ISLANDS
BY DESIGN

CUMMINS | CEDERBERG
Coastal & Marine Engineering

Environmental Impact Assessment (EIA)

Proposed Pier and Harbour Development

Great Stirrup Cay

The Berry Islands, Bahamas

December 2020

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ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED PIER AND HARBOUR DEVELOPMENT

GREAT STIRRUP CAY

THE BERRY ISLANDS, BAHAMAS

SUBMITTED ON BEHALF OF

NORWEGIAN CRUISE LINES

TO

THE MINISTRY OF ENVIRONMENT AND HOUSING DEPARTMENT

OF ENVIRONMENTAL PLANNING AND PROTECTION (DEPP)

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DECEMBER **2020**

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EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) for the Proposed Pier and Harbour Development for Great Stirrup Cay (GSC) has been prepared by Islands by Design, Ltd. and Cummins Cederberg, Inc. together with and on behalf of Norwegian Cruise Lines (NCL) relative to the proposed construction of two cruise ship piers and requisite dredging to accommodate the ships (hereinafter referred to as the Project). This EIA is in conformance with the Environmental Impact Assessment Regulations, 2020 and the guidelines for the preparation of an EIA and is being provided for review by the Department of Environmental Protection and Planning (DEPP), formerly the Bahamas Environment, Science, and Technology (BEST) Commission. This EIA presents baseline conditions within the Project area and provides an analysis of potential environmental impacts to marine and terrestrial habitats, that may result from harbour dredging and the construction of the cruise ship berthing piers and mooring dolphins. Preliminary recommendations for environmental management and mitigation represented here include the duration of construction and after construction. Independent, comprehensive documents will be prepared following the final EIA to include an Environmental Management Plan (EMP) and associated mitigation and monitoring plans.

Project History

GSC currently does not have a pier on the island. The piers are greatly needed to minimize the missed calls during higher wind/wave events that prevent passengers from safely disembarking the anchored cruise ship via tender transport and reaching the island destination via tender transport. The increased passenger efficiency afforded by the piers will ensure passengers arrival, and increase revenues for the Bahamas and NCL, employees and vendors who rely on the island's visitors. This development of GSC was proposed in phases. The first phase of infrastructure and coastal improvements (e.g., marina basin, beach enhancements, and recreational areas) was included in the 2008 EIA (Coastal Systems International, Inc., 2008). These improvements specifically supported severe weather events and water quality. This current EIA is specific to the construction of two permanent cruise ship piers on the north side of the island that will require dredging in the marine environment, minor alterations of the shoreline for the cruise pier connections, removal of vegetation for the creation of confined upland disposal areas (settlement ponds), temporary pipeline placement along existing roadways, as well as upland alterations for construction laydown areas, future staff roadways and back-of-house infrastructure. The following information and analyses are included in this EIA:

- An overview and history of island development
- Project need and basis
- Proposed project concept and description
- Existing conditions and facilities
- Environmental, socioeconomic, and physical conditions
- Impact identification and evaluation
- Proposed monitoring and management measures
- Potential mitigation measures
- Agency consultation and public interest
- Recommendations

After considering alternatives to the current preferred pier configuration, the two piers will be located east of the mouth of the existing harbor and oriented in a north-south (eastern pier) and northwest-southeast (western pier) orientation to optimize vessel maneuvering and sheltering, as well as minimize the wave/hydrodynamic agitation and loads on the structures. The eastern pier will be constructed as an earth-filled "combi-wall" system, approximately 1,500 feet in length, engineered to deflect the energy from the prominent eastern wave pattern. The western pier will be a pile-supported concrete structure approximately 1,100 feet in length. Dredging of the seabed in areas <34 feet of water depth will be required for clearance of the ships' hulls with dredge material to be deposited upland as opposed to offshore disposal.

Marine and Terrestrial Impacts

Marine resource surveys and terrestrial surveys were conducted as part of this EIA effort. They document various habitat types that have the potential to be impacted during the construction of the piers. Linear coral reef ridges, hardbottom communities, and seagrasses were mapped within the project footprint. Further west of the project area, and outside the zone of impact, NCL and Nova Southeastern University have multiple coral nurseries and coral outplanting areas where coral rearing, restoration, and research has been ongoing for several years. These areas will not be impaired from the construction of the piers.

It is anticipated that ~8 acres of reef will be impacted from the dredging, with another 0.07 acre of submerged aquatic vegetation (seagrass) from the pier construction. Final design criteria and specific details on construction methods may alter these estimates. Alterations of the ironshore shoreline from the concrete pad and abutment used to connect the pier to the island will likely have minor to no impact to the terrestrial environment.

Upland impacts will include removal of native flora during clearing of 17.6 acres for construction of confined upland disposal areas (settlement ponds), recontouring of the topography, and construction of the settlement bonds. Additional upland impacts may include modest clearing for new pathways for placement of dredge pipes and for an additional 3.5 acres of upland habitat for construction needs, roadways, paths, and staff housing. No impacts will occur to crown lands or native salt pond habitats.

Socioeconomic Impacts

Socioeconomic impacts are considered positive and are expected to increase prospects for growth in personal income for local Bahamians from construction labor positions to permanent positions on the island and vendor opportunities.

Recommendations

The following recommendations are based on an assessment of direct and indirect impacts and short and long-term impacts from the Project.

1) Environmental Management Plan (EMP). An EMP should be prepared as a separate document. Best management practices will be employed during construction activities and include turbidity and suspended sediment controls, ensure proper material storage and disposal, and monitoring of construction of activities during dredging and construction. Included in the EMP should be biodiversity

and environmental mitigation and monitoring plans, construction and operational plans, emergency response plans, health and safety plans, and contractor management plans.

2) The capital investment provided by this project is anticipated to positively impact the Bahamian community in the region by providing employment and occupational transfer of skills while expanding the touristic offerings of the northern Bahamas. Local Bahamian workforce should be utilized to the greatest extent possible during construction and operation. NCL has also pledged to support community improvements on Great Harbour Cay and assist in upgrading the condition of some of the sports fields and providing equipment for music courses at a local school.

Conclusion

It is recommended that due to the positive socio-economic impact and the development and adherence to a robust EMP and mitigation plan, the Project should move forward as proposed. Although environmental impacts are identified in the marine and terrestrial environments as both permanent and temporary, they have been minimized through a review of the alternatives and careful planning, and the application of environmental standards and requirements, and should be considered acceptable relative to the benefits gained and mitigation approaches.

1 INTRODUCTION AND OBJECTIVES

1.1 Project Overview, Purpose, and Extent

NCL purchased GSC with ~25 acres remaining under Bahamian ownership (crown land) and has increasingly invested in the evolution of the island experience from a destination stopover on a sparsely inhabited island to a site offering relaxing options such as dining and shopping and a day of water sports and excursion for the adventure seekers. Since NCL began utilizing GSC as a cruise ship destination facility in the late 1970's, passengers have been transported to the island aboard large passenger tenders from the cruise ship anchored offshore in deeper water to the embarkation/debarkation docks within the basin, or in earlier days direct via a beach landing.

NCL and its passengers have significantly, missed calls to the port due to unfavorable weather conditions when ferries are not able to safely load and transport passengers due to strong winds and heavy seas, resulting in an unused experience for the cruise passengers, and a loss of revenue for both the local Bahamians employees and vendors and NCL who rely on the island's visitors. To reduce the number of missed calls and lost earnings, and to further NCL's commitment to enhancing the visitor experience, as part of their Master Plan, NCL is proposing to construct two permanent cruise ship piers on the north side of the island (hereinafter referred to as the Project) to allow for cruise ship berthing with direct access to the island.

1.2 Project Location

Great Stirrup Cay is a small island situated on the northern portion of the Berry Islands chain at the northmost extent of the Great Bahama Bank (**Figure 1**). A privately owned island, GSC is approximately 3,000 meters (9,850 feet) in the east-west direction and approximately 580 m (1,900 ft) at its widest north-south direction. The northern shoreline where the pier construction is proposed consists of almost exclusively ironshore formation with a steep transition from the shoreline to submerged marine habitats of sparsely colonized carbonate substrate, hardbottom, coral reef, and seagrass communities. Immediately north of the island, water depths quickly plummet to more than 1,000 meters in the deep-water area known as the Northwest Providence Channel.

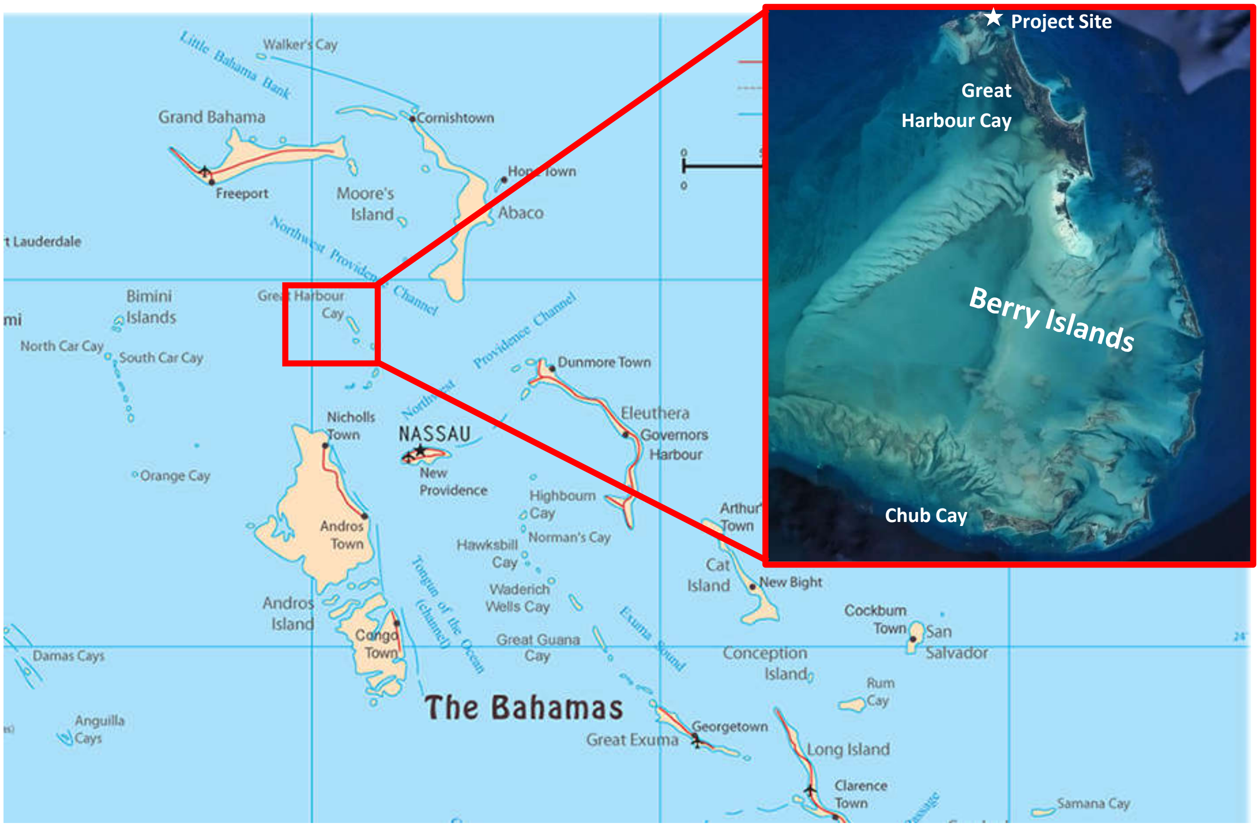


Figure 1: Map of The Bahamas and Berry Islands

1.3 Project Proponents

Norwegian Cruise Lines (NCL) intends to develop two piers on the north side of GSC (**Figure 2**) for cruise ship berthing and passenger dis-embarkment as an alternative to the present method of ferrying passengers from the ships anchored offshore to the island. Under certain weather conditions, excessive wave heights prevent the passenger transport vessels from safely carrying and offloading passengers, resulting in missed calls and preventing the passengers from enjoying their full experience on GSC. Using a wave analysis to determine the potential downtime reduction with the construction of the new piers, it was estimated that with a significant wave threshold of 3.0 ft., the downtime could be up to 30.9% under the assumption the island receives ships daily. The actual downtime could be higher or lower depending on the island's call schedule. To reduce this number, NCL is proposing cruise piers to improve the safety of mooring ships and guest access to the island during unsuitable weather conditions.

