology

The Bahama Islands are a relatively recent geological formations consisting of various forms of limestone and coral. Geological investigations throughout The Bahamas indicate limestone has been encountered as deep as 18,906 feet (Cay Sal, 1959). Such data suggests that limestone in The Bahamas was once located at the surface (Sealy, 1995). Geographically, the island, together with the Little and Great Abaco Island, make up the exposed portions of the Little Bahama Bank.

Grand Bahama like all other Bahamian Islands, consists of limestone rock formed over time through the process of diagenesis. A typical Bahamian island consists of a sequence of late Pleistocene and Holocene carbonate rocks of subtidal, intertidal, and eolian origin. The limestone in this area is very porous and contains secondary mineral deposits of calcite and sparry cement. From sea level to a depth of approximately five miles the geology is dominated by limestone and dolostone interbeds.

The surficial geological structure of Grand Bahama Island appears to have developed during the Quaternary period, when sea level fell during periods of glaciation and rose again during interglacial periods. When sea level rose during an interglacial period, new carbonate sediments were deposited on the flat-topped banks forming shallow marine flats and tidal marshes. Grand Bahama was possibly then a series of smaller cays or shallow banks separated by deeper tidal channels, like those in eastern Grand Bahama. Most have since become infilled but are still marked by areas of swash land.

The lithologic logs for deep disposal wells at the Grand Bahama Shipyard, Ltd. and Polymers International, Ltd. show that the limestone/dolostone sequence is present to a depth of 600 feet below grade.

8.4 Topography and Soils

Grand Bahama Island is relatively flat with the highest point being 50 feet above sea level, located in the central south portion of the island. A typical section of the island shows wetlands, tidal creeks and salt ponds near the southern sandy shore, a low ridge further inland from which there is an almost indiscernible slope down to the north coast followed by an extensive swash land before reaching the shallow open waters of the Little Bahama Bank. Please refer to **Figure 8-1** for a generalized cross-section which depicts the general topography and vegetation communities found on Grand Bahama Island.

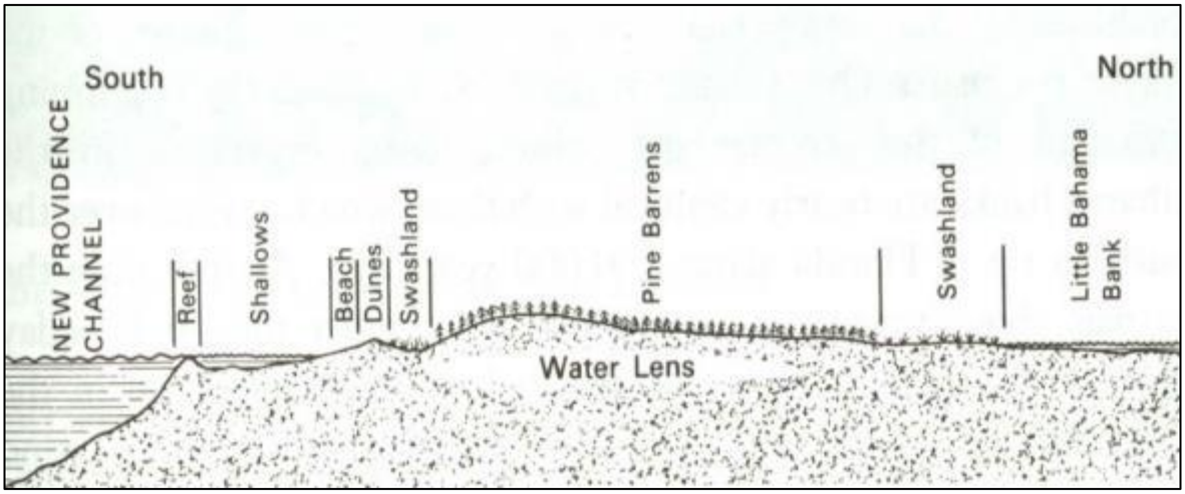

Figure 8-1. Generalized Cross-Section (Barret, 1989)

Soils on Grand Bahama Island’s south shore are composed of sand and/or limestone which are continually washed and further eroded by the action of the sea. The north shore is composed of calcareous muds and clayey limestone, also called marl beds. These white marl beds support thousands of acres of mangroves and other swamp-type vegetation. Further inland, beneath a canopy of pines and scrub vegetation, broken lime rock is ubiquitous and visible on the surface. Organic topsoil is occasionally found in the forested areas as a product of biological decay, but despite a thin cover of mosses and ferns, the rock is seldom more than a few inches below the surface. Infrequently sparse areas of lush vegetation is supported by rich organic loam found in the occasional "banana holes." Most of the agriculture since early times took place in the loamy coral sands slightly inland from the dunes of the south shore.

8.5 Ambient Air Quality

The island's relatively remote location and low density of development helps ensure that the quality of the air is good year around. The use of internal combustion engines to power vehicles, ships, and electrical generators are sources of air pollutants. The expansive character of Grand Bahama Island successfully keeps these pollution sources from having any measurable effect on the ambient air quality of the region. However, emission reports from the industrial park are not available and the cumulative impact from the industrial park companies is not known.

The project site is located in an undeveloped part of Freeport/Lucaya where no industrial activity takes place and traffic is at a minimum.

8.6 Storms and Flooding

Grand Bahama Island is located within the Atlantic Tropical Cyclone Basin. This basin includes much of the North Atlantic, Caribbean Sea and the Gulf of Mexico. On the average, six to eight tropical storms form per year in this basin. The formation of these storms, and the possible intensification into mature hurricanes, takes place over warm tropical and sub-tropical waters. Eventual dissipation or modification of these storms occurs on average seven to eight days later over the colder waters of the North Atlantic, or when the storms move over land away from the sustaining marine environment. The hurricane season extends from June to November.

Hurricanes passed over Grand Bahama in 1926, 1957, 1995, 1999, 2004, 2005, 2012, 2016, and 2019, bringing high winds and flooding. Hurricane Floyd passed Grand Bahama in August 1999 resulting in flooding of the north coast, including the Grand Bahama International Airport and the Queen's Cove subdivision. Hurricane Frances passed and stalled directly over Grand Bahama Island on September 5, 2004. The storm had maximum sustained winds of 105 mph or 165 km/hr. Flooding mostly occurred on the northern shoreline but included West End, Hawksbill, Bahamia, the Lucayan Waterway, and other parts of Grand Bahama with a storm surge ranging between 5 feet to 12 feet above normal tide levels. Shortly following Frances, Hurricane Jeanne passed just north of Grand Bahama Island on September 25, 2004, accompanied by similar wind speed and storm surge as Frances. Jeanne was noted as significantly impacting the Eight Mile Rock community located just west of the harbor. The eastern portion of Grand Bahama Island was cut off to vehicular traffic by storm surge and flooding at the Fishing Hole Causeway crossing of Hawksbill Creek.

Following Frances and Jeanne, Wilma was the next hurricane to impact Grand Bahama Island on October 25, 2005. Hurricane Wilma passed approximately 90 miles northwest of Freeport. Storm surge and rain caused significant flooding along the southwestern portion of the island particularly the coastal settlements along the south shore. In 2012, Hurricane Sandy passed over the eastern end of the island causing considerable flooding again occurring across Fishing Hole Road and in and around the properties proposed for the Sea Air Business Center. In October 2016, Hurricane Matthew passed over West End, Grand Bahama resulting in storm surge flooding that community.

Between September 1 – September 3, 2019, Hurricane Dorian struck Grand Bahama Island. Dorian was a category 5 hurricane on the Saffir-Simpson scale. Winds were reported at 185 mph sustained with gusts up to 200 mph. The hurricane moved at an average rate of 1.3 mph (and at times 0 mph) across Grand Bahama Island and the north shore. As Dorian crossed Grand Bahama and stalled, it pushed seawater from the Little Bahama Bank south, resulting in an approximately 20-foot storm surge which led to widespread flooding in Grand Bahama. Moreover, when the back end of the storm passed eastern Grand Bahama it resulted in flooding from the south shore. This natural disaster was the worst hurricane ever recorded in The Bahamas.

The immediate impacts to Grand Bahama included loss of electricity and severe damage to the power grid in some parts of the island and a loss of business throughout the island. The Grand Bahama Airport was flooded during the hurricane and will likely remain closed for months.

In the past, Hawksbill Creek has been the site of several flood events primarily resulting from hurricane induced storm surges and high winds. Storm surge is associated with lowered barometric pressure of the hurricane, combined with the storms forward motion and wind field stress applied to the waters' surface. Depending on the location and direction of a tropical storm relative to open water and a land mass, a hurricane can cause a dramatic increase in sea level. This is primarily caused by the high winds forcing and trapping water against a land mass. This storm wind driven tide combined with the overlying waves and wave run-up can cause significant flooding. Such circumstances have caused such flooding along the north side of the island during the hurricanes in 1999, 2004, 2012, and most recently in September 2019 (Dorian) and the south side of the island in 2005. Hurricane Dorian resulted in flooding across the island that was unprecedented for Grand Bahama.

8.7 Groundwater

As part of this EIA, an hydrogeological study (**Appendix 4**) was undertaken to determine if a freshwater lens is present, the extent of any existing lens in the area, and to assess the impact, if any, the 1.6 mile canal would have on changes to any freshwater lens and to Grand Bahama Utility Company (GBUC) wellfield W-6 located on the northside of the Grand Bahama Highway. The GBUC is responsible for the potable water supply for Grand Bahama Island.

To this end, a total of fourteen observation wells were drilled in the project area. The observation well locations are presented in **Figure 6** of the hydrogeological report. Two existing wells were used which are identified as observation wells OW-15 and OW-16.

Each observation well was drilled using a direct air drill rig. Starting at a depth of five feet below the water table and continuing at five-foot intervals thereafter, water air from each borehole was tested for salinity and conductivity. Drilling was stopped when the salinity test results gave assurance that no freshwater was present (freshwater being defined as having a salinity of 0.6 parts per thousand (ppt.), which is the GBUC standard).

Upon completion of drilling, all observation wells were rested for four to 18 days to allow for stabilization of the water column. Salinity and conductivity measurements were recorded at one-foot intervals in all observation wells on three occasions: 1) June 18-19, 2019, 2) August 10 and 11, 2019, and 3) post-Dorian in September 2019. The results are presented in **Table 3** in the hydrogeological report.

The vertical salinity profiles of each observation well established the presence of a freshwater lens in the northern portion of the CGPP property as shown in **Figure 8-2** and **Figure 3** in the hydrogeological report with the concentrations presented in **Table 3** for measurements taken on June 18 and 19, 2019 **(Appendix 4).** The minimum and maximum thicknesses were 20 feet and 52 feet in OW-13 and OW-10 respectively, based on a threshold concentration equal to 0.6 ppt or less. Salinity measurements were taken again on August 10 and 11, 2019, and the results are presented in **Table 3** of the hydrogeologic report confirming the presence of the freshwater lens. Note that no freshwater was detected in OW-10 and only 2 feet in OW-13 due to these wells being used for water supply during coring operations at those locations. The pumping most likely caused up-coning of higher salinity water from the deeper portion of each well. The minimum and maximum lens thicknesses for August 10 and 11, 2019, were 26 feet and 48 feet in OW-9 and OW-14, respectively. The onsite freshwater lens is part of a much larger lens that exists in this portion of Grand Bahama Island (**Figures 4** and **5** in hydrogeological report).

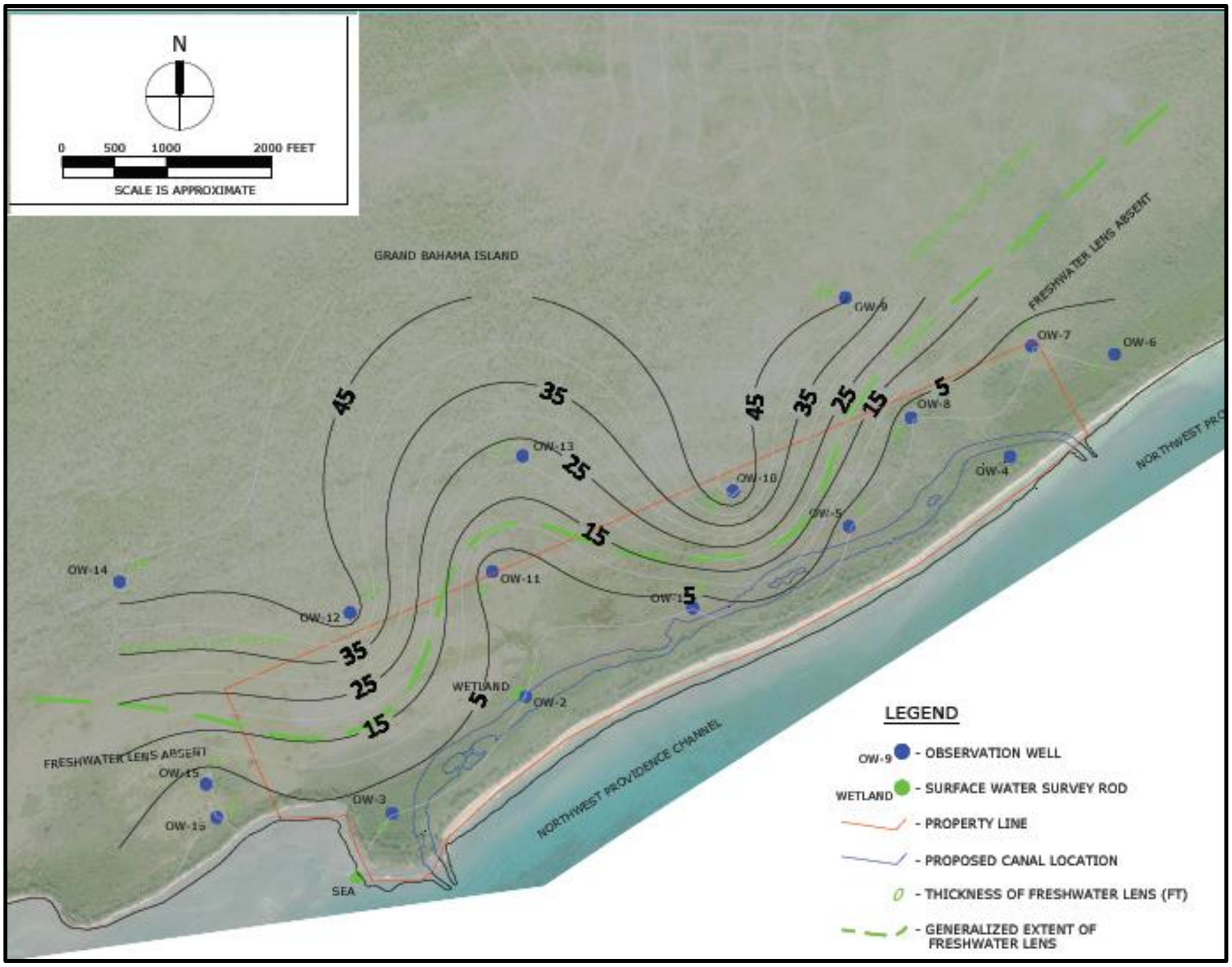

Figure 8-2. Generalized Thickness and Extent of Freshwater Lens (June 2019)

Post-Dorian salinity profiles were completed between September 13 to September 25, 2019, and the results are presented in Table 3 in the hydrogeological report. A comparison to the pre-Dorian profiles taken on June 18-19, 2019, and August 10-11, 2019, shows that the storm surge impacted groundwater quality. A portion of the freshwater lens described above remains at OWs 9 and 12. The groundwater quality in previously impacted OWs 10 and 13 remains degraded although to a greater degree than pre-Dorian conditions. Storm surge impacts on groundwater quality are also evident in the salinity profiles of the other observation wells.

Integral to the establishment of baseline conditions for the project site is water quality in both ground and surface waters. Establishment of these conditions entailed the collection of water samples from all fourteen observation wells, the wetlands and New Providence Channel. Samples collected from the groundwater observation wells, wetlands, sea water, duplicate sample and equipment blank were analyzed for the baseline parameters using the specified test methods. The parameter's analyzed for are provided in the **Table 8.1**.

Table 8.1. Sample Parameter and Test Method

Parameter	Method
Volatile Organic Compounds (GC/MS)	U. S. EPA Method 8260B
Polynuclear Aromatic Hydrocarbons by GC/MS (SIM)	U.S. EPA Method 8270D
Florida - Petroleum Range Organics (GC)	FL-PRO Micro
Metals (ICP) – Total Recoverable	U. S. EPA Method 6010D
Mercury (CVAA)	U. S. EPA Method7470A
Turbidity	Standard Methods (*)
Total Dissolved Solids	Standard Methods (*)
Chlorides	Standard Methods (*)

The properly prepared and preserved water samples were shipped via Federal Express on a daily basis to Eurofins TestAmerica Tampa under proper chain-of-custody procedures. Chloride and Bacteria samples were submitted to Adam's Analytical in Freeport, Bahamas.

The sample collection log sheets and analytical laboratory results are presented in the hydrogeological report.

8.8 Terrestrial Resources

A Terrestrial Resource Survey (TRS) was conducted for the proposed project and is in **Appendix 5**.

The terrestrial side of the project is approximately 329 acres of mostly undeveloped land. There is a beach road which parallels the coast and starts at Burnside Cove (to the east) and terminates west of Sharp Rocks Point. Additionally, with approval from the GBPA, a temporary road network was created to facilitate the hydrogeologic study and TRS. The TRS was conducted pre-Dorian and as discussed and photo-documented in the foreword, has been impacted by Hurricane Dorian.

The TRS found there are 10 different habitat types (**Figure 8-3**). Below in **Table 8.2** are the habitats and acreage. It is noted the Mangrove Wetland and Mangrove Forest calculations are integrated. The complete description of the habitats is provided in the TRS.

Table 8.2. Habitat Communities and Acreage

Habitat	Acres
Broadleaf Coppice Forest	25.48
Casuarina dominated Coastal Shrubland	26.43
Coastal Shrubland	13.98
Fire Impacted Coppice	3.96
Mangrove Forest and Wetland	155.18
Pine Woodland	21.61
Sabal Woodland	41.56
Semi Permanently Flooded Wetlands	20.23
Silver Palm-Bracken Fern Shrubland	13.44

It is noted post-Dorian, there is a small breach in the shoreline west of Sharp Rocks Point as waves from Dorian caused beach erosion which resulted in the beach road being eroded away (**Figure 8-4**). Also, the shoreline to the west of the property has been eroded away leaving the exposed organic material at the wetlands exposed (**Figure 8-5**).

On January 14, 2020 Caribbean Coastal Services returned to Grand Bahama to evaluate the vegetation post Hurricane Dorian at the site. In summary, the findings were 1) The vegetation (Broadleaf Coppice) is recovering with new growth of leaves but is still very stressed 2) The Casuarina trees are starting to grow new leaves and there is a concern that there may potentially be new growth of Casuarina's in the future 3) The beach road to the west of Sharp Rocks Point has been compromised. A more detailed assessment will be provided in the EMP.

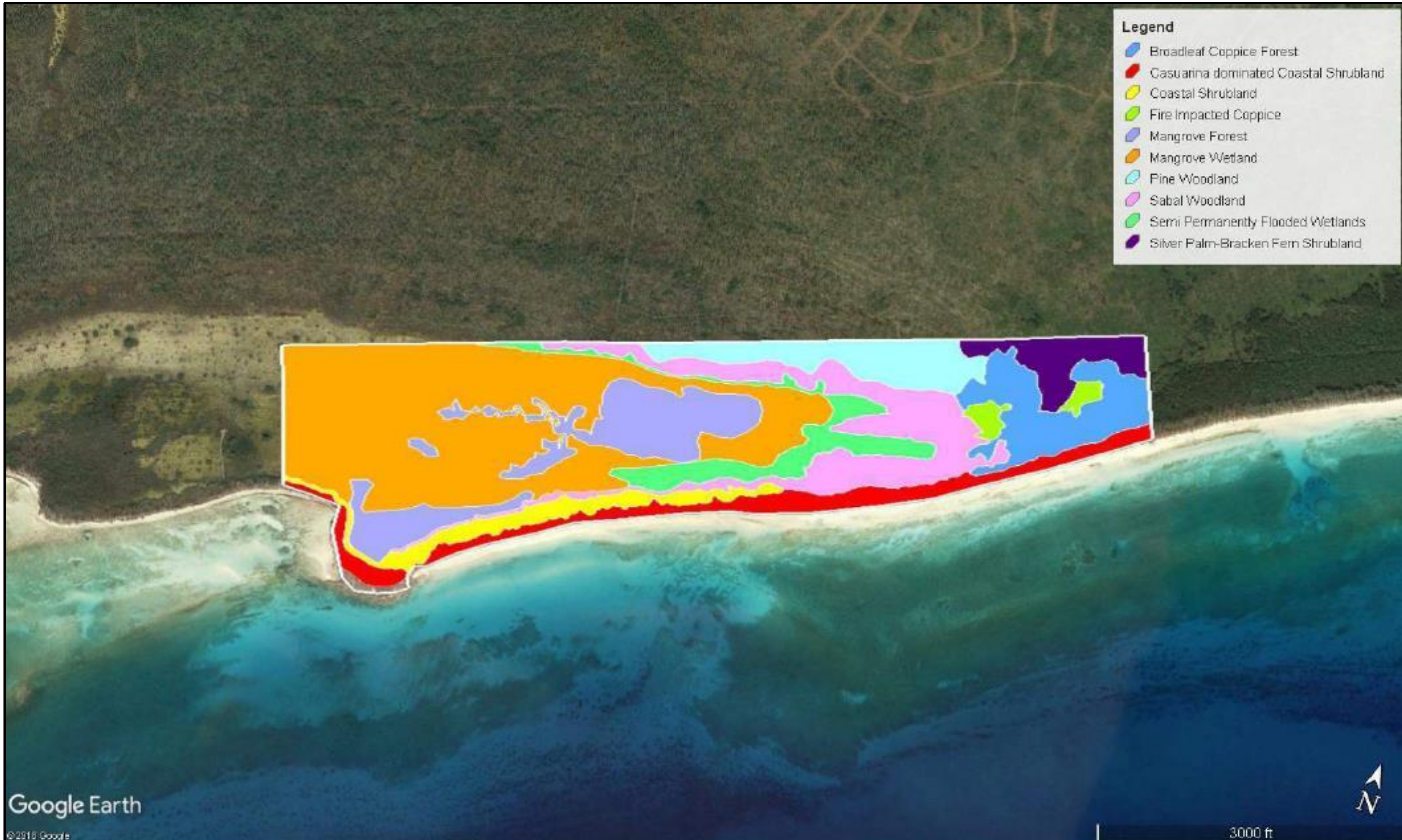

Figure 8-3. Map of Habitat Types

Figure 8-4. Eroded Beach Road West of Sharp Rocks Point

Figure 8-5. Beach Erosion on West Side of Project Boundary

8.9 Infrastructure and Public Services

The following sub-section describes the infrastructure setting and public services available in the vicinity of the project site and surrounding areas.

8.9.1 Water Resources

This is discussed in **Section 6.14** of this report.

8.10 Electrical Supply

Currently, a power transmission line is present along Sussex Drive, but it does not extend all the way to the CGBIL property. Prior to Hurricane-Dorian, CGBIL had were having conservations with Grand Bahama Power Company regarding the provision of solar power for the facility as well as from the grid. Due to Hurricane Dorian, the discussions regarding solar power have been suspended. CGBIL will continue to engage the Grand Bahama Power Company regarding power supply to the facility, including the installation of a solar farm near the facility.

8.11 Roads

Grand Bahama Island is approximately 80 miles long and nine miles wide at the widest point. With the exception of urban and residential areas, the road system on the island consists primarily of one major two-lane highway that extends from West End to McLean's Town on the east end of the island. The project site entrance is located off Grand Bahama Highway at Sussex Drive. Sussex Drive is a dirt track road that was extended approximately 0.67 miles to reach the northern boundary of the property. The distance from Grand Bahama Highway to the northern property boundary is approximately 2.30 miles.

8.12 Baseline Marine Environment

A summary of marine baseline conditions is provided in this sub-section. It is noted that conditions presented here are primarily based on historic data and field studies prior to impacts from Hurricane Dorian.

Physical Environment

The project site is situated on the southern shoreline of Grand Bahama, near the approximate center of the island. The local shoreline faces the south-southeast towards the Northwest Providence Channel and is exposed to regionally generated deep water waves over a range of southerly directions (**Figure 8-6**). The site is generally well protected from open ocean swell.

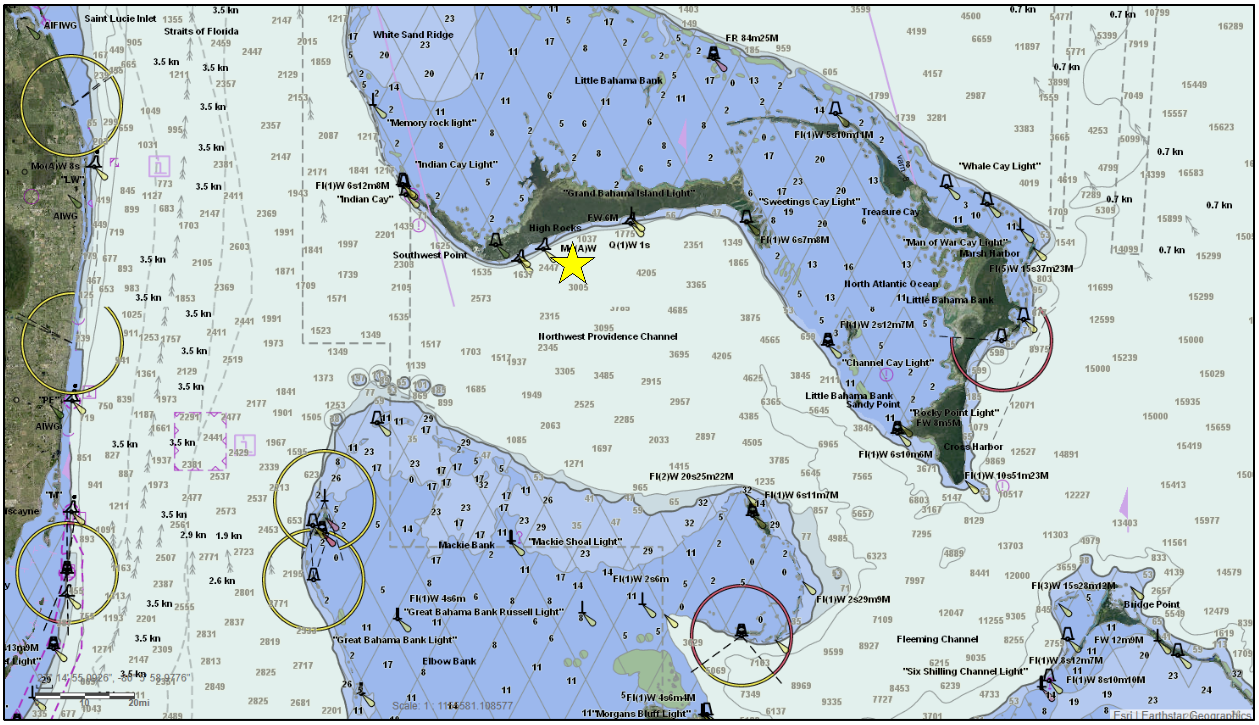

Figure 8-6. Project Location Exposure (source: NOAA Electronic Navigation Chart)

Local bathymetric data was collected at the project location and indicates nearshore depths sloping from the upland beach shoreline to approximately -40 feet below mean low water (MLW) 2,000 feet offshore. This relatively shallow shelf extends to a depth of -90 feet MLW 4,000 feet offshore. Bathymetry drops off quickly from this shelf, with NOAA chart depths of over 600 feet approximately 5,000 feet offshore.

Nearshore and Coastal Environment

The project shoreline is composed of a mix of sand beaches and limestone. Sharp Rocks Point is a prominent ironstone headland at the western boundary of the property. This feature acts as an impediment to longshore movement of sand resulting in a tendency for increased beach stability to the east (updrift) of the feature into the subject property and a tendency for recession to the west (downdrift) of the headland. Sandy beaches on the property are limited both in width and depth, consisting of a thin layer of sand overlain a cobble and base limestone substrate. Beaches exhibit a marginal dune feature on the upper beach, though again this feature largely consists of sand overlaying cobble substrate. Intermittent bar trough features are marginally present under persistent wave conditions, though significant nearshore hardbottom features tend to limit this behavior. Net transport of sand is from east to west within the immediate nearshore surf zone driven primarily by the predominate wave conditions from easterly directions. Significant transport is likely episodic and associated with major front or tropical events. Net annual transport is low, likely only on the order of a few thousand cubic yards per year net to the west. The area seaward of this transport zone is dominated by exposed low-profile base limestone with intermittent higher relief outcrops.

Coastal and Marine Site Forcing

The primary environmental forces that have the potential to affect marine project elements include geostrophic tide, wind, open ocean swell, wind generated waves, currents, and water level changes including future sea level rise. Wave, current and meteorological sensors were deployed within the vicinity of the project to collect site-specific data. This data was further expanded through a review of historic and regionally available data. A summary of coastal and marine forcing processes is provided in this sub-section and data collected in support of this study is provided in **Appendix 6** of this document.

Tides

Tides within the region are characterized as mixed, semidiurnal, which is characteristic of two tide cycles per day of unequal amplitude. Each tide cycle occurs over a 12 hour 25 minute period resulting in an advance in tide stage of 50 minutes every day. Tide amplitude is normally on the order of 1 meter (3.28 feet) between high and low tide. Peak (spring) tide amplitude is on the order of 1.2 meters (3.94 feet). Site specific water levels were measured as part of the field data collection effort. Representative data from this deployment is provided in **Figure 8-7**. In general, tides correlated well with projected tides for the site. Deviations from projected values were attributable to local sea and wind conditions.

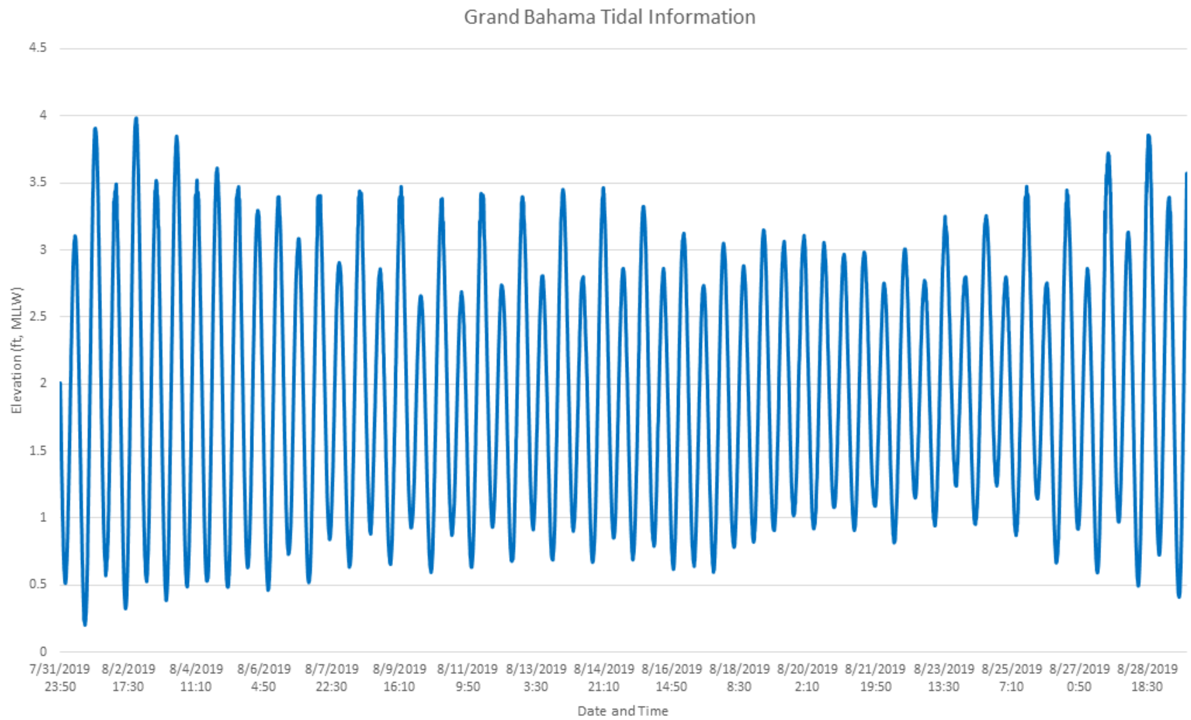

Figure 8-7. Representative tide measurements within the project area.

Currents

Figure 8-8 presents the facility footprint relative to the position of the two Acoustic Doppler Current Profilers (ADCPs) deployed from February 22, 2019 to April 11, 2019 by Sea Diversified, Inc. (SDI) and used to gather site-specific information on waves, currents, and water levels at the project location. Data measurements from this gauge deployment are provided in **Appendix 6**.

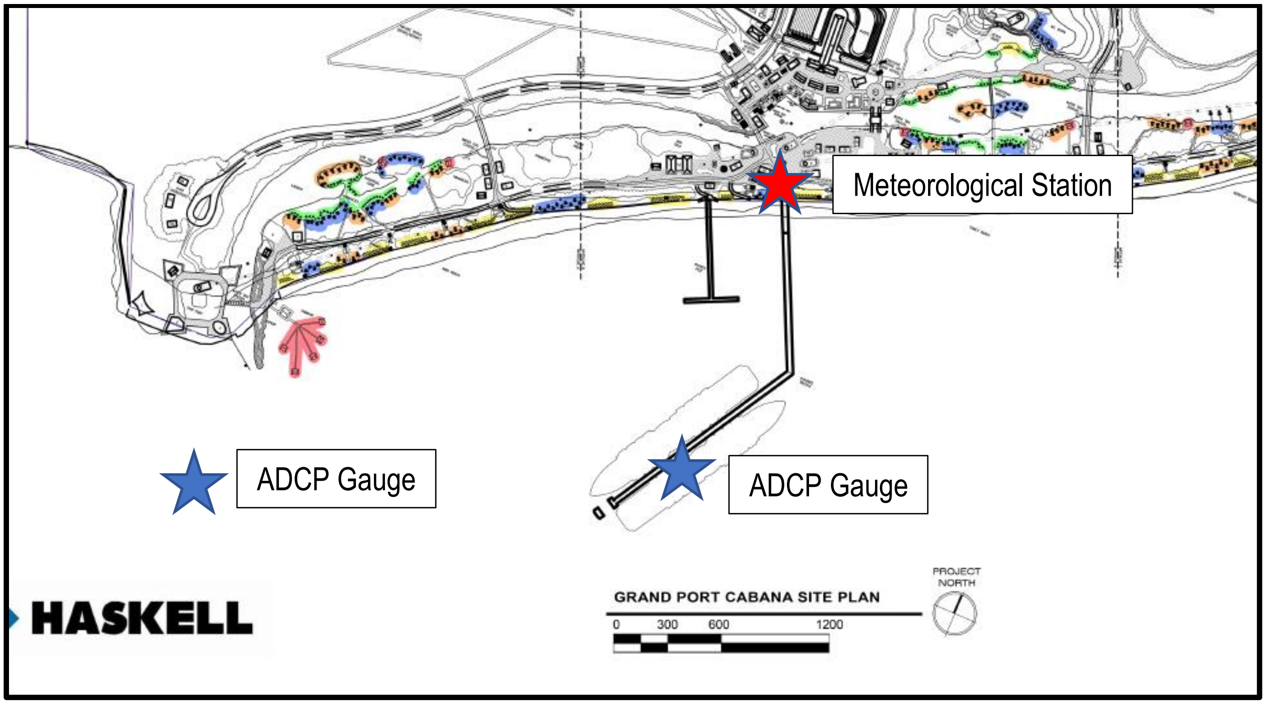

Figure 8-8. ADCP/Meteorological Gauge Deployment Locations.

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

Measured currents at the site are mild and appear to be both tidally and wind driven, with the potential for limited regional circulation effects. Maximum measured velocities (averaged over depth) of approximately 0.25 m/s (0.5 knots) were recorded at both ADCP locations. Regional ocean depth averaged current roses for the two locations are shown on **Figures 8-9 and 8-10**. The mean depth averaged currents over the entire time series are less than 0.1 m/s (0.2 knots) for both locations. The site, in general exhibits mild current velocities well within the operational envelope of the proposed facility. Current is primarily attributable to tidal forcing and localized winds. While seasonal variability likely occurs at the site, the overall magnitude of variability that could be attributed to reported seasonal tidal and wind variations is minimal. Currents at the site flow predominantly westward with a slight west southwest component. Maximum westerly current is on the order of 0.25 m/s and maximum easterly current is on the order of 0.2 m/s. Current distributions are presented in **Figure 8-9 and 8-10**. Tidal currents are further addressed in **Appendix 6**. This result is consistent with wind dominant circulation. Current reversals are common, likely due to tides or regular wind shifts, and an easterly or east northeast flow is commonly exhibited, though with less frequency and speed. In general, these currents follow the orientation of the local shoreline. This is expected due to the orientation of the nearshore bathymetry and shelf in the project area influencing currents to travel in these directions. Given the generally mild current environment, changes in site bathymetry will have a negligible impact on current flow. Note that this study used the standard convention for direction in which positive magnitude is in the direction to which the current is traveling. This is contrary (opposite) of the standard convention utilized for wind direction.

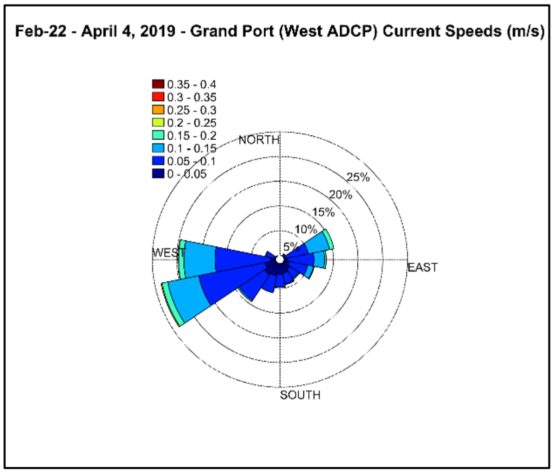

Figure 8-9. West Location ADCP Depth-Averaged Current Rose

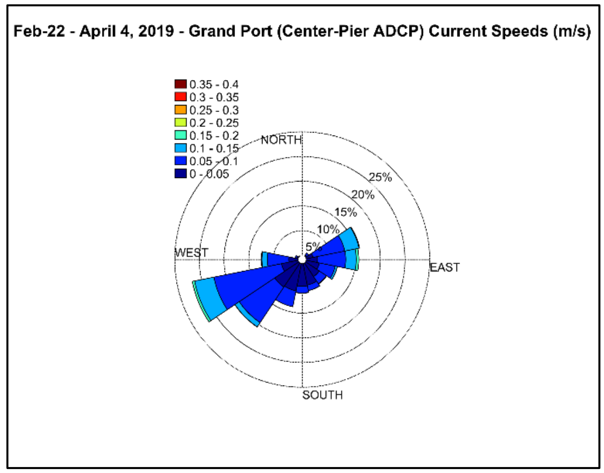

Figure 8-10. Center Pier Location ADCP Depth-Averaged Current Rose

Waves

The deployed ADCP instruments also recorded local wave characteristics, including wave heights (H_s), peak wave periods (T_p), and peak wave directions (D_p). In general, waves of any significance had peak periods less than 6 seconds during the gauge deployment. Longer-period swell (up to ~12 seconds) was measured but heights of these waves were less than 1 foot. The largest observed wave height measured during the gauge deployment was approximately 1.7 m. In general, the most common larger wave heights (1 to 1.5+ m) came from the southerly direction and had periods of 3.5 to 6 seconds. These regular, relatively larger wave events coincided with higher windspeeds, generally from southerly directions. Wave roses and summary tables of measured ADCP wave data are found in **Appendix 6**.

Wave heights are reported with respect to significant wave height (H_s) which is a statistical basis for project design and represent the mean of the highest one-third wave heights within a given sea state. Significant wave height is greater than the average wave height for a given wave sea state, but is representative of the nominal wave height that is generally used to describe a sea state. Larger waves than this height will occur, though they will be rare and not representative of general conditions.

In general, wave data recorded at the project site by the two bottom-mounted ADCPs were:

- Primarily from southerly directions, with south southeast incident waves being the most common.
- Mean significant wave heights (H_s) were typically under 0.5 m at both gauge locations, but heights of 1.0 m to 1.5 m and larger were observed on a regular basis.

PART 1 – Peak wave periods (Tp) ranged from approximately 3.5 to 12 seconds, with 3.5 to 6 seconds being the most commonly observed periods.

PART 2 – Longer periods coincided with lower wave heights. Wave heights associated with local/regional wind events typically exhibited wave periods between 3.5 to 6 seconds.

PART 3 – At the ADCP locations, the largest observed significant wave heights (H_s) were over 1.7 m with periods of ~5 seconds oriented from the southeast. This condition represents the largest wave conditions that were observed due to locally generated wind-wave conditions.

Due to the short-term observation length of the ADCP measured site waves, long-term wave data in the area was also evaluated utilizing NOAA's WaveWatch III (WW3) wave model. The WW3 model has been thoroughly tested worldwide and the operation wave forecasting systems at NOAA are based on the WW3 model. The project site is located within the WW3 model's 10-Minute Atlantic Grid **(**see **Figure 8-11**) which provides wave hindcast data over an approximately 14-year period or record (Feb. 2005 - Dec. 2018).

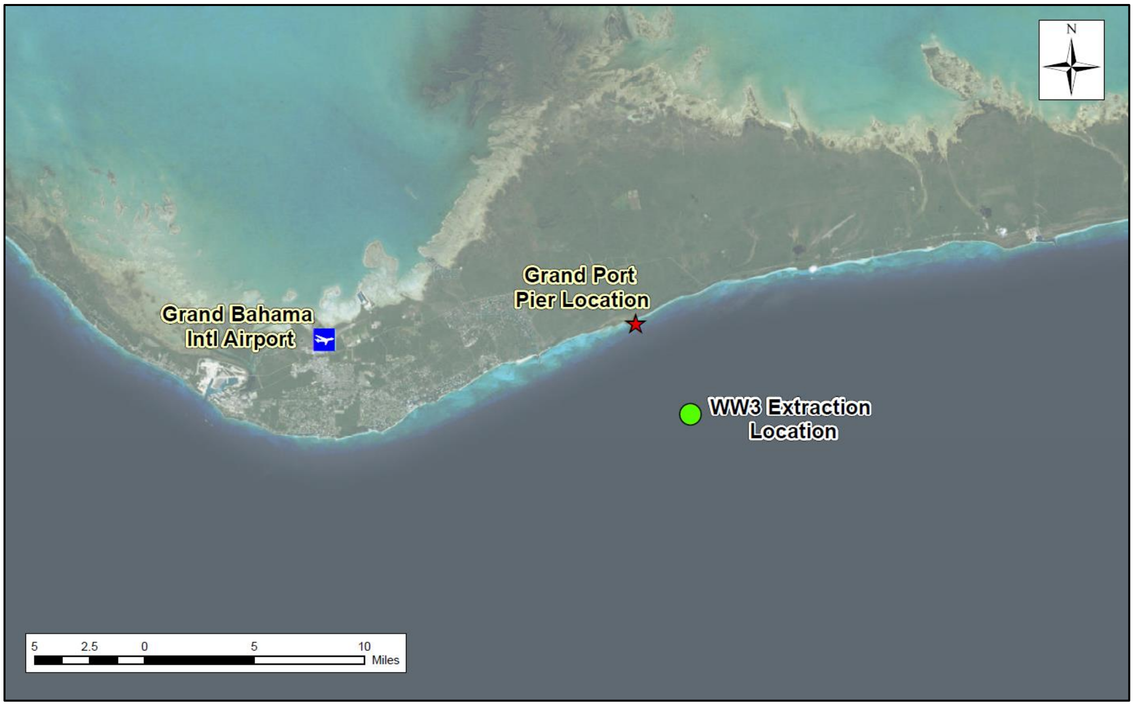

Figure 8-11. Grand Bahama-Freeport International Airport (Wind Data Location - Used for Operational Downtime Analysis) Relative to Project Site

Figures 8-12 and 8-13 provide a summary wave height and period roses based on NOAA's WW3 ~14-year dataset. **Table 8.3** provides summary wave statistics for the WW3 dataset. These long-term datasets provide better indication of operational and extreme event conditions just offshore of the subject site. Based on the prevailing direction (from the southeast to east southeast), and comparing to the ADCP measured site wave data, it is likely these offshore waves propagate to the site with some refraction and shoaling occurring. This is evident in the slightly more shore-normal incident wave directions (south southeast to southeast) recorded by the ADCPs at the site.

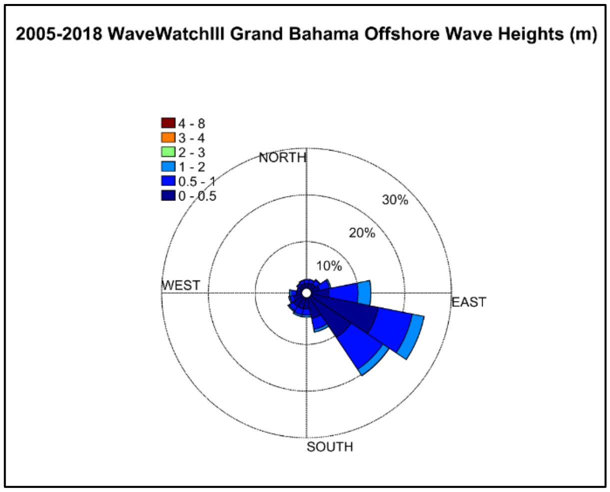

Figure 8-12. Wave Height Rose of NOAA WW3 Dataset

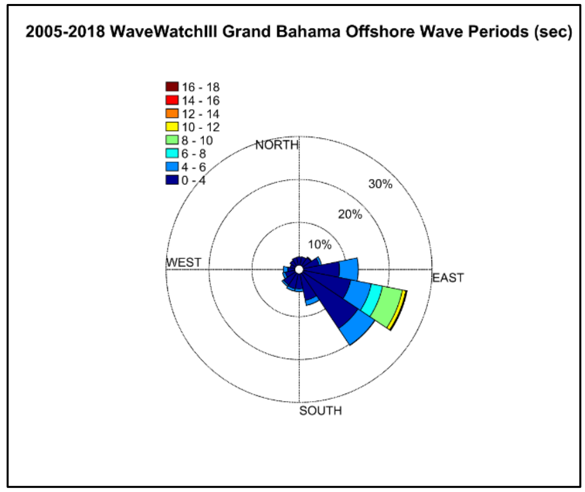

Figure 8-13. Wave Period Rose of NOAA WW3 Dataset

Table 8.3. NOAA WaveWatch III - Wave Characteristics Data Summary

Incident Wave Direction (Degrees)				*WW3 Offshore Wave Heights, m*						*WW3 Offshore Wave Periods, sec*							
				0-0.5	0.5-1	1-2	2-3	3-4	4-8	0-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
N	**-11.25**	***to***	**11.25**	1.1%	0.8%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NNE	**11.25**	***to***	**33.75**	1.3%	0.7%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NE	**33.75**	***to***	**56.25**	1.3%	1.2%	0.1%	0.0%	0.0%	0.0%	2.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ENE	**56.25**	***to***	**78.75**	1.8%	2.2%	0.3%	0.0%	0.0%	0.0%	3.8%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
E	**78.75**	***to***	**101.25**	3.8%	6.4%	2.8%	0.0%	0.0%	0.0%	8.6%	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ESE	**101.25**	***to***	**123.75**	14.9%	7.5%	2.6%	0.0%	0.0%	0.0%	11.5%	5.0%	2.7%	4.8%	0.8%	0.2%	0.1%	0.1%
SE	**123.75**	***to***	**146.25**	10.6%	8.3%	1.6%	0.1%	0.0%	0.0%	15.8%	4.8%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
SSE	**146.25**	***to***	**168.75**	4.6%	2.5%	0.6%	0.0%	0.0%	0.0%	6.4%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
S	**168.75**	***to***	**191.25**	2.4%	1.3%	0.4%	0.0%	0.0%	0.0%	3.6%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SSW	**191.25**	***to***	**213.75**	2.5%	1.4%	0.4%	0.0%	0.0%	0.0%	3.6%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SW	**213.75**	***to***	**236.25**	2.5%	1.1%	0.3%	0.0%	0.0%	0.0%	3.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSW	**236.25**	***to***	**258.75**	1.8%	0.8%	0.3%	0.0%	0.0%	0.0%	2.3%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
W	**258.75**	***to***	**281.25**	1.2%	1.1%	0.4%	0.0%	0.0%	0.0%	1.7%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WNW	**281.25**	***to***	**303.75**	0.6%	0.5%	0.1%	0.0%	0.0%	0.0%	1.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NW	**303.75**	***to***	**326.25**	0.9%	0.6%	0.1%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NNW	**326.25**	***to***	**348.75**	1.1%	0.7%	0.1%	0.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Analysis of the long-term wave dataset suggests that the measured wave climate is generally representative of the site. The site is fairly protected from open ocean swell and is primarily influenced by local and regional wind patterns. The primary directions of wave exposure are to the south and particularly to the south-southeast. Extreme wave events may occur, though such events are rare and directly attributable to discrete weather events (particularly tropical cyclones).

Wind

An analysis of long-term wind conditions in the project vicinity was conducted utilizing short-term wind measurements at the site with correlation to long-term data for the region. The long-term wind dataset from the Grand Bahama Airport was modified to correct for terrain effects and length of measurement record relative to the project site. Sensor elevation of 10 m was confirmed by visual observation of the anemometer at the airport by Sea Diversified staff on 6/5/19 and no elevation correction was applied. The data as modified represents a corrected open ocean windspeed at an approximate 10-m elevation and 10-minute time average consistent with the wind basis utilized for the simulations. Terrain effects were converted to overwater estimates based on the method of Resio and Vincent, (1977). Conversion of readings to a 10-minute measurement period was conducted utilizing the method of Simiu and Scanlan (1978).

The Freeport/Grand Bahama International Airport dataset (downloaded from NOAA's National Center for Environmental Information) spans from 1973 to 2019 and represents the best available long-term dataset near the site suitable for probability analyses. Several other sources and wind datasets were considered and utilized for other purposes (such as quality assurance), but these datasets do not cover a period of time significantly long enough for statistical purposes regarding operational downtime assessments. The airport windspeed data was adjusted for terrain for ATM's analysis and for assurance that the directional data of the airport is generally representative of conditions at the project location, the airport data was compared to both met stations deployed by Sea Diversified over the deployment period of 2/23/19 to 5/22/19. The wind speed headings of the three datasets generally correlated well, although with some variability (particularly at the Port Lucaya station), which is not unexpected given the differences in locations and surrounding conditions and terrain.

Additionally, the Equinor/Stat Oil Station just east of High Rock and ~16.5 miles from the project location also has a wind gauge sensor and produces daily logs, which were provided by Equinor, and these report predominant daily directions. Due to the similarities in settings and exposures between this station and the project location, the Stat Oil station daily logs were also compared with the airport dataset and showed overall consistent wind direction correlation. Shipboard reported windspeeds were also considered for use in verification of the airport. Only a limited amount of data and information is known in relation to ship anemometer heights and these do not represent consistent time intervals of observations. However, a reasonable correlation of wind directions was seen through a direct comparison of the ship, airport, and site stations for the observed periods where ship data is present for 2019. To further verify if the airport wind data can be considered representative of site conditions, Sea Diversified staff visited the airport on June 5, 2019, to compare real time measurements between the deployed met stations and the airport sensors. The airport currently has three wind stations in place, two of which were installed in January 2019 (it uncertain whether these stations remain operational post-Dorian). The stations are configured so two are at opposing sides of the runway, ~2 miles apart and the third is situated in the midway between these as a redundant instrument. Sea Diversified deployed two gauges at Sharp Rocks Point and both showed consistent readings with each other and were consistent with real time measurements from the airport. The Port Lucaya gauge reportedly showed more turbulence in real time, likely due to the surrounding physical environment.

Based on the modified airport data set, the number of anticipated days per month and year in which the wind would exceed 20 knots and 25 knot wind thresholds were calculated. These are presented in **Table 8.4** for all directions and the northeast and southeast quadrants. A summary of conclusions is provided below:

- While winds are most prevalent from the southeast for all velocities, stronger winds above 20 knots are most prevalent from the northeast quadrant and also occur to a lesser extent from the southeast quadrant.
- Wind velocities exceed 20 knots approximately 13.2 percent of the time from all directions. For the northeast quadrant, winds exceed 20 knots 5.9 percent of the time, and for the southeast quadrant 3.0 percent of the time.
- Wind velocities exceed 25 knots approximately 3.8 percent of the time from all directions. For the northeast quadrant, winds exceed 25 knots 2.0 percent of the time, and for the southeast quadrant 0.5 percent of the time.

As anticipated, higher wind velocities occur more frequently during late fall and winter months (from October through April) with peak occurrence in March. For March, winds exceed 20 knots 21.3 percent of the month for all directions. For the northeast quadrant, winds exceed 20 knots 7.4 percent of the month. For the southeast quadrant, this occurs 5.2 percent of the month.

While winds above threshold occur to a lesser extent from the southeast quadrant, there is greater exposure from this direction for wind induced seas. Winds from the northeast quadrant are also subject to terrain effects at the subject site.

Table 8.4. Estimate of Operation Downtime in Days

Operational Downtime (Days) Based on Grand Bahama-Freeport International Airport Wind Records				
Time Period	**Windspeed Threshold**	***Winds From Any Direction***	***Winds From Northeast Quadrant***	***Winds From Southeast Quadrant***
Annual / All Months	**>20 knots**	*48.2*	21.5	11.0
	>25 knots	*13.8*	7.3	1.9
January	**>20 knots**	*6.0*	2.0	1.0
	>25 knots	*1.9*	0.7	0.2
February	**>20 knots**	*5.5*	1.7	1.0
	>25 knots	*1.7*	0.6	0.2
March	**>20 knots**	*6.6*	2.3	1.6
	>25 knots	*1.9*	0.8	0.2
April	**>20 knots**	*4.9*	1.8	1.4
	>25 knots	*1.1*	0.5	0.2
May	**>20 knots**	*3.4*	1.8	1.0
	>25 knots	*0.8*	0.6	0.1
June	**>20 knots**	*1.7*	0.7	0.5
	>25 knots	*0.3*	0.2	0.1
July	**>20 knots**	*1.0*	0.2	0.6
	>25 knots	*0.2*	0.1	0.0
August	**>20 knots**	*1.7*	0.5	0.8
	>25 knots	*0.4*	0.2	0.2
September	**>20 knots**	*2.1*	1.1	0.7
	>25 knots	*0.6*	0.4	0.2
October	**>20 knots**	*5.3*	4.0	0.7
	>25 knots	*1.8*	1.6	0.1
November	**>20 knots**	*5.1*	3.3	0.9
	>25 knots	*1.6*	1.2	0.2
December	**>20 knots**	*4.9*	2.0	1.0
	>25 knots	*1.4*	0.6	0.1
**Period of observation record from 1973-2019*				
***Windspeeds were adjusted from terrain measurements to overwater 10-minute averaged windspeeds for this Operational Downtime Analysis*				

It is additionally worth noting that conditions which may result in operational downtime are primarily associated with the passage of cold fronts typical of winter weather patterns and tropical systems in the late summer and fall. As such, operational downtime is more likely to occur in the fall and winter and is less likely during the late spring and early summer seasons.

Given that site exposure primarily occurs towards deep water adjacent to the proposed pier, it is unlikely that corrective measures (such as a breakwater) could be implemented to mitigate conditions that result in operational downtime. Such a structure would only be effective for a narrow range of conditions affecting operational downtime and the cost of such a structure would likely not be justifiable in terms of the realized benefit to increased site availability.

Hurricanes and Tropical Storm Events

Grand Bahama is situated within the most active region for tropical cyclone activity in the western Atlantic. On average, the island is impacted by a tropical storm event every 1.63 years (ref. hurricane city) and experiences hurricane force winds on average every 4.08 years. The island experiences on average landfall of a major hurricane (category 3 or greater) every 9.19 years. The recent passage of Hurricane Dorian represents the most significant recorded impact to the area. Additional storms of note include the 1947 hurricane and Hurricanes Francis and Jeanne which both made landfall in the project vicinity in 2004. Based on NOAA's National Hurricane Center (NHC) data, over the past ~50-years, six named storms (i.e. hurricanes of Category 1 or greater) have come within 65 nautical miles of the site and/or significantly impacted the area (see **Figure 8-14**). Note this figure does not include the recent track of Hurricane Dorian. Historic records of these type events form the basis of predicting design conditions at the subject site.

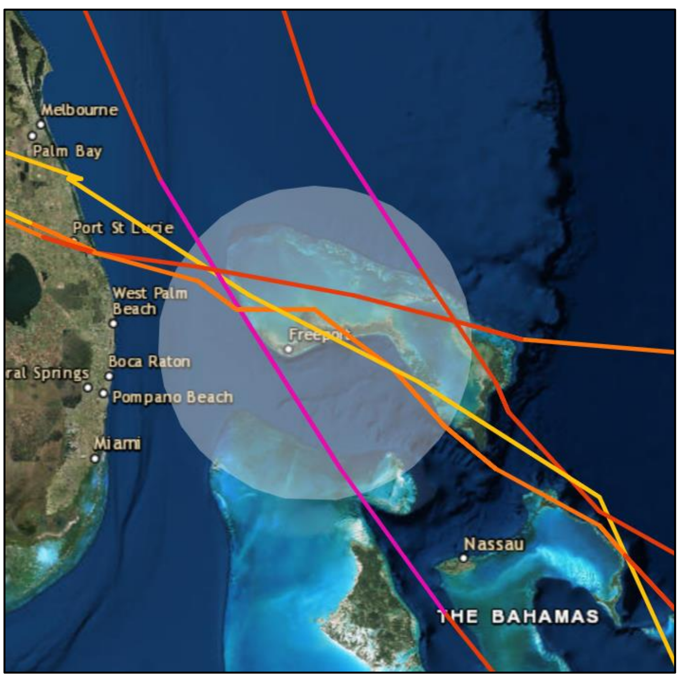

Figure 8-14. NOAA National Hurricane Center -Named Hurricane Tracks within 65 Nautical Miles of the Project Site (1967-2018)

Extreme event (return period) design conditions are developed based on statistical analysis of long-term records. The long-term observation record at the Grand Bahama-Freeport International Airport was used to determine extreme event wind speeds and NOAA's WaveWatch III model (WW3) dataset was used to determine extreme event wave characteristics. An extreme value analysis was conducted using the annual maxima method for each of these long-term datasets to provide the summary extreme event return period conditions found in **Tables 8.5 and 8.6**.

Table 8.5. Extreme Event Return Period Wind Speeds (10-min Windspeeds)

Return Period (Years)	Wind Speed From Any Direction (Knots)	Wind Speeds From Southerly Exposures (Knots)
1	53.1	35.2
5	73.0	51.2
10	84.4	61.5
25	97.0	73.9
50	105.4	82.6
100	113.1	90.9

Table 8.6. Extreme Event Return Period Wave Heights (by Direction) at the NOAA WW3 Offshore Point

Return Period (Years)	West H_s (m)	Southwest H_s (m)	South H_s (m)	Southeast H_s (m)	East H_s (m)	All Directions H_s (m)	Southerly Exposures H_s (m)
1	1.2	1.6	1.3	1.3	1.4	1.6	1.5
5	2.1	3.1	3.2	3.3	2.4	4.0	3.9
10	2.3	4.4	4.4	4.5	2.7	5.5	5.4
25	2.6	6.3	6.2	6.3	3.0	7.7	7.6
50	2.7	7.9	7.6	7.8	3.3	9.5	9.4
100	2.8	9.6	9.1	9.3	3.5	11.4	11.3

Extreme Event Storm Surge

Reported values for storm surge by return interval is provided in **Table 8.7** (GAR, 2015). While the project area is exposed to surge impacts, the potential is limited by the fetch of the Northwest Providence Channel and the limited width of the nearshore shelf. Surge is an issue for the area primarily due to the relatively low coastal elevation as the magnitude of potential surge is relatively mild in comparison to other regions. It is again noted that data from Hurricane Dorian is not included in this analysis.

Table 8.7. Summary of Reported Storm Surge Values by Return Interval (GAR, 2015)

Return Period (Years)	m, MSL
10	1.5
25	2.2
50	2.3
100	2.5
250	3.0

Sea Level Rise

Relative sea level (RSL) has been rising within the region since the beginning of the Holocene Epoch with the end of the last major glaciation cycle approximately 11,650 years before present. The rate of sea level rise (SLR) has varied significantly over this time and the issue has increased in urgency given the potential for SLR acceleration due to climate change. RSL is the sum of a number of global and regional factors that influence sea level, most importantly the local rate of subsidence and the global rate of (eustatic) SLR. The UNFCC Climate Change Report (2014) quantified the relative rate of vertical movement (subsidence) of Grand Bahama at 0 to 0.5 mm/year based on analysis of long-term tide records from Settlement Point. This value is less than reported values for subsidence in Florida and suggests relative geologic stability. This does not account for the rise associated with other factors, most notably eustatic sea level.

Various studies and methods are available for prediction of SLR. Utilizing the nearest NOAA tide stations with past sea level trends back to the mid-1970s (locations that may be generally representative of the region) would project relative mean SLR ranging from 0.9 foot to 1 foot in 100 years if considering the higher end of the 95% confidence limits at each station. This estimate does not include anticipated acceleration in the rate of SLR attributable to climate change.

Projections of global mean sea level (GMSL) rise can also be considered generally representative of the study location as “estimates of observed SLR from 1950 to 2000 suggest that SLR within the Caribbean appears to be near the global mean”, (Caribbean Community Climate Change Centre, 2014). This report cites a 2050 Caribbean SLR projection of 0.24 m (0.8 ft).

The most recent global projections from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2014 project the higher end and worst-case scenario to be just below 1 m by 2100 (shown in red line and confidence cone on **Figure 8-15**). However, other recent works have suggested worst-case upper limits of up to 2 m (Hall, 2016), while a 2017 NOAA modeling study on regional SLR utilized global SLR scenarios ranging from 0.3 m to 2.5 m (~1 ft to 8 ft).

For this study, a design rate of 1.5 feet (0.45m)/century has been adopted. This rate is greater than observed through regional tidal measurement but is within the medium risk estimates provided by current IPCC guidance.

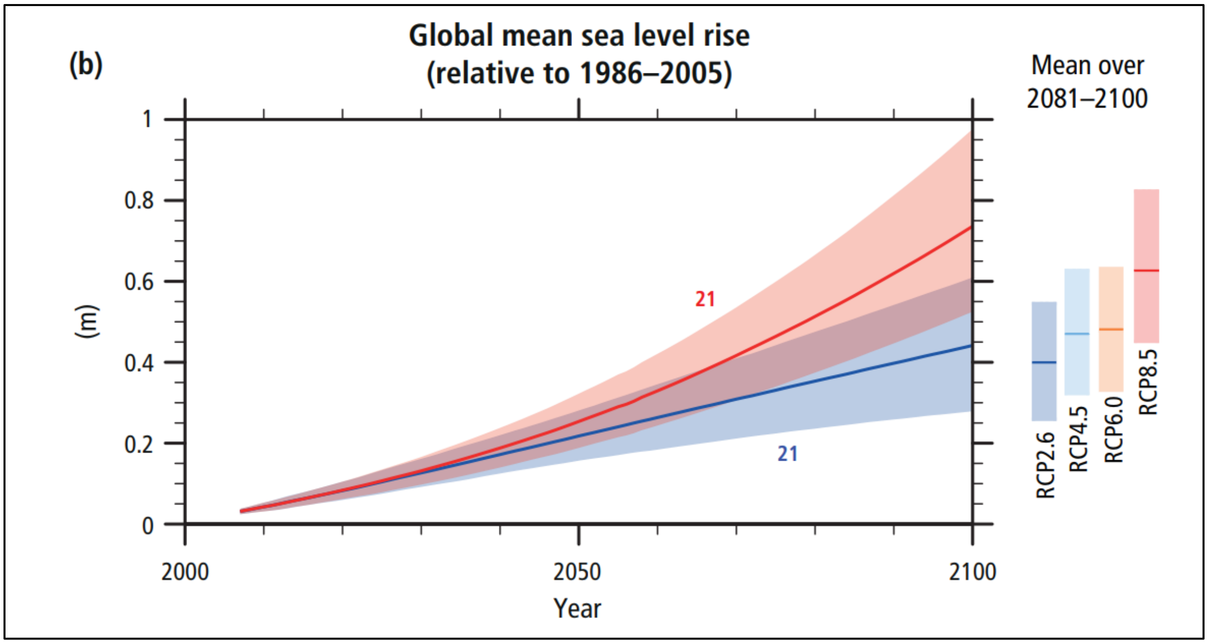

Figure 8-15. Global Mean Sea Level Rise Projections from 2006 to 2100 (IPCC, 2014) and Uncertainties (Shaded) Under Various Emission Scenarios (Blue – Low End, Red – Worst Case).

Coastal and Nearshore Environments

Significant benthic resources are present within the project area including within areas of direct project impacts. These resources are further delineated within **Appendix 7** and consist of extensive nearshore hardbottom communities and seagrass resources, though it is noted that seagrass is not present within the immediate project area. Hardbottom resources range from low profile ephemeral algae dominant communities to significant coral communities including listed species. It is important to note that baseline delineations of these resources presented within this study are based on field studies conducted just prior to Hurricane Dorian. It is likely that significant impacts to portions of these communities likely occurred from Dorian and the extent of these impacts has yet to be determined.

It is additionally noted that Petersons Cay is located approximately one mile to the west of the project area and includes significant environmental resources, particularly listed coral species. A specific habitat delineation of Petersons Cay was included within the baseline field delineations of this study and is provided in **Appendix 7**.

8.13 Benthic Habitat Mapping

It is noted that marine field investigations conducted in support of this study were completed in the summer of 2019 prior to observations and subsequent reports of the presence of Stony Coral Tissue Loss Disease (SCTLD) in Grand Bahama including the project and study area. An additional field effort will be conducted to assess the prevalence of SCTLD within the project area. Currently, The Bahamas are under emergency orders due to the COVID-19 pandemic. Therefore, the borders and many businesses are closed, and physical distancing measures are in place. This precludes the conduction of additional field efforts at this time. This additional field effort will be in addressed as an addendum to this EIA upon completion of the work. As SCTLD may now be present in the project area, we have proactively engaged with SCTLD expertise to begin consideration of appropriate response measures should they be required and will address further within both the field effort and EIA addendum.

8.13.1 Aerial Imagery Survey

The first step in the benthic mapping process was to obtain recent, detailed aerial imagery of the Project Area and PCNP to serve as the base layer from which benthic habitat maps of the seafloor would be created of the two sites. The imagery was collected using an unmanned aerial vehicle; specifically, a DJI Phantom 4 Pro drone equipped with a gimbal-mounted 20 mega-pixel camera.

The aerial survey was conducted from June 21-22, 2019 and covered the proposed survey area for each site plus a buffer zone extending a minimum distance of approximately 35 m [115 ft]) to each side for both the Project Area and PCNP (**Figure 8.16**). Imagery was collected by a USA-licensed drone pilot with Federal Aviation Administration certification. Permission to perform the drone-based survey was obtained through The Bahamas Civil Aviation Authority and clearance from Freeport Airport. The survey of each area was conducted from land on Barbary Beach near Sharps Rock with a flight height of 200 m (656 ft) above ground level.

The total area surveyed at the Project Area was approximately 150 acres and included nearshore waters from the beach extending offshore to approximately the 15 m (49 ft) depth contour. A total of 353 images were collected and total flight duration was approximately 21 minutes using 2 batteries. Flight speed was approximately 25 mph. Weather at the time of the survey was sunny with west winds approximately 5 kns and calm seas. The area surveyed for PCNP was approximately 860 acres and included the cay itself and surrounding waters extending to the beach to the north (lagoon habitats) and extending approximately to the 15 m (49 ft) depth contour to the south (reef habitats) (**Figure 8.16**). A total of 2,754 images were collected and total flight duration was approximately 128 minutes using 9 batteries. Flight speed was approximately 25 mph. Weather at the time of the survey was partly cloudy with southwest winds 5 to 10 kns and calm seas. Aerial images were collected using WGS 1984 BLM Zone 17N geodesy. Aerial imagery frames were mosaicked using Drone Deploy software with 75% front overlap and 65% side overlap. Frames were initially mosaicked in the field for both sites at low resolution for quality assurance and quality control and completeness purposes, then again at higher resolution at CSA. The resultant high-resolution aerial imagery was true color with a resolution of 0.08 m (0.26 ft).

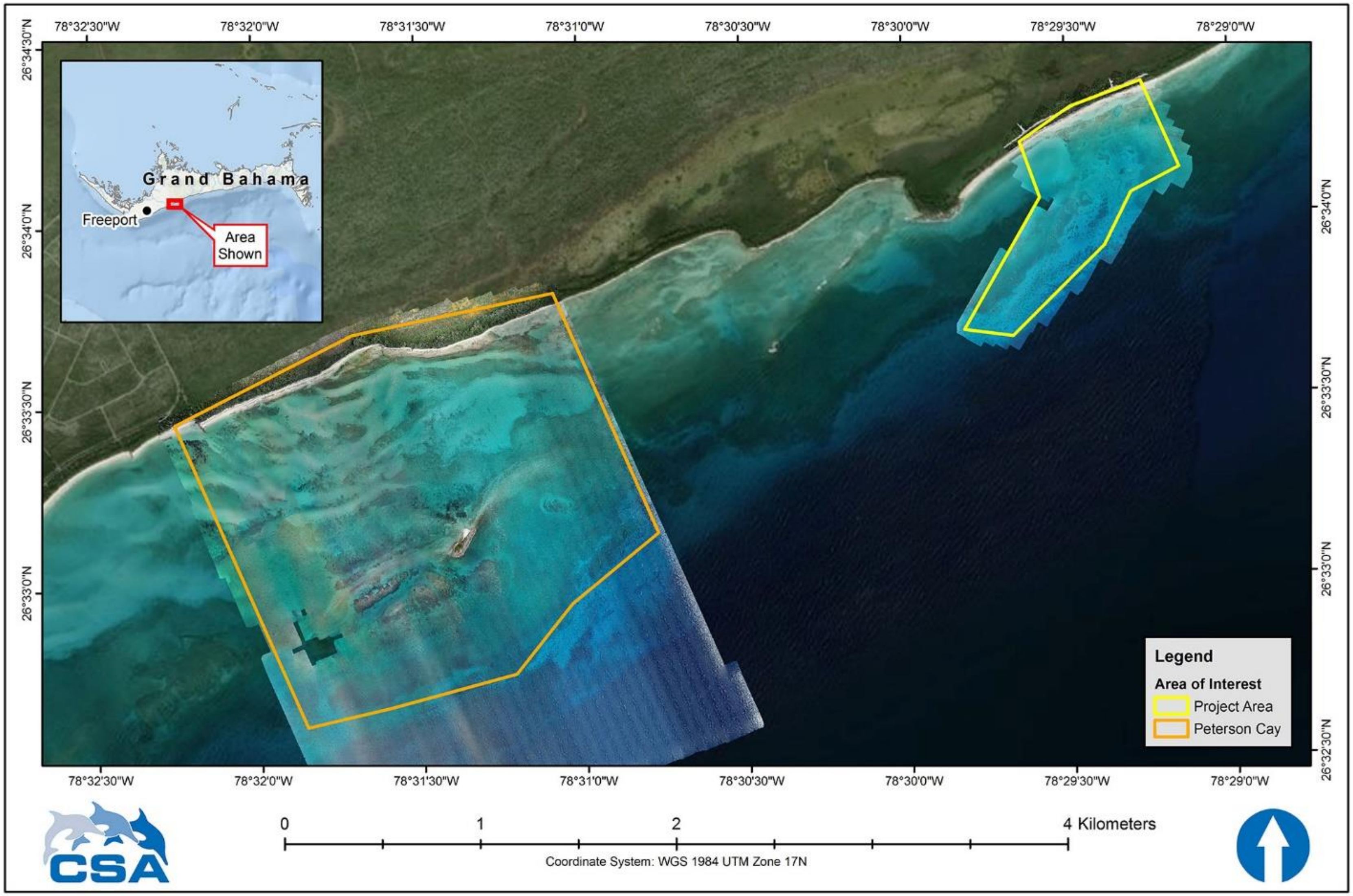

Figure 8-16. Overview map showing survey areas for the Project Area and Peterson Cay National Park.

8.13.2 Benthic Characterization And Groundtruthing Survey

Imagery from the aerial survey was reviewed by a marine biologist and geospatial analyst to identify broad benthic habitats such as hard bottom, sand bottom, seagrass meadows, and patch reefs. These benthic habitats served as the foundation for the diver-based groundtruthing and characterization survey. Groundtruth sampling stations were designated based upon a spatially balanced, random sampling design. The number of stations were allocated in proportion to overall area and complexity of the benthic habitat types (i.e., sand plains did not receive the same sampling intensity as more complex reef habitats).

Diving activities were conducted by a team of four CSA marine scientists/divers over a six-day period from July 26 to 31, 2019 from a 28-ft CSA dive vessel equipped with a Hypack navigation system. At each station, a weighted buoy was first deployed to mark the site. A two-person dive team then entered the water to perform groundtruthing and characterization surveys. A total of 32 groundtruthing stations (referred to hereafter as "Bounce Dive Stations") were surveyed within the Project Area (**Figure 8.17**) and a total of 34 Bounce Dive Stations were surveyed at PCNP (**Figure 8.18**). At each station, a qualitative, descriptive assessment of the benthic habitat type was performed for groundtruthing purposes, and underwater photos/video were collected to document the benthos during a roving diver survey of approximate 15-minute duration. Underwater photos and video were collected using a Canon G12 camera with Fisheye FIX housing and INON strobe and a GoPro Hero 7 Black video camera.

Sixteen Quadrat Stations within the Project Area were also surveyed to obtain quantitative habitat characterization data (**Figure 8.17**). The Project Area was sampled more intensely than PCNP to better inform management decisions regarding marine resources that will be directly impacted by dredging for the port development project. A rapid quantitative benthic assessment was performed at each of these stations via random quadrat sampling (5 × 1 m^2 quadrats, for a total area of 5 m^2) within a 25 m (82 ft) range from the center point of the designated station. Quadrats made of polyvinyl chloride were placed within each station using pre-determined random compass bearings and distances from the center point (**Photos 8.1** and **8.2**). In a few instances, the quadrat location landed on sand substrate adjacent to hardbottom/reef substrate, and the quadrat location was moved slightly in order to survey the hardbottom/reef substrate.