Figure 2: Great Stirrup Cay, The Bahamas

1.4 Need for Environmental Impact Assessment (EIA)

1.4.1 Key Issues

The proposed Project is anticipated to directly impact the marine environment from the permanent removal of habitat during dredging and construction, and indirectly from sedimentation and turbidity. Upland impacts include the development of the dredge material settlement ponds, upland clearing for construction laydown areas and future outbuildings, and discharge/return of water to the ocean.

1.4.2 Scope of the EIA

The scope of this EIA is limited to the Project area and its area of influence and includes comprehensive evaluations of the proposed plans and existing environmental conditions of the Project area. The degree of potential environmental, physical, and socioeconomic impacts during and after construction are considered and summarized. In accordance with the Bahamian *Environmental Impact Assessment Regulations, 2020* of the *Environmental Planning Act of 2019*, this EIA shall address and focus on significant environmental issues without presenting extraneous information not directly pertinent to the analysis of these issues. Several studies, including a detailed marine benthic habitat survey and terrestrial survey, were conducted to support the EIA and assist in decision making relative to impact analysis and mitigation. This EIA was prepared along with the Project Proponents application for a Certificate of Environmental Clearance (CEC) as per the procedures listed in the EIA Regulations.

1.5 Existing Conditions and Project Improvements

Currently, GSC is an active cruise ship destination where cruise ships moor offshore and utilize tenders to bring passengers ashore. On the island, there are fully functional infrastructure systems including a reverse osmosis water system, a sewage treatment plant, generators and generator building, a fuel storage facility, an incinerator, maintenance building, and other “back of house” supporting structures. There are recreational opportunities for the guests, dining areas, local vendor shops, and a cafeteria and housing for onsite staff. Current food & beverage operations include provisioning from the ship and removal of trash back to the ship or incinerated on the island. On the north side of the island where the piers are proposed, there are no existing marine or shoreline structures, infrastructure, or land-access points, with the exception of the marine harbour west of the proposed piers (**Figure 3**).

Figure 3: Northern shoreline showing proposed cruise ship piers

1.6 Local and Regional Benefits

The Project will result in immediate job creation and an increase in direct sales and service revenues during the dredging and construction phases. Additional economic benefits to the Bahamas include continued arrival of tourists and increased Bahamian revenues due to the investment in capital infrastructure. Project implementation would also mitigate economic losses to vendors and shopkeepers resulting from missed ports of call and lost pay due to closure of on-island facilities staffed by locals from Great Harbour Cay and nearby islands.

1.7 Environmental Considerations

The submerged lands in and around the Project site contain sensitive and protected marine resources, including sloping hardbottom communities, high-relief stony-coral (scleractinian) dominated elevated reef ridges, lower-relief hardbottom habitat, aggregated patch reefs, coral nurseries and outplanted coral areas, and seagrass communities interspersed with uncolonized areas of sand. Terrestrial habitats within the proposed pipeline corridors and dredge disposal ponds are comprised of rocky shore, dry broadleaf evergreen formation (e.g., dwarf shrubland and forest), and human altered upland areas where vegetation was removed.

1.8 Project Components and Methods to Minimize Adverse Impacts

The primary Project components GSC include dredging, upland dredge material disposal, and pier construction. To minimize adverse impacts, strategic planning and consideration of alternatives, including offshore disposal, were considered and essential to addressing environmental and upland issues. A detailed Environmental Management Plan (See **Section 6** for outline of content) will be developed in consultation with the selected contractor and DEPP. Best management practices will include selection of equipment, minimization and control of sediment spill, turbidity and runoff controls, timing of dredging events, land reuse of the dredge material spoil areas, and other operational considerations.

1.9 Supporting Surveys and Mapping

1.9.1 Marine Habitat Assessment and Mapping

A detailed marine resource survey and habitat mapping effort was conducted in July 2020 using a range of survey techniques to document, characterize, and quantify sensitive marine habitats within the Project area. The survey was designed to assess the density of hard corals (Scleractinian) and soft corals (octocorals), determine the condition and quantity of submerged aquatic vegetation, map the habitat transitions from the shoreline waterward, and document the presence of other marine resources. Additionally, fish and invertebrate species observed during the survey were noted to create a qualitative list of notable species within the survey area. The survey area is outlined in **Figure 4**.

The marine habitat within the survey area transitioned from a sloping hardbottom community comprised of uncolonized hard substrate to sparsely colonized by hard corals and octocoral colonies. Progressing offshore is the higher-relief (>1 meter) contiguous reef ridge with the highest coverage and density of hard corals, including larger boulder colonies. North of the contiguous reef ridge is a prominent sand gap feature that transitions into the reef flat habitat, a lower-relief habitat with fewer hard coral colonies than the neighboring aggregate patch reef ridge to the north or the contiguous reef ridge to the south. The aggregate patch reef ridge was documented to have a slightly higher percent coverage of living corals but a slightly lower density of large colonies than the continuous reef ridge, although both habitat types were documented as the predominant reef features harboring a range of species and size of hard corals and octocoral colonies within the survey area. Baseline conditions and more detailed descriptions are provided in **Section 4.5.1.** The full survey methodologies and results can be found in **Appendix A**.

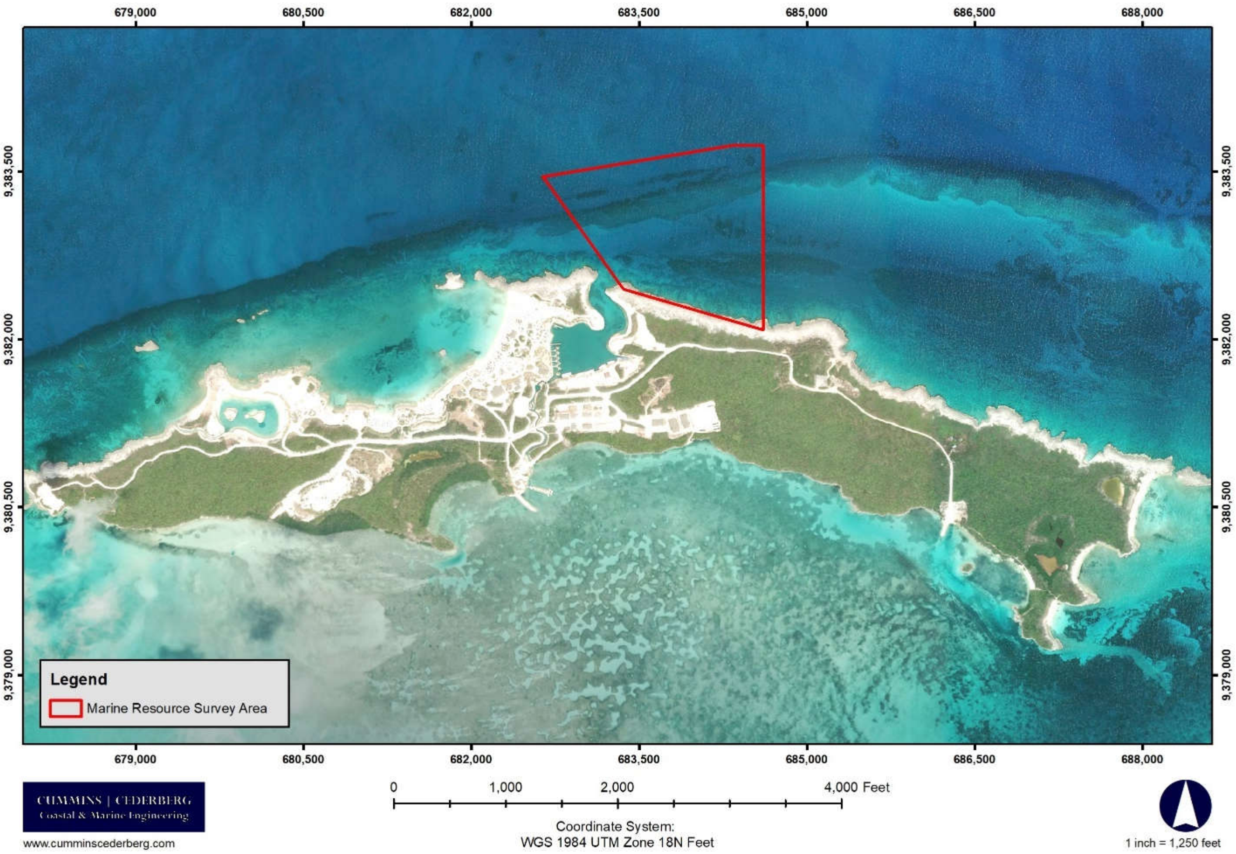


Figure 4: Marine survey area

1.9.2 Terrestrial Surveys

A terrestrial survey including flora and fauna from within areas of potential impacts from proposed works and surrounding areas was conducted on 11 October 2020. Baseline data collection included botanical habitats and wildlife species. The purpose of the botanical survey was to map vegetation types, determine floristic diversity, record protected species abundance, and identify the presence of invasive species. The avian investigation was performed to identify the presence, abundance, and habitat utilization of avian species within the general survey area.