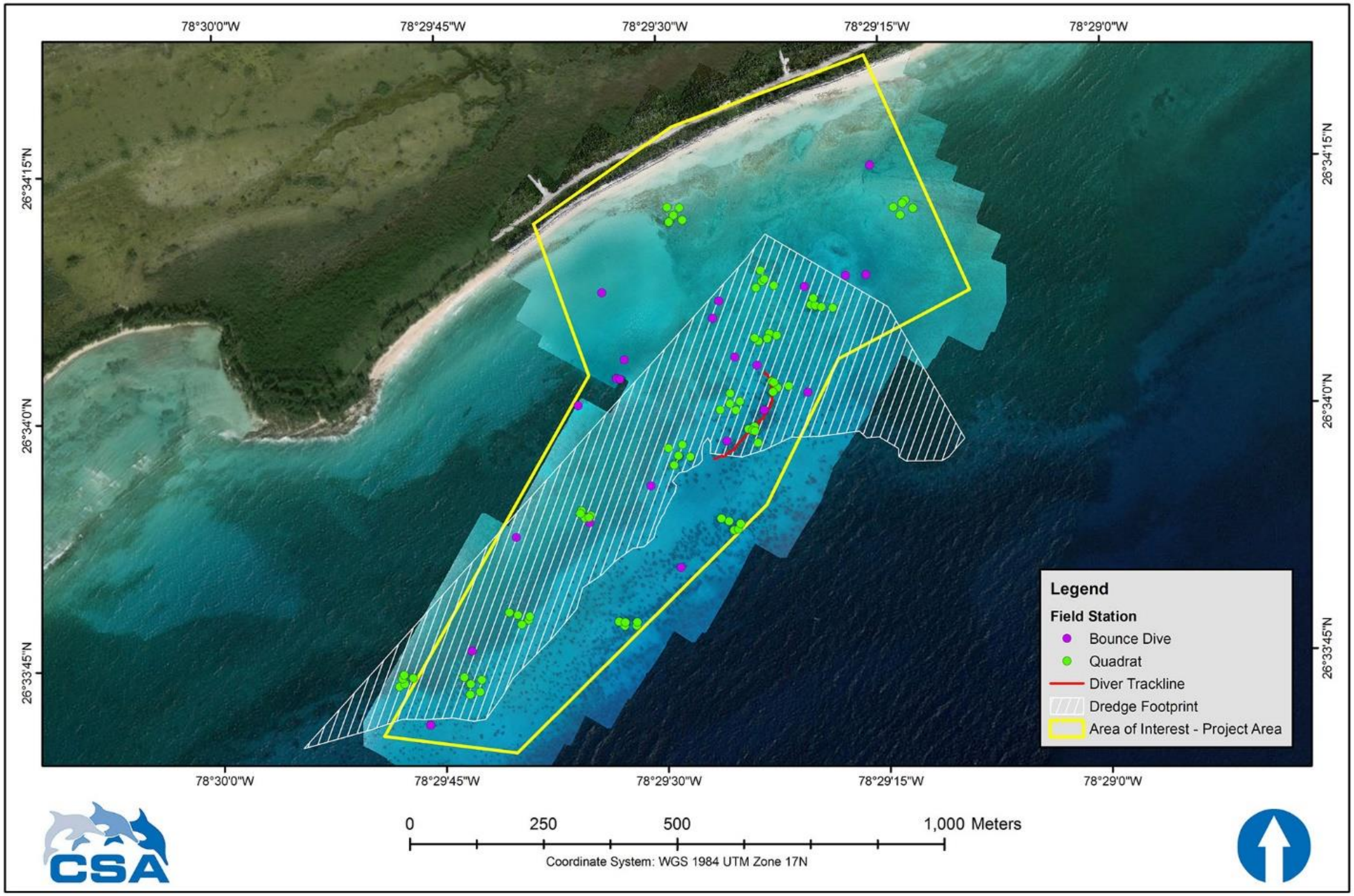

Figure 8-17. Field survey map showing all sampling stations within the Project Area, Grand Bahama.

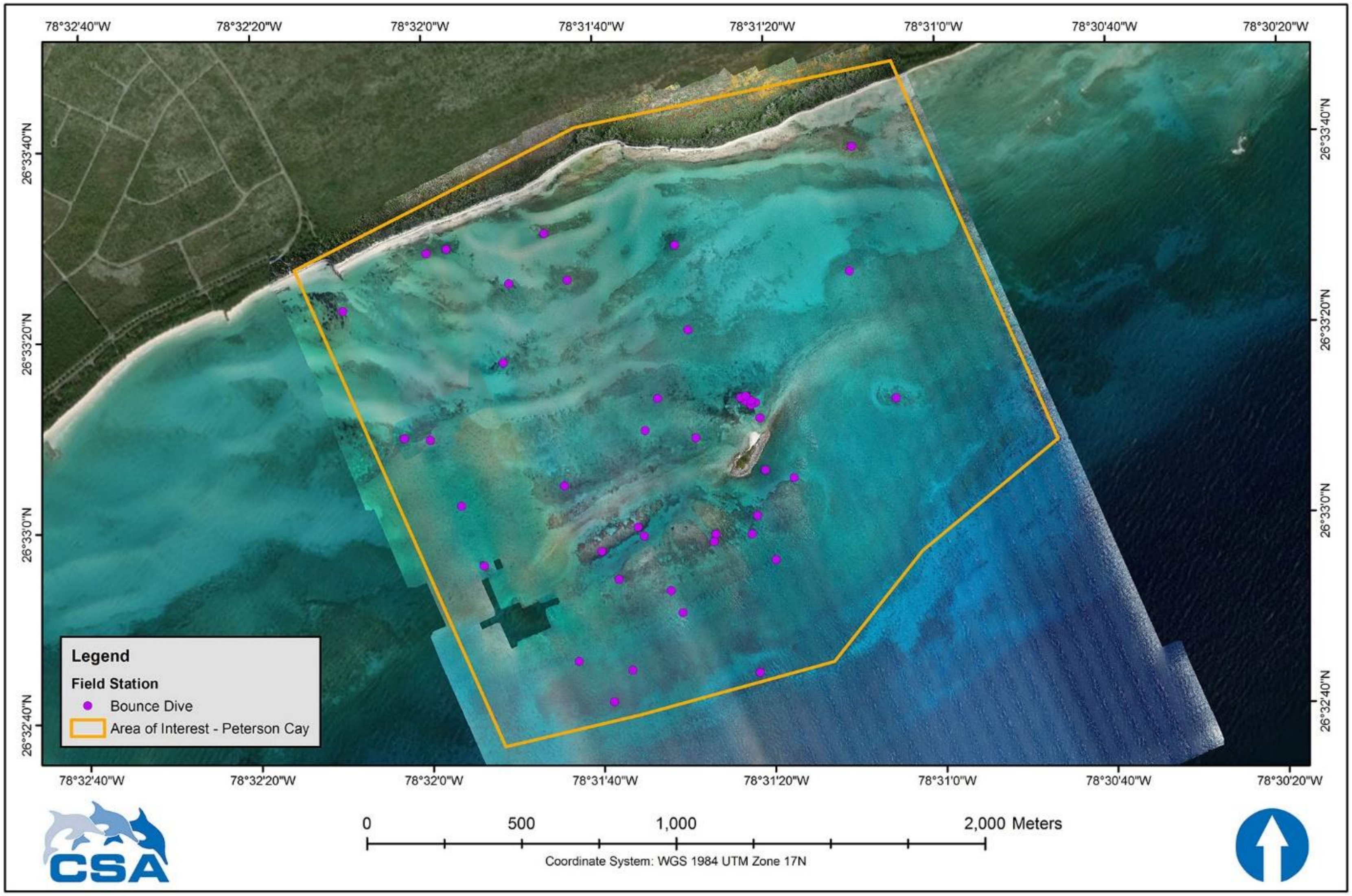

Figure 8-18. Field survey map showing all sampling stations within Peterson Cay National Park, Grand Bahama.

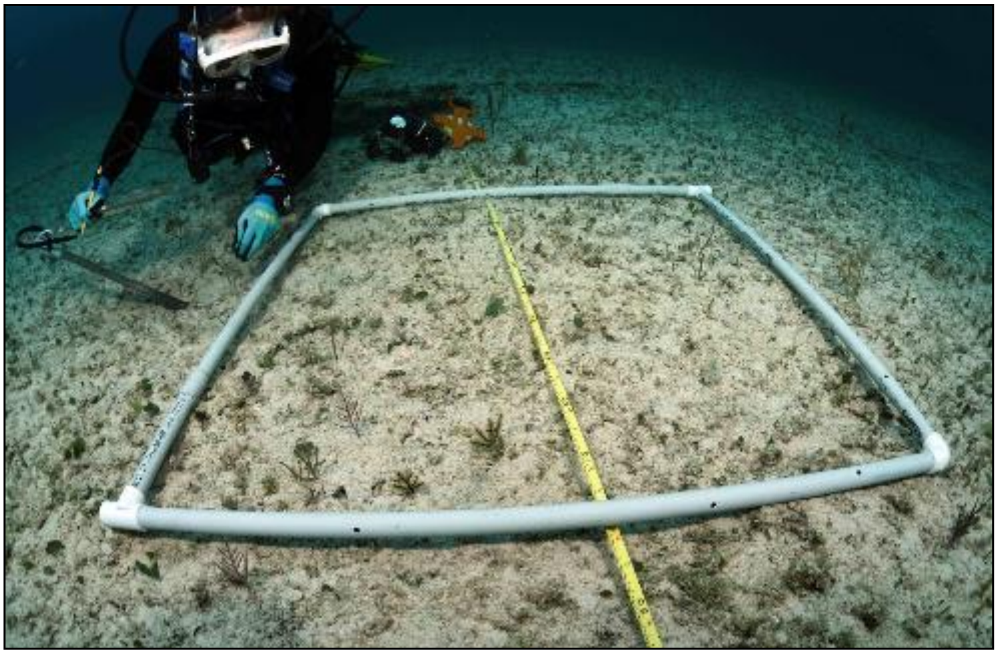

Photo 8.1. Marine biologist performing a quadrat assessment of benthos at Quadrat Station 36 in the Project Area off Grand Bahama on July 29, 2019.

Quadrat sampling entailed a visual assessment of percent cover of abiotic and biotic functional groups. Abiotic substrate groups included sand, hardbottom, and rubble and biotic groups included macroalgae, turf, stony corals, octocorals, sponges, and other fauna (**Photo 8.2**). All flora and fauna present within each quadrat were listed and identified to lowest taxonomic level. All stony corals and octocorals present in the quadrats were counted, assigned to a size class (0-5 cm, 6-10 cm etc.), and assessed for health status (e.g., bleaching, tissue loss, disease). These sample data were used to extrapolate stony coral and octocoral densities (by size class) to larger habitats within the Project Area.

All Endangered Species Act (ESA) and International Union for the Conservation of Nature (IUCN)-listed species (i.e., sea turtles, selected species of stony corals, marine mammals) observed during the entire survey were identified to species and their geographic location recorded. Any areas of special ecological significance were also investigated, and geographic location recorded.

At the completion of each field day, all navigation, video, and still photo data were downloaded and reviewed, and then copied onto multiple storage devices for security and redundancy. Biologists later reviewed the data to assist in providing a general description of benthic habitats and biological communities.

Photo 8.2. Quadrat containing macroalgae, stony corals, octocorals, and sponges at Quadrat Station 38 in the Project Area off Grand Bahama on July 28, 2019.

8.13.3 Benthic Habitat Mapping

Upon completion of the field survey, groundtruthing data collected by divers was incorporated into the aerial interpretation database.

The georeferenced, high-resolution mosaicked aerial image was then used to classify benthic habitat types. The image was subdivided into separate classification polygons based on similar pixel spectral signature ranges. An unsupervised classification was then performed on each classification polygon using a combination of iso cluster and maximum likelihood techniques using ESRI ArcGIS 10.6 software. After running the unsupervised classifications, each polygon was manually interpreted by denoting visually apparent benthic categories. Spectral noise and holes within the classification results were removed and corrected using a combination of majority filter, region group, set null (enhanced boundary edges and removed groups of small non-contiguous pixels that were smaller than a specified value), and eliminate polygon part (eliminated areas that were less than a specified value) tools in ArcGIS. Lastly, a manual classification technique was then applied to the classification with guidance from a geospatial analyst and a marine biologist.

Aerial imagery and groundtruthing data were merged in Geographic Information System to create benthic habitat maps of the seafloor for the Project Area and PCNP. The classified maps contain geographically quantified polygon features of the benthic habitat types. These quantified polygons provide estimates of the various benthic habitat types within the Project Area and PCNP. Several areas of ecological significance were also included in the maps as points or line features.

Project Area

The benthic habitat map of the Project Area resulting from interpretation of aerial imagery is displayed in **Figure 8-19**. The following eight benthic habitat types were identified: Land, Exposed Limestone, Hard Pan, Macroalgal Hard Pan, Sand, Ridge and Swale, Spur and Groove, and Reef Mounds; encompassing a total area of 165.50 acres (**Table 8.8**). Hard Pan habitat had the greatest areal extent within the Project Area (75.69 acres) followed by sand (60.10 acres). Together Hard Pan and Sand habitats accounted for approximately 80% of the Project Area. Other habitats ranged from 7.94 to 0.77 acres (**Table 8.8**).

Table 8.8. Area calculations for benthic habitat types identified from aerial imagery interpretation within the Project Area, Grand Bahama

Habitat	Location	Area (acres)	Area (ft^2)	Area (m^2)	Percent
Land	Project Area	7.94	345,786.41	32,124.74	4.8%
Sand	Project Area	60.10	2,618,096.54	243,230.10	36.3%
Exposed Limestone	Project Area	0.77	33,703.68	3,131.19	0.5%
Macroalgal Hard Pan	Project Area	4.95	215,576.41	20,027.78	3.0%
Hard Pan	Project Area	75.69	3,297,146.44	306,316.15	45.7%
Ridge and Swale	Project Area	7.17	312,463.70	29,028.94	4.3%
Spur and Groove	Project Area	4.41	192,145.84	17,851.00	2.7%
Reef Mounds	Project Area	4.46	194,280.50	18,049.32	2.7%
Total		**165.50**	**7,209,199.50**	**669,759.23**	**100.0%**

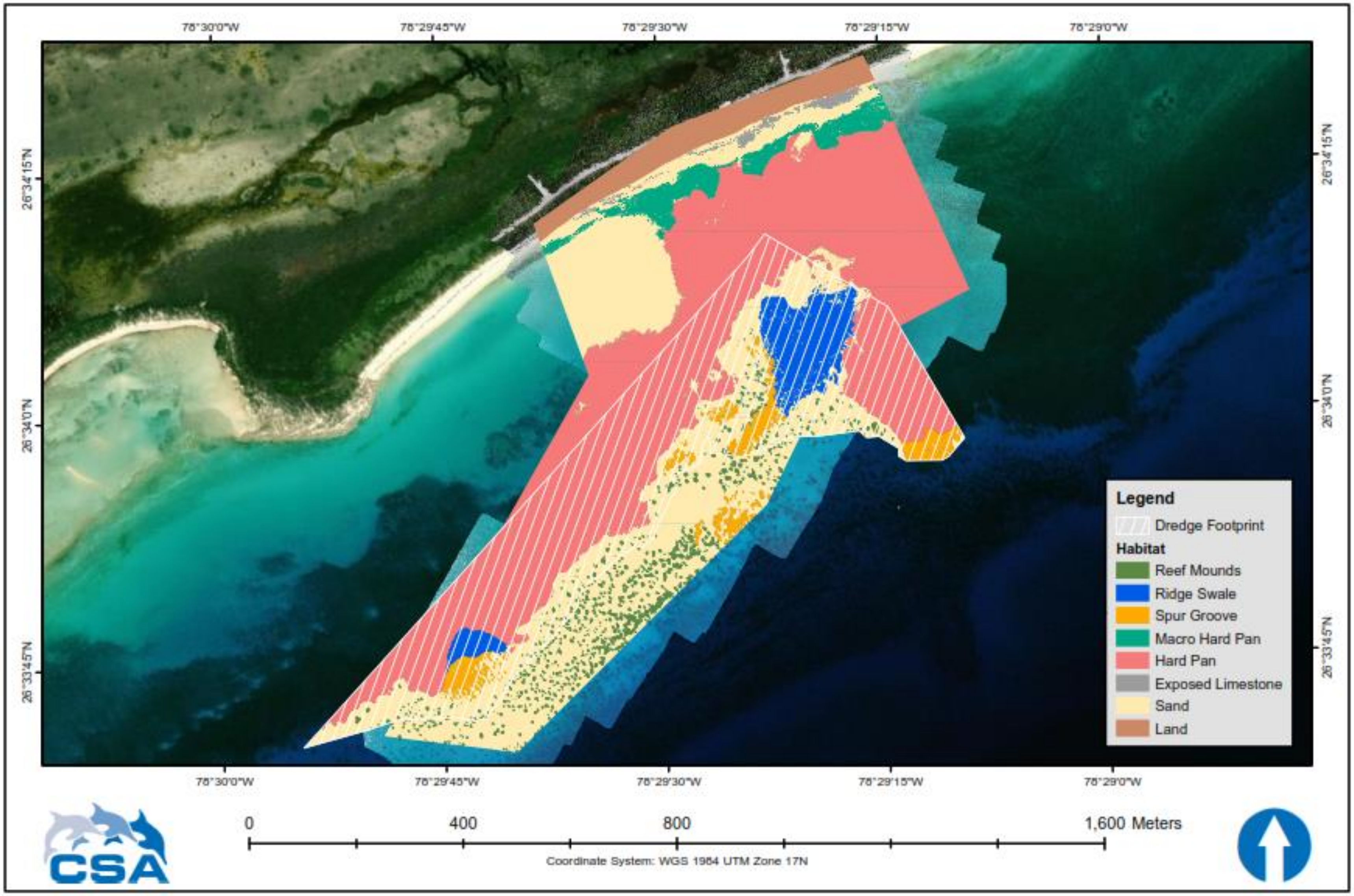

Figure 8-19. Benthic habitat map resulting from interpretation of aerial imagery collected in June 2019 of the Project Area, Grand Bahama.

Habitats falling within the proposed dredge footprint included Sand, Hard Pan, Ridge Swale, Spur Groove, and Reef Mounds, encompassing a total area of approximately 75.60 acres (**Table 8.9**). In parallel with results for the entire Project Area, Hard Pan and Sand were again the two most extensive habitats within the dredge footprint.

Table 8.9. Area calculations for benthic habitat types identified only within the proposed dredge footprint, Grand Bahama.

Habitat	Area (acres)	Area (ft^2)	Area (m^2)	Percent
Land	0.00	0.00	0.00	0.0%
Sand	22.85	995,343.89	92,470.84	30.2%
Exposed Limestone	0.00	0.00	0.00	0.0%
Macroalgal Hard Pan	0.00	0.00	0.00	0.0%
Hard Pan	40.77	1,775,875.44	164,984.89	53.9%
Ridge and Swale	7.17	312,463.69	29,028.94	9.5%
Spur and Groove	3.71	161,817.13	15,033.36	4.9%
Reef Mounds	1.09	47,501.45	4,413.05	1.4%
Total	**75.60**	**3,293,001.62**	**305,931.08**	**100.0%**

Calculations were performed in projected coordinate system WGS 1984 BLM Zone 17N, Units: Feet.

Benthic habitat types found in the Project Area are defined briefly below along with example photos.

- Land – Beach and dry, vegetated upland habitat (**Photo 8.3a**).
- Sand – Soft bottom comprised of primarily calcareous sand with no biological colonization (**Photo 8.3b**).
- Exposed Limestone – Recently exposed limestone with little to no biological colonization in the intertidal and subtidal zones, in water depths less than 1 m (3.3 ft) (**Photo 8.3c**).
- Macroalgal Hard Pan – Hardbottom with low relief (≤0.5 m [1.6 ft]), colonized only by turf and macroalgae, in water depths approximately 1 to 3 m (3.3 to 9.8 ft) (**Photos 8.3d, 8.3e**).

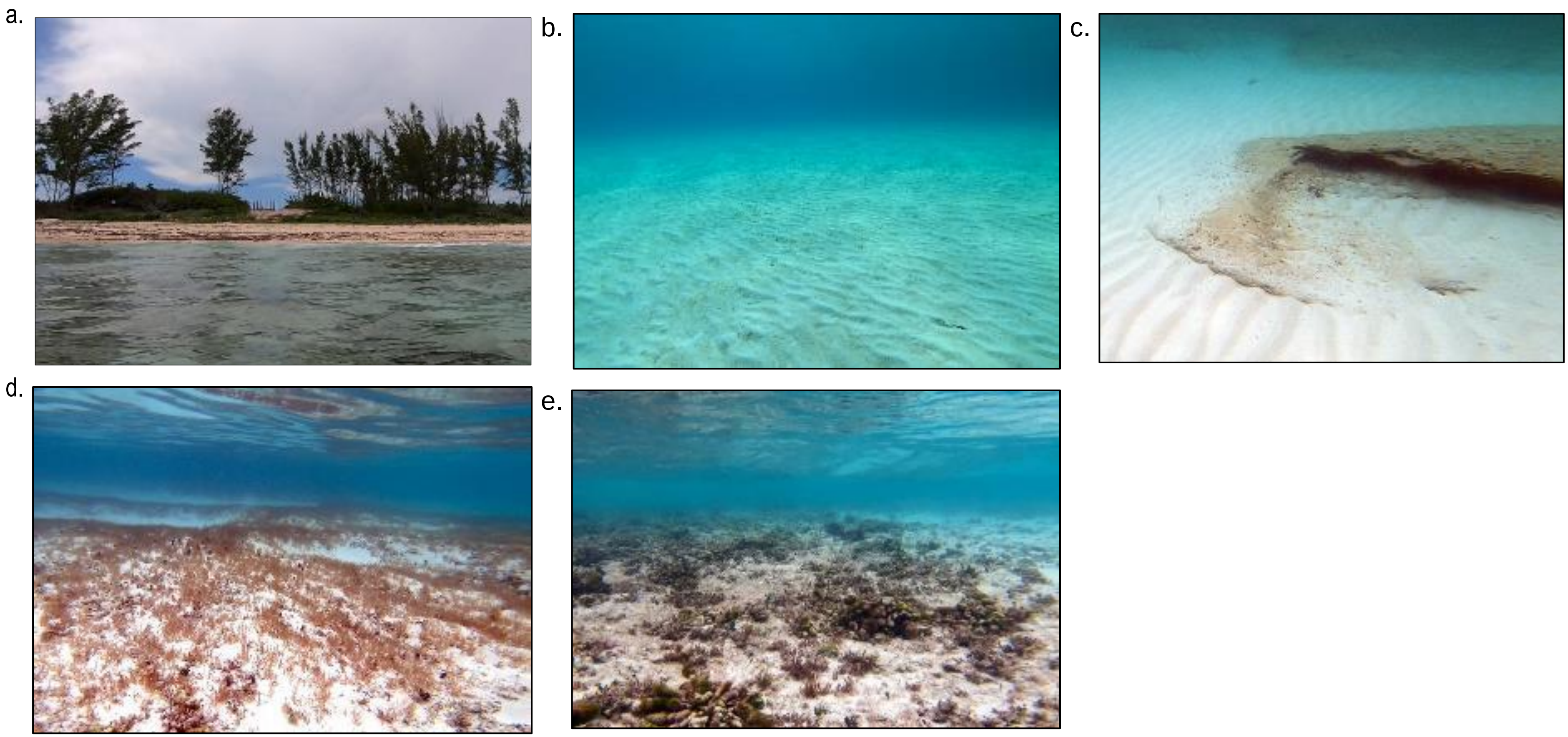

Photo 8.3. Representative photos of various benthic habitats identified in the Project Area, Grand Bahama. a) Land (including beach and vegetated upland), b) Sand, c) Exposed Limestone, d) Macroalgal Hard Pan – example 1, e) Macroalgal Hard Pan - example 2.

Hard Pan – Hardbottom with low relief (≤0.5 m [1.6 ft]), colonized primarily by algae and octocorals with sparse sponges and stony corals, in water depths ranging from approximately 1 to 10 m (3.3 to 33 ft) (**Photos 8.4a, 8.4b**).

Ridge and Swale – Hardbottom with undulating, alternating ridge and swale features. Ridges composed of hardbottom with up to 2 m (6.6 ft) relief colonized by algae, octocorals, sponges, and stony corals. Swales (trough-like low features between ridges) composed of hardbottom rubble and sediment veneer over hardbottom with little to no biological colonization, but often contain detritus. Occurring in water depths from approximately 5 to 15 m (16.4 to 49 ft) (**Photo 8.4c**).

Spur and Groove – Finger-like hardbottom features alternating with sand. Spurs with relief up to 3 m (9.8 ft) and heavily colonized by octocorals, sponges, and stony corals, with lower cover of algae relative to Ridge Swale habitat, in water depths from approximately 5 to 15 m (16.4 to 49 ft) (**Photo 8.4d**).

Reef Mounds – Isolated mounds of limestone hardbottom surrounded completely by sand. Range in maximum diameter from 1 to 10 m (3.3 to 33 ft) with average diameter of approximately 3 m (9.8 ft) and height of approximately 2 m (6.6 ft). Bases of mounds often eroded and undercut. Heavily colonized by algae, octocorals, larger sponges, tunicates, and stony corals. Percent cover of stony corals ≤ 10%. Occurring in water depths from approximately 5 to 15 m (16.4 to 49 ft) (**Photos 8.4e, 8.4f**).

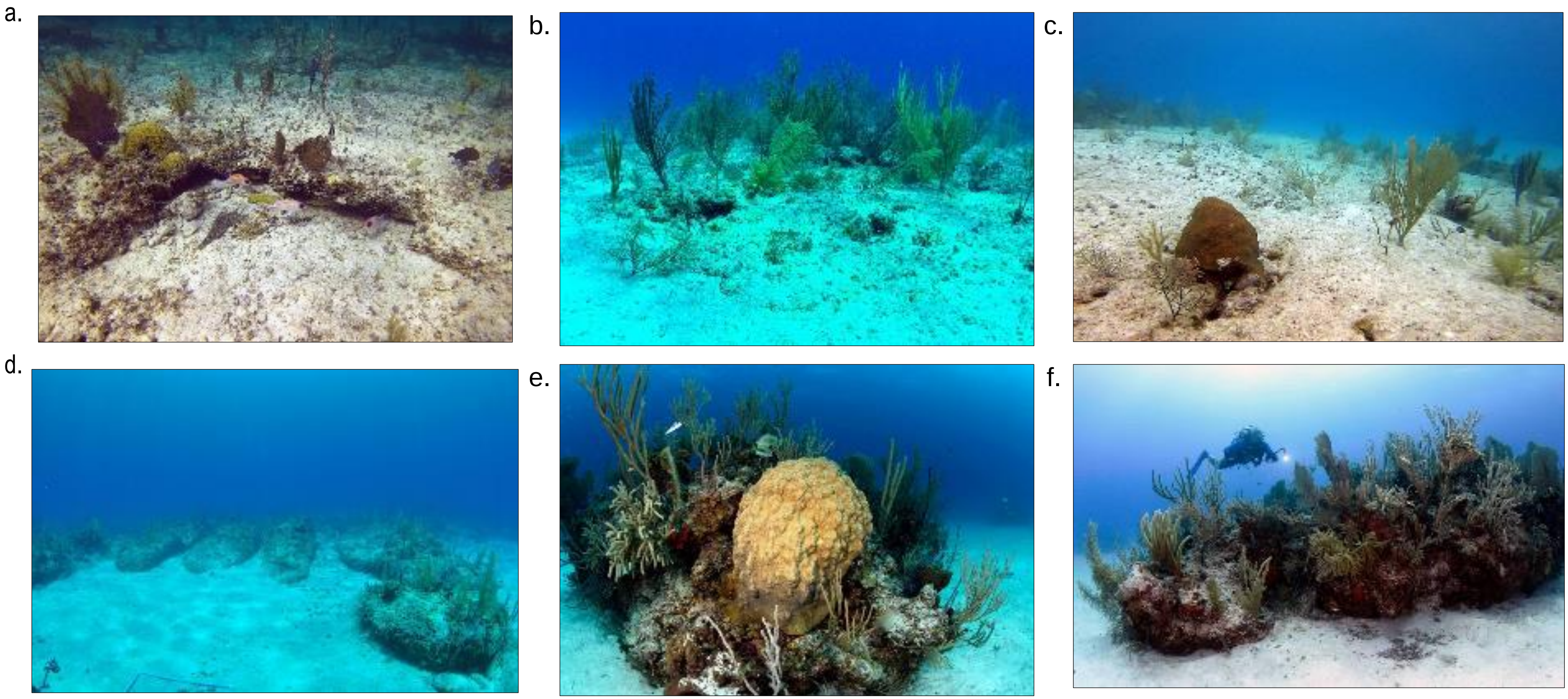

Photo 8.4. Representative photos of various benthic habitats identified in the Project Area, Grand Bahama. a) Hard Pan – example 1, b) Hard Pan – example 2, c) Ridge and Swale, d) Spur and Groove, e) Reef Mounds – example 1, f) Reef Mounds - example 2.

8.13.4 Peterson Cay

The resultant benthic habitat map of Peterson Cay following interpretation of aerial imagery is displayed in **Figures 8.20** and **8.21** (due to size two figures were necessary). Fifteen distinct benthic habitat types were identified within the Peterson Cay survey area, including the eight habitat types also present within the Project Area (however with some variation in water depth), accounting for a total survey area of approximately 860 acres (**Table 8.10**). Additional benthic habitat types found at Peterson Cay included Artificial Structure, Cay, Macroalgae In Sand, Low Relief Hardbottom, Patch Reef, Reef Crest, Rubble, and Seagrass (**Table 8.10**). Sand had the greatest areal extent within the survey area (242.17 acres) followed by Hard Pan (213.60 acres) and then Seagrass (171.60 acres). Together, Sand, Hard Pan, and Seagrass habitats accounted for approximately 73% of the Peterson Cay survey area. Other habitats ranged from 0.12 to 104.37 acres.

Table 8.10. Area calculations for benthic habitat types identified from aerial imagery interpretation within the survey area for Peterson Cay, Grand Bahama.

Location	Habitat	Area (acres)	Area (ft²)	Area (m²)	Percent
Peterson Cay	Land	48.82	2,126,510.43	197,560.07	5.7%
	Artificial Structure	0.12	5,202.71	483.35	0.0%
	Cay	2.32	101,028.64	9,385.91	0.3%
	Macroalgae In Sand	1.07	46,746.26	4,342.89	0.1%
	Exposed Limestone	8.97	390,644.54	36,292.21	1.0%
	Macroalgal Hard Pan	14.56	634,174.09	58,916.94	1.7%
	Hard Pan	213.60	9,304,509.07	864,420.64	24.8%
	Low Relief Hardbottom	2.89	125,685.11	11,676.58	0.3%
	Patch Reef	1.46	63,546.19	5,903.66	0.2%
	Reef Crest	13.46	586,425.76	54,480.95	1.6%
	Ridge and Swale	104.37	4,546,391.43	422,375.27	12.1%
	Rubble	3.67	159,899.46	14,855.21	0.4%
	Sand	242.17	10,548,670.26	980,007.46	28.2%
	Seagrass	171.60	7,474,653.00	694,420.76	20.0%
	Spur Groove	30.76	1,339,796.77	124,471.69	3.6%
Total		**859.83**	**37,454,194.8**	**3,479,608.56**	**100%**

Calculations were performed in projected coordinate system WGS 1984 BLM Zone 17N, Units: Feet

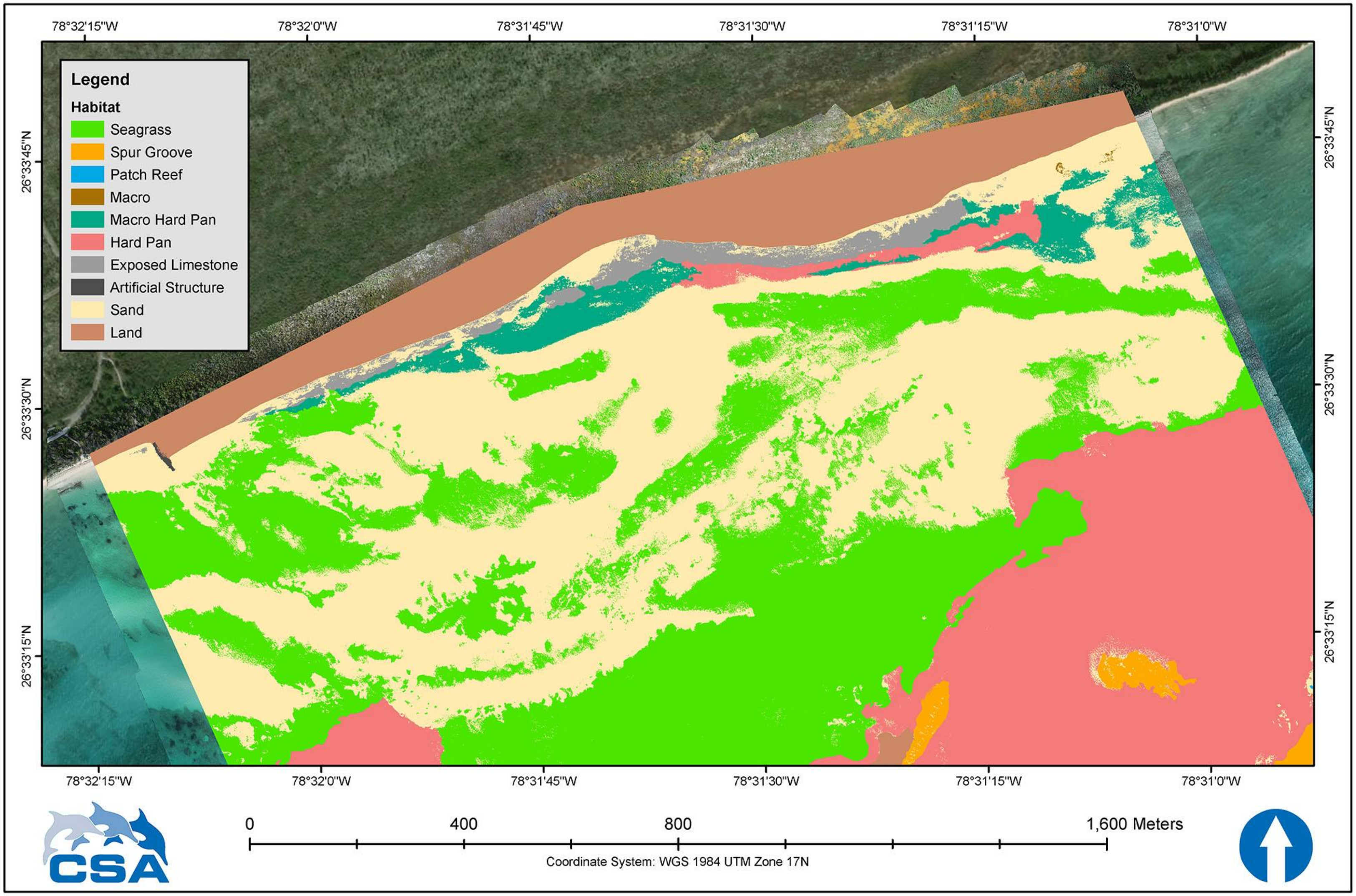

Figure 8-20. Benthic habitat map resulting from interpretation of aerial imagery collected in June 2019 of the northern half of the survey area for Peterson Cay, Grand Bahama.

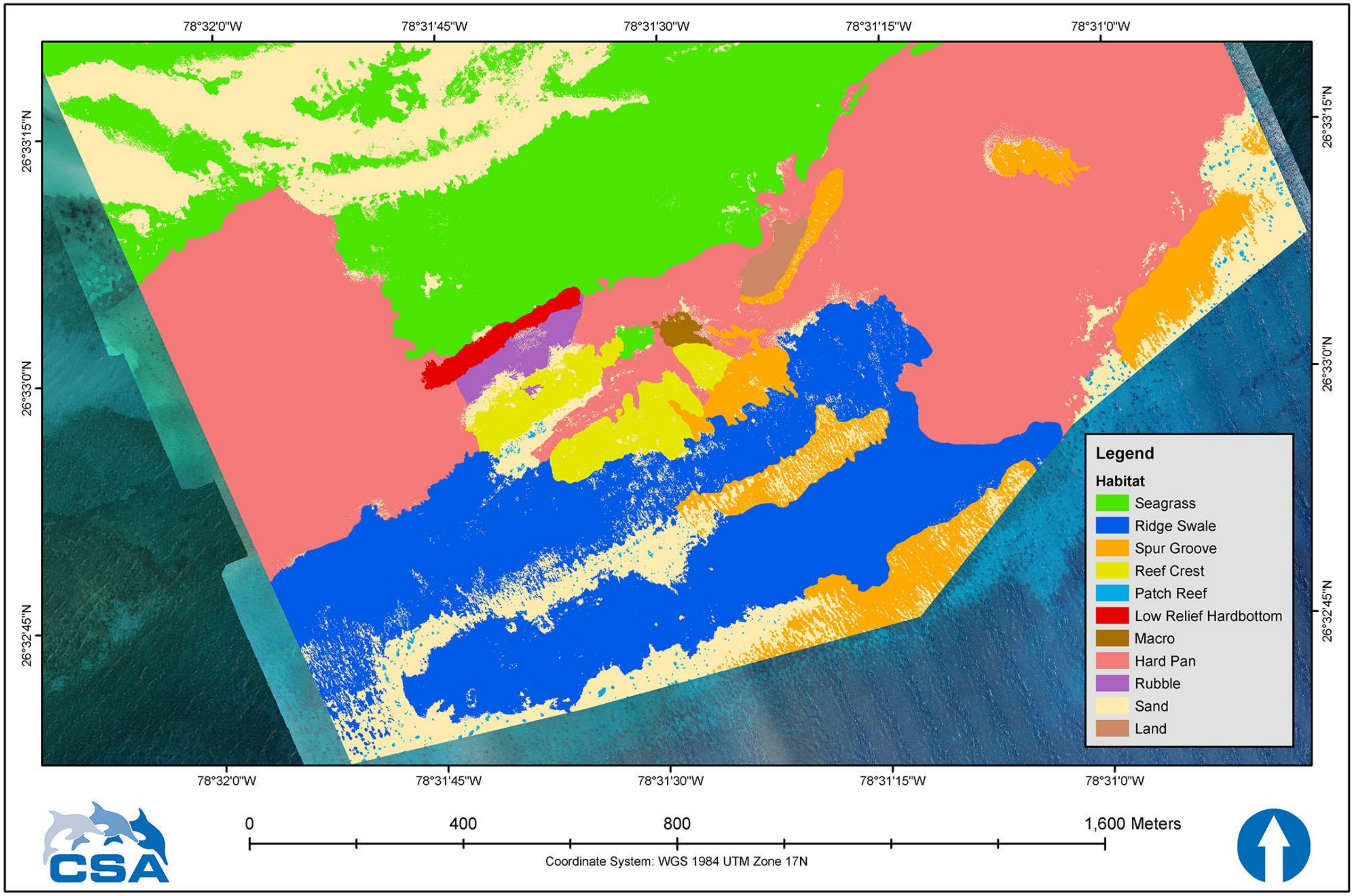

Figure 8-21. Benthic habitat map resulting from interpretation of aerial imagery collected in June 2019 of the southern half of the survey area for Peterson Cay, Grand Bahama.

Additional benthic habitat types found in the survey area for Peterson Cay (and not present within the Project Area) are defined briefly below along with example photos.

Artificial Structure – Man-made jetty containing rock boulders (**no photo**).

Cay – Small, carbonate-based island with low elevation, surrounded by sand or coral reef habitats (**Photo 8.5a**).

Macroalgae in Sand - Marcroalgae occurring in sand, occurring in water depths of approximately 1 m (3.3 ft) (**no photo**).

Low Relief Hardbottom – Hardbottom with relief up to 1 m (3.3 ft) colonized by primarily by fire coral (*Millepora* spp.), followed by octocorals, sponges, and stony corals, occurring at a water depth of approximately 2 m (6.6 ft) (**Photo 8.5b**).

Patch Reef – Isolated carbonate features, surrounded by sand or hardbottom, heavily colonized by algae, octocorals, sponges, and stony corals. Similar to reef mounds but smaller in diameter (up to 2 m [6.6 ft]), occurring in water depths from approximately to 3 to 15 m (9.8 to 49 ft) (**Photo 8.5c**).

Reef Crest – Shallowest portion of the fringing reef occurring in water depths from 0 to 3 m (0 to 9.8 ft), exposed to sustained wave action. Composed of Acroporid coral framework and other stony coral skeleton rubble supporting primarily live Acroporid corals (*Acropora cervicornis*, *A. palmata*, and *A. prolifera*), followed by large colonies of boulder and brain corals (*Diploria*, *Montastraea*, *Orbicella*, and *Porites* spp.), with occasional octocorals. Substrate is also heavily colonized by crustose coralline algae and fire coral (*Millepora* spp.) (**Photos 8.5d, 8.5e**).

Rubble – Eroded *Acropora* spp. (primarily *A. palmata*) skeletons and other loose carbonate pieces, colonized by crustose coralline algae, fire coral, and octocorals (**Photo 8.5f**).

Seagrass – Seagrass meadows composed primarily of turtle grass (*Thalassia testudinum*) followed by manatee grass (*Syringodium filiforme*), occurring within the shallow lagoon (0 to 3 m [0 to 9.8 ft] water depth) in the lee of Peterson Cay and the fringing reef (**Photos 8.6a, 8.6b**).

a. b. c. d. e. f.

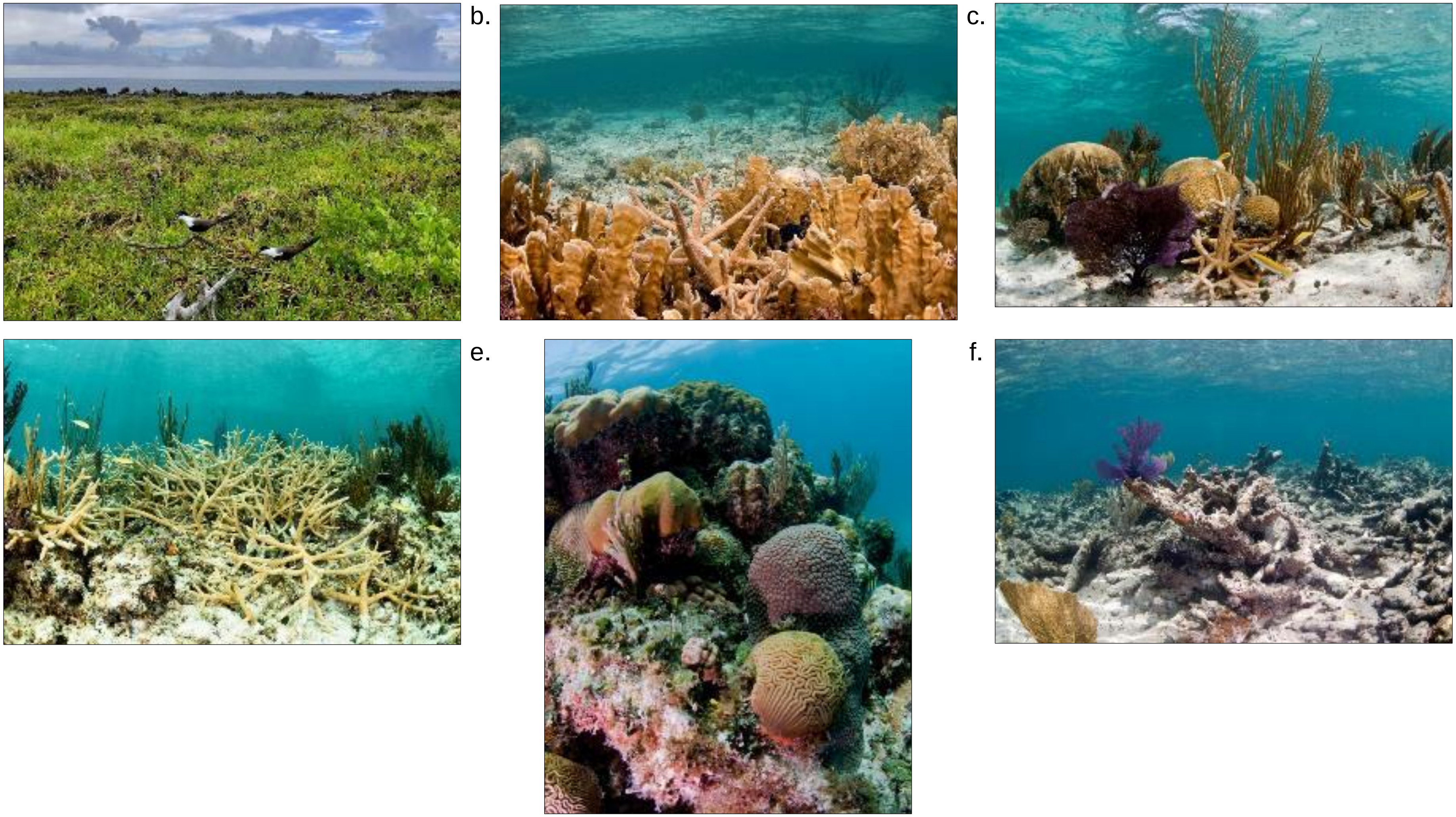

Photo 8.5. Representative photos of various benthic habitats identified in survey area for Peterson Cay, Grand Bahama. a) Cay, b) Low Relief Hardbottom, c) Patch Reef, d) Reef Crest – Staghorn coral (*A. cervicornis*), e) Reef Crest – boulder and brain corals, (f) Rubble.

a.

b.

Photo 8.6. Representative photos of seagrass habitat identified in survey area for Peterson Cay, Grand Bahama. a) Dense bed of turtle grass, b) bed comprised primarily by manatee grass also containing turtle grass.

8.14 Benthic Characterization

Benthic habitats in the Project Area and Peterson Cay are defined by various forms, exposure, and relief of hardbottom substrate, originating from underlying calcium carbonate bedrock and coral reef formation. Hardbottom substrates are colonized by a variety of tropical reef biota, typical of The Bahamas and tropical western Atlantic, differing in diversity and cover based on persistence of hardbottom exposure and water depth. Carbonate and aragonitic-based sand plains and channels intertwine hardbottom features, and sediment veneers over hardbottom are common on hardbottom platforms with low relief, particularly in the intertidal and shallow subtidal zones close to shore.

A total of 36 Bounce Dive Stations were surveyed in the Project Area, and 44 Bounce Dive Stations were surveyed at Peterson Cay, to document and characterize the marine biological communities present, and help differentiate and groundtruth the various benthic habitats. Within the Project Area, a total of 70 quadrats (each 1 m^2) were also sampled from 16 Quadrat Stations to provide quantitative data. Results from quadrat surveys provided estimates of percent cover of flora and fauna, densities and size classes of octocorals and stony corals, and an assessment of stony coral health. Lists of all taxa of sponges, octocorals, stony corals, and fishes observed within the Project Area and within Peterson Cay are displayed in **Table 8.11** through **8.14**, respectively. More taxa were recorded in the Project Area versus Peterson Cay likely due to greater sampling intensity. In addition to the species listed in Tables 8.11 to 8.14, two megafauna species; a green sea turtle (*Chelonia mydas*) and a giant manta ray (*Mobula birostris*) were observed within the study area during the field studies. There are no known traditional fisheries or dive locations within the project footprint.

Table 8.11. Megafauna species and families observed during field surveys of the Project Area and Peterson Cay listed in phylogenetic order.

Common Name (Family)	Family	Common Name (Species)	Scientific Name	Project Area	Peterson Cay
Sea turtles	Cheloniidae	Green turtle	*Chelonia mydas*	--	+
Nurse sharks	Ginglymostomatidae	Nurse shark	*Ginglymostoma cirratum*	+	--
Whiptail rays	Dasyatidae	Southern stingray	*Hypanus americanus*	+	--
Manta rays	Mobulidae	Giant manta	*Mobula birostris*	+	--
Moray eels	Muraenidae	Spotted moray	*Gymnothorax moringa*	+	--
Lizardfishes	Synodontidae	Redbarred lizardfish	*Synodus*	+	--
Squirrelfishes	Holocentridae	Longspine squirrelfish	*Holocentrus rufus*	+	+
		Reef squirrelfish	*Neoniphon coruscum*	+	--
		Dusky squirrelfish	*Neoniphon vexillarium*	+	--
Trumpetfishes	Aulostomidae	Atlantic trumpetfish	*Aulostomus maculatus*	--	+
Scorpionfishes	Scorpaenidae	Red lionfish	*Pterois volitans*	+	--
Cardinalfishes	Apogonidae	Barred cardinalfish	*Apogon binotatus*	+	--
		Sawcheek cardinalfish	*Apogon quadrisquamatus*	+	--
Groupers and hinds	Epinephelidae	Graysby	*Cephalopholis cruentata*	+	+
		Coney	*Cephalopholis fulva*	+	--
		Red hind	*Epinephelus guttatus*	+	--
		Black Grouper	*Mycteroperca bonaci*	+	--
		Tiger grouper	*Mycteroperca tigris*	+	--
Seabasses	Serranidae	Butter hamlet	*Hypoplectrus unicolor*	+	--
		Lantern bass	*Serranus baldwini*	+	--
		Tobaccofish	*Serranus tabacarius*	+	--
		Harlequin bass	*Serranus tigrinus*	+	+
Fairy basslets	Grammatidae	Royal gramma or Fairy basslet	*Gramma loreto*	+	--
Tilefishes	Malacantidae	Sand tilefish	*Malacanthus plumieri*	+	+
Jacks	Carangidae	Yellow jack	*Carangoides bartholomaei*	+	+
		Bar jack	*Carangoides ruber*	+	+

Table 8.11. Megafauna species and families observed during field surveys of the Project Area and Peterson Cay listed in phylogenetic order.					
Common Name (Family)	Family	Common Name (Species)	Scientific Name	Project Area	Peterson Cay
		Blue runner	*Caranx crysos*	+	+
		Horse-eye jack	*Caranx latus*	+	+
Snappers	Lutjanidae	Mutton snapper	*Lutjanus analis*	+	--
		Schoolmaster snapper	*Lutjanus apodus*	+	+
		Blackfin snapper	*Lutjanus buccanella*	+	--
		Cubera snapper	*Lutjanus cyanopterus*	+	--
		Grey snapper	*Lutjanus griseus*	+	+
		Mahogany snapper	*Lutjanus mahogoni*	+	--
		Lane snapper	*Lutjanus synagris*	+	--
		Yellowtail snapper	*Ocyurus chrysurus*	+	+
Mojarras	Gerreidae	Spotfin mojarra	*Eucinostomus argenteus*	--	+
		Yellowfin mojarra	*Gerres cinereus*	--	+
Grunts	Haemulidae	Porkfish	*Anisotremus virginicus*	+	--
		Bonnetmouth	*Emmelichthyops atlanticus*	+	--
		Margate grunt	*Haemulon album*	+	+
		Tomtate grunt	*Haemulon aurolineatum*	+	+
		Smallmouth grunt	*Haemulon chrysargyreum*	+	+
		French grunt	*Haemulon flavolineatum*	+	+
		Cottonwick grunt	*Haemulon melanurum*	+	+
		Sailor's-choice grunt	*Haemulon parra*	+	--
		White grunt	*Haemulon plumierii*	+	+
		Bluestriped grunt	*Haemulon sciurus*	+	+
		Boga	*Haemulon vittata*	+	+
		Striped grunt	*Haemulon striatum*	+	--
Porgies	Sparidae	Saucereye porgy	*Calamus*	+	--
		Sheepshead porgy	*Calamus penna*	+	--
		Pluma porgy	*Calamus pennatula*	--	+

Table 8.11. Megafauna species and families observed during field surveys of the Project Area and Peterson Cay listed in phylogenetic order.

Common Name (Family)	Family	Common Name (Species)	Scientific Name	Project Area	Peterson Cay
Goatfishes	Mullidae	Yellow goatfish	*Mulloidichthys martinicus*	+	+
Seachubs	Kyphosidae	Yellow seachub	*Kyphosus vaigiensis*	+	+
Spadefishes	Ephippidae	Atlantic spadefish	*Chaetodipterus faber*	+	--
Butterflyfishes	Chaetodontidae	Foureye butterflyfish	*Chaetodon capistratus*	+	+
		Reef butterflyfish	*Chaetodon sedentarius*	+	--
		Banded butterflyfish	*Chaetodon striatus*	+	+
Angelfishes	Pomacanthidae	Queen angelfish	*Holacanthus ciliaris*	+	--
		Rock beauty	*Holacanthus tricolor*	+	--
		Grey angelfish	*Pomacanthus arcuatus*	+	+
		French angelfish	*Pomacanthus paru*	+	+
Damselfishes	Pomacentridae	Sergeant-major	*Abudefduf saxatilis*	+	+
		Night sergeant	*Abudefduf taurus*	--	+
		Blue chromis	*Chromis cyanea*	+	+
		Brown chromis	*Chromis multilineata*	+	+
		Yellowtail damselfish	*Microspathodon chrysurus*	--	+
		Dusky damselfish	*Stegastes adustus*	+	+
		Longfin damselfish	*Stegastes diencaeus*	--	+
		Beaugregory	*Stegastes leucostictus*	+	+
		Bicolor damselfish	*Stegastes partitus*	+	--
		Threespot damselfish	*Stegastes planifrons*	+	+
Hawkfishes	Cirrhitidae	Redspotted hawkfish	*Amblycirrhitus pinos*	--	+
Jawfishes	Opistognathidae	Yellowhead jawfish	*Opistognathus aurifrons*	+	--
		Mottled jawfish	*Opistognathus maxillosus*	+	--
Wrasses and parrotfishes	Labridae	Spanish hogfish	*Bodianus rufus*	--	+
		Creole wrasse	*Clepticus parrae*	+	+
		Slippery dick	*Halichoeres bivittatus*	+	+
		Yellowhead wrasse	*Halichoeres garnoti*	+	+
		Clown wrasse	*Halichoeres maculipinna*	+	+

Table 8.11. Megafauna species and families observed during field surveys of the Project Area and Peterson Cay listed in phylogenetic order.					
Common Name (Family)	Family	Common Name (Species)	Scientific Name	Project Area	Peterson Cay
		Rainbow wrasse	*Halichoeres pictus*	+	+
		Blackear wrasse	*Halichoeres poeyi*	+	+
		Puddingwife	*Halichoeres radiatus*	+	+
		Hogfish	*Lachnolaimus maximus*	+	--
		Redband parrotfish	*Sparisoma aurofrenatum*	+	+
		Redtail parrotfish	*Sparisoma chrysopterum*	+	+
		Bucktooth parrotfish	*Sparisoma radians*	+	+
		Yellowtail parrotfish	*Sparisoma rubripinne*	+	+
		Stoplight parrotfish	*Sparisoma viride*	+	+
		Bluehead wrasse	*Thalassoma bifasciatum*	+	+
		Blue parrotfish	*Scarus coeruleus*	+	--
		Striped parrotfish	*Scarus iseri*	+	+
		Princess parrotfish	*Scarus taeniopterus*	--	+
		Queen parrotfish	*Scarus vetula*	+	+
Labrisomids	Labrisomidae	Hairy blenny	*Labrisomus nuchipinnis*	+	--
		Goldline blenny	*Malacoctenus aurolineatus*	--	+
		Diamond blenny	*Malacoctenus boehlkei*	+	+
Tube blennies	Chaenopsidae	Roughhead blenny	*Acanthemblemaria aspera*	+	+
		Spinyhead blenny	*Acanthemblemaria spinosa*	--	+
Blennies	Blenniidae	Redlip blenny	*Ophioblennius macclurei*	--	+
Gobies	Gobiidae	Frillfin goby	*Bathygobius soporator*	+	+
		Colon goby	*Coryphopterus dicrus*	+	+
		Pallid goby	*Coryphopterus eidolon*	+	--
		Bridled goby	*Coryphopterus glaucofraenum*	+	--
		Peppermint goby	*Coryphopterus lipernes*	+	--
		Masked goby	*Coryphopterus personatus*	+	--
		Bluelip parrotfish	*Cryptotomus roseus*	+	--

Table 8.11. Megafauna species and families observed during field surveys of the Project Area and Peterson Cay listed in phylogenetic order.					
Common Name (Family)	Family	Common Name (Species)	Scientific Name	Project Area	Peterson Cay
		Cleaner goby	*Elacatinus genie*	+	+
		Goldspot goby	*Gnatholepis thompsoni*	--	+
Surgeonfishes	Acanthuridae	Doctorfish	*Acanthurus chirurgus*	+	+
		Blue tang surgeonfish	*Acanthurus coeruleus*	+	+
		Ocean surgeon	*Acanthurus tractus*	+	+
Barracudas	Sphyraenidae	Great barracuda	*Sphyraena barracuda*	+	--
Mackerels	Scombridae	Cero mackerel	*Scomberomorus regalis*	+	--
Trunkfishes	Ostraciidae	Scrawled cowfish	*Acanthostracion quadricornis*	+	+
		Smooth trunkfish	*Lactophrys triqueter*	+	+
Triggerfishes	Balistidae	Queen triggerfish	*Balistes vetula*	+	--
		Ocean triggerfish	*Canthidermis sufflamen*	+	+
		Black durgon	*Melichthys niger*	+	--
Filefishes	Monacanthidae	Orange filefish	*Aluterus schoepfii*	+	--
		Scrawled filefish	*Aluterus scriptus*	+	--
		Orange-spotted filefish	*Cantherhines pullus*	--	+
		Slender filefish	*Monacanthus tuckeri*	--	+
		Sharpnose-puffer	*Canthigaster rostrata*	+	+
Total Species Observed				**108**	**74**

+ = present; -- = absent

Table 8.12. Sponge taxa and families observed during field surveys of the Project Area and Peterson Cay listed in alphabetic order.

Family	Common Name	Scientific Name	Project Area	Peterson Cay
Agelasidae	Brain sponge	*Agelas cerebrum*	+	+
	Elephant ear sponge	*Agelas clathrodes*	+	+
Aplysinidae	Branching tube sponge	*Aiolochroia crassa*	+	+
	Row pore rope sponge	*Aplysina cauliformis*	+	--
	Yellow tube sponge	*Aplysina fistularis*	+	+
	Netted barrel sponge	*Verongula gigantea*	+	--
	Pitted sponge	*Verongula rigida*	+	--
Axinellidae	Orange tree sponge	*Ptilocaulis sp.*	+	--
Callyspongidae	Azure vase sponge	*Callyspongia plicifera*	+	--
	Branching vase sponge	*Callyspongia vaginalis*	+	+
Clionaidae	Green boring sponge	*Cliona viridis*	+	--
Clionaidae	Loggerhead sponge	*Spheciospongia vesparium*	+	+
Geodiidae	Leathery barrel sponge	*Geodia neptuni*	+	--
Hadromerida	Orange wall sponge	*Spirastrella sp.*	+	--
Iotrochotidae	Green finger sponge	*Iotrochota birotulata*	+	+
Irciniidae	Stinker sponge	*Ircinia felix*	+	+
	Black-ball sponge	*Ircinia strobilina*	+	+
Mycalidae	Orange icing sponge	*Mycale laevis*	+	--
	Strawberry vase sponge	*Mycale laxissima*	+	--
Niphatidae	Erect rope sponge	*Amphimedon compressa*	+	+
	Brown bowl sponge	*Cribrochalina vasculum*	+	+
	Pink vase sponge	*Niphates digitalis*	+	+
Petrosiidae	Giant barrel sponge	*Xestospongia muta*	+	+
Raspailiidae	Brown encrusting octopus sponge	*Ectyoplasia ferox*	+	--
Spongiidae	Grass sponge	*Spongia tubulifera*	+	--
Total Species Observed			**25**	**13**

+ = present; -- = absent

Table 8.13. Octocoral taxa and families observed during field surveys of the Project Area and Peterson Cay listed in alphabetic order.

Family	Common Name	Scientific Name	Project Area	Peterson Cay
Briareidae	Corky sea finger	*Briareum absestinum*	+	+
Anthothelidae	Encrusting gorgonian	*Erythropodium caribaeorum*	+	--
Plexauridae	Sea rods	*Plexaura spp.*	+	+
Plexauridae	Bent sea rod	*Plexaura flexuosa*	+	+
Plexauridae	Porous sea rods	*Pseudoplexaura spp.*	+	+
Plexauridae	Knobby sea rods	*Eunicea spp.*	+	+
Plexauridae	Slit-pore sea rods	*Plexaurella spp.*	+	+
Plexauridae	Spiny sea rods	*Muricea spp.*	+	+
Gorgoniidae	Slimy sea plume	*Pseudopterogorgia americana*	+	+
Gorgoniidae	Bipinnate sea plume	*Pseudopterogorgia bipinnata*	+	+
Gorgoniidae	Caribbean sea plume	*Pseudopterogorgia elisabethae*	+	+
Gorgoniidae	Sea whip	*Pterogorgia spp.*	+	+
Gorgoniidae	Common sea fan	*Gorgonia ventalina*	+	+
Gorgoniidae	Venus or Bahamian sea fan	*Gorgonia flabellum*	+	+
Gorgoniidae	Wide-mesh sea fan	*Gorgonia mariae*	+	--
Gorgoniidae	Colorful sea whip	*Leptogorgia spp.*	+	+
Telestinae	White telesto	*Carijoa riisei*	+	--
Total Taxa Observed			**17**	**14**

+ = present; -- = absent

Table 8.14. Stony coral taxa and families observed during field surveys of the Project Area and Peterson Cay listed in alphabetic order.

Family	Common Name	Scientific Name	Project Area	Peterson Cay
Acroporidae	Staghorn coral	*Acropora cervicornis*	--	+
Acroporidae	Elkhorn coral	*Acropora palmata*	--	+
Acroporidae	Fused staghorn coral	*Acropora prolifera*	--	+
Agariciidae	Lettuce coral	*Agaricia agaricites*	+	+
Agariciidae	Fragile saucer coral	*Agaricia fragilis*	+	--
Agariciidae	Dimpled sheet coral	*Agaricia grahamae*	+	--
Agariciidae	Whitestar sheet coral	*Agaricia lamarcki*	+	--
Astrocoeniidae	Blushing star coral	*Stephanocoenia intersepts*	+	--
Caryophylliidae	Smooth flower coral	*Eusmilia fastigiata*	+	--
Faviidae	Boulder brain coral	*Colpophyllia natans*	+	+
Faviidae	Symmetrical brain coral	*Diploria strigosa*	+	+
Faviidae	Knobby brain coral	*Diploria clivosa*	+	+
Faviidae	Grooved brain coral	*Diploria labyrinthiformis*	+	+
Faviidae	Golf ball coral	*Favia fragum*	+	--
Faviidae	Rose coral	*Manicina areolata*	+	--
Faviidae	Great start coral	*Montastraea cavernosa*	+	+
Faviidae	Boulder star coral	*Orbicella annularis*	+	+
Faviidae	Mountainous star coral	*Orbicella favelota*	+	+
Faviidae	Boulder star coral	*Orbicella franksi*	+	+
Faviidae	Smooth star coral	*Solenastrea bournoni*	+	+
Meandrinidae	Pillar coral	*Dendrogyra cylindrus*	+	+
Meandrinidae	Elliptical star coral	*Dichocoenia stokesi*	+	+
Meandrinidae	Maze coral	*Meandrina meandrites*	+	+
Mussidae	Cactus coral	*Mycetophyllia sp.*	+	--
Mussidae	Artichoke coral	*Scolymia sp.*	+	--
Pocilloporidae	Ten-ray star coral	*Madracis decactis*	+	+
Poritidae	Mustard hill coral	*Porites astreoides*	+	+
Poritidae	Finger coral	*Porites porites*	+	+

Table 8.14. Stony coral taxa and families observed during field surveys of the Project Area and Peterson Cay listed in alphabetic order.

Family	Common Name	Scientific Name	Project Area	Peterson Cay
Siderastreidae	Lesser starlet coral	*Siderastrea radians*	+	--
Siderastreidae	Massive starlet coral	*Siderastrea siderea*	+	+
Total Species Observed			**27**	**20**

+ = present; -- = absent

8.14.1 Project Area

The Project Area contained several predominant hardbottom habitat types, each with increased epibiotic cover and species richness in a gradient from shore to increasing water depth. Areas of bare exposed limestone in the intertidal and shallow subtidal zones graded to hard pan substrate (pavement-like hardbottom with less than or equal to 0.5 m [1.6 ft] relief) heavily colonized by macroalgae. Slightly further offshore, hard pan substrate was colonized by a mix of turf algae, macroalgae, and octocorals, with occasional stony corals. Stony corals were typically found on areas of the hard pan habitat with slightly higher relief. The hard pan habitat merged into undulating hardbottom with higher relief typified by ridges and swales that generally ran north to south. Ridge features supported heavier colonization by reef biota. At deeper water depths, relief of hardbottom features continued to increase forming "spur" finger-like features alternating with narrow sand channels ("grooves"), also running generally north-south. Finally, isolated mound-like hardbottom features surrounded completely by sand, supporting the highest cover and species richness of epibiota, were observed in the deepest waters surveyed (maximum of 14 m [46 ft]). The project will not result in an impediment to species movement. Mitigation is proposed for impacts to benthic resources.

Epibiota

Mean percent cover estimates of epibiota and non-living substrate for each habitat from quadrat surveys are displayed in **Figure 8-22**. The Macroalgal Hard Pan habitat was the most distinct among habitat types, having high cover of each macroalgae and substrate relative to other habitat types (**Figure 8.22a**). Hard Pan habitat was differentiated from the other more "reef-like" habitats (Ridge and Swale, Spur and Groove, and Reef Mounds) by a higher percent cover of turf algae (over 50%) and lower cover of fauna (6.4%) (**Figure 8.22b**). Ridge and Swale, Spur and Groove, and Reef Mound habitats were more similar, with smaller variations in the contributions by turf algae, macroalgae, fauna, and substrate (**Figures 8.22c**, **8.22d**, **8.22e**). Percent cover of fauna increased with distance from shore and was highest on reef mounds at 34.7% (**Figure 8.22e**).

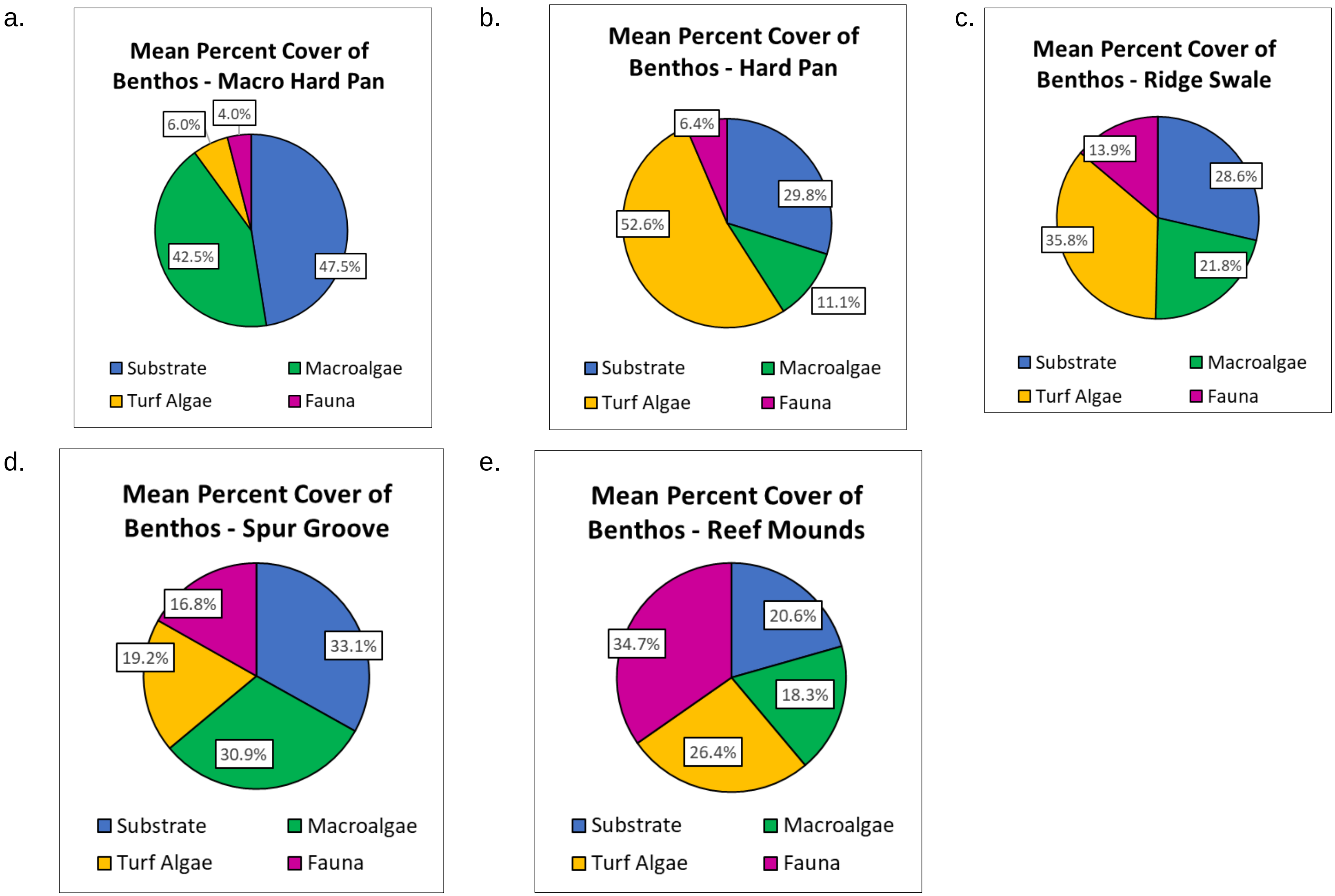

Figure 8-22. Mean percent cover results of epibiota and non-living substrate based on quadrat surveys for a) Macroalgal Hard Pan, b) Hard Pan, c) Ridge Swale, d) Spur Groove, and e) Reef Mound benthic habitats in the Project Area, Grand Bahama.

All octocoral and stony coral colonies occurring within each quadrat were enumerated. Densities of colonies with a maximum height or diameter greater than or equal to 10 cm (3.9 in) were calculated for the Hard Pan and “Reef” habitat (Reef = combined Ridge Swale, Spur Groove, and Reef Mound habitats) (**Figure 8-23**). Mean density of stony corals in the Hard Pan habitat was 0.13 (±0.07 SE) colonies/m^2 and in “Reef” habitat was 1.07 (±0.21 SE) colonies/m^2.

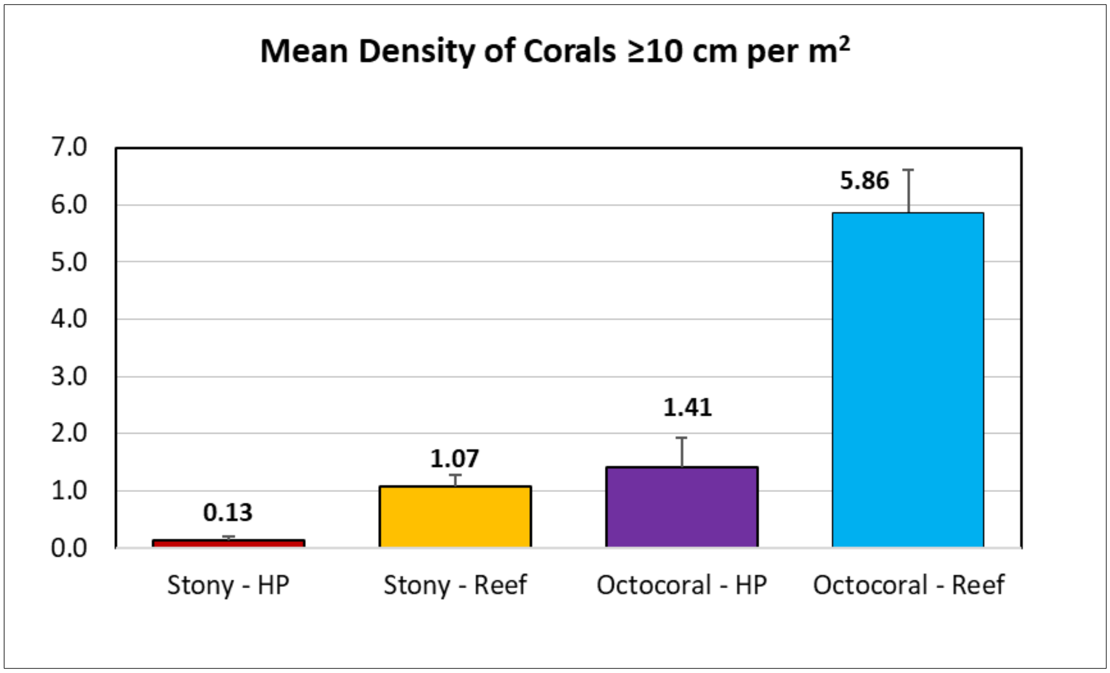

Figure 8-23. Mean density of stony corals and octocorals in Hard Pan and “Reef” (combined Ridge Swale, Spur Groove, and Reef Mound) habitats for the Project Area, Grand Bahama.

A total of 17 octocoral taxa and 27 stony coral taxa were recorded in the Project Area (**Tables 8.13** and **8.14**). The bipinnate sea plume (*Pseudopterogorgia bipinnata*) and knobby sea rods (*Eunicea* spp.) were the most frequently observed octocorals (**Photo 8.7**). The most abundant stony corals were massive starlet coral (*Siderastrea siderea*), lettuce coral (*Agaricia agaricites*), and mustard hill coral (*Porites astreoides*). Numerous sponge taxa (total of 25) were observed in the Project Area, especially in the reef mound habitat. The most frequently observed species were yellow tube sponge (*Aplysina fistularis*) (**Photo 8.8**) and stinker and black-ball sponges (*Ircinia* spp).

Photo 8.7. Various octocorals including the bipinnate sea plume (*Pseudopterogorgia bipinnata*) (lower right) and knobby sea rods (*Eunicea* spp.) (top middle of photo) on a reef mound in the Project Area, Grand Bahama.

Photo 8.8. Yellow tube sponge (*Aplysina fistularis*) on a reef mound in the Project Area, Grand Bahama.