1.9.3 Upland Geotechnical Borings

Ardaman & Associates, Inc. conducted a preliminary geotechnical evaluation of upland soil borings for GSC (Ardaman and Associates, Inc. , 2020). Fourteen borings were taken from March 5, 2020 to March 18, 2020 and vary from 25 feet to 50 feet in depth. Geographical locations and vertical details of the borings can be found within **Appendix B**. The boring logs show descriptions of the types of soils encountered and their respective depths. Additionally, soil strength tests were conducted throughout the strata of each using the Standard Penetration Test (SPT) specified by ASTM D1586. This test involves dropping a 140-pound hammer 30 inches onto a guide rod and counting the number of blows (N) required to travel 6 inches twice after an initial 6 inches are driven. Higher blow counts indicate stronger soils that can withstand larger forces.

The tests indicate that most of the soil at GSC is composed of various grades of limestone (i.e. very poorly cemented, poorly cemented, fair, well cemented, and containing sand). Finely grained sand of varying colors (white, brown, gray, and yellow) was also collected within the borings ranging from the surface to approximately 30 feet below depending on the boring. The blow counts ("N-value") for the limestone range from 22 to 180, indicating a strong bearing capacity at depths where limestone is found. Sand blow counts range from 4 to 70, suggesting weak bearing capacities in select locations. However, the blow counts typically are higher than 11 in sandy areas, indicating that weaker sandy strata are not common for the upland Project site. Additional soil properties including unit weight and friction angles can be found in **Appendix B**.

1.9.4 Marine Geotechnical Borings

In addition to the recent upland geotechnical evaluation, Ardaman & Associates, Inc. previously collected a marine boring north of GSC within the vicinity of the proposed current Project to prepare for the development of the marine harbour (Ardaman & Associates, Inc., 2007). Boring C-13 was drilled on October 24, 2007 to a depth of 100 ft below the water's surface, as seen in **Appendix C**. Porous fragmented oolitic limestone, a sedimentary rock made of tiny concentric grains cemented together, was encountered at 32 ft indicating that much of the seabed in the Project area contains little sand. Moderately hard limestone continued for 19 ft (51 ft below the water's surface) until the rock transitioned into hard vuggy (containing cavities, voids, or pores) fragmented oolitic limestone. This continued to the termination of the boring at a depth of 100 ft.

1.9.5 Bathymetry

GSC is located along the northern edge of the Great Bahama Bank. The Great Bahama Bank is a large shallow sand bank, which extends approximately 62 miles (100 km) westward from Andros as well as approximately 47 miles (75 km) north and 186 miles (300 km) south. Water depths within the bank are generally less than 33 feet (10 m) with localized shallow areas exposed at low tide. The shallow areas, along with various islands, significantly limit wave propagation, resulting in a mild wave climate dominated by local wind generated waves within the Bank.

The northern center of GSC includes a man-made marine harbour for ferries to dock after collecting visitors from offshore cruise ships. This harbour is sheltered by revetments and a meandering inlet to protect the uplands from offshore waves and boat wake erosion. Additionally, a small bay outlined with beaches and shoreline stabilization groins borders the water just west of the harbour. A shoreline stabilization groin is a hard structure that combines rock and fabric to minimize littoral transportation and trap sand in designed locations for accumulation. The beaches have been enhanced to provide larger areas of sand for guests.

The majority of water depths around the Project site at the northern point of the island are shallow, typically less than 40 feet (12 m), (see **Appendix D**). Water depths are shallower and gently slope into upland conditions within the constructed beaches to the west. The bathymetry drops to deepwater conditions approximately 0.8 miles (1.2 km) north of the island, providing water deep enough for cruise ship anchorage.

1.9.6 Topography

Several site visits were conducted to the island to observe existing conditions. A topographic and bathymetric survey was conducted in January of 2020 and is illustrated in **Appendix D**. GSC is a low-elevation island with marinas and enhanced sandy beaches presently used for tourism. Native vegetation grows throughout most of the island, particularly on the eastern half where little development to date has occurred. At the waterline, there are several sandy beaches that are flanked by ironshore and rocky revetments. In many areas, beach quality material appears to have naturally accumulated. Silt deposits were observed along the graded surface beneath the proposed north shoreline of the main lagoon.

The Project site consists of a natural ironshore bluff along the northeastern and northwestern edge of GSC. This ironshore is a jagged raised bluff that is both a result of and testament to exposure to high-energy waves that generally terminates abruptly inland, and protects the upland vegetation and roadway used to navigate through the sparsely populated island. Natural vegetation borders all the southern portion of the island, where the greenery abuts natural revetments, sandy bottoms, reefs, and seagrasses. Several dredged and filled areas exist around the island as part of installation of jetties and groins, and beach enhancements.

The ironshore bluffs where the proposed piers are to be placed increase in elevation from approximately 1 feet, Mean Sea Level (MSL) to +6 feet MSL upland in under 10 linear feet. This datum (MSL) is in reference to NOAA Station 8723214 at Virginia Key, Florida. The steepness of the shore flattens out and slowly increases in elevation further inland, reaching a maximum height of approximately +60 feet, MSL in the eastern center of GSC by the lighthouse. The southern border of the island exhibits similar steepness as the northern shoreline albeit without the ironshore bluffs to protect the upland vegetation. The area proposed for the construction of the confined disposal areas (settlement ponds) is fairly flat with the maximum height in the eastern area around +44 feet, MSL sloping down to +41 feet, MSL in the north, +31 feet, MSL at the western end, and +26 feet MSL in the south.

2 PROJECT DESCRIPTION

2.1 History and Background

Great Stirrup Cay is a privately-owned 268-acre island at the northern end of the Berry Islands, The Bahamas, approximately 140 miles east of Miami, Florida and 65 miles north-northwest of New Providence. Norwegian Cruise Line (NCL) purchased the western end of GSC from Belcher Oil Company in 1977 and developed a “day resort” (Cruise Point Insider, n.d.) as an out-island destination experience for their cruise passengers. GSC was fully purchased by NCL in 1986 (Cruz, 1991) and has increasingly invested in the development of the island experience from a destination stopover on a sparsely inhabited island to a site offering relaxing options such as dining and shopping and a day of water sports and excursion for the adventure seekers. As part of a previously approved EIA (Coastal Systems International, Inc., 2008), starting in 2010, NCL spent 2 years developing the island carving a new marina basin in the northern center, constructing dining areas and bars to the west, and expanding the beach along the northwestern shoreline. NCL further improved Great Stirrup Cay in 2017 to 2018 with the expansion of the beach area, new shoreline stabilization structures, and the construction of private villas for guests (Sloan, 2017). Since NCL began providing Great Stirrup Cay as a cruise ship destination facility, passengers have been transported to the island aboard large passenger tenders from the cruise ship anchored offshore in deeper water.

Today, NCL is the only cruise line without a pier on their privately-owned island in the Bahamas. NCL and its passengers have, at times, missed calls to port due to unfavorable weather conditions causing ferries to not be able to safely load and transport passengers. Strong winds and heavy seas cause a missed experience for the cruise passengers and a loss of revenue for NCL and the employees and local vendors relying on the island visitors. To reduce the number of missed calls and lost earnings and to further NCL’s commitment to enhancing the visitor experience, NCL is proposing the Project to allow passengers to debark directly onto the pier safely during normal and unfavorable weather conditions. In early 2020, the Bahamas Investment Authority’s National Economic Council provided a letter of approval for significant renovations and improvements at Great Stirrup Cay, including the construction of a pier and dredging of a deep-water basin (**Appendix E**).

After analyzing other alternatives, the preferred configuration involves two piers located east of the mouth of the existing marine harbour and oriented in a north-south (eastern pier) and northwest-southeast (western pier) orientation to minimize the hydrodynamic loads on the structures. The eastern pier will be constructed as an earth-filled “combi-wall” system approximately 1,500 feet in length, engineered to deflect the energy from the prominent eastern wave pattern. The western pier will be a pile-supported concrete structure approximately 1,100 feet in length. Dredging of the seabed in areas <34 feet of water depth will be required for clearance of the ships’ hulls.

A marine resource survey conducted as part of the EIA effort documented various habitat types that will be impacted during the construction of the piers. Linear coral reef ridges, hardbottom communities, and seagrasses will be impacted both directly and indirectly because of the project. Alterations of the shoreline from the concrete pad and abutment used to connect the pier to the island will have a minor impact on the terrestrial environment. Mitigation to minimize long-term impacts from the dredging and construction will be developed during the EMP process. Socioeconomic impacts are considered positive, as the project is expected to increase prospects for growth in personal income for local Bahamians from temporary labor positions during construction to permanent positions on the island and vendor opportunities.

2.1.1 Site Location and Layout

The GSC cruise pier Project is located on the north side of GSC and includes dredging to accommodate the NCL cruise fleet; the construction of two piers (an East and West Pier) and associated mooring bollards, dolphins, and catwalk system; and utilities to support ship services. **Figure 5** shows the general location and layout of the proposed piers configuration as part of the Master Plan for the island.

Figure 5: GSC Master Plan with cruise ship pier layout (illustrative purposes only)

2.2 Project Components

2.2.1 Dredging

Dredging between the East and West Piers shall be to an elevation no less than -34.0 ft (-10.4 m), MLLW with an over dredge limited to 2 ft. The total estimated footprint of the dredge area is approximately 12.5 acres, with approximately 150,000 CY of material being removed. Slide slopes will generally be cut at a stable slope or step-wise manner corresponding to the material encountered. No blasting is proposed or allowed. **Figure 6** shows the 30% proposed dredging plan for the Project; the final volumes and area to be dredged will be determined by the contractor following completion of detailed design-build methods and dredge operation plans. See **Appendix F** for the full 30% drawing set of the proposed dredging and pier construction.

Offshore material disposal was not considered due to the potential environmental considerations and opportunity for material re-use on island. Dredge material will be discharged upland into three confined upland disposal areas (settling ponds) on the south side of the island (**Figure 7**) estimated to total approximately 17.6 acres; an additional 3.5 acres will be cleared to support construction laydown areas and future roadways, paths and back-of-house infrastructure and staff housing as shown in **Figure 7** The two main objectives inherent in design and operation of confined upland disposal areas are adequate storage capacity and efficiency in retaining the solids. When the dredged material is initially deposited in the settling ponds, the discharge may occupy several times its original volume, but over time, the sediment will eventually consolidate as effluent and desiccation occur.

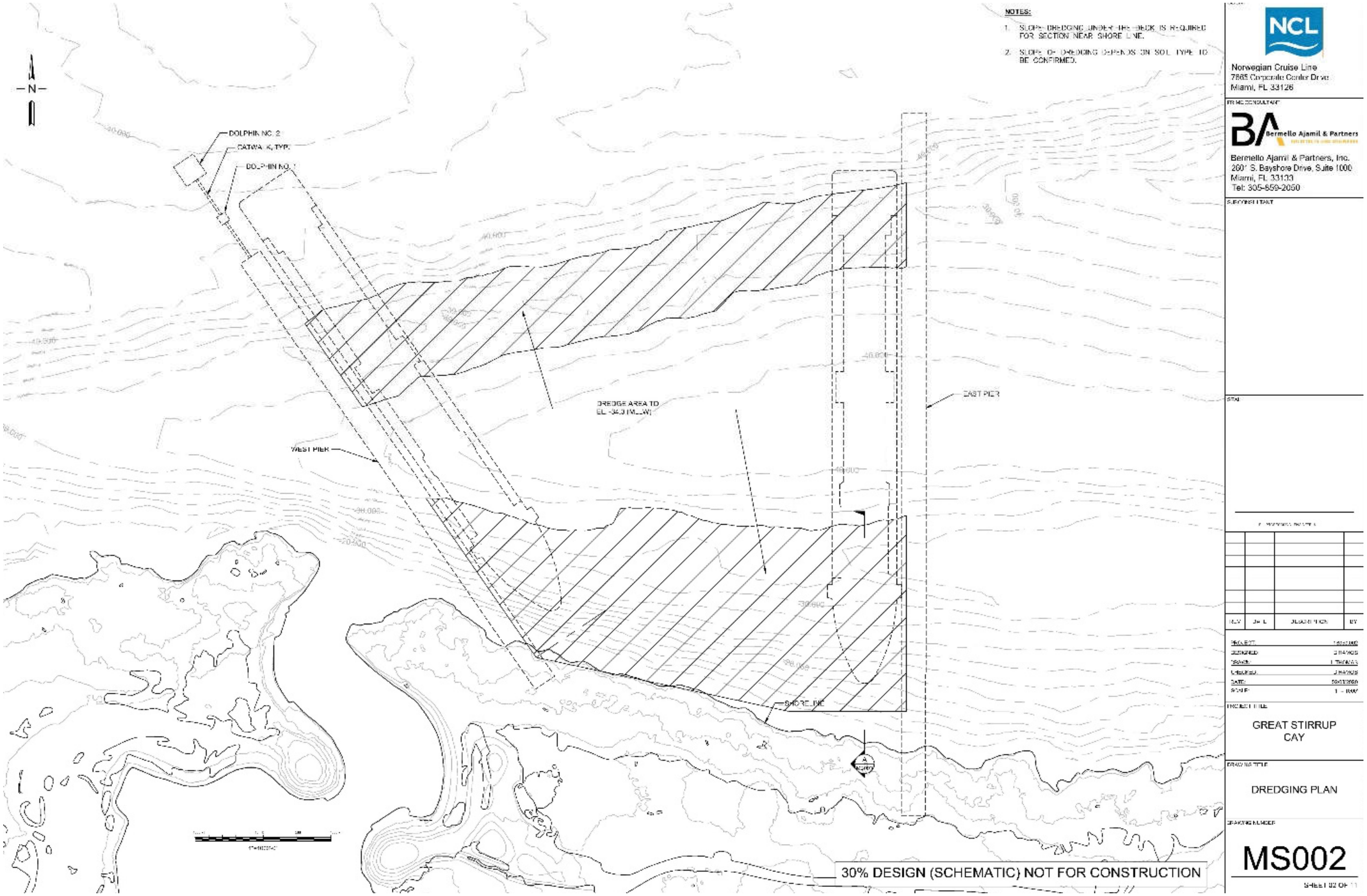


Figure 6: Proposed dredging plan for the cruise ship piers on GSC

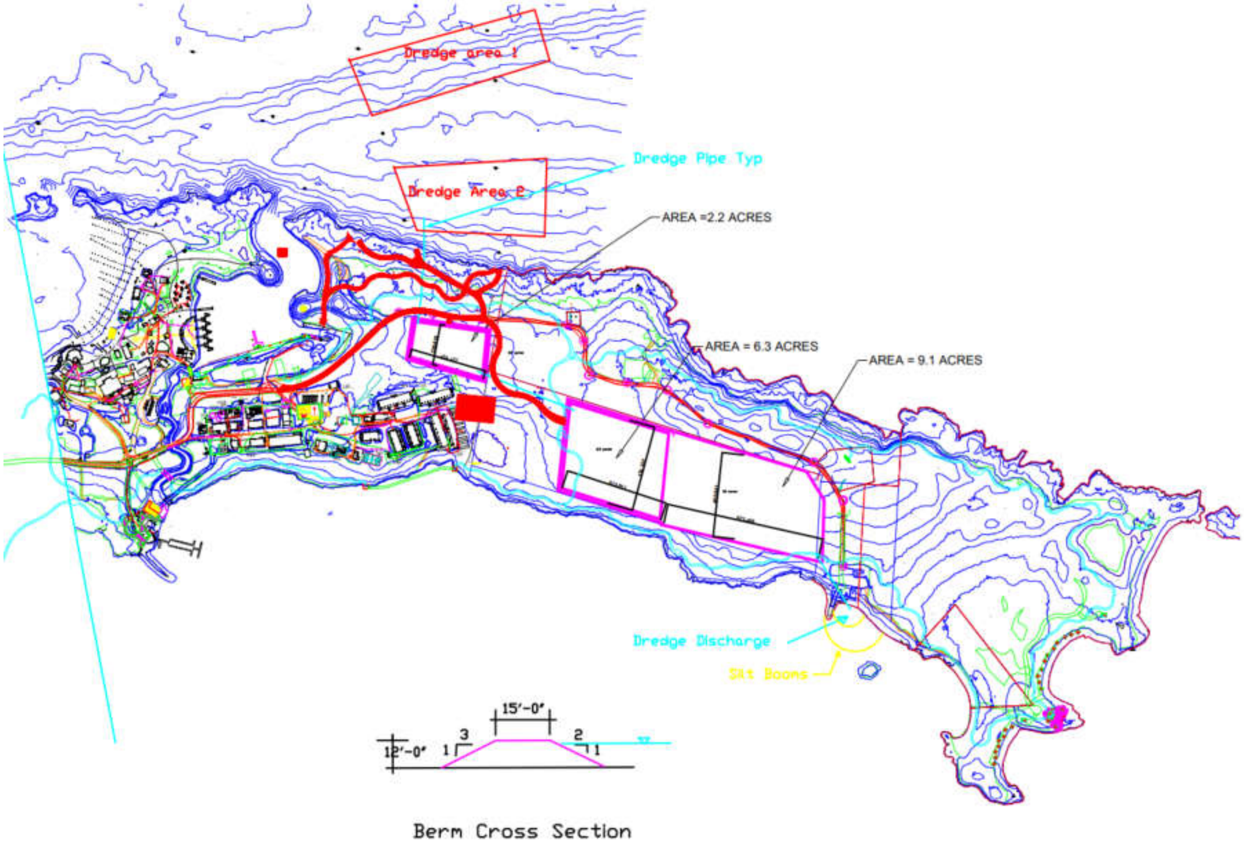


Figure 7: Proposed dredge areas (red polygons), dredge material settling ponds (pink polygons), roadways, paths, and dorms (solid red lines), and pipeline corridor (hatched red lines)

2.2.2 Piers and Berthing Facilities

Several alternatives to the pier design were considered (see **Section 2.2.3**) with an ultimate design of constructing an East Pier approximately 1,500 ft by 50 ft and a West Pier approximately 1,110 ft by 50 ft. The East Pier will include both solid and open sections with a 100-ft concrete abutment at the shoreline. The West Pier will be an open, pile-supported design with mooring dolphins and cat walks beyond the end of the main pier and a 48-ft concrete abutment at the shoreline. A barge landing will be constructed between the East and West Piers to accommodate an approximate 190-ft landing craft for ro-ro cargo operations to the island.

2.2.3 Project Alternatives

The purpose of the discussion of alternatives in an EIA is to provide a reasonable range of potentially feasible alternatives that could lead to avoidance or lessening of significant environmental effects of a project, even if these alternatives would result in altering the project objectives or are more costly. Feasible project alternatives are those that could achieve the basic underlying purpose and objectives of the Project but may lessen the effects to the environment and is capable of being accomplished in a successful manner within a reasonable period of time considering economic, environmental, legal, social, and technological factors. A feasible alternative is also one that accomplishes the Project's "underlying fundamental purpose."

During planning, several alternatives were investigated culminating in a preferred layout. The alternatives were analyzed for their impacts in comparison to a No-Action Alternative. A No-Action Alternative means continuing with the existing conditions (i.e., continuing the use of ferrying passengers from the anchored cruise ships to the island).

2.2.3.1 Alternative 1 – Filled Parallel Piers

Figure 8: Alternative 1

Alternative 1 (**Figure 8**) utilized two parallel fixed piers of concrete and steel sheet piles extending northeast from the island just east of the existing marine harbour. These piers were to be of compacted earth from excavated dredge material to provide bathymetry deep enough for cruise ship mooring. The two extending piers were to be 900 ft long and 50 ft wide with a gap of 600 ft between the inside faces of the piers. Two dolphin piles were to be spaced 100 ft apart on center at the end of each pier for mooring stability, and one large dolphin pile of 50 ft by 50 ft was to be added 100 ft after the smaller dolphin piles as anchorage for the piers and cruise ships. The piers were proposed to intersect a 50-ft wide marginal dock that ran parallel to the shoreline. Approximately 192,500 SF of ironshore and other upland material was to be dredged to allow for construction of the marginal dock and piers.

Alternative 1 has large environmental impacts due to the fixed piers and upland dredging. The piers covered approximately 90,000 SF of seabed/upland and prevent the opportunity for hydrodynamic flow through the piers. The fixed piers also created concerns regarding wave action where internal seiching could become an issue. Without wave attenuation and the opportunity for vessel wakes to escape from within the piers, waves from cruise ships and tugboats will reflect off the pier walls and interact with other waves causing constructive interference. This could cause vessels to batter the piers and create unfavorable docking conditions.

Regarding the environmental aspects of Alternative 1, the removal of approximately 192,500 SF of upland ironshore and vegetation would be costly and negatively impact the local ecosystem. This excludes the nearshore dredging that would be needed to provide depths deep enough for cruise ships to safely moor. Due to the high quantity of dredging and associated costs, environmental concerns, and potential for large waves from seiching between the piers, Alternative 1 was not chosen for development.

2.2.3.2 Alternative 2 – Filled Angled Piers

Figure 9: Alternative 2

Alternative 2 (**Figure 9**) utilized similar concepts as Alternative 1 with fixed piers of concrete and steel sheet piles extending from the island just east of the existing lagoon. However, Alternative 2 altered the length and direction of each pier. Rather than a northwest direction, the easternmost pier (East Pier) was designed to be constructed in a north-south direction, and the westernmost pier (West Pier) was designed to be in a northwest-southeast direction. Both piers were to be of compacted earth from excavated dredge material, similar to Alternative 1.