Green algae *Halimeda* spp. and *Microdictyon marinum* were the most frequently observed macroalgal taxa in the Project Area. At the time of the survey, a dense algal mat, several centimeters thick covered many portions of reef substrates in the Ridge Swale, Spur Groove, and Reef Mound habitats (**Photo 8.9**). The algal mat was primarily comprised by *M. marinum* and *Boodlea struveoides* (also a green alga). Monospecific fields of each the red alga *Chrondria littoralis* (**Photo 8.3d**) and the green alga *Cymopolia barbata* were observed in the Macroalgal Hard Pan habitat. A mix of several calcareous green algal species were commonly observed in the Hard Pan habitat, consisting of *Avrainvillea* spp., *Halimeda* spp., *Penicillus* spp., and *Rhipocephalus* spp.

Photo 8.9. Algal mat comprised primarily by green algae *Microdictyon marinum* and *Boodlea struveoides* in the Project Area, Grand Bahama.

Areas and Features of Ecological Significance

Several unique areas of ecological significance were surveyed within the Project Area and are described herein. The benthic resources study, along with the study methodology, is provided in **Appendix 7**.

Reef Mounds

This benthic habitat type had the highest percent cover and species richness of epibiota, as well as the highest species richness of fishes. Commercially valuable taxa such as snappers and groupers were most frequently observed in this habitat type. The unique spatial arrangement of the mounds, with maze-like channels between mounds, and structure of the mounds themselves with high relief and undercut bases providing over-hang features, provides excellent shelter and foraging areas for fishes (**Photo 8.10**). Higher species richness of stony corals was observed in this habitat compared to all other habitat types, in part due to the availability of vertical substrates on the sides of the mounds, which are preferred by some species, especially *Agaricia* spp. Large, healthy colonies of whitestar sheet coral (*Agaricia lamarcki*), currently listed as threatened by the United States ESA and Vulnerable by the IUCN (Aronson et al., 2008) were frequently observed on the vertical surfaces of mounds (**Photo 8.11**). At the time of the survey several colonies of *Agaricia* spp. exhibited paling or partial bleaching of tissues. Sponges were also observed in higher frequency and species richness on the reef mounds (**Photo 8.12**). Approximately 160 reef mound features varying in size and also varying in abundance and health of epibiotic cover were enumerated *in situ* within the dredge footprint (**Photo 8.13**). At present, the intent is to relocate all of the coral mounds which can be physically removed and relocated.

Photo 8.10. Undercut area at the base of a reef mound with schoolmaster snappers (*Lutjanus apodus*), a red lionfish (*Pterois volitans*), and royal grammas (*Gramma loreto*) in the Project Area, Grand Bahama.

Photo 8.11. A colony of whitestar sheet coral (*Agarcia lamarcki*) on the vertical face of a reef mound in the Project Area, Grand Bahama. Note the colony is exhibiting slight paling of tissues.

Photo 8.12. A variety of sponge taxa including the barrel sponge (*Xestospongia muta*), yellow tube sponge (*Aplysina fistularis*), green finger sponge (*Iotrochota birotulata*), and branching vase sponge (*Callyspongia vaginalis*) on a reef mound in the Project Area, Grand Bahama.

Photo 8.13. Several reef mounds in the Project Area, Grand Bahama.

Pillar Corals

Three large (≥ 1 m [3.3 ft]) colonies of pillar coral (*Dendrogyra cylindrus*) were observed in the Project Area and their geographic locations were recorded (**Appendix 7**). Pillar corals are currently listed as Threatened under the United States ESA and have drastically declined throughout the Caribbean in recent years due to coral white diseases (Kabay, 2016). Colonies observed had healthy tissue but evidence of recent tissue mortality at the base was observed on some colonies (**Photo 8.14**).

Photo 8.14. Large colony of pillar coral (*Dendrogyra cylindrus*) exhibiting an area of recent tissue mortality as evidenced by the detailed calices still evident on the bare skeleton (lower middle of photo).

Sharp Rocks

A wave-cut, jagged limestone platform extending out over the sea runs along the shoreline at the west end of the Project Area. This feature, locally known as "Sharp Rocks" exhibits honeycomb weathering giving the rock a jagged and sharp morphology (Sealy, 1994). This limestone platform extends into the water and connects to expanses of Exposed Limestone and Hard Pan habitats along the shoreline. Healthy colonies of predominantly brain (*Diploria* spp.) and starlet (*Siderastrea* spp.) stony corals were occasionally observed colonizing the hardbottom substrate along with various octocorals (**Photo 8.15**). A giant manta ray (*Mobula birostris*) was observed near this area in the Macroalgal Hard Pan habitat (**Photo 8.16**).

Photo 8.15. Brain (*Diploria* spp.) and starlet (*Siderastrea* spp.) stony corals, sea fans (*Gorgonia* spp.), fire coral (*Millepora* sp.), and turf algae within the Hard Pan habitat near Sharps Rock in the Project Area, Grand Bahama.

Photo 8.16. Giant manta ray (*Mobula birostris*) observed in the Macroalgal Hard Pan habitat close to shore in the Project Area, Grand Bahama.

8.14.2 Peterson Cay

The entire area of impact was assessed based on accepted survey standards (**Appendix 7**). The surveyed area within PCNP included a fringing reef, which surrounds emergent land of a cay. The reef has a well-developed reef buttress zone at 10 m (33 ft) water depth, which progresses shallower to a reef crest which is nearly emergent at low tide. The buttress zone is populated by massive varieties of boulder and brain stony corals including *Montastraea cavernosa*, *Orbicella* spp., *Porites astreoides*, and *Diploria spp.* These species give way to elkhorn coral (*Acropora palmata*), staghorn coral (*A. cervicornis*), blade fire coral (*Millepora complanata*) and coralline algae at the shallowest portions of the reef crest. Landward from the reef crest, in the reef flat, lies a rubble zone consisting of primarily staghorn and elkhorn coral which fragment over time during rough weather and form a substrate of coral skeleton rubble behind the wave-impacted reef crest. Within and landward of the rubble zone lie patch reefs which support brain corals (*Diploria* spp.), staghorn coral, and sea fans (*Gorgonia* spp.). Immediately landward of the reef flat lies a shallow lagoon in the lee of the cay and fringing reef. The substrate in the lagoon is primarily carbonate sand, with dense seagrass cover by turtle (*Thalassia testudinum*) (**Photo 8.6a**) and manatee (*Syringodium filiforme*) (**Photo 8.6b**) grass. Shoreward in < 2 m (6.6 ft) water depth, macroalgae were prevalent and intermixed with seagrasses. At approximately 0.5 m (1.6 ft) water depth, exposed bare limestone (occasionally colonized by turf algae or cyanobacteria) was found close to shore among sand plains extending to the beach.

To the east and west of the cay and surrounding fringing reef lies hard pan substrate (pavement-like hardbottom with less than 0.5 m [1.6 ft] relief) which is colonized by macroalgae, sponges, and octocorals with sparse stony corals. Moving further offshore, the hard pan substrate was colonized by a mix of turf algae, macroalgae, and octocorals, with occasional stony corals. Stony corals were typically found on areas of the Hard Pan habitat with slightly higher relief. Small patch reefs were also observed within the Hard Pan habitat, rising 1 to 1.5 m (3.3 to 4.9 ft) from the hard pan substrate. These were often colonized heavily by stony corals including the vulnerable species *Dendrogyra cylindrus* and many genera of octocorals.

Offshore, the hard pan substrate merged into ridge and swale features (undulating hardbottom with ≥2 m [6.6 ft] relief ridges) that generally ran north to south. The ridges supported heavier colonization by reef biota with larger stony corals, sponges, and octocorals. Macroalgae and sponges were more abundant on the deeper ridges.

Areas and Features of Ecological Significance

Acropora Corals

All three species of Caribbean *Acropora* corals were observed on the fringing reef at Peterson Cay. *A. palmata* was dominant within the reef crest community, where large stands extended from the shallowest portion of the reef crest to the fore reef slope (**Photo 8.17**). *A. palmata* was the major contributor of skeletal material for substrate in the rubble zone; hundreds of coralline encrusted relic *A. palmata* branches comprised the majority of the habitat. *A. cervicornis* was a major component of the back-reef community, forming stands up to 4 m (13 ft) in diameter (**Photo 8.5d**). The substantial lee provided by the reef crest and fore reef communities provides a relatively quiescent habitat ideal for growth of *A. cervicornis*. Both species, *A. palmata* and *A. cervicornis* are listed by the IUCN as Critically Endangered (Aronson et al., 2008). Behind the reef crest within the rubble zone, *A. prolifera* was occasionally observed, one of the only live coral species observed in the Rubble habitat (**Photo 8.18**). This species is a hybrid of the other two Acroporids and was located in between stands of the other two species. Data on *A. prolifera*'s stability are deficient and the IUCN does not report on this species.

Photo 8.17. Stands of live elkhorn coral (*Acropora palmata*) in the Reef Crest habitat within the survey area for Peterson Cay, Grand Bahama.

Photo 8.18. Several colonies of fused staghorn coral (*Acropora prolifera*) observed in the Rubble habitat within the survey area for Peterson Cay, Grand Bahama.

Other Vulnerable Coral Species

The *Orbicella* species complex (*O. annularis*, *O. faveolata*, *O. franksi*) was observed on the fore reef slope portion of the fringing reef and all species are listed as Endangered or Vulnerable by the IUCN (Aronson et al., 2008). These species are also listed as Threatened under the United States ESA.

Three colonies of pillar coral (*Dendrogyra cylindrus*), listed as Vulnerable by the IUCN, were found within the survey area, within Hard Pan habitats south of the cay and within the lagoon (Aronson et al., 2008). The largest colony (approximately 2 m [6.6 ft] in diameter) was located in a sparsely colonized seagrass meadow in the lagoon of Peterson Cay (**Photo 8.19**).

Based on the benthic field assessment approximately 25% of the corals observed exhibit some form of bleaching stress. These corals were distributed throughout the area with no spatial or depth trend, and therefore no overlay of stressed coral locations is provided. The observed stressed corals may recover, and a re-assessment will be conducted prior to relocation efforts in concert with planned boring investigations. Stressed corals observed within the study area are typical of anticipated conditions during summer months. Note the field investigations were conducted in July of 2019. No evidence of coral disease was observed during the field investigations. It is noted that a pre-construction survey will be conducted to reassess site conditions including the potential presence of disease prior to any relocation efforts.

Photo 8.19. Large colony of pillar coral (*Dendrogyra cylindrus*) observed within Seagrass habitat in the lagoon of Peterson Cay, Grand Bahama.

<u>Seagrass Meadows</u>

The seagrass habitat in the lagoon of Peterson Cay was extensive in area of cover and supported meso-grazers including queen conch (*Strombus gigas*), king helmet (*Cassis tuberosa*), west Indian chank (*Turbinella angulata*), various sea urchins, and cushion sea star (*Oreaster reticulatus*), as well as macro-grazers such as green sea turtles (*Chelonia mydas*). Green sea turtles are listed as Endangered under the U.S. ESA and are listed as X by the IUCN (Seminoff, 2004). Significant grazing by turtles was evident in seagrass beds immediately adjacent to Peterson Cay. Upon close examination, many seagrass blades in this area were clipped bluntly at the tips. During the survey, scientists had close encounters with one resident green sea turtle (**Photo 8.20**).

Photo 8.20. A juvenile green sea turtle (*Chelonia mydas*) observed in the Seagrass habitat in the lagoon of Peterson Cay, Grand Bahama.

Bridled Tern Nesting Habitat

The emergent Cay at Peterson provides habitat for nesting Bridled Terns, (*Sterna anaethetus*) a regionally endemic species noted by the Conservation Unit, Bahamas Department of Agriculture (Cary et al., 2001) as warranting protection due to population declines. Mating pairs were observed on the cay at the time of the survey (July 2019) (**Photo 8.5a**).

Turtle Resources

The project vicinity is known for providing foraging and nesting habitat to sea turtles, most notably green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles. Green turtles are currently listed as endangered and loggerheads are currently listed as threatened under U.S. ESA guidance.

Leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*) and kemp's ridley (*Lepidochelys kempii*) turtles may also utilize the area though these species are not commonly observed. The extent of use of the area is currently unknown though sitings of green and loggerhead turtles in the area are common, and the resources present represent a significant food and habitat source for these species. It is likely that nesting does occur on the beaches in this area, though no specific nesting study has to date been conducted.

8.15 Impacts to Benthic Resources from Hurricane Dorian

A post-Dorian reconnaissance survey of the project area was conducted on January 24-25, 2020 (4 months post storm) to provide a general assessment of storm impacts to benthic resources. This survey indicated significant impacts to benthic resources within the immediate nearshore from the shoreline to depths of approximately 20 feet. Within this zone, sand scouring has largely denuded exposed hardbottom substrate to barren rock. Soft coral (octocoral) and macroalgal communities within this zone have been lost. The exposed substrate is suitable for re-colonization by soft coral and algal communities. Re-establishment of macroalgal cover was visibly evident at the time of the survey and should continue to occur relatively rapidly. Re-establishment of octocoral communities will likely require a multi-year timeframe. Isolated high points in the rock substrate that extend above the sand scour zone retain some resources, including soft corals, macroalgal cover and very limited stony corals.

Scouring of the hardbottom diminishes seaward to an approximate depth of 20 ft. Within deeper water, impacts from the storm are less pronounced. Impacts to hardbottom communities within the project area (and in deeper water) appear to be nominal, with no observable impact that can be directly attributed to Dorian. Observations suggest that, with respect to the project and the assessment of impacts, the baseline conditions that were utilized for the EIA study continue to be representative of the project area post-Dorian. Coral communities within the dredge footprint do not appear to have been significantly impacted, and relocation of these resources as proposed within the EIA remains a primary recommendation. The proposed dredging will directly impact existing habitat but will produce a post-dredge habitat that will be supportive of fisheries and benthic resource recovery. The imposition of the project security perimeter will eliminate fishing in the area, but the habitat will continue to support fisheries. The impacted wetlands are not hydraulically linked to the sea and their impact will have a negligible impact on fisheries.

While a detailed survey of Peterson Cay was not conducted, the level of impacts observed within the study area shallows suggest that additional impacts to shallow water stony coral resources within the national park likely occurred, particularly to shallow water branching corals. These resources are outside of the direct zone of impact from this project. Long-term monitoring of these resources as proposed within the EIA remains a primary recommendation.

There have been unsubstantiated reports of coral disease post Dorian within this region. At present, it is undetermined whether coral disease has emerged since completion of the field studies in July 2019. An additional field effort will be conducted to assess current coral health prior to any coral relocation efforts. If coral disease is present within the project area coral relocation efforts will need to specifically address this condition.

9 ENVIRONMENTAL IMPACTS

The environmental impacts have either been discussed in some of the individual reports (see Appendices) or are discussed in this chapter. An impact is defined as a change to baseline conditions caused by project activities. This chapter discusses impacts to the existing baseline conditions defined in **Chapter 8** caused by project activities defined in **Chapter 6**.

9.1 Site Preparation

Based on the development plan and project architect's calculation, approximately 148 acres of the 329 acres (**Figure 9-1**) will be cleared and developed. This represents 45 percent of the property. The site will be surveyed, and the areas designated for conservation will be identified and marked. The site will be cleared of vegetation using heavy equipment and the vegetation removed will be either hauled to the landfill or transported for size reduction using a tub grinder, which will produce mulch. As part of the mass grading plan, the site will be used for the turbidity control for the dredge spoils using a series of cells before the seawater is returned to the sea. The elevation of the site for areas where building construction will take place will be +13 from mean low water.

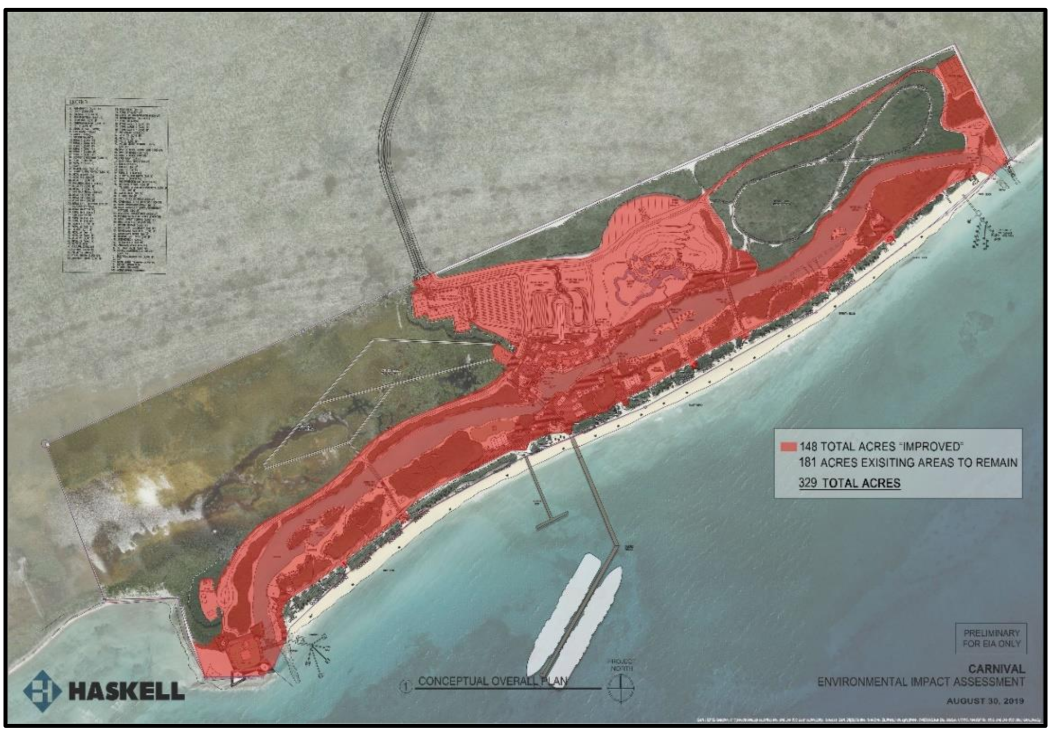

Figure 9-1. Site Plan Showing Calculated Areas of Disturbance

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

9.2 Canal

The impacts due to the construction were assessed in various studies, which included the Hydrogeologic Study (**Appendix 4**), Terrestrial Resource Study **(Appendix 5**), and Coastal Impact Modeling Study (**Appendix 6**).

The hydrogeologic study involved the drilling of 14 observation wells, performing salinity profiles from wells, collecting core samples for permeability testing, and numerical modeling completed using Visual Modflow and the SEAWAT code. The impacts for the Hydrogeologic Study are presented in Section 9.2.1.

In summary, impacts from the canal have been quantified and represent a minimal impact to the current hydrogeological processes within the study area. The canal will have negligible impacts on freshwater resources within the project area which post-Hurricane Dorian are not significant. Mechanical flushing of the canal will be used to ensure adequate water quality. Pumping will be implemented as a means of assuring interior water quality through the pumping of ocean water into the interior. No nutrient discharge into the waterway will occur, and the pumping will recirculate ocean water. Additional detail regarding mechanical pumping will be provided within the EMP including water quality standards and a monitoring plan. A design exchange rate of 90% overturn within 24 hours has been adopted as a minimum standard for the interior swimming areas. A design exchange rate of 90% overturn within four days has been adopted for the entire waterway system.

9.2.1 Groundwater Resources

The hydrogeological study identified the existence of a freshwater lens on the property and determined the impacts from the dredging of the canal and impacts from the placement of a seawater/dredge cuttings mixture onto the property with the canal. Fourteen observation wells were installed within and outside the project boundary and salinity measurements collected from each at 1-foot intervals. Hydrogeologic modeling was completed to simulate the current presence and thickness of the freshwater lens and how planned changes at the project site may affect this configuration.

Numerical modeling for this project was completed using Visual Modflow and the SEAWAT code. Modflow was developed by the U.S. Geological Survey and is the standard for three-dimensional groundwater flow and transport modeling. SEAWAT couples the flow portion of the Modflow code with a mass/density-related flow transport model MT-3DMS. In addition to other solute transport projects, SEAWAT is specifically designed to simulate saltwater/freshwater interactions due to the density variations between salt and freshwater.

Various calibration runs were conducted to determine a reasonable set of the input parameter values such that the model simulated the estimated freshwater lens extent and the observed field data. One of the complexities of the field measurements was the tidal cycle. It is extremely complex to run a long model simulation that considers every tidal cycle. To better conceptualize this situation, average values of water levels were used during the calibration as discussed above. This limited the number of time steps required for a simulation, but still provided a reasonable approach to calibration.

The study concluded for the following:

- Groundwater in the aquifer is tidally influenced and is in good hydraulic communication with the Northwest Providence Channel. There is very poor to negligible hydraulic communication between the surface water in the wetlands and the groundwater in the aquifer.

- The excavation of the canal will slightly change the location and shape of the freshwater lens, moving the boundary between fresh and saltwater inland several hundred feet. The shape of the lens also illustrates a “bump” landward similar to the shape of the canal itself. Moreover, the change in the freshwater lens due to the canal construction would be relatively quick and the system would re-equilibrate shortly thereafter. See **Figure 15** in the hydrogeologic report (**Appendix 4**).

- The placement of dredge spoils and seawater based on simulations would not have a significant impact on the freshwater lens as most of the water would be returned to the sea. See **Figure 16** of the hydrogeologic report (**Appendix 4**).

- No impact was predicted for the freshwater lens in the landward portion of the project site and points northward up to and including the W-6 wellfield. Also, there should be no or minimal impacts to observation wells OW-9 and OW-12.

- Hurricane Dorian did not affect the freshwater lens in the vicinity of OW-9 and OW-12. The previously degraded lens at OW-10 and OW-13 appears to have undergone further deterioration as did the salinity concentrations in the other observation wells due to Hurricane Dorian.

Specifically, the construction of the waterway will effectively move the interface between the groundwater flow system and the sea water inland an average distance of 458 (+/-) ft. There is no freshwater in the Lucayan Aquifer in the near-shore portion of the project. The fresh water/brackish water interface that occurs landward in the central to northern portion of the property will shift to the north (landward) approximately 200 ft (+/-). The freshwater lens to the north including the area of the GBUC W-6 well field will not be impacted, and the water levels therein will not be lowered.

The Grand Bahama Utility Company, the water resource management and potable water supplier for Grand Bahama was presented a copy of the Hydrogeological Study and the Deep Well Functional and Technical Specifications for review. They will issue a letter of support for the project if they do not have any concerns regarding the provided information

9.2.2 Vegetation

The Terrestrial Resource Study (**Appendix 5**) assessed the impacts to the construction of the canal in Appendix B in Canal Impact Classified by Terrestrial Habitat drawing. The table below is from the drawing:

Table: Canal Percentage by Habitat Class

Broadleaf Coppice	15.5%
Casuarina Dominated Coastal Shrubland	2.7%
Coastal Shrubland	3.3%
Fire Impacted Coppice	13.5%
Mangrove Wetland	6%
Sabal Woodland	14.2%
Semi Permanently Flooded Wetlands	31.9%

9.2.3 Flushing Analysis

A flushing analysis was conducted as part of the Coastal Impact – Modeling Study. This is discussed in Section 9.17 of this report. Based on the flushing analysis it has been determined that mechanical pumping will be needed to aid in flushing and improve water quality within the canal. This will be further addressed in the Environmental Management Plan, including a water quality monitoring program.

9.2.4 Non-Point Sources of Pollution

As the facility is touristic in nature, there should not be non-point sources of pollution from various amenities to the marine environment. Storm water on the site will be managed with no marine discharge. Non-point sources of pollution to the canal will be minimized through the use of electric powered ferry boats. The use of the electric boats eliminates the need to store fuel and oil as required by traditional internal combustion engines and eliminates the need to fuel boats in the waterway. Additionally, the miniature golf course will be constructed using artificial turf. Carnival Corporation, as a matter of policy, do not use fertilizers at its port facilities. Storm water collected from the parking areas are directed into storm drains drilled to 150 ft with 70 ft. of pvc casing and sealed with grout as per the GBPA Building and Sanitary Code.

The site will consist of shops, restaurants, offices, and recreational activities and all liquid wastes generated will be only discharged to the wastewater collection systems conveying wastewater to the Advanced Wastewater Treatment Plant. Moreover, A site plan with storm drain locations for the parking areas and any paved work equipment storage areas will be submitted to the Grand Bahama Port Authority for approval as part of the building permit approval process.

9.3 Potable Water Supply

There is no water main for the distribution of potable water to the site. It is estimated that approximately 4 - 5 million gallons per month will be needed to support the facility at full capacity. The original plan pre-Dorian was to have the potable water supplied by GBUC, which is responsible for city water in Grand Bahama. The GBUC water supply was intended to be used for the facility and for water bunkering of the cruise ships. However, as a result of Hurricane Dorian, the W-6 wellfield was adversely impacted. Conversations with GBUC indicate that GBUC will have a potable water supply available by late 2021 by combining water treated by reverse osmosis with water from the wellfield. If this is the case, then the project site will utilize that supply.

However, CGBIL plans to install a SWRO system in the event that Grand Bahama is stricken by another hurricane or for some reason GBUC cannot meet the supply demand or water quality standards at the time of facility opening. The supply well and disposal well will be located on the Grand Port property. All necessary drawings and specifications for the wells will be submitted to GBPA and GBUC to obtain the necessary approvals. CGBIL will communicate with GBUC on potable water requirements.

9.4 Wastewater Treatment

Wastewater treatment will be performed through the use of an advanced wastewater treatment plant (AWWTP). The CGBIL Grand Port will not have residences; therefore, hydraulic loading will be based on passengers in port. The wastewater produced by a cruise center is characterized by a sharp variation of flow and contaminant loads because it is mainly generated by guests and their stay in the cruise center. Therefore, flows are concentrated during certain hours of the day. For instance, **Table 9.1** provides an example of the typical daily flow for Carnival's Grand Turk Cruise Center, located in the Turks and Caicos Islands.

Conventional wastewater treatment systems are sensitive to changes in the quality and the quantity of influent. Any sudden increase in the strength or volume may adversely affect the operation of the plant. Plant upsets also will produce disagreeable odors and poor effluent quality. Other factors to consider with these systems are space, system deploy ability and sludge volume.

Consequently, Carnival Corporation's Global Port and Destination Development Group has installed in three of Carnival's Caribbean ports AWWTPs with MBR technology. This technology is designed to provide a very high quality of water capable of operating within varying and at higher pollutant loading. Biologically treated wastewater is filtered using MBRs to produce reuse quality effluent. Based upon the excellent performance of the MBR systems currently installed, Carnival has decided to install an MBR system in Grand Port, with treatment requirements intended to exceed the standard set in The Bahamas and the U.S. At this preliminary stage of Grand Port's design, an average day flow of approximately 30,000 gallons is estimated.

To minimize the fluctuations in the influent to the wastewater treatment plant, an equalization tank will be sized to store at least the peak day flow. As shown in the example from Carnival's Amber Cove facility MBR system in **Figure 9-2**, the last lift station from the wastewater collection system pumps raw wastewater (influent) passing through the fine screens to this equalization tank. Equalized influent (raw wastewater) is then pumped to fill the MBR process.

Table 9.1. Flow rates from Grand Turk Cruise Center

Time	Minimum Day Flow GPD	Average GPD	Maximum Day Flow GPD
00:00 – 01:00	0	0	0
01:00 – 02:00	0	0	0
02:00 – 03:00	0	0	0
03:00 – 04:00	0	0	0
04:00 – 05:00	0	0	0
05:00 – 06:00	0	0	0
06:00 – 07:00	0	0	0
07:00 – 08:00	251	503	754
08:00 – 09:00	458	916	1,374
09:00 – 10:00	739	1,479	2,218
10:00 – 11:00	1030	2060	3,090
11:00 – 12:00	1051	2102	3,153
12:00 – 13:00	831	1663	2,494
13:00 – 14:00	295	591	885
14:00 – 15:00	162	325	487
15:00 – 16:00	80	160	240
16:00 – 17:00	8	17	26
17:00 – 18:00	0	0	0
18:00 – 19:00	0	0	0
19:00 – 20:00	0	0	0
20:00 – 21:00	0	0	0
21:00 – 22:00	0	0	0
22:00 – 23:00	0	0	0
23:00 – 24:00	0	0	0

Process oxygen is delivered by membrane aeration. If required for increasing hydraulic throughput, a supplemental oxygen system could be employed which consists of an oxygen concentrator, looped pumps and a saturation system. Biologically treated wastewater is filtered using the membranes to produce reuse quality effluent. Air scouring and a cleaning in place system are used to clean the membranes.

When required, wasted activated sludge is conveyed to a storage tank where it can be digested, dewatered and used for the nursery/landscaping purposes and/or hauled to the Pine Ridge Landfill for disposal.

Disinfection is achieved through a UV system, and to provide residual disinfection, a dry calcium hypochlorite feeding system will prepare and automatically deliver a consistent accurate dose of chlorine. Chemical dosing systems will provide either alum for phosphorus reduction or supplemental carbon to assist in adjusting the BOD-to-Total Nitrogen ratio for the required reduction of Total Nitrogen.

The control system is equipped with programming necessary for seamless integration. The effluent water criteria are presented below in **Table 9.2.** The Bahamas Building Code criteria for WWTP's is $BOD_5 < 30$ mg/L and TSS < 30 mg/L.

Table 9.2. Effluent Requirements

Parameter	Effluent
Ave. Annual Daily Flow, GPD	30,000
cBOD5	<10 mg/L
TSS	<2 mg/L
TKN	<30 mg/L
NH3-N	<2 mg/L
TP	<10 mg/L
FOG	<15 mg/L
Max. Water Temp	30 ^{o}C
Min. Water Temp	24 ^{o}C
Fecal Coliforms	<25 mpn

The treated effluent will be used for irrigation where guest activity is low and when needed (dry season). Additionally, a deep well will be provided for the disposal of the treated wastewater. An application with supporting design drawing for the deep well will be provided to GBPA and GBUC. The deep well for the SWRO and treated effluent will more than likely be the same well. Moreover, water from backwashing the pool area will be discharged into the deep well.

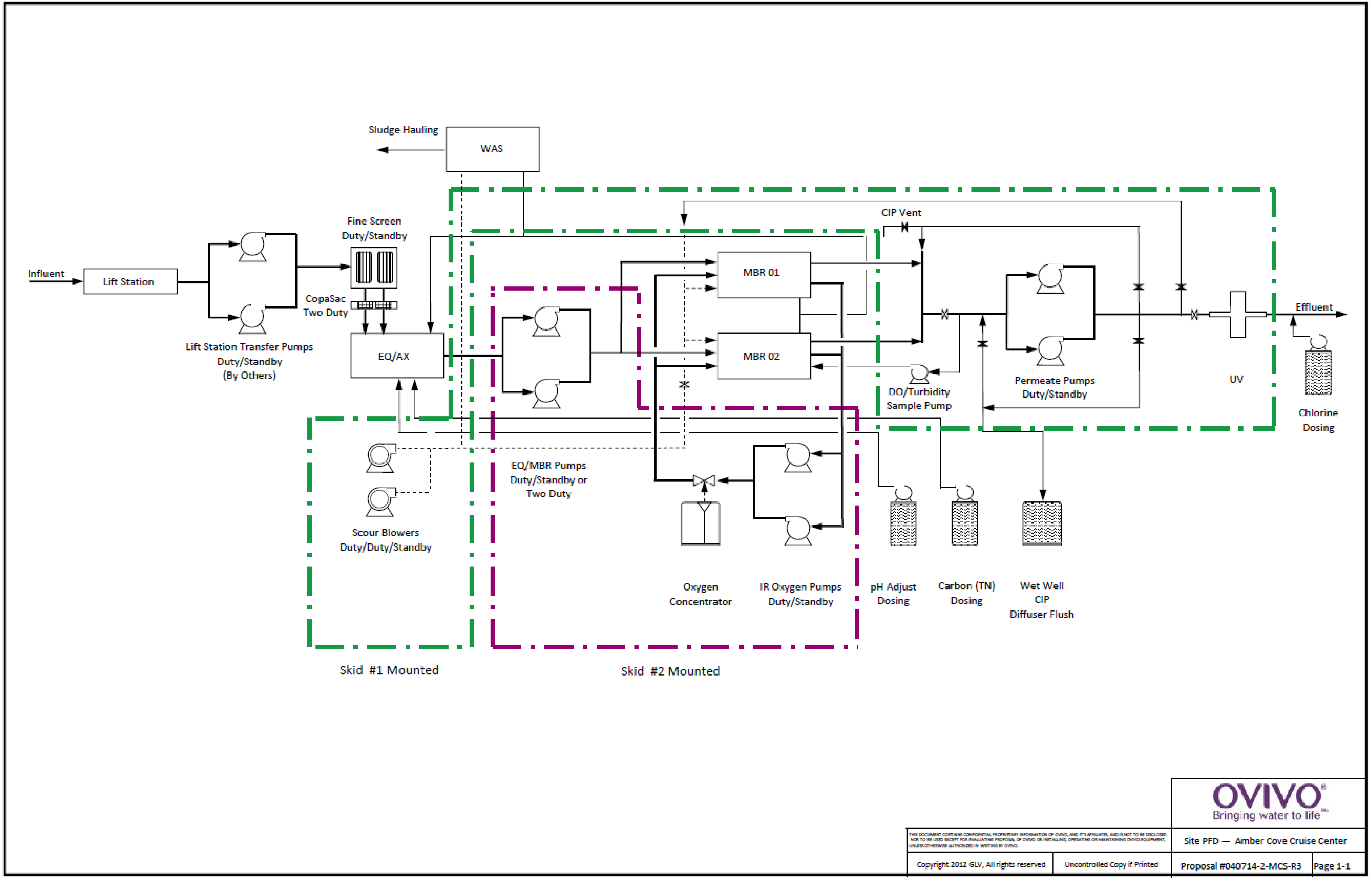

Figure 9-2. Diagram of Carnival's Amber Cove Advanced WWTP

9.5 Air Quality

The potential impacts on local air quality can be divided into three topic areas: emissions from the vessels to the air while at port, emissions from associated mobile sources during port visits, and impacts from accidental release of LNG.

9.5.1 Emissions from Vessels to the Air While at Port

Relocating some of the vessels east of the existing port facilities will "spread" the vessel-generated emissions, resulting in lower local ambient ground level concentrations at the current port and decreasing the local air pollutant concentrations in proportion to the quantity of ships relocated. The introduction of vessel emissions to the new port will have a negligible effect on the local air quality at the location, considering that they are a fraction of the total originally generated at the existing port, and the total emissions showed no ambient air quality issues.

While at port, the ships will operate some of their engine capacity to provide power for the ship's needs. The combustion products are exhausted through the "stacks," typically located at the highest point of the ship. Ship dimensions vary with the vessel displacement but may range from 860 feet long and 100 feet wide to as much as 1,000 feet long and 122 feet wide. Stack heights may range from 150 feet to 190 feet or more. Computer modeling was not performed as there was insufficient information available. Currently, there is no ship schedule to determine the class of vessels or information on other brands that may visit Gran Port. When a range of possible values for each of the parameters needed for computer modeling is present, modelers usually develop a "weighted average" set of values. At this point in the study, there is insufficient data to accurately develop that data set. We have only rough estimates at best of the number of ships to be in port over any given time period, the duration of stay, fuel used, and the size of the ships. And these estimates vary widely between peak and lean cruise seasons. We could potentially develop a "worst case" scenario and derive the values needed by the model, but the modeling would predict artificially high concentrations based on an unrealistic scenario, with no confidence that those concentrations would ever be observed. As a result of the difficulties encountered in developing representative values for the model parameters, computer modeling to estimate the maximum ambient ground level concentration for the pollutant species and the possible impact on air quality was not performed. The majority of the Carnival Line diesel fueled ships are equipped with Advanced Air Quality Systems (AAQS), which reduce SO_2 and particulate species in the exhaust, and the Carnival Line is introducing LNG fueled ships, further reducing all criteria pollutants compared to older ships that would be sharing the port. Although reliable modeling could not be performed, and in consideration of the distance between the existing and proposed ports and the exhaust discharge heights, it is reasonable to conclude that there will be no adverse effects on the local air quality due to ship activity while in port.

The majority of Carnival Cruise Line diesel fueled ships are equipped with the AAQS, and the percentage of ships in the fleet equipped with AAQS is projected to increase. This system significantly reduces sulfur oxides (SO2) and particulates (PM10), and Carnival Cruise Lines has achieved increased fuel economy and reduced CO2 emissions. It is also expected that newer, larger vessels will be powered by Liquid Nitrogen Gas (LNG). LNG is a much "cleaner" fuel than diesel. As shown in **Table 9.3**, obtained from U.S. EPA Air Pollution Volume 42, chapter 3, the emissions of particulate matter, the "acid gasses" nitrogen oxides (NOx) and sulfur oxides (SOx), and CO2 are significantly less for LNG combustion than for diesel fuel. Also, LNG combustion yields essentially no trace metals and reduced toxic/polynuclear aromatic compounds compared to diesel combustion. Therefore, port visits by large LNG powered ships will have less overall ambient air impact than current smaller diesel fueled ships. All cruise ships flagged under countries that are signatories to the International Convention for the Prevention of Pollution from Ships (MARPOL) are required to strictly comply with MARPOL, IMO regulations. All ships utilizing the new facility will comply with MARPOL regulations.