The East Pier was to be 1,500 ft long and 50 ft wide with approximately 150 ft of the length of the Pier cutting into the ironshore bluff. A revetment on the east side of the East Pier was proposed to dissipate incoming wave energy and reduce the forces impacting the Pier from the predominantly eastern winds.

The West Pier was to be a short 800 ft long and 50 ft wide with approximately 350 ft of the length of the Pier cutting into the ironshore. Two dolphin piles were to be spaced 100 feet apart on center at the end of the West Pier for mooring stability, and one large dolphin pile of 50 feet by 50 feet was to be added 90 feet after the smaller dolphin piles as anchorage for the piers and cruise ships. The piers were proposed to intersect a 780-ft long by 50-ft wide marginal dock that ran parallel to the shoreline like Alternative 1. Approximately 166,500 SF of ironshore and other upland material was to be dredged to allow for construction of the marginal dock and piers.

Like Alternative 1, Alternative 2 has large environmental impacts due to the fixed piers and upland dredging. The piers covered approximately 115,000 SF of seabed/upland and prevent the opportunity for flow through the piers. The fixed piers also created slight concerns for seiching; however, the angle of the West Pier provided an opportunity for diffraction to potentially redirect the wave energy north of the island rather than simply between the piers as in Alternative 1. Nonetheless, constructive interference would still be a concern with waves reflecting westward from the East Pier and could create unfavorable docking conditions.

Regarding the environmental aspects of Alternative 2, the removal of approximately 166,500 SF of upland ironshore and vegetation would be costly and negatively impact the local ecosystem. This excludes the nearshore dredging that would be needed to provide depths deep enough for cruise ships to safely moor. Due to the high quantity of dredging and associated costs, environmental concerns, and potential for large waves between the piers, Alternative 2 contained similar concerns to that of Alternative 1 and therefore was not selected for development.

2.2.3.3 Alternative 3 - Preferred Pier Construction

Figure 10: Alternative 3

While the preferred alternative will result in some negative impacts, the changes proposed will overall result in improved functionality over the No-Action Alternative. Alternative 3 utilizes one fixed pier of concrete and steel sheet piles extending north from the island (East Pier) and one fixed pile-supported pier extending to the northwest (West Pier), as seen in **Figure 10** and in **Appendix E.** The East Pier is to be composed of similar materials suggested in Alternatives 1 and 2; this includes the steel pipe and sheet pile combi-wall system with a cast-in-place concrete slab cover surrounding the compacted earth from dredge material (beneficial re-use of dredge spoils). The West Pier is to be a pile-supported system composed of steel batter pipe piles and a precast concrete pile cap encasing the top of the piles. The East Pier is to be 1,198 ft long and 50 ft wide with an additional 202 ft of pile-supported pier and 100 ft of concrete slab-on-grade landward of the combi-wall system to provide a safe pathway for visitors. The West Pier shall be 1,052 ft long and 50 ft wide with an additional 48 ft of concrete slab on grade landward of the Pier for pedestrian traffic. A 20-ft by 20-ft dolphin pile is to be placed 90 ft after the end of the West Pier for mooring stability, and one large dolphin pile of 50 ft by 50 ft is to be added 90 ft after the smaller dolphin pile as anchorage for the piers and cruise ships.

Alternative 3 has less environmental impacts than Alternatives 1 and 2 due to the 202-ft pile-supported section of the East Pier and all the West Pier requiring less dredge fill to cover the existing seabed.

Approximately 122,600 SF of seabed and upland area is still covered by the proposed piers, but 62,700 SF of these piers are pile-supported, thus permitting hydrodynamic flow along the shoreline and limiting the potential for seiching. Additionally, the marginal dock proposed for Alternatives 1 and 2 was eliminated for Alternative 3, preserving approximately 185,100 SF of ironshore and upland vegetation when accounting for the proposed slab on grade and concrete abutment. Conserving the ironshore helps lower design, permitting, and construction costs and reduces impacts on the local ecosystem. Due to the reduced impacts to the seabed, permissibility of flow through the pile-supported piers, and reduction in costs and environmental impacts to the upland ironshore and vegetation, Alternative 3 was chosen for construction.

2.2.3.4 No-Action Alternative

The No-Action Alternative would keep the Project site "as is," eliminating the potential of mooring piers and dredging of the nearshore area. Current passenger transit operations from an anchored cruise ship offshore to GSC via ferry transport would continue. While the No-Action Alternative contains the least environmental impact, the likely economic stimulus to the northern Bahamas through new employment opportunities and infrastructure investment would be lost. Additional missed calls to port would be also expected, thus further reducing economic benefits over many years. Social, cultural, and economic factors will continue to influence the ongoing development of other island properties, creating the opportunity for other investors to improve various other locations within the Caribbean, potentially reducing tourism for the northern Bahamas. With these factors considered, it is not recommended to pursue the No-Action Alternative.

2.3 Projected Infrastructure and Utilities

Temporary and permanent electrical power and water will be necessary for the construction and long-term operation of the piers. Utility trenches sheltered by precast concrete covers within the piers are proposed to accommodate the electrical and water lines. Utilities lines, including power, water, data and communication lines will be installed from the existing back of house area to the piers and the ro-ro ramp. The piers will have lighting, security cameras, audio, and water connections (hose bibs) for fire protection and cleaning of the piers. Additionally, there will be stormwater drainage allocation during storm events or potential high wave action, site lighting for visitors and employees, security cameras, bollards to prevent vehicles from potentially rolling into the water, large fenders to protect the ships and piers, cleats for mooring, railings to guide visitors to proper destinations, temporary or permanent tents for customs, and fencing to prevent visitors from entering improper locations of the piers.

Upland required developments to connect the proposed cruise piers to the amenities at GSC will include roadways for guests who need assistance reaching the island features or for security and employees to assist in the cleaning, mooring, and other required servicing. Sidewalks will need to be built for pedestrian traffic along with railing and stairs if necessary. Temporary piping will need to be constructed to transport the dredged material to the allocated dredge spoil area.

Upgrades will be needed and completed for the existing infrastructure of the island amenities, including the wells, storage areas, water distribution methods, wastewater treatment equipment, power generation, data and communication methods, and fueling stations. These infrastructure upgrades are estimated to cost approximately $15 million.

2.4 Project's Relevance to Existing and Proposed Regional Development Plans

2.4.1 Adjacent Communities

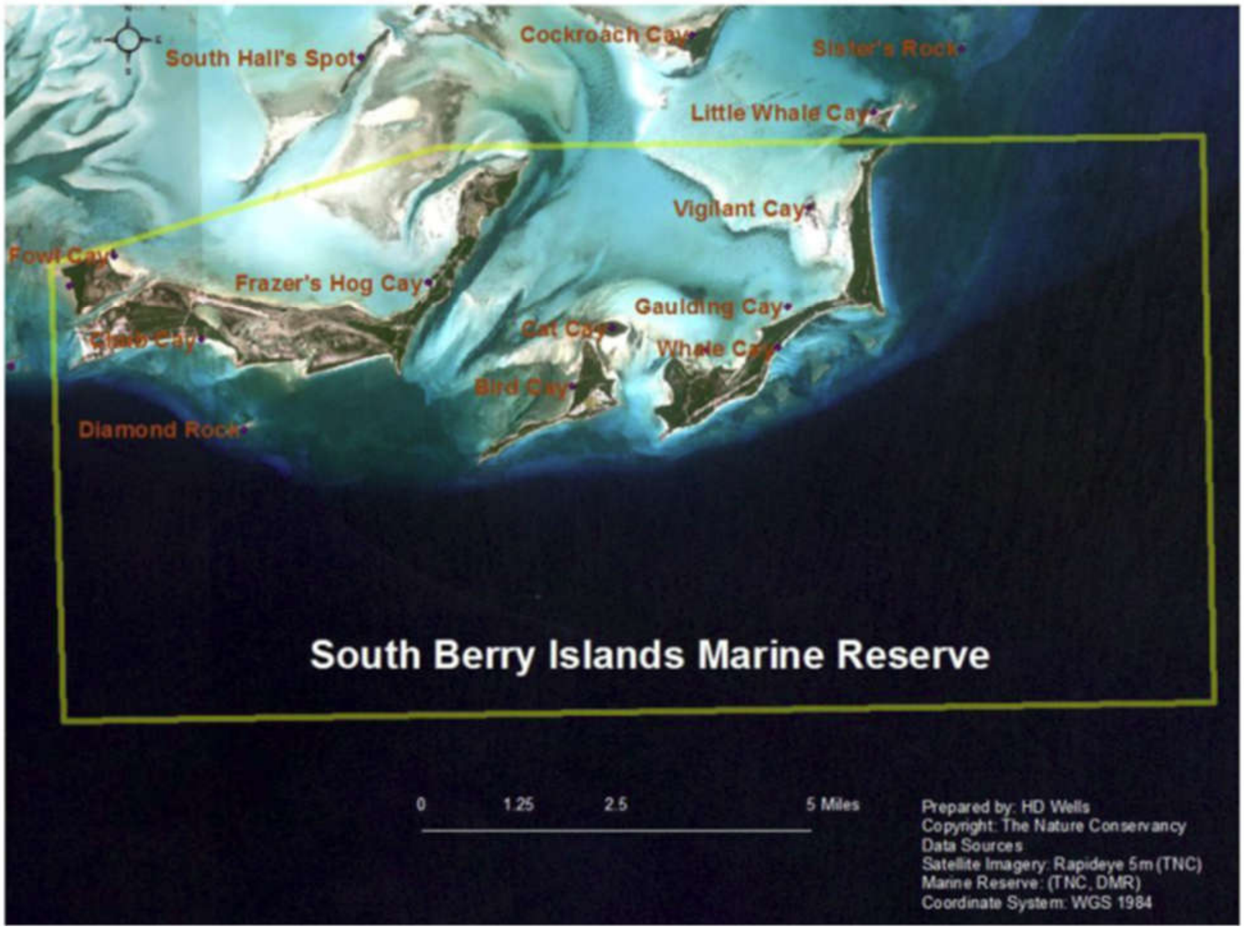
The development will be limited to GSC's northern submerged habitats, ironshore, and upland/terrestrial areas. The only adjacent community is Great Harbour Cay with a population of a few hundred residents and an epicenter located approximately 5.5 miles to the south-southeast of GSC. The privately owned island Cistern Cay lies south of GSC just west of Great Harbour Cay. To the west is Coco Cay, another privately owned island and destination for cruise passengers with no permanent residents or communities. **Figure 11** shows the proximity of GSC to its nearby islands.

Figure 11: Proximity of nearby islands to GSC

2.4.2 National and Local Parks, Protected Areas and Marine Reserves

There are no formally established natural parks, protected areas, or marine reserves currently located on or immediately adjacent to GSC. The nearest area of interest is the South Berry Island Marine Reserve (SBIMR) approximately 43 km (27 miles) south-southeast of GSC, which includes the waters of the South Berry Islands surrounding Crab Cay, Chub Cay, Bird Cay, Cat Cay, Vigilant Cay, Diamond Rock, Frazer's Hog Cay, and Whale Cay.

The SBIMR was declared by the Government of The Bahamas on December 29th, 2008 (Homer, 2009). The Reserve was declared under Section 13 of the Fisheries Resources and Jurisdiction Act and is managed by the Department of Marine Resources under the Ministry of Agriculture and Marine Resources. **Figure 12** shows the approximate location of the SBIMR.



Prepared by: HD Wells
Copyright: The Nature Conservancy
Data Sources
Satellite Imagery: Rapideye 5m (TNC)
Marine Reserve: (TNC, DMR)
Coordinate System: WGS 1984

Figure 12: South Berry Islands Marine Reserve location

2.4.2.1 Marine Protection Plan

The Bahamas Protected project (a collaborative effort between The Nature Conservancy, Bahamas National Trust & Bahamas Reef Environment Educational Foundation) submitted their Marine Protection

Plan for expanding The Bahamas Marine Protected Areas Network to the Government of The Bahamas. BPAF is committed to the aims of the Project. These are:

1. Design new set of MPAs so that Bahamas has at least 20% of its marine habitat protected by 2020.
2. Increase the effective management of PAs within the MPA Network.
3. Increase sustainable funding dedicated to PA management.
4. Strengthen public awareness and support for MPAs.

The two areas under consideration for the Berry Islands are as follows:

West Berry Islands Marine Managed Area

This proposed West Berry Islands site is located west of the northern Berry Island chain, stretching 12 miles south offshore of Goat Cay to include shallow bank and deep-water habitats. The area is a popular fishing ground that is used by commercial fishers from New Providence, Spanish Wells, and other Bahamian islands.

Protected status would facilitate effective management to an area that is abused by illegal fishing activities, including fishing with compressors during the summer months, harvesting of juvenile conch, poaching by foreign vessels, uncontrolled use of jet skis, and anchoring in sensitive areas.

Kemps Cay and Pigeon Cay

The proposed protected area is about 4 miles south of Great Harbour Cay, extending from Kemp Cay in the north to Pigeon Cay in the south. The cays are uninhabited and show no evidence of previous human settlement. The tidal flats are of economic importance to the local community and are frequently used by local fishers and recreational anglers. The aquatic habitats support economically important fishery species, including bonefish, queen conch, lemon sharks, barracuda, permit, jacks, snappers and more. The recreational fishery in the Bahamas is worth over $141 million annually, and the bonefish is a particularly important sportfish species. Endangered green and loggerhead sea turtles also frequent the Berry Islands.

2.5 Construction Methods and Equipment

2.5.1 Dredging

Capital dredging is proposed to create adequate water depths to accommodate the cruise vessels to a depth of no less than -34.0 ft (-10.4 m), MLLW. Due to the geology of the site, dredging will likely be completed by a cutterhead suction dredge (**Figure 13**) with either a 30 or 36-inch diameter cutterhead.
Cutter suction dredges are generally used for dredging harder materials and pumping short distances. The dredge will set up at the northernmost edge of the dredge field and work south towards the shore. From the cruise harbour, dredged material will be pumped as a slurry through high-density polyethylene (HDPE) pipes that will be sized to match the cutterhead discharge. Pipes will be routed from the cutterhead and primarily along existing roadways and disturbed areas to the first of three confined upland disposal areas (settling ponds) on the south side of the island (**Figure 7**). The contractor will take periodic soundings to verify that the design depths have been met. At the conclusion of the dredge, the contractor will submit a complete bathymetric survey of the dredged areas and surrounding waters. A detailed dredge

operations plan will be developed in conjunction with the EMP upon selection of a contractor and final plans.

The settling ponds will be constructed using native soils from within the pond areas. The perimeter berms will be built with a 2 horizontal to 1 vertical slope on the interior wet side and a 3 horizontal to 1 vertical on the outside. The berms will be tamped using mechanical compaction equipment. Weir pipes will connect the ponds; the inlets will be two feet below the top of the berms to achieve maximum settlement in each pond by providing deep pools for particulates to settle. The heaviest particles will primarily settle within the first pond allowing excavation equipment to remove and stockpile the dredge spoils for reuse in the eastern pier backfill. The second and third ponds are successively larger ponds to allow greater settling area for the finer particles. The final pond discharge will have a double silt boom surround with one boom at 50 feet and second at 75 feet from discharge. Constant turbidity monitoring will be done to ensure turbidity levels do not exceed allowable limits.

Figure 13. Illustration of cutter suction dredge

2.5.2 *Pier Construction*

Construction of the piers will be subsequent to completion of dredging operations and contingent to the methods decided upon the design-build process. The West Pier will likely be done utilizing top-down construction. With this methodology, the construction crane and other equipment will be supported by the pier structure itself while it is under construction (Clark, 2011). The procedure typically involves commencing at the landward-most pile bent and working seaward. Each pile is driven into the seabed and a pile cap is placed to cover the full pile bent. The connecting beams are placed and linked to the pile caps, and this procedure continues until the full length of the pier is constructed.

The initial pile-supported 202 ft of the East Pier will be constructed in the same top-down manner as above. A modified version of the top-down method will likely be used for the remaining earth-filled 1,198 ft. The placement of steel sheet and pipe piles will be placed in stages. A small frame of piles will be driven by an upland crane with temporary sheet piles being used for the northern face. The frame will be cofferdammed, filled and compacted within, and a concrete slab will be placed at the end as part of the permanent structure. Another small frame will be created immediately after to the north with permanent sheet piles on the northern face. Fill will be brought in and compacted, and the previous temporary sheet piles will be removed to create a singular frame. Another concrete slab will be placed over the remaining fill area, and this process will continue until the end of the pier is reached at 1,500 ft.

2.6 Proposed Operations and Maintenance

Maintenance dredging is not anticipated to regularly occur, as there is limited sediment supply to significantly fill the dredged areas. Nearby ironshore and local hardbottom found throughout the Project site creates minimal layers of sand that lie on the seabed. This is confirmed with the marine borings taken by Ardaman and Associates, Inc. in 2007 where limestone was immediately met at the seabed in 32 ft of water. Due to minimal modifications to the seabed since that time, these conditions are considered to still be prevalent today. Transportation of sand is not anticipated to be voluminous and therefore refrain from filling the proposed dredge.

Additionally, the dredge to -34.0 ft (-10.4 m), MLLW with a maximum over dredge of 2 ft is to take place in two select locations of approximately 315,500 SF near the shoreline and 226,000 SF located 800 ft offshore. Bathymetric surveys show the elevation of the shoreline dredge area is below -10.0 ft (-3.0 m), MLLW, and the offshore dredge area is below -28.0 ft (-8.5 m), MLLW. The proposed dredge is not to be significantly deeper than the surrounding areas, implying that the infill rate should be slow and maintenance dredging is not anticipated to occur within 8-10 years. However, a large storm event can create high flows of sediment transportation, which has the potential to fill the dredged areas at a greater rate.

Routine maintenance of the piers is to be expected. This involves cleaning, removing trash, monitoring the concrete for cracks or rebar exposure, filling concrete voids, replacing fenders, etc. When necessary, infrequent improvements will need to be made including replacing rusted metals such as cleats, light poles, rebar, and bollards, restituting vegetation, and restoring utilities and pipelines such as stormwater, force mains, and water mains to an operational capacity.

3 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

3.1 National Legislation and Regulations

Relevant national government agencies and entities that have governance over or interest in this EIA include, but are not limited to:

- Ministry of Environment and Housing
    - Department of Environmental Protection and Planning (DEPP), formerly Bahamas Environment, Science and Technology (BEST) Commission
- Bahamas Investment Authority
- Ministry of Tourism
- Department of Physical Planning
- Ministry of Works
- Port Department
- Berry Islands Department of Labour

Additionally, a series of laws and regulations have been accepted in The Bahamas which may affect activities occurring within the coastal zone, and include the following:

Ministry of Environment Bill (2019)

This Bill established the Ministry of the Environment which functions to maintain the "integrity of the environment of the Bahamas" by protecting and conserving all land, water, air, and living resources. As these resources will be altered and affected with the construction of groins and breakwaters and with beach nourishment, the Ministry of the Environment will be invested in the project.

Environmental Planning and Protection Act, 2019 (No. 40 of 2019) and the Environmental Impact Assessment Regulations, 2020

This Act established the Department of Environmental Protection and Planning serves to protect the environment of the Bahamas with an integrated environmental management system that provides a legal framework for the sustainable management, protection, conservation, development, and enjoyment of the people. The *Environmental Impact Assessment Regulations, 2020* of the *Environmental Planning Act of 2019* were created by the Minister and provides procedures for proposed project for which any project proponent must follow. The regulations state that a Project cannot commence or proceed without the granting of a Certificate of Environmental Clearance which shall specify any environmental conditions and terms of compliance.

Environmental Protection (Control of Plastic Pollution) Bill (2019)

This Bill sets forth laws relating to the use of plastics including: 1) prohibiting single use plastic food ware; 2) prohibiting non-biodegradable, oxo-biodegradable, and biodegradable single use plastic bags; 3) prohibiting the release of balloons; and 4) regulating the use of compostable single use plastic bags. During construction, personnel on the island will need to refrain from using the prohibited plastics to prevent degradation to the environment.

Conservation and Protection of the Physical Landscape of the Bahamas Act (1997)
This Act provides for the regulation of the physical landscape, including but not limited to the filling up of lands and wetlands, any excavation that may affect the coastline, and the digging up or removal of sand from beaches and dunes. The Project involves the removal and transportation of sand from one beach to another to fill in the shoreline, which will be regulated by this Act.

National Invasive Species Strategy for The Bahamas, 2013
The goal of the Strategy is the protection of environment, genetic diversity of flora and fauna, as well as of ecosystem services, through the prevention of introduction as well as management and eradication of invasive species.

Environmental Health Services Act (1987)
This Act sets forth provisions to regulate both public health and environmental health through preventing pollution, managing wastes, maintaining general sanitation, training personnel, and several other measures. All construction personnel working on the island will need to follow the protocols and regulations provided in this Act.

Wild Birds Protection Act (1987)
This Act protects wild birds by prohibiting the killing, capturing, or possession of specified wild birds. The Act specifically prohibits the kill or capture of the White Crowned Pigeon at any time of the year, which construction personnel may encounter on the island.

Coast Protection Act (1968)
This Act makes a provision for the protection of the coast relative to erosion and encroachment by the sea. This will need to be considered when establishing erosion controls and protection measures to prevent erosion and ensure compliance with this Act.

Port Authorities Act (2006)
This Act sets forth provisions to appoint port authorities to all ports and harbours of the Bahamas to better regulate and control port operations.