Table 9.3. Emission Factors for Large Stationary Diesel and Dual Fuel Engines

	lb emitted/MMBtu	
Pollutant	Diesel fuel	Dual fuel
TOC	0.09	0.8
CO	0.85	1.16
NOx	3.2	2.7
PM10	0.1	0
SOx	1.01*S	0.05*S
CO2	165	110

9.5.2 Emissions from Associated Mobile Sources

During dockage, passengers will be transported by bus, taxi or other source to and from the ship. These activities generate emissions to the air from the combustion of fuels in the vehicle's engines, and introduce dusts and particulates into the air from traveling on the roadways.

Initially, as with ship emissions, the relocation of some of the vessels east of the existing port facilities will disperse the emissions, resulting in lower local ambient ground level concentrations and improving the air quality. As the number of ships increases as planned through 2025, with larger ships and more passengers, there will be a concomitant increase in the number of light and heavy-duty trucks delivering supplies and materials to the ships. There will potentially be more passengers requiring taxis, rental cars, or other public transportation to travel to and from the developed western part of the island. The increased vehicle usage will generate additional emissions relative to 2019, but the increase will not be necessarily proportional, and any estimate would be subject to wide error margins.

However, a single example will serve to illustrate the potential significance of the expected increase. The following table is derived from the U.S. EPA document, "Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks," Office of Transportation and Air Quality, EPA420-F-08-024 October 2008, and the companion document for Heavy Duty Gas and Diesel Trucks. **Table 9.4** presents the emissions in tons per year of the criteria pollutants from 100 gasoline powered cars, gasoline powered light duty trucks, and diesel heavy duty trucks each driven for 12,000 miles per year.

Table 9.4 clearly shows that an increase in each class of vehicle traffic of 100 vehicles, each driven 12,000 miles per year, will have a negligible impact on ambient air quality.

Table 9.4. Estimated Emissions, Passenger Cars, Light and Heavy-Duty Trucks

	tons emitted/yr		
Pollutant	**cars - gas**	**light duty trucks - gas**	**heavy duty diesel**
VOC	1.37	1.62	0.59
THC	1.42	1.70	0.60
CO	12.42	15.65	3.05
NOx	0.92	1.26	11.38
PM10	0.01	0.01	0.29
PM2.5	0.01	0.01	0.27
CO2	486.87	678.63	

Assuming 100 vehicles of each class each traveling 12,000 miles/yr each

9.5.3 Accidental Releases of LNG

While an LNG powered ship is docked, some LNG will continue to boil off from the ship storage tank due to the temperature difference between the LNG and the significantly higher ambient temperature of the environment. A portion of this boil off gas will be used to run the ship engine to produce power while docked. Any boil off gas generated beyond what is required for the engines is typically vented to the atmosphere. Natural gas (methane) is lighter than air and if unobstructed will rise away from the ship and disperse. The methane will have no impact on local ambient air quality. However, methane is many times more active as a "greenhouse gas" than carbon dioxide, and best management practices will be used to minimize methane losses.

Should any leaks in the LNG piping or other equipment develop which would release methane into ship structures which would confine the methane and allow it to accumulate, such as an enclosed passageway, would result in a potential for explosion. Similarly, if a fire aboard ship heats the LNG tanks and causes more LNG to boil off than the vent lines can accommodate, a potential for explosion will develop.

A common practice in the preparation of a risk management plan is to utilize the U.S. EPA "RMPComp" computer model to conservatively estimate the distance to the overpressure endpoint of one pound per square inch. Below this overpressure, it is assumed no significant building damage would occur. The "accident" scenario is subject to a wide range of possibilities, but as an illustration, the RMPComp model predicts that a tank containing 10,000 lb of LNG suffering a catastrophic release and detonation would have an overpressure endpoint of 0.3 kilometers.

With the application of known and common safety procedures, the potential for an accidental release is minimized.

The operation of the cruise ships at the proposed port, the increase in cruise ship visits, and an increase in vessel size and the use of LNG fuel are all expected to have negligible impacts on the air quality of the region.

9.6 Vegetation

The information provided in this sub-section is pre-Hurricane Dorian. Conditions changed at the project site due to the destructive nature of the hurricane. However, on a recent site visit, some of the vegetation in the Broadleaf Coppice area is experiencing growth of new leaves. Pictures of the site post-Dorian are presented in the foreword and the TRS in **Appendix 5.**

Below are excerpts from the survey:
"During field surveys, 131 species of terrestrial flora distributed within 60 plant families were identified. Eight (8) invasive species were recorded on the property, with Casuarina equisetifolia, Scaevola taccada and Schinus terebinthifolius the most dominant species colonizing coastal and ephemeral wetland habitats. Three (3) species of protected trees were identified during surveys, Pinus caribeaum var. bahamensis, Guapira obtusata and Swietenia mahagoni. Pine were only recorded as trees species in the Pine Woodland on the property, Guapira obtusata were abundant within areas of the interior broadleaf coppice as mature tree and saplings, and few small saplings of Swietenia mahagoni were observed in the Pine woodland."

It is noted that while Caribbean *Pine* is listed as a protected tree that Grand Bahama is one of the four pine islands of The Bahamas. Development in Freeport typically involves the removal of pines, where land clearing is regulated by GBPA.

Approximately 103 acres of the 155 acres of mangrove wetlands on the western side of the of the site will be conserved (see site diagram at **Figure 9-3**). Also, a nature trail consisting of approximately 55 acres will be set aside for future development. The wetland conservation area and surrounding land will be kept in its natural state with the exception of a boardwalk trail similar to that as at the Lucayan National Park. The area to the west of the mangrove wetlands and to the north are owned by others.

The calcualtion of the habitat impacts for the canal and the entire property are provided in **Table 9.5. and Figure 9-4**

Table 9.5. Habitat Impacts from Terrestrial Resource Survey

Habitat Class	Total Habitat Acreage	Total Impact (ac)	Total Impact (%)
Broadleaf Coppice Forest	25.48	14.78	58.01
Casuarina dominated Coastal shrubland	26.43	4.77	18.03
Coastal Shrubland	13.98	10.17	72.76
Fire Impacted Coppice	3.96	1.29	32.65
Mangrove Wetlands	155.18	54.60	35.19
Pine Woodland	21.61	5.76	26..66
Sabal Woodland	41.56	31.97	76.91
Semi permanently flooded wetlands	20.23	18.62	92.05
Silver Palm-Bracken Fern Shrubland	13.44	3.27	24.31

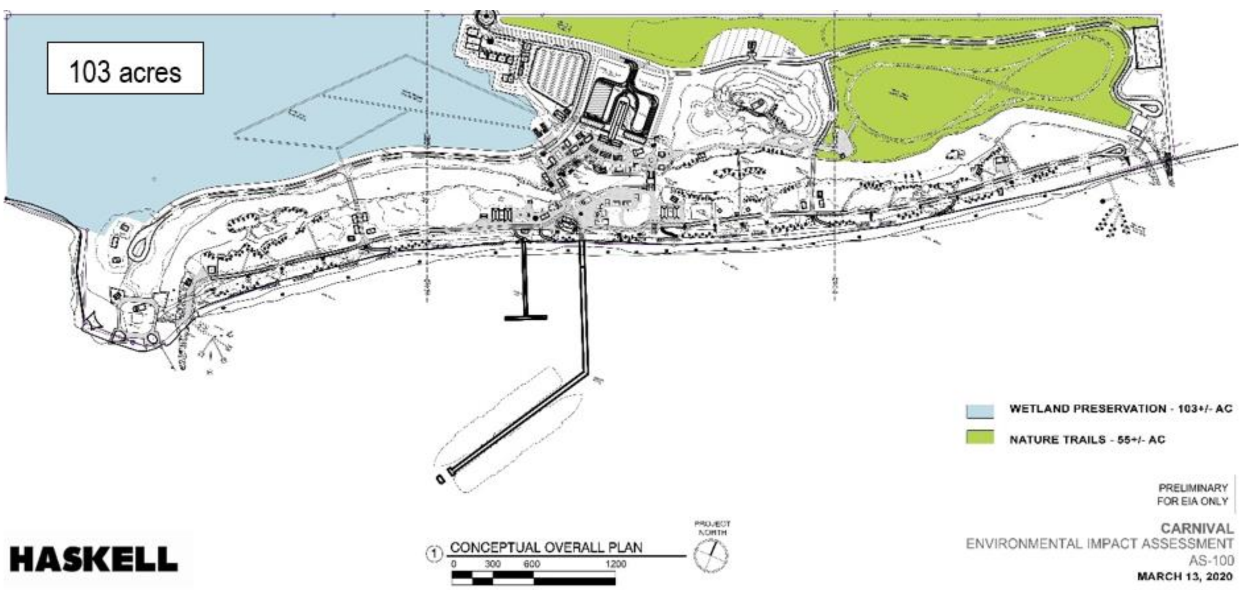

Figure 9-3. Wetland Conservation Area and Nature Trails

Note: Over water structures (cabanas) as depicted in this master plan have been removed from the overall project development proposal.

A post-Dorian assessment was conducted and is included in the Environmental Management Plan. The EMP also includes the plan for the removal of the casuarina trees along the shoreline and mitigation measures for the vegetation impacts will be presented in the Environmental Management Plan.

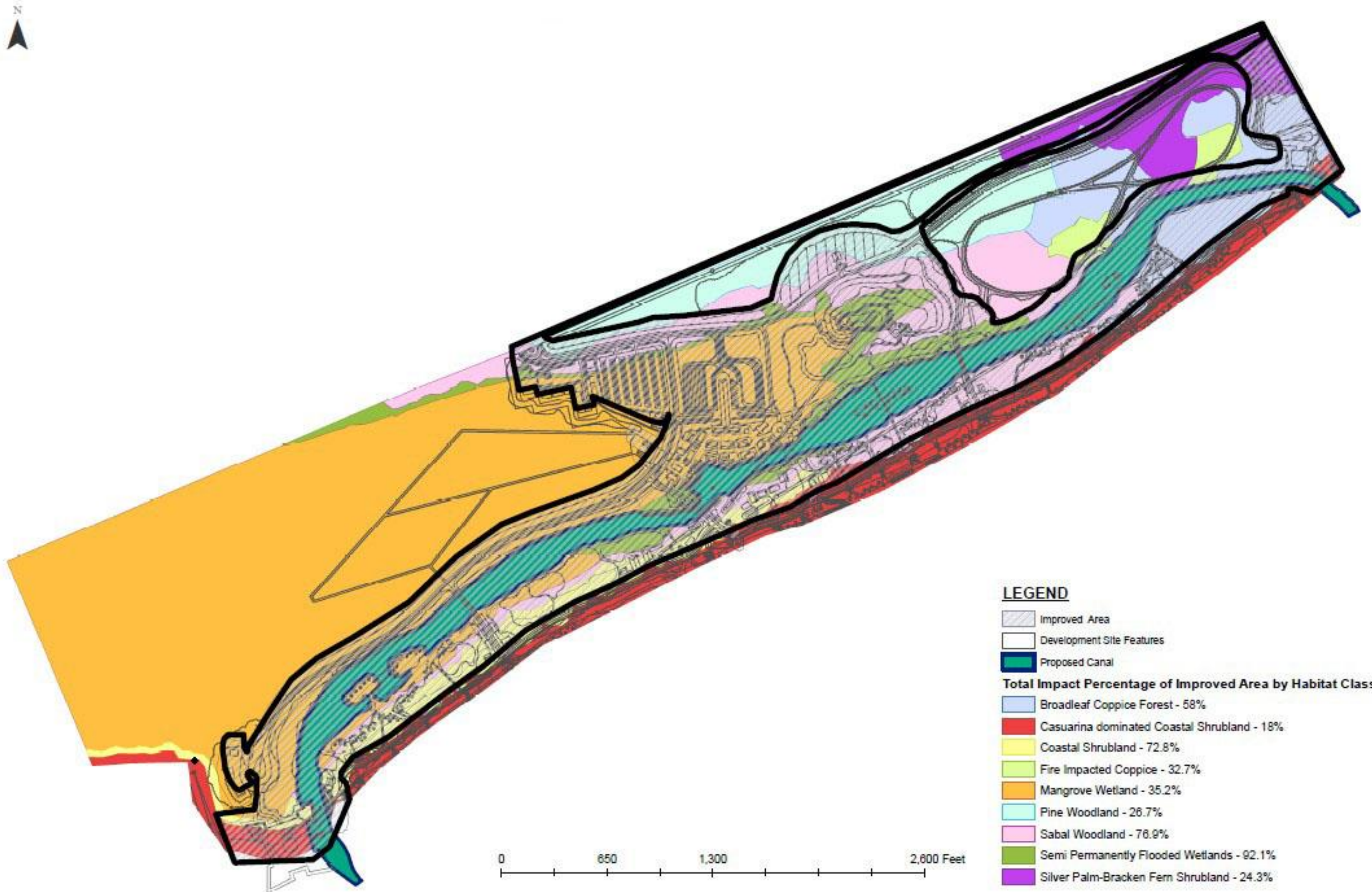

Figure 9-4. Potential Development Impacts Classified by Terrestrial Habitat

9.7 Mass Grading Plan

Material from the berth excavation will be beneficially used to raise the grade of upland areas proposed for development. A mass grading plan is provided in **Appendix 2.** Material will be hydraulically placed within these areas to attain the final grades. In total, approximately 1.1 million cubic yards of material will be excavated and placed. This operation will eliminate all existing vegetative cover within the placement areas and significantly raise the grade of development areas.

The final design grade was developed to attain a mass balance between the volume of excavated material and the capacity within the mass grading plan. In addition, final design grade elevations were developed based on site conditions to ensure that major habitable structures would be elevated above the projected 100-year flood elevation. The project design grade within areas of development was set at a minimum of 13 feet MLW. Factors considered while preparing the design grade elevation are presented in **Table 9.6**. The design grade elevation includes consideration of tide range, 100-year storm surge projections and SLR over the next century. This elevation is assumed for areas landward of the shoreline where additional wave setup is not a factor. It is additionally noted that the design finished floor elevation (FFE) for major habitable structures for the project is 14 feet relative to MLW (one foot above design grade).

Table 9.6. Factors for Design Grade Elevations

	Meters	Feet
Nominal Tide Range	1	3.3
100-Year Storm Surge	2.5	8.2
100-Year SLR	0.46	1.5
Total (all factors)	**3.96**	**13.0**

9.8 Coastal Dune

The coastal dune has an existing beach road which is near the top of the dune. The dune is dominated by Casuarina trees with native beach vegetation as noted in the TRS. The setback for the dune will be variable which is outlined in green in the drawing (see electronic **Appendix 2**) on the accompanying thumb drive. The minimum width of the setback is 7 feet and the maximum width is 115 feet, the average setback is approximately 50 feet. There will be a breach in the dune where the pier meets the shoreline and transitions to the security center and Shorex Dock. According to the planners, “Where needed, boardwalks will be elevated over the dunes. Any proposed structure (beach access stairs, ramps, showers, lifeguard stations, beach cabanas, or other miscellaneous elements) lying within the boundary of the existing sand dune, i.e. between the seaward toe and top of dune, will be treated as a “stilt-pile structure.” Such structures will not have floors or slabs on-grade. Rather, they will be built on a minimum number of wood piles (generally a single pile is each corner of the structure), with a wood structure built on a wooden platform supported by wood beams, supported by said piles.”

While it is recognized that the protection of the dune is important, there will likely be some disturbance in the removal of the overabundance of Casuarina trees in the dune area. However, it is noted that where the Casuarina tress were removed on the north side of the beach road, the native vegetation has started to regrow. The dune will be preserved as much as possible. The method(s) of clearing and planting for stabilization will be discussed in the EMP.

9.9 Waste Management

Waste generated at the project site will be domestic waste. The waste will be collected by Sanitation Services Company Ltd. and disposed at the Pine Ridge Landfill. Reduction of garbage will be utilized using a trash compactor at the facility and other waste reduction technologies. A garbage collection schedule will be discussed with Sanitation Services as the port comes online. Additionally, a low volume of sludge from the wastewater treatment plant will be generated. The sludge may be dried and used in the nursery/landscaping purposes or disposed at the landfill.

During construction of the facility, any waste generated will be stored on the premises for collection and disposal by Sanitation Services or through contractors delivering directly to the landfill. Contractors will be required to show proof of disposal at the landfill, which will be addressed in the EMP.

The facility may generate a minimum volume of hazardous waste. Hazardous waste is generated, will be collected, stored and disposed in a responsible manner.

9.9.1 Ship Waste

Cruise ships calling on Grand Port will strictly comply with MARPOL, governing waste disposal. Ships utilizing the facility are regulated under international and Bahamian regulations separate from the proposed facility.

This EIA addresses the proposed port facility which is distinct and separate from vessel operations outside of the facility. All cruise ships flagged under countries that are signatories to the International Convention for the Prevention of Pollution from ships (MARPOL) are required to strictly comply with MARPOL, IMO regulations, the applicable Bahama Laws and Regulations and Corporate Environmental Standards. Consequently, while in port, cruise ships will not carry our ballast water exchange and will not discharge any wastes. There will be no discharge of black, gray, or treated wastewater from the ship to the sea while in port. The beach is a recreational area; discharges will be prohibited.

9.10 Roadways

The entrance road from Grand Bahama Highway to the northern property boundary is approximately 2.27 miles along Sussex Drive. Sussex Drive is a two-lane dirt track road through pine forest. The pine forest was partially impacted from Hurricane Dorian as felled trees are visible. An easement has been granted on the eastern side of the roadway. The new entrance road will be a dual lane road. The entrance road will terminate at the parking lots for the facility. The road improvements will be permitted through GBPA.

9.11 Electricity

Electricity will be provided by GBPC. As mentioned previously, CGBIL has been in discussions with the power company on the use of solar power. Currently, there is no power to the property boundary. Given the impacts from Hurricane Dorian, CGBIL will have further discussions with G.B. Power on the provision of power to the facility and how best the demand can be met with a focus on solar power. GBPC will have to secure land near the facility to install a solar farm. An easement for power and utilities is incorporated into the Sussex Drive design.

Given the history of hurricanes in Grand Bahama, the facility will have an emergency standby diesel generator in the event of a power outage. This is necessary for communication of ships for arrivals and departure and convenience of the guests. An above ground diesel fuel tank will be present at the facility.

9.12 Phone and Cable

Phone and cable will be provided either by The Bahamas Telecommunications Company (BTC) and/or Cable Bahamas. CGBIL will make the necessary arrangements. Currently, there is no phone or cable line to the facility; however, an easement is designated on Sussex Drive.

9.13 Marine Environment

Impacts from the project can be characterized as direct, indirect (secondary), or cumulative. Each of these impacts to the marine environment has been assessed and is discussed further in this sub-section.

9.14 Direct Project Impacts

Direct impacts consist of impacts due to actions within the immediate project vicinity. Such impacts are immediate and inherent to project implementation. There is a high level of certainty that these impacts will occur. The following sections present the direct impacts anticipated from the proposed project.

9.15 Direct Impacts to Benthic Communities and Substrate (Berth Construction)

The project will result in direct impacts to 75.60 acres of existing benthic habitat from berth construction (**Figure 9-5** and **Table 9.7**). This area of impact is primarily associated with dredging of the berth to a nominal depth of 35 feet (MLW) and includes slope adjustment along the boundary of the dredge footprint. Existing resources within this area will be lost, unless they are relocated before construction. Excavation within this area will permanently modify existing benthic substrate and site bathymetry. The majority of material that will be removed consists of base limestone rock with minor sand fractions. The post-dredge condition will consist of a deepened berth of consistent depth of -35 feet (MLW). A prominent limestone slope/ledge system will be formed at the boundary of dredging transitioning into the berth. This new ledge system will be most prominent along the landward (northern) boundary of the dredge area where the change in depth will be greatest, approaching a maximum elevation on the order of 15 feet. The post-dredge berth bottom will primarily consist of limestone rubble overlaying base limestone substrate. Further detail regarding impacted habitats including species descriptions and abundance is provided in **Appendix 7.** The entire footprint of the dredge area was assessed based on accepted benthic assessment protocols including quantified assessments throughout the area of impact. Impacts to each specific habitat are summarized as follows:

Hard Pan (hardbottom): Dredging will impact 40.77 acres of hard pan (hardbottom) habitat. This represents the dominant habitat that will be directly impacted by berth excavation and approximately 60.9 percent of the total area that will be excavated. This habitat consists primarily of low profile exposed limestone substrate dominated by macroalgal communities. Isolated soft and hard corals are present, particularly on high points in the substrate and with increased density in deeper portions of the habitat. In general, observed coral communities are limited in size and extent.

Ridge Swale (hardbottom): Dredging will impact 7.17 acres of ridge-swale (hardbottom) habitat. This habitat exhibits increased rugosity and coral density in comparison to the hard pan habitat within the dredge footprint. The substrate in this area includes undulating bathymetry with higher areas (ridges) and lower areas (swales). Benthic species range from macroalgae communities on exposed, low-profile limestone substrate to a more diverse assemblage of sponges, and soft and hard corals on the ridge formations.

Spur Groove (hardbottom): Dredging will impact 3.71 acres of spur groove habitat. This habitat exhibits species similar to that present within the ridge swale habitat, though these areas exhibit an increase extent of ledge formations. Benthic species range from macroalgae to sponge, soft coral and hard coral assemblages.

Reef Mounds (hardbottom): Dredging will impact 1.09 acres of reef mound habitat. This area consists of discrete limestone mound features extending several feet above a sand substrate. Given the rugosity of these mound features, they exhibit the highest diversity and quality of benthic species within the area of direct project impact. There are approximately 100 reef mounds that are suitable for relocation. At present, the intent is to relocate all of the coral mounds which can be physically removed and relocated. There are no specific reef mounds that are unsuitable for relocation. The primary constraint regarding relocation is the physical integrity of each mound. The surface of the mounds is dominated by soft coral and sponge communities, though hard corals are also present. The sides of the mounds include undercuts and cavities which provide refuge and habitat to a range of reef species. The acreage estimate includes both the mounds and open sand areas between the mounds. The spatial extent of individual mound features within this habitat is 1.1 acres. One U.S. ESA listed threatened species (*Agarcia* sp.) were identified within this area during the baseline benthic assessment. Both species were present on vertical substrate in isolated colonies and not representative of the dominant benthic assemblage.

Sand: Dredging will impact 22.85 acres of open sand substrate. This habitat supports a range of ecological functions including foraging habitat for reef species.

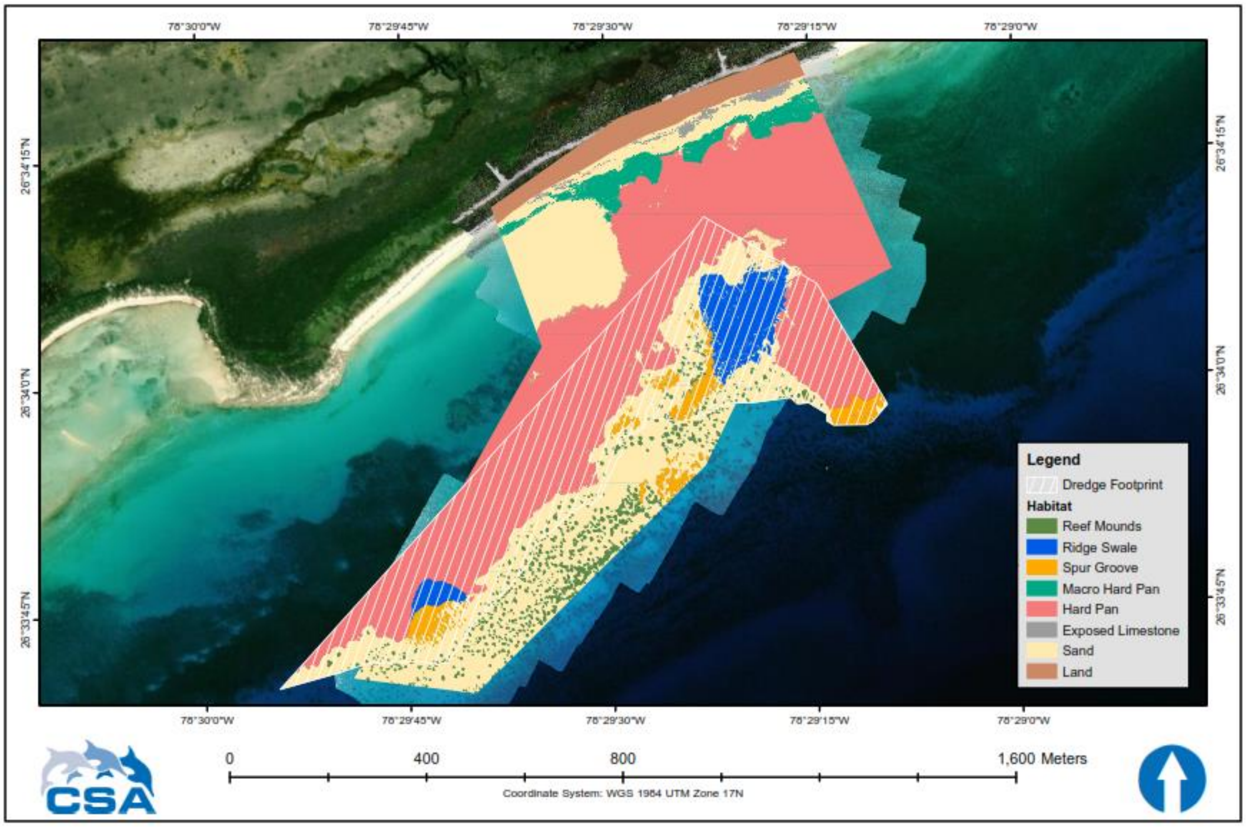

Figure 9-5. Benthic Habitats within the Dredge Footprint

Table 9.7. Summary of Direct Impacts from Berth Excavation

Habitat	Area (acres)	Area (ft²)	Area (m²)	Percent
Land	0.00	0.00	0.00	0.0%
Sand	22.85	995,343.89	92,470.84	30.2%
Exposed Limestone	0.00	0.00	0.00	0.0%
Macroalgal Hard Pan	0.00	0.00	0.00	0.0%
Hard Pan	40.77	1,775,875.44	164,984.89	53.9%
Ridge and Swale	7.17	312,463.69	29,028.94	9.5%
Spur and Groove	3.71	161,817.13	15,033.36	4.9%
Reef Mounds	1.09	47,501.45	4,413.05	1.4%
Total	**75.60**	**3,293,001.62**	**305,931.08**	**100.0%**

Mitigation for impacts to benthic resources are addressed in **Section 10.6.3**. These include transplantation of high value reef mound substrate from the impact area and relocation of individual coral colonies to a newly constructed mitigation reef. Additional details regarding the monitoring protocol will be provided within the EMP including protocols for long term monitoring of benthic resources. Construction of mitigation reef habitat and reef mound relocation will occur upon approval of this EIA and the EMP. Both efforts will occur prior to the initiation of dredging. This will require between 3 and 6 months to complete. Both reefs will be monitored for success for two years following construction.

9.15.1 Impacts to Coral Species

Healthy stony corals of sufficient size warrant relocation from the impact area. Other benthic species, most notably sponges and soft corals, are in general not suitable for relocation of individual colonies as they cannot be effectively re-attached to substrate and survivorship is very low. A total of 27 stony coral species were identified within the project footprint. In terms of total coverage, stony corals are a minor fraction of total benthic habitat and will be relocated. Stony coral coverage represents approximately 5% of the total benthic coverage within the area of impact. The predominant coverage within hardbottom habitats is macroalgal turf. Other benthic resources within the reef mound area will be relocated by transplantation of the physical substrate. Hardpan areas are dominated by macro algae and octocorals which cannot be effectively relocated. Observed stressed corals may recover and if so will be relocated. Coral health will be re-assessed prior to the relocation effort. Details of species occurrence and relative density are provided in Appendix 7. Corals within the reef mound area will remain in-situ attached to the rock substrate which will be relocated in large block sections. This strategy will preserve soft coral and sponge communities as well for this substrate. Healthy substantial, individual colonies within the remaining areas will be dislodged from the substrate and re-attached to substrate at the proposed mitigation reef sites.

Three threatened coral species (as designated under the US ESA) are present within the area of direct impact. These species, their locations and relative abundance are provided in **Table 9.8**. Whitestar Sheet Coral (*Agaricia lamarki*) is present only within the reef mound area and utilizes vertical faces of the reef mound substrate. Relocation of the mound structures in sections is proposed to preserve these colonies and the vertical nature of their attachment. Sheet corals are not good candidates for relocation as individual colonies as they tend to fracture upon removal. Three species of star coral (*Orbicella faveolata*, *Orbicella annularis* and *Orbicella franksi*,) are present within all of the reef and hardbottom habits within the impact area. These species are closely related and can be difficult to differentiate. Based on the field study all three species are present within the area at low densities. Relocation of healthy, individual colonies to a mitigation reef is proposed to preserve these colonies. Three colonies of pillar coral (Dendrogyra cylindrus) were observed within the impact area.

Table 9.8. Summary of Threatened Stony Coral Species within Project Area

Common Name	Scientific Name	Habitat	Relocation Strategy	Estimated No. of Coral Colonies
Whitestar Sheet Coral	*Agaricia lamarki*	Reef Mounds	Moved in-situ with Reef Mound Substrate	218
Star Corals	*Orbicella Sp.*	Reef and Hardpan Areas	Relocation of individual colonies. Moved in-situ with Reef Mound substrate	1,034
Pillar Coral	*Dendrogyra cylindrus*	Reef areas	Relocation of individual colonies	3
			Total	**1,255**

9.16 Direct Impacts from Pier Construction

Pier construction will result in direct impacts to an additional 0.94 acres outside of the immediate dredge/excavation footprint. Direct impacts will occur due to the installation of pier piles within this area and the shading impact of the pier deck to the underlying substrate. The majority of impact will occur to 0.75 acres of sand dominant substrate. This represents 79.8 percent of the total impacted area. The remaining area of impact consists of nearshore macroalgal hard pan substrate (0.14 acres) and intertidal hard pan (0.05 acres). Direct impact from the pier piles is estimated to be 0.15 acres. No U.S. ESA listed benthic species are present in this area, though macroalgal hard pan is a noted habitat for green sea turtle foraging. The resulting pier pile structure will provide additional (vertical) benthic substrate post construction.

9.17 Direct Impacts from Coastal Inlets

The construction of two coastal inlets will result in direct impacts to 0.2 acres of intertidal hard pan (hardbottom) and macro hard pan (hardbottom) associated with excavation of the inlet channels and installation of inlet jetties. Construction will also impact approximately 3.0 acres of sand substrate. These two coastal inlets will connect to the planned interior waterway and introduce a tidal exchange from the waterway into the ocean. Numerical modeling of this exchange was conducted and is further discussed in **Appendix 6.** This analysis suggests that induced currents within the waterway from natural process (tidal forcing, wind and waves) will result in mild current velocities, with maximum velocities in the inlet throat approaching 0.5 meters per second. Mechanical pumping will be implemented, and numerical modeling of the waterway has been completed to determine system requirements. Mechanical pumping will be utilized to reinforce natural flushing of the interior waterway. Pumping will be implemented as a means of assuring interior water quality through the pumping of ocean water into the interior. No nutrient discharge into the waterway will occur, and the pumping will recirculate ocean water. Additional detail regarding mechanical pumping will be provided within the EMP including water quality standards and a monitoring plan. A design exchange rate of 90% overturn within 24 hours has been adopted as a minimum standard for the interior swimming areas. A design exchange rate of 90% overturn within four days has been adopted for the entire waterway system.

Both inlets will be stabilized with terminal rock jetty structures that will be nominally 200 feet long. The terminal structures will create additional nearshore hardbottom substrate that will partially offset impacts to nearshore hardbottom from inlet construction.

A coastal study was performed and considered the potential for both direct and indirect impacts, including to adjacent properties. The construction of the inlets and terminal jetty rock structures will be minor and within the interior of the proposed development. The modification of the wave and sediment transport environment, as a result of the construction of the inlets and jetty structures, was specifically assessed through numerical modeling provided in Appendix 6. This analysis suggests relatively minor changes to the nearshore wave field and relative stability of the adjacent beach. The coastal assessment determined the beach will remain relatively stable and will only require nourishment from impacts from a major storm event. Regular maintenance (sand bypassing) of sand in the eastern inlet may be required as an ongoing maintenance activity.

9.18 Direct Impacts from Ancillary Coastal Structures

The construction of the excursion dock will result in approximately 0.2 acres of impact to nearshore substrate consisting of intertidal hard pan (hardbottom) and macro hard pan (hardbottom, and sand substrate. As will the pier, these structures will be pile supported structures. Direct impacts will occur due to the installation of the structure piles and the shading impact of the structure decks. The resulting pile structure will provide additional (vertical) benthic substrate post construction.

9.19 Direct Impacts to Water Quality During Construction

The project will require the hydraulic excavation of approximately 1.1 million cubic yards of primarily limestone rock material. Excavated material will be discharged to the upland property. The average production rate is anticipated to be around 5,000 cubic yards per day (cy/day) and will require the deployment of a large, ocean-going dredge. Active construction will require approximately 220 days and will advance on a 24-hour / 7-days-a-week cycle. This 220-day estimate includes operational down time for maintenance and other operational needs.

Given the magnitude of hydraulic excavation, impacts to water quality are inevitable and primarily consist of increases in suspended sediment (turbidity) associated with both the excavation of material and the hydraulic discharge of return water from the upland disposal site. Depending on the rate of production, the implementation of best management practices (BMPs) and weather conditions, the magnitude and extent of turbidity can vary significantly. The contractor will be required to provide sufficient turbidity curtain to contain active work areas. No minimum extents have been specified as the contractor will be required to meet this performance standard regardless of the extent of the turbidity curtain required.

Aside from direct removal of natural habitat, sedimentation and turbidity are the main concerns for all areas. Sedimentation can bury or smother the live cover of hardbottom substrate while turbidity can reduce water clarity, which limits photosynthesis and increases the stress response of benthic species. Both of these effects may cause habitat degradation or reduced species populations.

9.20 Direct Impacts from Construction Operations

Given the magnitude of construction, major ocean-going construction equipment (a cutter suction dredge, barges and cranes) will be required. In addition, hydraulic placement requires the deployment of a direct submerged pipeline to the beach from the dredge. Construction as proposed will result in direct impacts within the project area. The level of impact, however, may vary significantly depending on construction operations. In general, properly deployed equipment with appropriate oversight should result in de minimis direct impacts to the project area. Examples of potential construction impacts include damage from anchors, cable or pipeline drags; barge or tug groundings; and unauthorized discharges. While such impacts are avoidable, an appropriate level of oversight, BMPs, and independent monitoring is warranted.

Unavoidable direct impacts also include increases in carbon discharge (exhaust) from construction equipment, increases in construction-related noise, and aesthetic impacts associated with operations. Construction is proposed to occur on a 24-hour/7-days-a-week basis and, as such, will include night operations. Sufficient lighting for nighttime operations will be provided for employee safety and will meet international and Bahamian requirements for vessel lighting. Additionally, high visibility vests and clothing will be worn. Nighttime operations will be specifically addressed within the EMP.

9.21 Marine Construction Noise

Construction operations will result in increased noise within the marine environment. Increases in marine noise are a documented concern relative to marine mammals, particularly migratory species. However, the project area is not within any known migratory corridor for marine mammals. Bottlenose (*Tursiops truncatus*), spiiner (*Stenella longirostris*) and spotted dolphin (*Stenella frontalis*) are common to the region, but no specific association to the project site has been documented. Excessive noise has the potential to interrupt marine mammal behavior due to the species reliance on echolocation. The level of noise generation associated with an operational cutter suction dredge excavating limestone has been measured and exhibits a broadband source level (BSL) values on the order of 175 dB (re. 1 μ Pa^2 @ 1m) (Jones and Marten., 2015). This compares similarly with the magnitude of ship noise which exhibits BSL values ranging from 176 to 188 dB (re. 1 μ Pa^2 @ 1m) (McKenna et al., 2011). It is additionally notable that ship sound increases with vessel speed while dredge noise levels are attributable primarily to machine noise and noise generated by excavation. The primary distinction between the two vessel types (ships and dredges) is the lack of mobility of the dredge and its operational location near the shoreline. While it has been documented that anthropogenic noise is a concern relative to marine mammals, the proposed operation of a cutter suction dredge does not propose a noise source that is of particular concern given the intensity of the sound generated and limited mobility and nearshore location of the dredge. The dredge operation likely represents a lesser potential contributor to the marine anthropogenic noise environment than existing ship traffic.

Similarly, noise associated with pile driving has the potential to impact marine mammals. The noise level associated with pile driving varies significantly depending on the equipment utilized, the overall size of the piles and the substrate into which the piles are driven. Typical maximum (source level) reported values range from 220 dB (re. 1 μ Pa^2) for a 0.75 meter diameter pile at a range of 10 meters to a value of 200 dB (re. 1

µ Pa^2) for a 5 meter diameter pile at a range of 300 meters (Dahl, Jong and Popper, 2015). The issue of pile driving noise impacts has become a notable concern with the increase in installation of offshore wind energy farms which require the driving of large piles in the offshore environment. The proposed construction will require pile driving within shallow water, reducing the propagation potential for sound created by the activity. The use of turbidity curtains will also provide limited dampening of noise levels. To date, there is no uniform acceptable international standard for acceptable noise levels relative to marine mammals, though several counties have adopted noise restrictions (Dahl, Johng and Popper, 2015). In terms of application, these restrictions predominantly define an avoidance zone (distance) around the activity requiring shutdown of the activity if a marine mammal of concern is within the area.

9.22 Indirect (Secondary) Impacts

Indirect or secondary impacts are those that occur as a result of project implementation but are not directly linked to project activity. They may occur at some time following project implementation or outside of the immediate project area. The probability of a secondary impact varies depending on the mechanism of impact and may need to include consideration of secondary factors such as environmental forcing (waves, storm events, etc.) and BMPs. The following sections present the indirect (secondary) impacts anticipated from the proposed project.

9.23 Secondary Impacts to Benthic Communities

Project construction represents a major perturbation in the marine environment in the vicinity of the project area. While the majority of anticipated impacts will be direct and predominant during construction activities, there is a potential for additional indirect and secondary impacts both during and post-construction. The excavation of approximately 1.1 million cubic yards of material will cause the mobilization of a significant volume of fine silt and sand material. The dredge spoil will be utilized to raise the central portion of the upland property (See Mass Grading Plan; **Section 9.7**). Depending on the efficacy of the proposed turbidity control measures, this could result in a latent volume of mobile fine material remaining within the project area. Such material can lead to excessive sedimentation and stress of benthic communities beyond the immediate construction phase and over areas adjacent to the immediate project area. Two separate mechanisms may lead to this additional secondary impact. In general, any remaining fine load will be dissipated through wave and current agitation. If post-construction conditions are particularly calm, this fine sediment load will not dissipate quickly and may result in impacts to benthic communities. Secondary impacts may also occur from high sea conditions in which the full latent fine load is suspended all at once, again resulting in additional secondary impacts to benthic resources. In principle, the potential for such secondary impacts is a function of distance from the immediate project area, with diminished potential at greater distances away from the area.

While secondary sedimentation impacts may not be of sufficient magnitude to result in perceivable impacts to benthic resources, it is important to acknowledge that these resources are currently under stress from a range of natural and anthropogenic factors and the project represents an additional contributing factor to the overall health of these resources within the project vicinity.

Secondary impacts to benthic resources are a particular concern regarding Petersons Cay. Resources within Peterson's Cay were included within the baseline benthic assessment which is provided in **Appendix 7**. The project EMP will include a monitoring program element to identify any potential impacts from the project on Peterson Cay. This monitoring will occur for a minimum of two years following construction. The baseline assessment identified high value coral assemblages within the park including multiple species designated as threatened by the U.S. ESA. Potential secondary impacts to these resources could occur form excessive and persistent turbidity plumes from the project. However, given that these resources are more than 1.5 miles from the excavation area, the relative risk of such impacts is low and preventable though proposed monitoring protocols and BMPs.

9.24 Secondary Impacts to the Coastal Sediment Transport System

Berth construction will permanently alter the bathymetry in the project area, resulting in a modification of the local wave climate and resulting sediment transport system. The two coastal inlets will interrupt the transport of sand within the beach system. Numerical modeling of the wave and sediment transport system was conducted and is discussed further in **Appendix 6**. **Figure 9-6** provides an overview of the modeling analysis and highlights areas of potential increased erosion and accretion. This modeling suggests the following modifications to the current coastal sediment transport system:

- Changes in beach stability (erosion potential) will be primarily limited to interior portions of the property.

- Infilling of the eastern inlet channel is predicted suggesting that maintenance dredging may be required. This material can be beneficially used to address erosion to the immediate west of the inlet.
- The main areas of increased erosion potential occur adjacent and downdrift (to the west) of the proposed eastern canal inlet and immediately landward of the berth.
- Downdrift impacts as a result of the project outside of the property boundaries are not anticipated as the Sharp Rock headland already largely isolates the project site within its own littoral cell.
- Dredging of the berth will cause waves to refract and break closer to shore. These impacts in terms of increased wave heights at the shoreline and erosion potential are minor and limited to the study area.
- Increased wave energy seaward of the proposed jetties is possible due to wave reflection. This can be mitigated during design through mild sloping structures and/or the use of less reflective material.

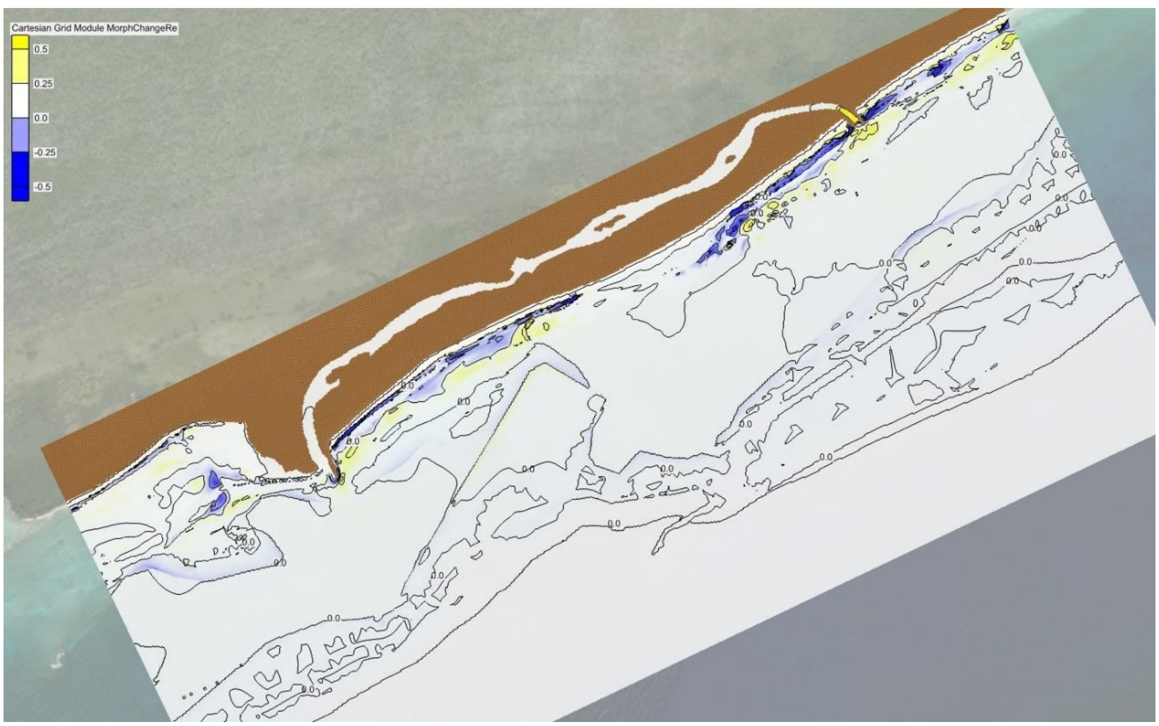

Figure 9-6. Morphology Change (in Meters) Following 30-Day Simulation

In terms of existing facilities, the proposed development is most like the Grand Turk, site which has been in place for over ten years. The dredge footprint and beach processes are similar between the two sites. To date, minimal infilling of the dredged areas from the beach has occurred at Grand Turk including during hurricanes and nourishment of the beach has not been required. The main difference between the two is the additional of the two inlets for this project, which pose the greatest potential for impact to the beach. This issue is addressed within the coastal impact study (**Appendix 6**) and is addressed through a monitoring program established within the EMP including beneficial use of any sand deposited within the inlets.

9.25 Secondary Impacts to Water Quality

The project will increase the level of development and site usage of the property. This will introduce the potential for upland and marine contaminants into the coastal system. While no discharge of any contaminant is proposed, unanticipated or accidental discharges could occur. Given that the project will be designed and implemented based on current, established design standards and BMPs, the level of risk associated with this concern is low and there is no particular element of the project that raises a particular concern regarding water quality degradation.

9.26 Secondary Impacts from Vessel and Port Operations

The project will result in significant increases in vessel usage of the marine environment in the vicinity of the project. This includes the introduction of large cruise vessels which are not currently present in the area in addition to increased traffic by smaller vessels. Increasing vessel activity raises the potential for adverse impacts from accidents including vessel groundings and unanticipated discharges. However, it is worth noting that the risk of such accidents involving cruise ships are increasingly rare, and this risk is further diminished with more modern vessels. The project will also increase usage of the area by smaller vessels supporting visitor excursions in the project vicinity. While tethered to the pier, vessels must maintain a minimum level of engine operation to maintain ship function. The magnitude of heat discharge is negligible and will not measurably increase water temperature in the vicinity of the vessel or the pier.

9.27 Secondary Impacts to Sea turtle Nesting

While the extent of turtle nesting on the property is not currently known, the beach and dune system provide viable nesting habitat that may be utilized by nesting sea turtles. As facility usage will primarily occur during daytime hours, the primary potential for impact is associated with changes in the nighttime light environment. Artificial lighting and lighting associated with structures has the potential to disorient both nesting sea turtles and hatchlings. BMPs can significantly reduce the potential for such impacts.

9.28 Cumulative Marine impacts

Cumulative impacts are those attributable to the proposed activity in concert with additional activities that are occurring or are likely to occur. Such impacts include the cumulative or combined impacts of multiple activities that, taken together, may result in a net impact greater than assessed for each individual activity. Cumulative impacts may occur due to a series of contributing factors including those not directly associated with the proposed facility. The following sections present the potential cumulative impacts anticipated from the proposed project.

Grand Bahama is an island with limited resources, so issues of further development are critical to the long-term health of environmental resources. There is a finite carrying capacity for available resources and increasing demand can result in long-term and irreparable harm to these resources if not properly managed. Impacts to marine resources represent a significant concern relative to the proposed project.

The majority of anticipated impacts to the marine environment are associated with direct and secondary impacts associated with facility construction. Additional cumulative impacts may occur if regular maintenance dredging or berth expansions is required to maintain or expand berth facilities. Cumulative impacts may also occur from port operations.

The most significant cumulative impact that may occur is with regard to an increase in use of marine resources. The facility will result in a significant increase in visitation to the immediate area. This increase in visitors will increase use of resources not only within the port property confines but will extend to all areas where cruise ship passengers may go on excursions.

Like beaches, carrying capacities for coral reefs have become an issue of increased scientific concern (Lim, 1998). Determinants for reef carrying capacity include the size and shape of the reef, composition of the coral communities, depth, current and visibility, level of experience of the snorkelers and divers, accessibility and attractions. As tourism continues to increase, management plans that consider carrying capacities for marine areas may need to be prepared and implemented by the appropriate authorities.

9.28.1 Fisheries

The project will not have any significant impact to fisheries. According to Chapter 244 Fisheries Resources (Jurisdiction and Conservation) Regulations Part 1 paragraph 6:

"No person shall use any spearfishing apparatus to fish —

(a) within one mile of the coast at low water mark of New Providence; or

(b) within one mile of the southern coast at low water mark of Freeport, Grand Bahama; or

(c) within two hundred yards of the coast at low water mark of any other Family Island."

Traditional fishing areas on the Northshore are off Western Grand Bahama and the Abaco Cays. On the south shore off Eastern Grand Bahama. Sportfishing does occur along the south shore of Grand Bahama in deeper water depths.

9.29 Cumulative Impacts to Peterson Cay National Park

It is important to acknowledge that the proposed facility is located approximately one mile east of Peterson's Cay National Park which is afforded an increased level of protection though this designation. While the marine portions of the new facility are not within the park boundaries, the influence of the new facility (particularly passenger visitations) has the potential to have a profound impact on the park. Current management of Peterson's Cay does not specifically address the increase in passenger visitations that will occur due to this proposed project.

9.30 Beach Capacity

The existing capacity of the project beach has been calculated from a low value 18,500 to a high value of 39,000, depending on assumptions of nominal per user area and turnover rate. It is noted that these figures have been determined based on the assumption of a high-demand (resort) beach and are considerably higher than the nominal environmental carrying capacity for natural (undeveloped) beach areas. In general, the 1.3 mile nominal extent of beach present on the property is sufficient to accommodate the anticipated level of visitations for the facility including calls by two large vessels at the same time. The general character of the beach, however, will be converted from the existing undeveloped state to a more developed, higher density/

resort type beach experience, consistent with the proposed development but complying with its environmental management plan avoiding exceeding its environmental carrying capacity.

9.31 Socioeconomics

Grand Port is a $100,000,000.00 project. The proposed project is viewed as a positive impact to Grand Bahama. The economy of the island has been suffering since the hurricanes in 2004, 2005, 2016, and more recently September 2019. The project will generate construction jobs for land clearing, site preparation, excavation, road building, infrastructure, and building construction. Additionally, services from engineers, land surveyors and architects will be required.

The project will include a number of food and beverage facilities and retail shops. These will all be operated by qualified Bahamian entrepreneurs. These retail and dining locales are expected to employ up to 500 workers.

With the transition to the larger XL Class ships, the facility will allow a greater number of guests to visit Grand Bahama as well as free berth space in Lucayan Harbour, which will allow other cruise lines to add Grand Bahama to their itineraries. According to The Economic Impact of the Proposed Carnival Cruise Line Expansion on Grand Bahama Island by Tourism Economics the following has been forecasted:

"Over the 23-year time horizon, Carnival's proposed development on Grand Bahama Island would boost Bahamian employment, income, GDP and government revenues:

- *A total investment of B$170 million*
- *More than 40 additional calls to Freeport annually, on average ▪An estimated 500k incremental cruise passengers annually, on average*
- *706 new Bahamian jobs during the development phase*
- *More than 1,680 new Bahamian jobs annually during ongoing operations*
- *B$1.5 billion (in B$2019) increase in Bahamian GDP*
- *B$647 million (in B$2019) in income earned in The Bahamas*
- *B$363 million (in B$2019) increase in Bahamian government revenues, outweighing proposed concessions by a factor of 3.8."*

Moreover, additional businesses may take advantage of Grand Port and by establishing near the facility, thereby creating more opportunities. A narrative on socioeconomic issues and the importance of the cruise industry to Grand Bahama are discussed in **Chapter 11** of this report.

Ultimately, The Bahamas Government and the GBPA will evaluate the environmental impacts against the benefits of the project. Consideration will have to be given to the cumulative impacts from previous storms and the current economic situation and future prospects of Grand Bahama as a result for Hurricane Dorian.

9.32 Chemicals

The Grand Port will need to store chemicals on-site for pool, landscaping, and general maintenance. Below is a tentative list of chemicals that may be used at the site and estimated volumes. This list is based on the Carnival facility at Amber Cove, Dominican Republic. The chemicals will be stored indoors with adequate ventilation. Safety Data Sheets (SDS) will be kept in a folder in the storage facility and other locations for employee use. The storage of acids and bases will be segregated to prevent any safety incidences from occurring.

Chemical	Use/Area	Presentation	Qty
Sodium Hypochlorite 10% (Liquid Chlorine)	Pool and Potable Water	55 gals drums	15
Muriatic Acid 35%	Pool and Potable Water	55 gals drums	4
Sodium Carbonate (Granular)	Pool, waste water and potable water	50 pound bags	10
Sodium Bicarbonate (Granular)	Pool and Potable Water	50 pound bags	20
Cyanuric Acid (Chlorine Stabilizer)	Pool	100 pound buckets	5
Sodium Tiosulfate (Chlorine Neutralizer)	Pool	50 pound bags	5
Calcium Chloride 77% (In flakes)	Pool	50 pound bags	65
Algaecides	Pool	32Oz Bottles	60
Calcium Hypochlorite granular (Chlorine)	Pool	75 pounds buckets	6
Calcium Hypochlorite tablets (Chlorine)	Pool	100 pound buckets	5
Fertilizer 15:15:15	Gardens	50 pound bags	3
Antibacterial Soap	Maintenance		
All purpose cleaner soap	Maintenance		
Glass cleaner	Maintenance		
Aerosol Lubricant	Maintenance		

Employees will be provided training in the use of handling these compounds and will be provided the necessary personal protection equipment.

10 AVOIDANCE, MINIMIZATION, MITIGATION

This section discusses avoidance, minimization, mitigation measures incorporated into the project plan for both the terrestrial and marine environments. Wherever possible the project team focused on how to avoid or minimize impacts.

10.1 Mangrove Wetlands

The project will directly impact 52 acres of mangrove wetland habitat. Based on the TRS there are approximately 155 acres of mangrove wetlands. The project plan calls for the conservation of 103 acres of this habitat. Therefore, the project will avoid impacts to 66.5 percent of the mangrove habitat. The mangrove conservation area will be delineated by land surveyors before the site clearing process. Contractors will be made aware of the conservation area with directions to avoid this habitat. A boardwalk will be constructed for guest to navigate and be able to appreciate this habitat. In addition, extensive mangrove planting is proposed along the majority of the interior canal margin to mitigate impacts on mangrove habitats creating a living shoreline, stabilize the shoreline, and reduce the potential for upland discharge into the canal system.

10.2 Nature Trail

The Nature Trail located in the northeast quadrant of the site is expected to avoid impacts to an additional 55 acres of combined Silver Palm - Bracken Fern Shrubland, Broadleaf Coppice, and Sabal Woodland. The narrow nature trail loop will be configured in a figure “8” fashion.

10.3 Coastal Dune

The dune which parallels the coastline will be protected as much as possible as part of the project plan. The project will minimize impacts to the dune by having a variable setback for hard construction. Where walkways or beach cabanas will be erected, they will be constructed on silts and elevated above the dune. The dune has an overabundance of invasive trees, specifically Casuarina trees. The removal of these trees are not only important from a dune stabilization viewpoint but for the safety of guests and for reducing beach erosion. The method(s) utilized to remove these trees along the beach road, beach, and in between will likely result in some disturbance to the dune. The removal of the Casuarina trees along the beach will require multiple access points across the dune so that the trees can be hauled for disposal. Impacts will be mitigated by the planting of compatible dune vegetation along with the regrowth of natural vegetation to help stabilize the dune.

10.4 Canal

The impacts from the canal are unavoidable and cannot be minimized. The 1.6 mile long canal is the central feature of the project and traverses across wetland habitat. Sediment and turbidity control from waterway excavation will be addressed within the EMP. The waterway footprint will be de-mucked prior to excavation and the discharge of fine material into the environment will be minimized. Once excavated, the waterway shoreline will be stabilized including the use of a mangrove fringe for large portions of the waterway. During operational phases, there will be no nutrient discharge or discharge of fine material into the waterway system. There will be no hydraulic connection between the waterway and the remaining wetlands on the site. Mitigation for the canal will be the planting of mangroves along the edges in selected areas and also in the wetland areas to the west. Turbidity curtains will be deployed at these terminal ends during excavation.

Observation wells installed for the hydrogeologic study can be utilized during construction of the canal for water quality monitoring. Where new wells are required, they will be installed and incorporated into a groundwater sampling regime. Salinity profiles should be collected on a monthly basis for the first year to monitor the changes in salinity to groundwater and comparisons made to the predicted model outputs.

10.5 Vegetation

Vegetation will be saved as much of possible. To mitigate the habitat impacts CGBIL will establish a nursery to grow native vegetation for replanting. The facility will be landscaped using primarily native vegetation and coconut trees. Some ornamental plants may also be included in the landscape architect's plan. The landscaping for the facility will be discussed in further details in the Environmental Management Plan.

10.6 Avoidance, Minimization, Mitigation and Monitoring – Coastal and Marine Project Elements

This section provides a summary and evaluation of the avoidance, minimization and mitigation strategies for marine elements of the proposed project. International best practices for project assessment incorporate an assessment hierarchy, which is intended to avoid, reduce, repair, offset and compensate potential environmental impacts to a no net loss level (NNL). The hierarchy is structured in descending order, with avoidance as the most-preferred practice and compensation as the least-preferred option (IFC, 2012).

10.6.1 Avoidance

Standard practice requires the identification of critical resources relevant to the project and avoidance of these resources if practicable in meeting the intent of the project. It should be noted that for many of the immediate area impacts, avoidance is only possible if the project is deemed not feasible. The facility requires sufficient depths and dimension to allow for safe passage of vessels which also prevents additional future damage to resources from vessel operations. For this project, the primary critical resource of concern is the presence of hardbottom habitats, particularly stony corals within the project vicinity. Where practicable direct impact to these resources have been avoided and are further addressed as a key element in minimization, mitigation and monitoring efforts.

10.6.2 Minimization

Minimization of project impacts is proposed through the following project elements.

Minimization through Project Design

The project design includes adoption of a minimum design footprint to provide a safe operational envelope for vessels while minimizing impacts to benthic resources, most notably hardbottom habitats including corals. Minimization of impacts to these resources to the greatest extent practicable is achieved through the limiting of the dredge footprint to the minimum area of need to meet the project intent (minimum berth width for the design vessel) and siting of the berth to minimize the volume of material to be removed and higher value resources in the project vicinity. Siting included consideration of berth location relative to Peterson's Cay and was specifically moved to the east within the interior of the property to maximize the distance between the facility and the park's eastern boundary. The berth location is sited within a bathymetric low adjacent to the property to minimize the extent of dredging required. It is sited as close as practicable to the shore to limit impacts to higher value stony coral communities which are more prevalent in deeper water while remaining sufficiently seaward to not interrupt the nearshore (beach) sediment transport system. Berth design has been further verified through vessel simulation of berth alternatives based on the current and future vessel fleet.

Minimization through Best Management Practices

The extent of potential project impacts to benthic resources is largely attributable to the means and methods of construction and project oversight. This project proposes to adopt BMPs to minimize the potential for adverse project impacts thereby minimizing project impacts. In general, these practices include the use of turbidity curtains where practicable, containment of dredge spoil within the upland disposal area through diking and sequential containment, and the monitoring of site conditions during construction to ensure compliance and allow for corrective action if needed.

10.6.3 Mitigation

Mitigation is proposed for marine project impacts and is summarized within this section. It is noted that two distinct mitigation strategies are proposed. Mitigation actions are proposed for the impacts associated with project construction and for secondary and cumulative impacts associated within the increase in passenger visitation to the area, and specifically the potential for impacts to Peterson Cay.

Mitigation for Direct and Secondary Impacts of Berth Construction

Proposed mitigation for impacts from the berth expansion includes relocation of environmental resources from the area of impact where practicable, the protection in place of resources through the deployment of turbidity curtains, and the monitoring of resources throughout construction to ensure compliance and allow for corrective action if needed. The following sections present the mitigative actions for the proposed project.

The baseline environmental survey conducted in support of this EIA (**Appendix 7**) identified the presence of hardbottom with stony coral resources within the dredge footprint that are suitable for relocation. Two distinct relocation strategies are proposed based on the type of substrate and resources present:

Relocation of Reef Mound Substrate

The dredge footprint includes approximately 1.09 acres of reef mound substrate. This represents in general the most significant benthic resources within the area of impact. These structures are largely undercut discrete rock formations that can be dislocated and transplanted in large boulder sections utilizing lift bags or barge/crane equipment (similar to that proposed for pier construction operations). This will allow for preservation of the substrate structure in addition to the established benthic communities on the mound structures including soft coral and macroalgal communities that cannot be practically transplanted on an individual basis and established coral communities on vertical structure. Each individual mound will be lifted from its current position and suspended within the water column during transportation to the receiver site. This will limit stress and damage to the biota during the transplantation process. The mounds will be transported to the receiver site and placed on open sandy bottom. The reef mound relocation site is outside of the property boundary lease. The reef mound structures are sufficiently large and heavy to remain stable once they are placed on a sandy substrate. No additional mounting efforts are proposed. Coral relocation will require several weeks to complete. Coral relocation can be conducted at any time, however, relocation during periods of high water temperature is not recommended given the potential for elevated coral stress during this condition. Additional detail regarding coral mitigation will be addressed within the EMP.

A 5.81-acre receiver site has been identified approximately 1.5 miles to the east of impact area which provides similar conditions as the existing site (**Figure 10-1 and 10-3**). The area consists of an open sand area within a bathymetric low of similar depth surrounded by similar isolated mound features. The mound features will be placed randomly within the area leaving open sand areas between the mounds resulting in a habitat similar to that impacted by the project. The site was selected based on its proximity to the project area, similarity in depths, acceptable bottom substrate, presence of similar structures and habitat adjacent to the receiver site.

<u>Construction of Additional Hardbottom Substrate and Coral Relocation</u>

The construction of additional substrate can offset project impacts to hardbottom can create a suitable habitat amenity to support recreational use by divers and snorkelers who would otherwise visit (and proportionally impact) existing reefs. Such a strategy can increase the carrying capacity of availed benthic habitats and reduce the overutilization of existing natural reef systems. Further, the strategic placement of such a structure can encourage redistribution of visitors to underutilized areas or areas of focus for future economic development (such as the proposed facility).

A mitigation reef will be constructed on a 5.18 acres receiver site in the nearshore adjacent to the western property boundary (**Figure 10-2**). The reef will be constructed of limestone boulders of approximately 4-foot diameter in random groupings interspersed with open sand areas between groupings. The limestone boulders for the mitigation reef will be acquired from local sources out of Freeport, Grand Bahama Island.

This site will also serve as a receiver site for suitable coral colonies from areas of direct impact. The proposed mitigation site is not in our leased area. Thus, allowing the general public easy access to the receiver site for their continued enjoyment as before. Furthermore, the site was selected based on similarity in depths, acceptable substrate, presence of similar structures and habitat adjacent to receiver site. The reef will provide additional substrate for both coral relocation and recruitment and will provide an additional nearshore amenity for visitor excursions and an alternative to natural reef resources.

The mitigation reef is located in depths similar to the shallow portion of the proposed dredge footprint where the majority of individual corals are located. The deeper portions of the dredge footprint contain the dredge mound features that will be relocated to the deeper, eastern mitigation site.

Isolated coral communities of sufficient size and dimension occur within hardbottom habitats within the dredge footprint. No specific adaption strategy is proposed for coral relocation. Coral relocation is a mitigative action and there are no applicable adaptation strategies. Relocation of these coral communities to the mitigation reef is proposed under the following protocol:

1. Only healthy coral colonies with no visible signs of overt stress, disease or tissue necrosis will be considered for relocation. Based on the baseline benthic survey conditions **(Appendix 7)** approximately 75% of the stony corals overserved within the dredge footprint met this condition. It is additionally noted that the baseline survey was conducted prior to Hurricane Dorian and it is likely that storm impacts have significantly reduced the overall health of corals in this area. Relocation of non-visibly healthy corals is not recommended as this can lead to disease transmittance to healthy corals at the mitigation reef site. Under typical conditions, survivorship of relocated corals is on the order of 85% or greater. This does not account for outside environmental facets (such as coral disease or bleaching events) which can adversely impact the survivorship of both relocated and in-situ corals. Given the regional impacts from Dorian disease outbreak on a regional scale is an additional concern that could limit the potential for coral relocation if an outbreak is observed in the area. A post-Dorian rapid assessment of the mitigation receiver site was conducted and indicated no material change from pre-Dorian conditions. The proposed mitigation area remains an acceptable location for mitigation reef construction. While coral disease has not been recently reported in the area, a significant outbreak of Stony Coral Tissue Loss Disease (SCTLD) has persisted in the

southeast Florida reef tract and regions in the Caribbean. While the mechanism of transmittance for SCTLD is currently not known, coral disease has been known to be transmitted by major storms.

2. Three coral species listed as threatened under the US ESA are present within the dredge footprint. Whitestar sheet coral (*Agaricia lamarki*) is present on vertical surfaces on the reef mound substrate. As this substrate will be relocated in sections, relocation of individual colonies will not be required and these colonies will remain attached (in-situ) to the relocated substrate. Three colonies of pillar coral (*Dendrogyra cylindrus*) were observed and their locations identified. These colonies will be relocated to the mitigation reef and any additional colonies identified during the relocation surveys will also be relocated. An undetermined number of star coral (*Orbiella sp.*) are present within the dredge footprint. Colonies of sufficient size to withstand relocation (nominally 10 cm in diameter) will be relocated to the mitigation reef.

3. Substantial colonies (nominally of 30 cm diameter or greater) of common stony corals within the dredge footprint will be relocated to the mitigation reef. Dominant species representative of these corals include starlet corals (*Sidastrea sp*.), brain corals (*Diplora sp*.) and other corals common to the area. Adoption of a larger nominal size that for listed ESA species is proposed to maintain diversity and prevent overcrowding by more dominant common coral species on the mitigation reef.

In addition to coral communities within the dredge footprint, high value coral colonies may occur within a buffer zone adjacent to the dredge footprint. These colonies will be identified during pre-construction surveys and assessed relative to their vulnerability to project secondary turbidity/sedimentation impacts. If the impact from relocation is deemed secondary to potential turbidity impacts these colonies will also be relocated either to the reef mound site or mitigation reef (whichever more closely matches site conditions). Relocation of coral colonies within the buffer zone is addressed within the EMP.

Based on the proposed relocation protocol and the baseline benthic study, the nominal number of corals that could be potentially relocated is on the order of 10,000 individual colonies. Again, it is important to note that this number could be reduced significantly if the overall health of coral colonies is reduced at the time of relocation (either due to latent effects from Dorian, disease or other factors).

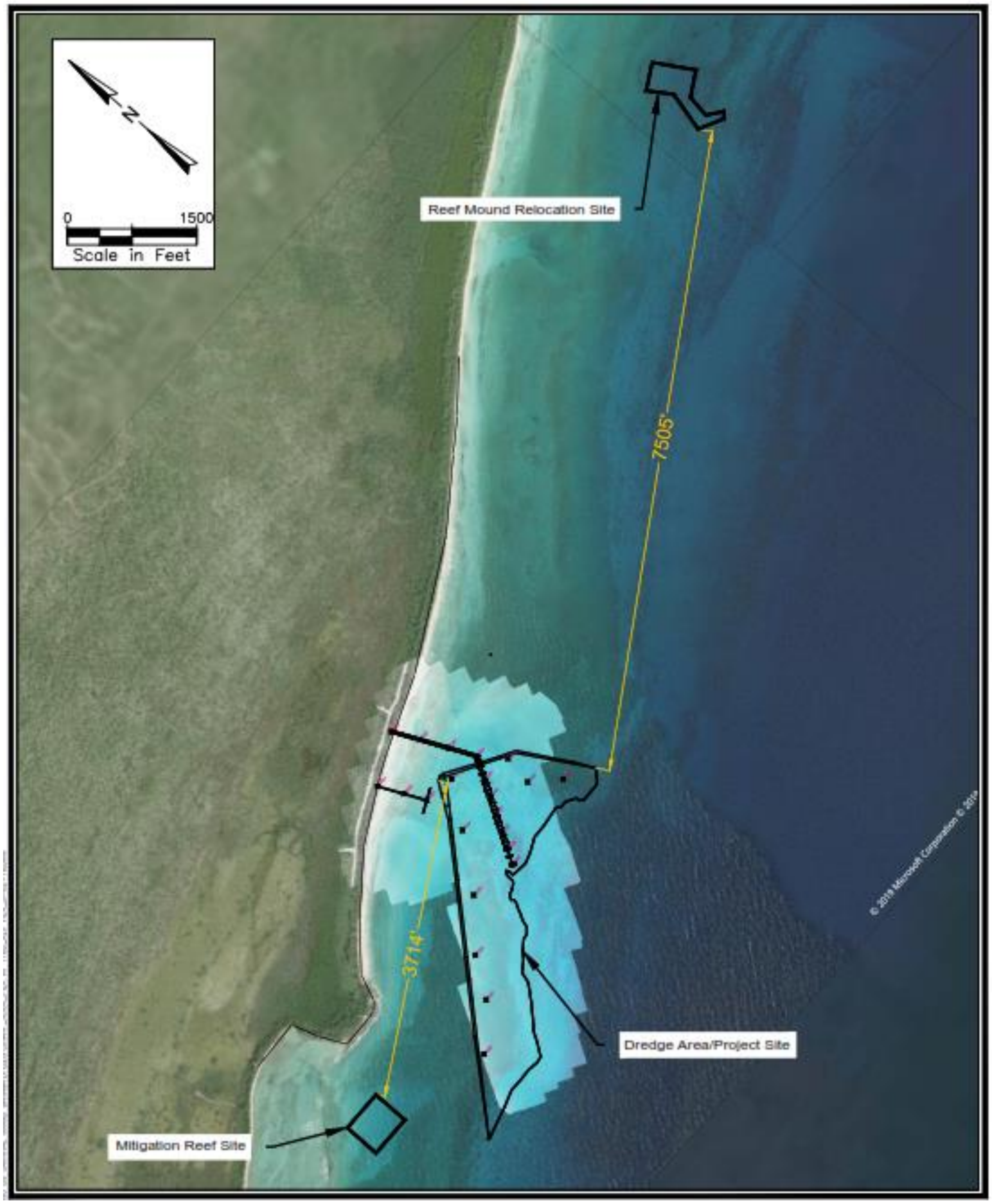

Figure 10-1. Reef Mound Relocation and mitigation Reef Locations

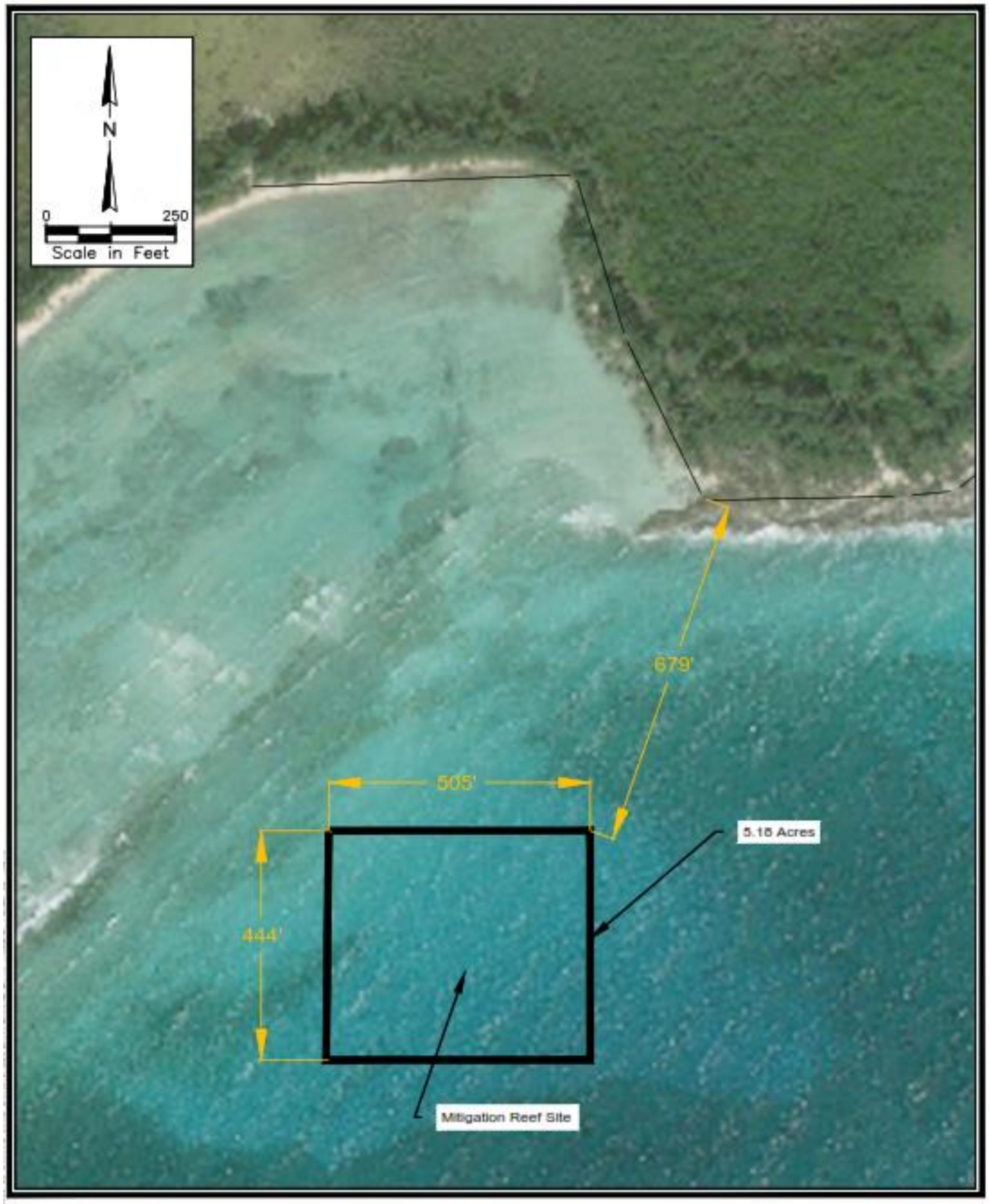

Figure 10-2. Mitigation Reef Sites

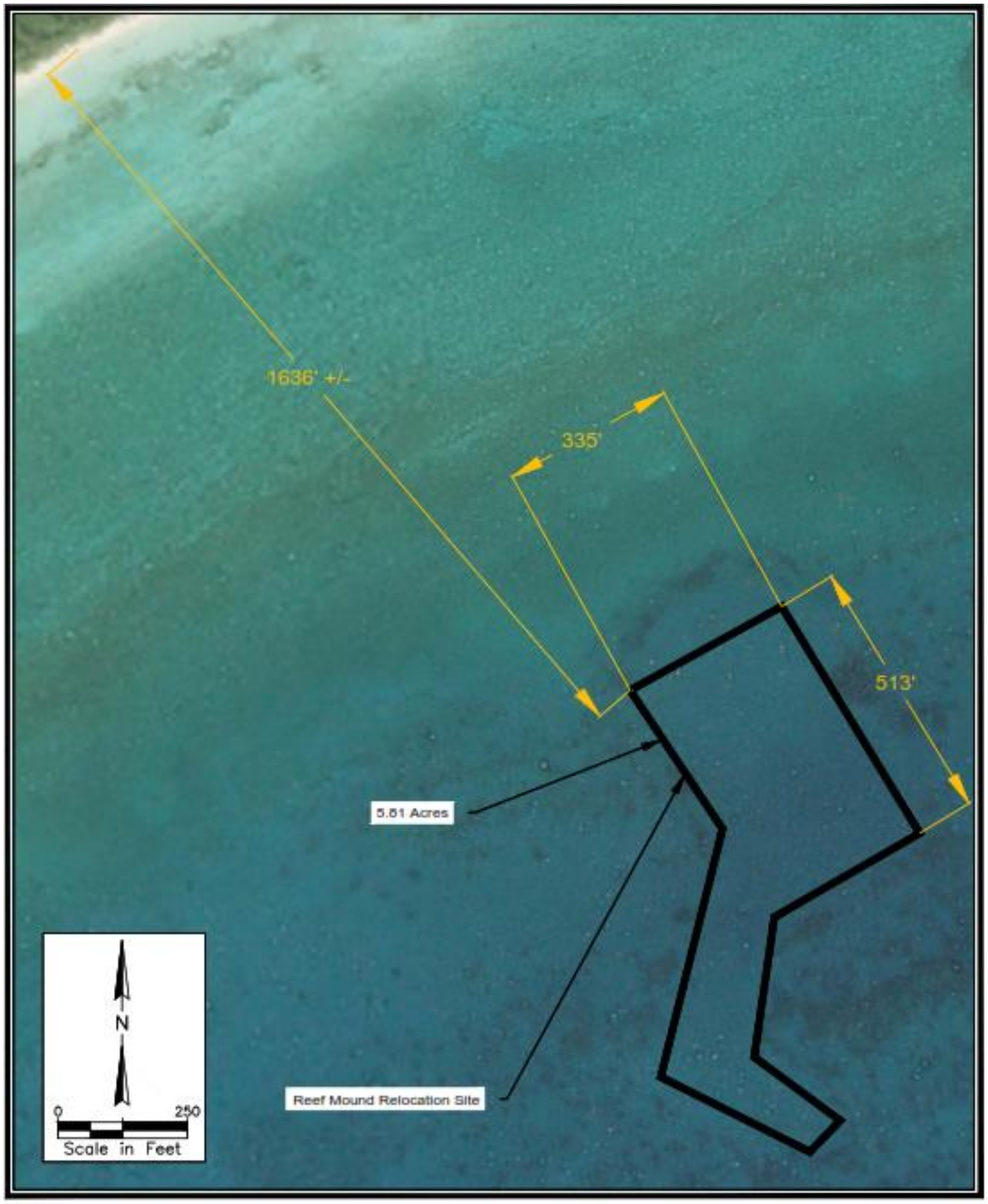

Figure 10-3. Mitigation Reef Site – Reef Mound Receiver Site

Installation of Mooring Buoys

The installation of mooring buoys reduces the potential for anchor related impacts to benthic substrate. Mooring buoys will be installed in conjunction with the creation of the reef mound transplant reef and the nearshore mitigation reef. Installation of mooring buoys with Peterson's Cay National Park will be considered in coordination with The Bahamas National Trust. These deployments have been shown to reduce the potential for user impacts and are commonly installed in high-usage reef areas. Deployments also facilitate the efficient ingress and egress of vessels, which can increase the rate of turnover of vessels and reduce the potential for user conflicts.