Marine Mammal Protection Act (2005)
This Act sets forth provisions to protect marine mammals, including prohibiting import of marine mammals and prohibiting the taking, harassing, etc. of marine mammals, among other guidelines. As construction will occur in the water where marine mammals may be found, construction personnel will need to follow all protocols regarding marine mammal protection.

3.2 Regional and International Treaties and Conventions

The Bahamas is a signatory to several international environmental agreements that either affect or may affect the management of the coastal resources of The Bahamas. For example, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (The Cartagena Convention, 1986), coordinated by United Nations Environment Programme (UNEP), includes three protocols: the Oil Spill Protocol, the Specially Protected Areas and Wildlife (SPAW) Protocol, and the Land Based Sources of Marine Pollution (LBSMP) Protocol. The SPAW Protocol (2000) calls for the protection, management, and development of marine and coastal resources individually and jointly among countries. Although the Bahamas is not a party to the Protocol, several other Caribbean countries have entered into these agreements and their actions may have impacts on the coastal zone of The Bahamas. Additionally, noise pollution standards of the World Bank and World Health Organization will be met. Also, the United Nations Convention on the Laws of the Sea should apply during construction and operations to protect the marine waters of the Bahamas.

The Ramsar Convention

The Bahamas is a signatory to the Convention on Wetlands of International Importance, also known as the Ramsar Convention. This convention provides a framework for the international protection of wetlands as contributors for human resources and, moreover, for avifauna which do not adhere to international boundaries. Ramsar defines wetlands as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters” (Ramsar Convention Secretariat, 2016).

The Convention on Biological Diversity

The Bahamas is a signatory to the Convention on Biological Diversity which came into force December 1993. It has three main goals:

- The conservation of biological diversity
- The sustainable use of components of biological diversity
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources

3.3 Environmental Impact Assessment Process

In accordance with EIA Regulations, 2020, the project proponent shall make application to carry out any proposed project. As per the regulations, if the DEPP Director determines that an EIA or EMP is required, the Director shall advise the project proponent of the process to be followed for the preparation of an EIA or EMP, including a pre-feasibility study, securing of a performance bond, provide detailed information for a consultative process, submit an electronic and hard copy of an EIA or EMP, and issue public notices in general circulation in The Bahamas on the project to include specific information as directed by the Director. Due to the nature of this Project and anticiated impacts, this EIA will accompany the application with development of an EMP to be provided anon.

3.3.1 Scoping

Scoping is one of the initial steps early on in the EIA process, and helps establish what will be included in the terms of reference (TOR) and helps define the boundaries of the EIA. Both the TOR and the required application process will help identify the key environmental issues to ensure only studies and assessments are focused on specific environmental impacts. Scoping helps determine what is relevant, and thus can serve to minimize unnecessary and exhaustive information gathering in areas that are not anticipated to be impacted.

3.3.2 Consultation

As per the EIA Regulations, 2020 the DEPP shall give notice to the public and stakeholders that a consultative process shall be conducted by the project proponent. The mode and procedure of the consultative process shall be determined by DEPP but shall be done to make sure there are opportunities for stakeholders to comment on the proposed project. Public consultation is required as part of the EIA process and required to receive a Certificate of Environmental Compliance from DEPP.

4 BASELINE ENVIRONMENTAL AND SOCIOECONOMIC CONDITIONS

4.1 Climate and Meteorology

The climate in Bahamas is typically tropical marine, moderated by warm waters of the Gulf Stream.

4.1.1 Temperature and Precipitation

The mean daily maximum temperature during January in the Berry Islands is 26°C (79°F) with the average minimum 18°C (64°F), while in September the average maximum is 31°C (88°F) with a minimum of 24°C (75°F). The average precipitation in GSC peaks in the late summer (September) with ~75 mm. The driest months are December through April with precipitation of less than ~25 mm per month.

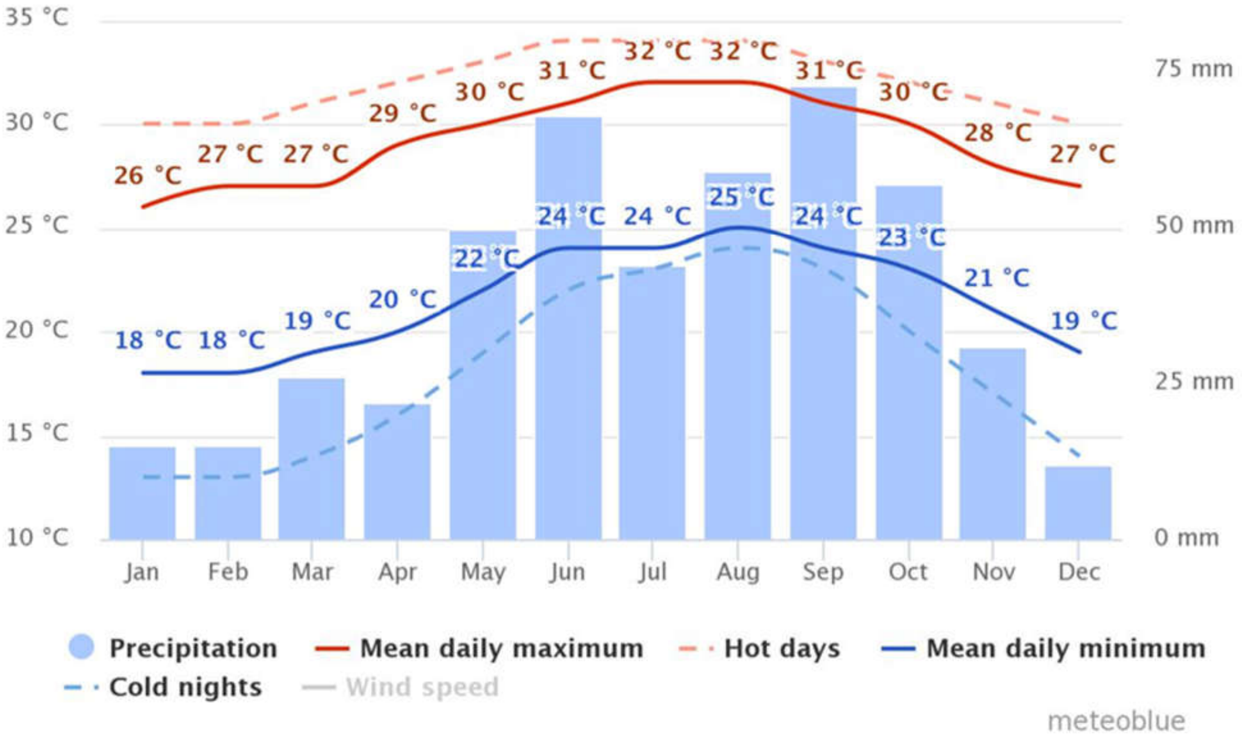


Figure 14: Average monthly temperatures and precipitation in the Berry Islands

4.1.2 Sea Surface Temperatures

The coldest sea surface temperatures in the Berry Islands occur during February with temperatures varying between 23°C (73°F) and 24°C (75°F). The warmest temperatures occur during August, varying between 29°C (85°F) and 30°C (86°F). This indicates sea surface temperatures have little change throughout the calendar year ranging 7°C (13°F). **Table 1** gives the temperature range by month for the Berry Islands.

Table 1: Sea surface temperatures at GSC

Month	Temperature (°F)	Temperature (°C)
January	73-76	23-24
February	73-75	23-24
March	74-76	23-24
April	76-79	24-26
May	78-82	26-28
June	81-84	27-29
July	83-86	28-30
August	85-86	29-30
September	84-86	29-30
October	80-84	27-29
November	77-80	25-27
December	75-78	24-26

4.1.3 Winds

An analysis of the wind climate was conducted to understand the magnitude, direction, and any seasonal trends relating to the wind climate. Offshore wind data provided by NOAA during the period of January 1979 to December 2009 was extracted at grid point latitude 26 0’N and longitude 78 0’W, located approximately 20 kilometers north of the Project site. Specifically, the data is from NCEP Climate Forecast System Reanalysis and Reforecast (CFSRR) dataset, which was validated using archived wind observations. The acquired data from the hindcast includes a time series of approximately 31 years of wind information at 3-hour intervals. A statistical analysis was conducted and percentage occurrences for various directions and wind speeds are summarized in **(Figure 15)** as a wind rose. A wind rose is a bar plot with angles representing the directions, bar length representing the percentage occurrences to scale, and the colors representing the magnitude (i.e. wind speeds).

Based on the statistical analysis and developed wind rose winds are predominantly from the east and southeast with some seasonal variation. The wind speed is less than 10 knots 45% of the time, and the wind speed is below 20 knots 94% of the time. The seasonal changes in wind speed and direction were evaluated. One of the trends observed is the winds in the winter months are stronger than those in the summer, with the exception of hurricane events. Additionally, the winds in the winter months not only include easterly winds, but also northern and northwesterly winds with relatively high magnitudes. The northeasterly and northern winds are typically associated with winter fronts approaching from the west and are typically accompanied with inclement weather.