Removal of Marine Debris and Invasive Species

Benthic field studies identified the presence of marine debris within the study area including portions of Petersons Cay. It is additionally likely that marine debris within the area has increased due to hurricane Dorian. Marine debris has the potential to become mobile during significant storm events resulting in impacts to benthic species. Removal of marine debris from the study area including Peterson's cay is proposed as a mitigative measure to offset marine project impacts. This effort will be conducted in concert with preconstruction field and coral relocation efforts. Debris removal will also be incorporated into the long term benthic monitoring effort.

The presence of Lionfish (*Pterois volitans*) was also noted during the benthic field studies. This species is a non-native, invasive fish that competes with native species. Removal of specimens encountered during marine field efforts is proposed as a mitigative measure. Additional eradication measures may be further proposed if field monitoring efforts indicate excessive populations, particularly within the Peterson Cay area.

Passenger Education

Carnival will explore efforts to increase education opportunities for guests regarding Grand Bahamas environmental resources through signage, pamphlets and excursion experiences. Carnival will explore the ability to reduce the use of potentially reef-harmful sunscreens thought the promotion of appropriate reef-friendly alternatives and visitor education.

Beach Management

Beach conditions will be monitored post project and if there is a need the implementation of beach nourishment will be considered.

Management of Turtle Nesting Habitat

The approximately 1.6 miles of beach within the property represents a potentially significant habitat for nesting sea turtles. The proposed development will likely enhance habitat potential through the removal of non-native vegetation and the establishment of a recreational beach and dune. As the area is within the development security zone, protection of nests from poaching and predation is feasible as is monitoring of nests for occurrence and success. A long term sea turtle nesting management and monitoring plan is proposed as a mitigative measure for marine project impacts.

Peterson Cay Management Plan

Increases in site visitation represent the most significant long term potential impact to resources within Peterson Cay. In concert with The Bahamas National Trust, Carnival will support the development of a long term management plan for the area. Carnival supported a similar initiative associated with the development of a cruise port in Grand Turk which is also in the vicinity of a marine park. The Grand Turk plan has been in place for over a decade and can provide a template for the development of a site-specific plan for Peterson Cay. Support for plan development is proposed as a mitigative measure for project cumulative impacts to the marine environment.

Utilization of the mitigation reef by visitors will reduce the impacts that would otherwise occur to natural reef systems within the vicinity (including Peterson Cay). It is preferable to direct visitor impacts to the artificial/mitigation reef instead of the natural reef. This is an accepted management practice for benthic resources.

10.6.4 Monitoring and Construction Oversight – Marine Elements

The following construction oversight and monitoring tasks are proposed in support of project construction. It is anticipated that a design-build contract will be negotiated by Carnival with an appropriate dredge and marine construction contractor. Given the scope of the construction and the type of equipment required, this contractor will need to be an international firm with sufficient experience, resources and expertise. Appropriate oversight of the construction contractor will be required, as will monitoring of the project throughout the construction process. The following major oversight and monitoring tasks will be implemented:

Pre-Construction Benthic Surveys: Baseline marine environmental surveys have been conducted in conjunction with this EIA study and are summarized in this EIA document and **Appendix 7**. Additional pre-construction surveys will be conducted to supplement existing site data and document pre-construction conditions. Survey effort will include identification and relocation of suitable resources within the project footprint to appropriate receiver sites outside the zone of influence of the project. These additional surveys will also address the potential for coral disease presence prior to the initiation of coral relocation efforts. These surveys will be conducted in consultation and potential participation of the BEST Commission and DMR.

Pre-construction monitoring will set the protocols for during construction monitoring tasks, immediate post construction and for operational phases through 2 years of post-construction monitoring.

All removable living organisms, such as anemones, urchins and corals need to be removed from areas where the turbidity curtains are to be maintained. A sweep prior to the installation of the curtains and a final sweep once the curtains are in place should be undertaken. Areas for relocation should be established prior to this endeavor.

Pipeline Corridor Survey: A diver survey will be conducted of the proposed submerged pipeline route to the shoreline to ensure that the route avoids hardbottom and seagrass resources to the greatest extent practicable. This effort will include demarcation of the route to support pipeline deployment by the construction contractor and will include a post-deployment visual assessment of placement to document site condition after pipe deployment. The reference to a pipeline corridor is in regard to the hydraulic dredging of the facility berths. The dredging will utilize a cutter-suction dredge that will discharge a slurry of dredge material via a temporary pipe leading from the dredge to the upland disposal area. As this pipe will be placed on the bottom, a corridor is typically delineated to minimize the potential to impact resources if present. This pipe will remain in place only during the dredging operations and will be completely removed. The main pier may be utilized as a corridor for a seawater intake line for mechanical flushing of the interior waterway system. This would minimize impacts as it would be under and anchored to the pier. The need for such a system is currently under development.

Beach Profiles and Nearshore Bathymetry: A pre-construction survey of the adjacent beach and bathymetry in the vicinity of the project area will be conducted along the monitoring stations previously established to document pre-construction conditions and provide a basis for the contractual determination of excavation volumes.

Pre-Construction Conference: Carnival will facilitate a pre-construction conference to review salient elements of construction with all relevant parties. At a minimum, this conference will include representatives from Carnival, the construction contractor, the engineer of record, monitoring support staff, and relevant governmental entities. The conference will be held in Grand Bahama with the ability to participate by conference call.

Identification of Key Staff Roles and Responsibilities: The pre-construction conference will include identification of key points of contact for all relevant parties and a contact list will be prepared and distributed, delineating each key staff member and his or her role and responsibility. The role and responsibility of each key staff member will be discussed at the pre-construction conference and will include identification of staff with the contractual authority to suspend construction operations as a result of impacts. The pre-construction conference will provide a review of major project elements, appropriate means and methods of construction, BMPs, and monitoring.

Review and Training of Oversight Monitoring Personnel: To the extent practicable, construction oversight will utilize local, on-island resources to provide daily observations of construction. Oversight procedures and responsibilities will be reviewed with individuals identified to support construction operations. This will include project-specific training of local staff to support construction oversight monitoring.

Oversight and Monitoring during Construction

The following sections provide a summary of oversight and monitoring activities that will occur during construction operations.

Oversight of Construction Operations: Oversight of construction operations will be a shared responsibility of all relevant construction parties, including the construction contractor, Carnival, the engineer of record and monitoring support staff. The roles and responsibilities between all parties will be clearly delineated in the EMP and discussed at the pre-construction conference.

Daily Reporting: The construction contractor will prepare a daily report of project progress during active construction in a format agreeable to the project engineer. This daily report will be distributed to relevant parties and will include a summary of the previous day's progress, details of any issues or accidents, and assurance that turbidity curtains are in place and functional.

Turbidity Monitoring: Turbidity monitoring will be conducted to ensure that values will not exceed a maximum increase of 15 Nephelometric Turbidity Units (NTU) above background concentration during dredging at all sampling locations. Monitoring details are outlined below:

Turbidity curtains should be installed at all sites of turbidity generating activity, including the jetty construction area, dredge site and the dewatering site. The curtains may need to be removed during periods of rough weather in order to prevent damage to the curtain and surrounding habitat; however, storm conditions should also necessitate cessation of dredging activities.

Sampling locations should include the following areas: 1) jetty construction area, 2) dredge areas and 3) discharge site. Background sample points shall be taken at least 1000 meters from the project site outside of the zone of influence of the project. The GPS coordinates of each turbidity sample location should be recorded, and samples should be taken about the middle of the water column at each location.

Pre-construction in situ turbidity measurements shall be taken weekly within the month prior to the commencement of dredging. Turbidity samples (in NTUs) shall be collected and analyzed at each sample location at the surface and mid-depth within the water column. The distance between the sample locations will be at least 500 feet. These measurements will help to characterize the conditions existing immediately prior to construction.

Turbidity monitoring will be conducted on a daily basis by a trained individual. The following protocol will be utilized.

Equipment and Monitoring Protocol: Samples will be measured in nephelometric turbidity units (NTUs) per the device manufacturer's guidelines. The device shall be factory calibrated within at least the previous year. Field calibration shall be conducted at least every week or if warranted, based on a reading comparison to a standard. A quality assurance check to a 10 NTU standard shall be conducted prior to each sampling event to ensure the device is calibrated and reading properly. Samples shall be collected mid-depth utilizing a niskin bottle or comparable sampling device. Samples shall be tested within 10 minutes of sample collection.

Frequency: Two sampling events will be conducted per day, nominally one in the morning and one in the afternoon, at least 4 hours apart. Samples will be taken during active construction when the dredge has been operational for a minimum of 2 hours. Samples will not be taken if the dredge is not operating for a period greater than 4 hours, and this condition will be noted in the daily sampling report.

Background: The turbidity monitoring protocol will follow accepted standards including the measurement of background at a location outside of the area of influence of the project. A representative background sample will be collected a minimum of 1,200 feet up-current of the project in an area free of project influence. Turbidity monitoring is proposed and will be discussed further in the EMP.

Compliance Sampling (Dredge): The dredge compliance sample will be collected at a distance of 500 meters down-current of the operational dredge, within the densest portion of any visible turbidity plume. Compliance stations should be altered if the plume is heading for the reef wall resources (sample should be taken at the location of the resource regardless of distance). Levels should be below the 15 NTU + background standard in this event.

Compliance Sampling (Discharge): The discharge sample will be collected a distance of 500 meters from the discharge, within the densest portion of any visible turbidity plume. Levels should be below the 15NTU + background standard in this event.

Compliance Sampling (Jetty Construction): The discharge sample will be collected at a distance of 500 meters from the turbidity curtain perimeter, within the densest portion of any visible turbidity plume. Levels should be below the 15NTU + background standard in this event.

Compliance Standard: Compliance will be demonstrated through a compliance turbidity reading of no more than 15 NTUs above background at each compliance station.

If an exceedance is observed at any compliance station, the monitor will immediately notify the engineer, who will notify the Owner, the construction contractor and relevant governmental parties. If an exceedance is observed, the contractor will immediately cease the relevant construction operations until turbidity values fall within operational parameters. The contractor will then make whatever practical modifications to the construction means and methods necessary to achieve turbidity compliance.

A daily report delineating each sampling event will be prepared which will include the following:

1. Date, time, and location of sampling;
2. A schematic map with the sample site(s) shown;
3. Water depth at sample site
4. Sample depth
5. Weather, wind, and current conditions
6. Approximate tide (e.g. incoming or outgoing)

Each report shall include a summary of turbidity values and a map delineating sample locations and relative extent of the turbidity plume. Reports will be submitted to relevant governmental entities for review on a weekly basis.

Once construction is completed, the removal of the turbidity curtains should only occur when turbidity levels inside and outside the curtain are reasonably equal and consistent with background samples.

In addition to turbidity sampling at discharge sites, turbidity samples should be taken at each of the biological monitoring sites during bi-weekly monitoring events. Samples at these locations should be taken at the surface, mid-depth and near the seafloor.

Weekly Reporting

A weekly onsite progress meeting will be conducted between the contractor, Carnival, the engineer, and relevant governmental entities, with the ability to attend the meeting by conference call. This meeting will review construction progress to date and identify any issues or required corrective actions. A meeting summary will be prepared including action items and will be distributed to relevant parties.

During Construction Benthic Surveys

On a bi-weekly basis following the initiation of construction, a reconnaissance survey of benthic resources within the project vicinity will be conducted. This survey will generally adopt the protocols utilized for the baseline and post-construction surveys and will focus on the general health and levels of stress and sedimentation observed on these resources. A summary report will be prepared and distributed to the project team. The engineer will be notified of any excessive sedimentation or visible stress of coral resources and, if deemed significant, will direct the contractor to alter construction means and methods to further reduce project turbidity and sedimentation.

Post-Construction Oversight and Monitoring

The following post-construction tasks will be conducted to document post-project conditions and certify that construction was completed in compliance with project plans and specifications.

Post-Construction Bathymetric Survey

A post-construction bathymetric survey of the excavation area will be conducted and compared to the pre-construction survey. A comparison plot of the two surveys will be prepared to quantify the volume of material removed and to verify that all excavation occurred within the depths and spatial limits of the dredge template.

Post-Construction Upland Survey

A post-construction survey of the upland disposal area will be conducted and compared to the pre-construction elevations. A comparison plot of the two data sets will be prepared to quantify the volume of material placed and to verify that all placement occurred within the spatial limits of the delineated disposal area.

Post-Construction Benthic Survey

A post-construction benthic survey will be conducted to document post-construction condition. The survey will include the project vicinity, including the pipeline corridor (following pipe removal) and will include an assessment of any transplanted resources.

Project Certification

Following a review of all project data, the engineer of record will prepare a project certification attesting to the completion of the project in conformance will the project plans and specifications. Any deviations from the project plans will be identified, including justification, and any incidences or unanticipated project impacts will be identified and discussed. The certification will include a summary of project construction, including final volumes, dates of construction, and turbidity monitoring values.

Long-Term Monitoring

Two additional benthic monitoring surveys will be conducted at year 1 and 2 post construction utilizing the same protocols as the previous surveys. These surveys will include any coral relocation sites. The surveys will document recovery and recruitment within the areas of project impact and will identify any secondary or operational issues observed relative to this project or the facility in general.

Monitoring Based Contingency

At any time, if monitoring surveys suggest impacts beyond those anticipated within this EIA, relevant governmental entities will be notified of the nature of the impacts and consulted regarding corrective or mitigative actions. This may include the implementation of additional monitoring or specific mitigative action as determined through consultation with relevant governmental entities.

Sea Level Rise Adaptation and Resiliency Considerations

The beneficial use of dredge spoil to raise the upland prior to development is a significant contribution to the overall resiliency of the development. The adoption of a project design Finished Floor Elevation (FFE) of +14 (re: MLW) ensures that major structures are elevated above the 100-year storm surge estimate inclusive of high tide and 100 year Sea Level Rise (SLR) projections. In addition, the project design includes sufficient setbacks to upland structures and a siting of site utilities and infrastructure within the interior portions of the property. As such, the master plan incorporates accepted strategies of resiliency and SLR adaptation into the proposed development.

Site elevation is the primary adaptation strategy for the project and addressed the primary site vulnerabilities (impacts from storm surge and sea level rise). In addition, the project design includes sufficient setbacks to upland structures and a siting of site utilities and infrastructure within the interior portions of the property. Additionally, the height of the piers, and all upland facilities were determined considering sea level rise projections. All these structures will be designed to withstand category 5 hurricanes, similar to other Corporate Ports. For instance, the pier in GTCC remained intact despite being subject to the direct impacts of three major Hurricanes: Ike, Irma and Maria. As such, the master plan incorporates accepted strategies of resiliency and sea level rise adaptation into the proposed development.

11 SOCIOECONOMIC ISSUES

An Economic Impact Assessment and cost-benefit analysis titled; *The Economic Impact of the Proposed Carnival Cruise Line Expansion on Grand Bahama Island* was prepared for Carnival Corporation by Tourism Economics an Oxford Economics Company. This report is attached In **Appendix 8**.

To appreciate the significance of the proposed Grand Port project, one has to understand the Hawksbill Creek Agreement and the history of the City of Freeport and Grand Bahama.

Prior to the signing of the Hawksbill Creek Agreement (HCA) in August 1955, Grand Bahama Island was one of the least developed islands in the archipelago. It consisted of several settlements along the southern coastline from West End to McCleans Town. HCA was an agreement between the Government of The Bahamas and Wallace Groves, President of GBPA.

Through the HCA, the Crown granted conditional purchase leases to GBPA for 50,000 acres of Crown land surrounding and in the vicinity of Hawksbill Creek on the Island of Grand Bahama and granted a conditional purchase lease to GBPA of the seabed underlying Hawksbill Creek plus other concessions. These concessions included the granting of business licenses and building permits by GBPA without having to obtain any approval from the Government of The Bahamas. More importantly, the HCA allowed for the importation of equipment, vehicles, goods and materials "duty free" (bonded) for licenses of GBPA. In return, GBPA agreed to construct a deep water harbour and a turning basin (**Figure 11-1**) at Hawksbill Creek with a view to encouraging the establishment of factories and other industrial undertakings within GBPA.

The HCA had a profound impact on the growth and development of Freeport. From the signing of the HCA the City of Freeport was founded, which was administered by GBPA. GBPA created a land use masterplan which utilized different zoning for development for Freeport/Lucaya. GBPA was responsible for the construction of the harbour and airport and the infrastructure needs of Freeport, which included power, potable water, sanitation services, construction of roads and bridges. As a result, Freeport is the most well-planned city in The Bahamas with designated zones for heavy industrial use, light industry and civic area, tourist commercial development, and single and multi-family residential areas with the infrastructure needed to support the city.

Figure 11-1. Aerial Photograph of Freeport Harbour and Freeport Container Port

Initially, Freeport was developed with a view towards developing industry, which included The Bahamas Cement Company, Bahamas Oil Refining Company, and Syntex Pharmaceuticals International Ltd., and other light industry. Today, the harbour area (heavy industry zone) is home to the Freeport Container Port, Grand Bahama Shipyard, Bradford Marine, Quality Services, Grand Bahama Power, Bahama Rock, BICHAM, Polymers International Ltd., and others.

However, as the early economy of Freeport struggled at times, GBPA turned to tourism to help diversify the economy. As Wallace Groves, the Chairman of GBPA once said, "*Our formula is simple: We attract industry by making life pleasant for people working here - and for visitors as well. Without tourists we could not afford a jet airport, golf courses, theaters-all the things that make a community. These bring more industry.*"

Thus, Freeport has a unique economy to The Bahamas, in that it has a duel economy - one based on tourism and the other on heavy industry. The HCA had a profound impact on the transformation of a relatively undeveloped island to becoming the nation's second city, in a very short time span. Freeport became known as the "Magic City" due to its rapid development and good infrastructure. Based on the 2010 Census, Grand Bahama is home to some 51,756 persons and is the second most populated island in The Bahamas.

The early years of Freeport saw tourist development with the construction of several hotels, the first being the Lucayan Beach Hotel (**Figure 11-2**) and Monte Carlo Casino in 1963 followed by the Holiday Inn which were constructed on Lucayan Beach. Other hotels were the Kings Inn, Lucayan Marina Village, Oceanus North and South, Xanadu Beach Resort and Marina, Princess Towers, Shalimar Hotel, Freeport Inn, The Sun Club, Castaways Hotel, Royal Islander Hotel, and Bell Channel Inn.

Figure 11-2. Holiday Inn Under Construction and Lucayan Beach Hotel in Background.

In more recent history, other hotel properties developed were: Club Fortuna (Fortune Beach), Pelican Bay (formerly Oceanus North property), Island Seas, Port Lucaya Resort and Yacht Club. When Hutchison Whampoa invested in Freeport constructing the Freeport Container Port, they also purchased the Atlantik Beach Hotel (formerly Oceanus South), Lucayan Beach Hotel and Holiday Inn properties. They then constructed the Grand Lucayan Hotel. The Grand Lucayan now includes the Lighthouse Point Hotel (formerly Lucayan Beach Hotel), The Breakers Hotel, and The Reef Hotel (formerly Holiday Inn).

11.1 Period of Decline

Through the history of Freeport, it has experienced periods of boom and bust. However, in 2004 the passing of Hurricanes Frances and Jeanne severely impacted the Freeport economy. Hurricanes Frances and Jeanne swept over Grand Bahama in a three-week period in September 2004. Frances was the most destructive of these causing flooding at the airport and generally along the north shore. The hurricane stalled over Grand Bahama and the island was hit was sustained high winds for a period greater than 24 hours. This led to downing of many power poles and lines, trees and structural damage to homes and resort properties. While Grand Bahama was still in recovery mode it was hit again by Hurricane Jeanne.

The damage resulting from the hurricanes had far reaching economic consequences for Freeport and Grand Bahama Island. The adverse impacts from the two hurricanes resulted in the closure of the Royal Oasis Resort, Crown Plaza, and El Casino which were then owned by the Driftwood Group. The Royal Oasis was originally the Kings Inn Hotel and the Crown Plaza was the Princess Towers. The Royal Oasis was a 900-room resort and the Crown Plaza a 500-room property. The closure of the hotel resulted in over 1,000 employees being jobless. The Royal Oasis property was an important part of the Freeport economy. The casino was an attraction for visitors from the U.S. to gamble and enjoy Freeport's nightlife and hotels. These properties remain shuttered today and are in a serious state of disrepair.

With the closure of the hotels, the nearby International Bazaar, a one-time unique shopping complex comprising of shops with items from around the world, soon fell on hard economic times due to lack of tourists. Some shop owners moved to Port Lucaya while other shops simply closed. Another causality of the Driftwood Group hotel closure was Laker Airlines, which serviced both tourist and local residents. Driftwood Properties sold its properties to the Harcourt Group based in Ireland but Harcourt never was able to reopen the properties. In fact, the Royal Oasis properties and the International Bazaar are in such a state of disrepair today that it is difficult to conceive that there is a willing buyer to take on the challenges of redevelopment. With more new hotels being built along the coast lines throughout The Bahamas and the region, the prospect that an inland hotel development, such as the former Driftwood properties would be successful remains to be seen.

Other hotels that closed are: The Shalimar, The Xanadu Beach Resort and Marina, the Freeport Inn, and The Port Lucaya Resort and Yacht Club.

In October 2016, Hurricane Matthew struck Grand Bahama. This further impacted Freeport as the Grand Lucayan Resort was adversely impacted and forced the closure of the Reef Hotel, which was leased to Sunwing based in Canada and rebranded as Memories, and the Breaker Hotel. That closure only left the Lighthouse Point hotel in operation. The partial closure of the property led to more unemployment in Freeport. The Bahamas Government purchased the Grand Lucayan in 2018 with the purpose of reselling to a committed investor (s) for fear that by not doing anything, the Grand Lucayan Resort and nearby Port Lucaya Market Place would have the same fate as the former Royal Oasis and International Bazaar.

It is obvious to those who reside in Grand Bahama, that since 2004 the island has been plagued with economic hardship. The cumulative impacts from all of the hotel closures have adversely impacted both direct and indirect employment associated with these properties. With more children graduating from high school there is also a need to provide employment opportunities. Moreover, with the high cost of living there are many that live paycheck to paycheck and struggle to pay bills. Grand Bahama is in need of direct foreign investment if it is to regain the title of the “The Magic City” and to provide employment opportunities to those that reside on the island. The last major tourist development in Freeport was the investment by Hutchison Whampoa in the Grand Lucayan Resort almost two decades ago.

Recently, Hurricane Dorian struck both Great Abaco and Grand Bahama leaving devastation on both islands resulting in the loss of life, homes, and businesses. Hurricane Dorian struck Grand Bahama Island between September 1 - September 3, 2019 as a category 5 hurricane based on the Saffir-Simpson scale. Winds were reported at 185 mph sustained with gusts up to 200 mph. The hurricane moved at an average rate of 1.3 mph (and at times 0 mph) across Grand Bahama Island and the north shore. As Dorian crossed Grand Bahama and stalled, it pushed seawater from the Little Bahama Bank south, resulting in an approximately 20-foot storm surge which led to widespread flooding in Grand Bahama. Moreover, when the back end of the storm passed eastern Grand Bahama, it resulted in flooding from the south shore. This natural disaster was the worst hurricane ever recorded in The Bahamas and has adversely impacted the economies of Grand Bahama and Great Abaco. Grand Bahama and Great Abaco are the second and third largest economies, respectively in The Bahamas.

The immediate impacts to Grand Bahama include loss of electricity and severe damage to the power grid in some parts of the island. A loss of business throughout the island and a loss of the tourism market. The Grand Bahama Airport was flooded during the hurricane and will likely remain closed until sometime in November or December. Therefore, there are no foreign air arrivals today and the island is solely dependent on cruise ship visitors.

Given the cumulative impacts form all of the past hurricanes, which Grand Bahama has not recovered, the recent blow from Hurricane Dorian is very profound over the short, medium, and long-term outlook. The economy was limping along but has now slowed to a crawl. The future prospects are uncertain and there is no doubt that the island needs direct foreign investment to sustain itself.

Given the severe adverse impacts from Hurricane Dorian, this project will be a catalyst for the rebuilding of Grand Bahama as a significant tourism destination. While no single project can solve all of the economic problems of Grand Bahama, this project will go a long way in aiding the recovery by stimulating the economy during site preparation, construction, and operation. Grand Port will provide both direct and indirect employment opportunities for Bahamians. Below is a summary from the economic report.

11.2 Summary of Proposed Development

"Over the 23-year time horizon, Carnival's proposed development on Grand Bahama Island would boost Bahamian employment, income, GDP and government revenues:

- A total investment of B$170 million
- More than 40 additional calls to Freeport annually, on average
- An estimated 500k incremental cruise passengers annually, on average
- 706 new Bahamian jobs during the development phase
- More than 1,680 new Bahamian jobs annually during on-going operations
- B$1.5 billion (in B$2019) increase in Bahamian GDP
- B$647 million (in B$2019) in income earned in The Bahamas
- B$363 million (in B$2019) increase in Bahamian government revenues, outweighing proposed concessions by a factor of 3.8."

The proposed project includes plans for more than 250 calls by 2025, a 26 percent increase from current levels as shown in the following Figure.

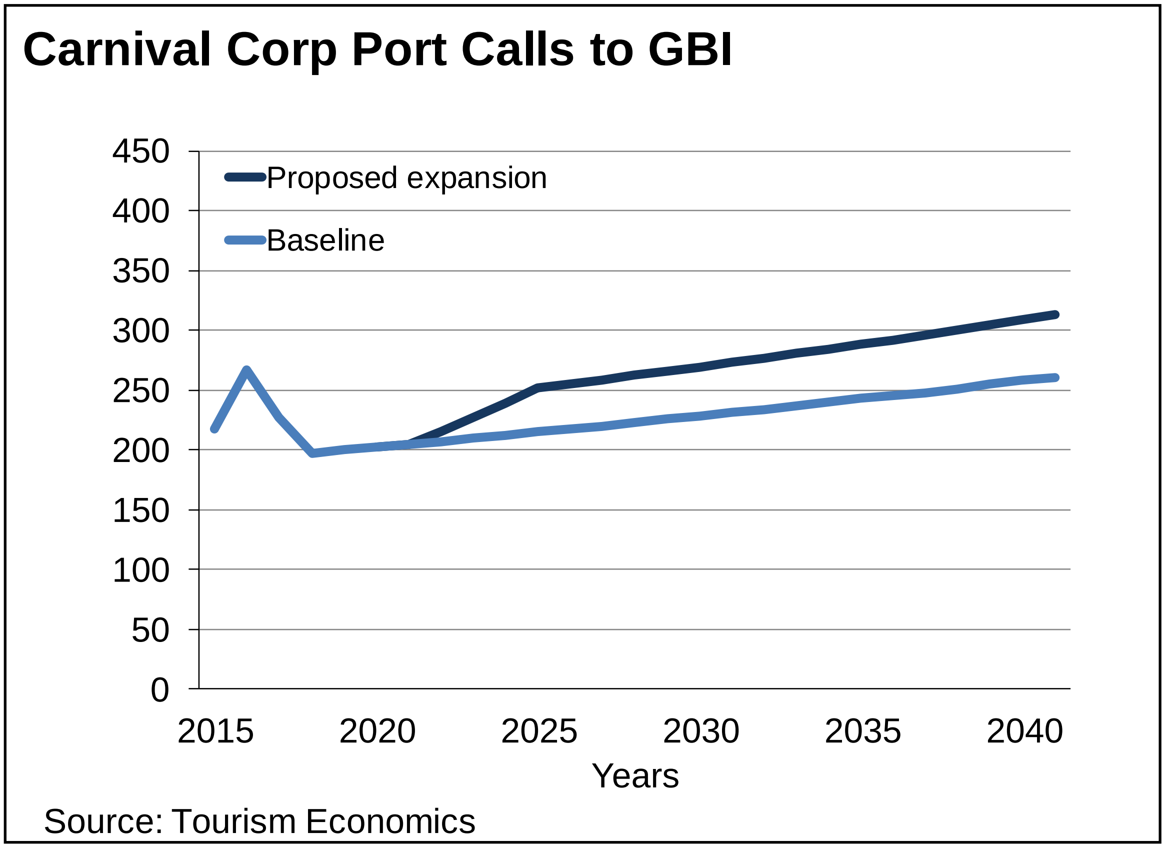

Figure 11-3. Project Port Calls to Grand Port, Grand Bahama Island

11.3 Tourism Statistics

Tourism statistics for Freeport and Grand Bahama Island were obtained online from The Bahamas Ministry of Tourism Website http://www.tourismtoday.com/services/statistics. The statistics reviewed were:1) The Bahamas Ministry of Tourism Visitor Statistics Total Foreign Arrivals to Grand Bahama Island by Air & Sea 1971-2018 and 2) Foreign Arrivals to The Bahamas YTD 2018-1998. These data are provided in **Charts 2** and **3** in **Appendix 8.**

The Bahamas Ministry of Tourism Visitor Statistics Total Foreign Arrivals to Grand Bahama Island by Air & Sea 1971-2018 only distinguishes between sea arrivals and air arrivals and therefore does not differentiate between arrivals by pleasure boaters or cruise ships. However, back in the early years of Freeport there were only three marinas, the Lucayan Marina, Running Mon Marina, and a dock facility at the Jack Tar Hotel. Therefore, the number of pleasure boaters versus cruise ship passengers was likely to be small at that time. The Foreign Arrivals data from 1998 to 2018 differentiates air and cruise arrivals. Based on a review of the data, it is apparent that there was a shift in transportation mode for arrivals to Grand Bahama Island from 1971 to 2018. In 1971 the primary mode of transportation was by air arrivals with 355,180 passengers (65.4%) versus 187,890 passengers (34.6%) by sea. See **Figure 11-4** below.

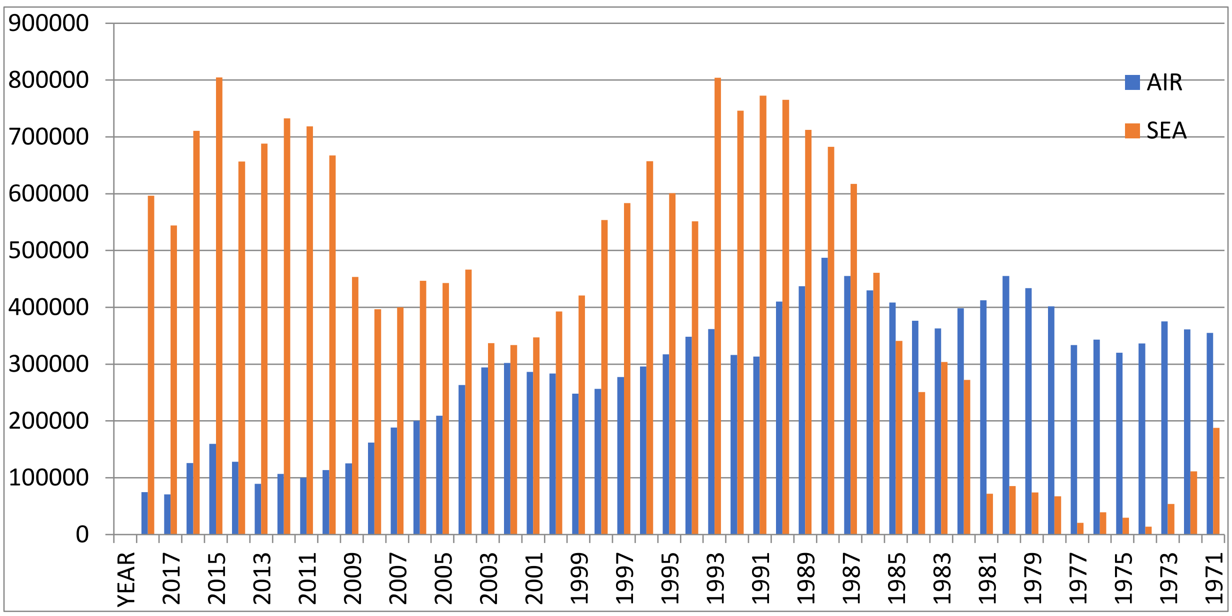

Figure 11-4. Foreign Arrivals by Air vs. Sea 1971 – 2018.

This trend of air travel dominating sea travel continued through 1982, when sea arrivals started to close the gap. In 1983 foreign air arrivals were 363,060 passengers (54.4%) and foreign sea arrivals 304,030 passengers (45.6 percent). By 1986 foreign arrivals by sea forged ahead of foreign air arrivals, with 430,100 passengers (48.3 percent) by air and 460,850 passengers (51.7 percent) by cruise ship. From 1986 to 2018 the predominate transport mode to Grand Bahama for foreign arrivals has been by cruise ship. In 2018, cruise arrivals (514,112) far outweighed air arrivals (73,792). This represents 85.64 percent arriving by cruise ship versus 14.36 percent by air. Also notable is that the peak number of foreign arrivals (combined sea and air) was in 1,175,537 in 1990 versus 670,745 in 2018.

Presented in **Table 11.1** are the number of Carnival Corporation brands' cruise passengers taken to Grand Bahama for each of the last five years (Bahamian Fiscal Year).

Table 11.1. Carnival Brand Passengers to Grand Bahama Island

Brand	July 2014 - June 2015	July 2015 - June 2016	July 2016 - June 2017	July 2017- June 2018	July 2018- June 2019
CCL	431,370	647,135	555,384	474,632	480,450
Costa	13,558	7,296	0	7,790	4,520
P&O / CAU / CUK	0	0	0	704	4,964
Total	**444,928**	**654,431**	**555,384**	**483,126**	**489,934**

Based on the Ministry of Tourism and Carnival Corporation data it is evident how dependent Grand Bahama is on the cruise ship industry and particularly Carnival brands for bringing tourists to the island. Thus, the Grand Port project will have a significant positive impact on the economy of Grand Bahama particularly after the adverse impacts of Hurricane Dorian and the cumulative impacts from previous hurricanes. Without a major development in Grand Bahama, the question is how sustainable the Grand Bahama economy will be, given the current situation and what are its prospects for the future.

12 DRAFT ENVIRONMENTAL MANAGEMENT PLAN -TERMS OF REFERENCE

See **Appendix 9** for a draft terms of reference for the environmental management plan.