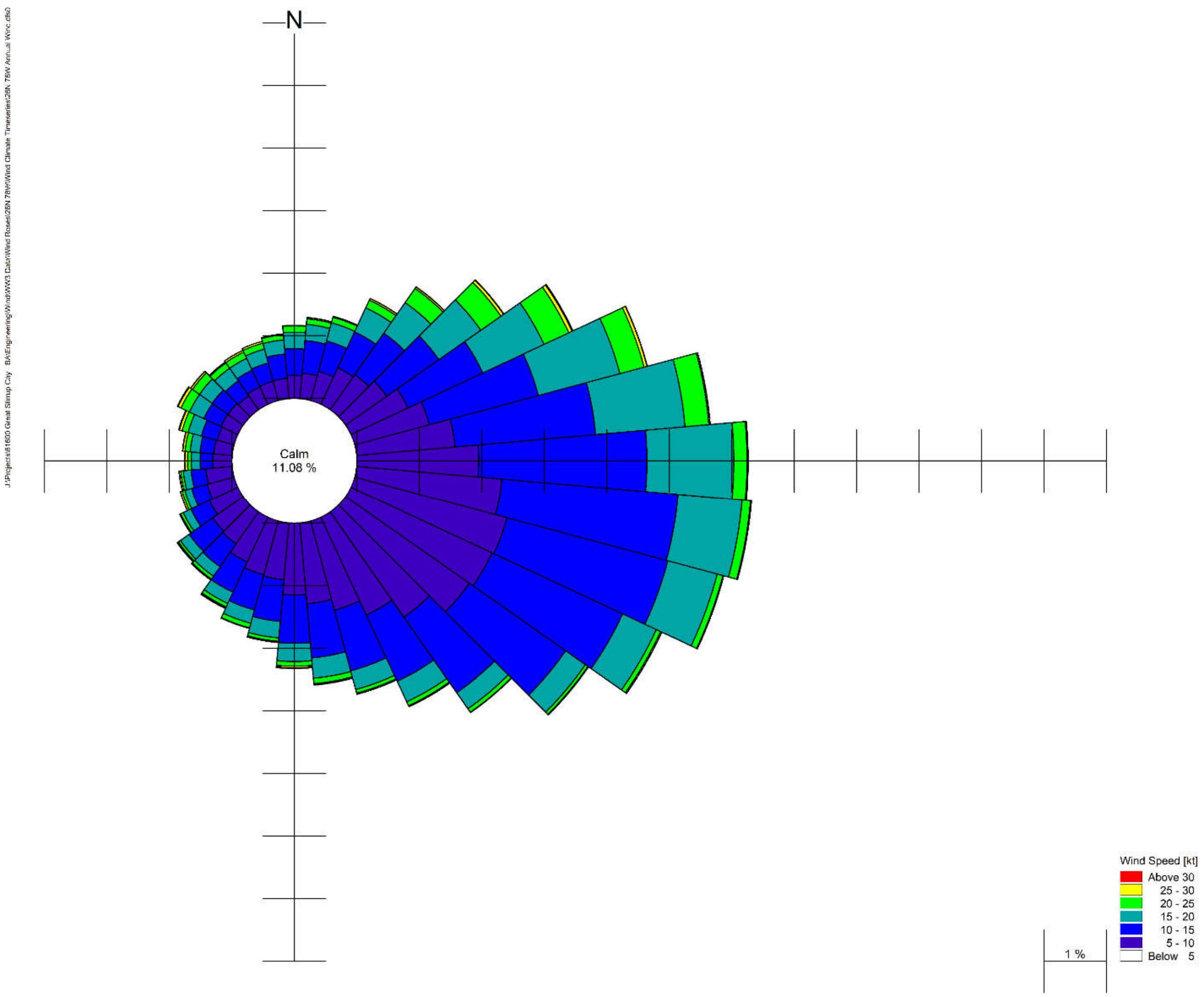


Figure 15: Annual wind rose plot for Great Stirrup Cay from 1979-2009

4.1.4 Hurricanes

A hurricane is defined as a severe tropical, cyclonic storm with sustained wind speeds above 64 knots (33 m/s). Hurricanes impact coastal areas with elevated water levels (storm surge) and large storm waves, which propagate and break further inshore due to the elevated water levels. In the Northern Hemisphere, hurricanes typically develop north of the equator in the tropical and subtropical latitudes of the Atlantic Ocean. Characteristics of hurricanes include low barometric pressure, high wind speeds, heavy rainfall, large waves, and storm surges. The Project site is located in an active hurricane zone and therefore the design of shoreline structures and marine facilities should consider the potential for hurricane impacts.

The hurricane season for the Project vicinity generally lasts from June through October, although hurricanes outside this period have occurred. Hurricanes forming in the months of June and July are typically spawned on the western side of the Atlantic Ocean, in the lower latitudes, and in the western Caribbean. These hurricanes are typically weaker and seldom present any significant threat to the coastal areas of The Bahamas. Hurricanes occurring in August and September usually form in the Atlantic Ocean and often develop into mature, severe storms. Their paths are generally unpredictable and can range from due westward to a gradual curvature northward, thereby impacting the Caribbean Islands and U.S. coastal states ranging from Texas to Maine. Storms that occur in late September through November are mainly formed in the western Caribbean Sea and the Gulf of Mexico.

As a result of the difficulty in relating the different characteristics of hurricanes to the destruction they provoke, the Saffir-Simpson Scale was formed in 1972 and introduced to the public in 1975 (Doehring, et. al., 1994). This scale, shown in **Table 2**, has been used to estimate the relative damage potential of a hurricane due to wind and storm surge. The Saffir-Simpson Scale classifies a hurricane as a category 1, 2, 3, 4, or 5, depending upon wind speeds. Wind velocities are 1-minute averages.

Table 2: Classification of hurricanes by Saffir-Simpson Scale

Meteorological Characteristics					
Category	**Wind Speed**		**Pressure**	**Storm Surge**	**Damage**
	[knots]	**[m/s]**	**[millibars]**	**Elevation* [m]**	
1	64 - 83	33 - 43	> 980	1 – 1.5	**Minimal**
2	84 - 95	44 - 49	965 - 979	1.5 – 2.4	**Moderate**
3	96 - 113	50 - 58	945 - 964	2.4 – 3.7	**Extensive**
4	114 - 135	59 - 70	920 - 944	3.7 – 5.5	**Extreme**
5	> 135	> 70	< 920	> 5.5	**Catastrophic**

* Elevation difference from sea level for larger coastal land masses

Category	Damage Characteristics
One	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
Two	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
Three	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
Four	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
Five	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Hurricanes bring: 1) high winds with flying debris, 2) torrential rainfall with flooding, 3) ocean wave battering to coastlines and near shore areas, 4) high energy ocean waves causing seafloor damage, and 5) storm surge flooding. In addition, damaging after-effects include continuing rainfall plus many disruptions to living and operating conditions.

4.1.4.1 Great Stirrup Cay Historic Hurricanes

In 1933, Great Stirrup Cay suffered a direct hit from a Category 4 hurricane known as the Treasure Coast hurricane. In 2016, Hurricane Matthew and in 1992 Hurricane Matthew, both Category 4 hurricanes, passed approximately 25 miles west of GSC, resulting in storm surge and waves affecting the Project site. However, apart from anecdotal information, specific historical wave and storm surge observations from these and other events in the vicinity of the Project site are limited. This is generally the case on smaller remote islands, as staff and residents often evacuate due to the extreme conditions providing limited empirical data. Therefore, a detailed hurricane study was conducted to evaluate the potential risk and severity of hurricane impacts, as well as provide the design conditions for the engineering of the various coastal elements and subsequent flood mapping.

To further understand historical trends and impacts of hurricanes to GSC, the National Hurricane Center's (NHC) Atlantic Hurricane Database (HURDAT2) was utilized by Cummins Cederberg as part of a coastal engineering analysis to prepare a flood map and identify areas of vulnerability (Landsea & Franklin, 2020). The HURDAT2 records indicated that 56 hurricanes passed within a 100-mile radius of the GSC from year to year.

Analysis of these storm paths revealed three general approaches of storms, namely from the southwest, southeast, and east directions. The historic storms were further used to statistically identify maximum sustained wind speeds, radius of maximum winds, duration and speed of a storm, and pressure of a storm, all to be utilized in developing and simulating theoretical hurricanes.

4.1.4.2 Simulated Hurricanes

Ten of the 56 historical hurricanes were simulated using the couple model mentioned, as seen in **Table 3**. These ten historical hurricanes were chosen as a representation of approach directions and intensity. The assortment of simulated hurricanes provides information on how past storms impacted the Project site under varying circumstances.

Table 3: Historic hurricanes for GSC

Hurricane	Category	Wind Speed	Direction
Matthew (2016)	4	138 mph	Southeast to Northwest
Frances (2004)	2	98 mph	Southeast to Northwest
Andrew (1992)	4	150 mph	East to West
Unnamed (1939)	1	75 mph	Southeast to Northwest
Unnamed #1 (Aug 1933)	4	133 mph	Southeast to Northwest
Unnamed #2 (Oct 1933)	3	121 mph	Southwest to Northeast
Unnamed (1908)	2	110 mph	South to Northeast
Unnamed (1903)	1	86 mph	Southeast to Northwest
Unnamed (1899)	3	121 mph	Southeast to Northwest
Unnamed (1893)	3	121 mph	East to Northeast

Six theoretical hurricane paths were created and simulated to understand the sensitivity of storm directionality to Great Stirrup Cay, as seen in **Table 4.** The directions include hurricanes approaching from the southwest of the Project and passing on the east and west side of the island, hurricanes approaching from the southeast of the Project and passing on the east and west side of the island, and hurricanes approaching from the east of the Project and passing on the north and south of the island. These approach directions were identified to represent the various types of hurricanes impacting the island based on the study of the HURDAT2 data. All simulations were conducted under 100-year return period statistical conditions for all directions and the results utilized to identify the 2 worst case of the six directions.

Table 4: 100-year design hurricanes for GSC

Component	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6
Wind Speed	190 kts	190 kts	135 kts	135 kts	126 kts	126 kts
Pressure	925 hPa	925 hPa	926 hPa	926 hPa	925 hPa	925 hPa
Radius of Maximum Wind Speed	40.26 km	38.52 km	32.43 km	32.36 km	35.18 km	34.48 km
Forward Speed	10 mph	10 mph	10 mph	10 mph	10 mph	10mph
Approach Angle	Southwest to Northeast	Southwest to Northeast	Southeast to Northwest	Southeast to Northwest	East to West	East to West

4.1.4.3 Storm Surge

Storm surge is the abnormal rise in sea level accompanying a hurricane or any other intense storm. This water level rise is caused by the continued action of wind, decreased atmospheric pressure, and breaking waves. Storm surges impact coastal areas by allowing storm waves to propagate further inshore, thus impacting coastal upland areas otherwise not exposed to coastal conditions. The storm surge associated with a given hurricane is related to several important hurricane parameters including the central pressure, the maximum wind speed, the forward speed, and the hurricane's route. Surge heights also vary with rainfall, tidal elevation, shoreline configuration, and bottom topography.

4.1.4.3.1 Historic Storm Surge

Specific data relating to storm surge Hurricane impacts at Great Stirrup Cay is not available. However, storm events at other locations within The Bahamas can be analyzed and provide insight as to potential storm surge for the Project site. Hurricanes Dorian, Matthew, and Frances were major hurricanes that traveled within 100 miles (161 km) of the project site and brought strong winds and high surges to The Bahamas.

Hurricane Dorian traveled approximately 75 miles (121 km) northeast of Great Stirrup Cay in the west direction over Elbow Cay, Great Abaco on September 1, 2019 at approximately 4:00 PM. The storm at this time registered as a category 5 hurricane with wind speeds maximizing at 184 mph (160 knots) and is the strongest hurricane in modern records to ever hit The Bahamas (Avila, Stewart, Berg, & Hagen, 2020). Water level gauges were not available east of Elbow Cay, but eyewitnesses approximate the storm surge reached 20 ft of inundation in some areas. At the western end of Grand Bahama Island, water level gauges measured the water to reach a peak of 6.4 ft above Mean Higher High Water (MHHW), suggesting that 6-7 ft of inundation was likely at the western end of the island. With the Project site being approximately 70 miles (113 km) southeast of the Grand Bahama water level gauge, this indicates that storm surge was probably similar but slightly lower than what was measured. Storm surges of around 5-6 feet likely inundated the northern portion of Great Stirrup Cay.

Hurricane Matthew traveled approximately 24 miles (38 km) southwest of Great Stirrup Cay in the northwest direction on October 6, 2016 at approximately 6:00 PM. The storm at this time registered as a category 4 hurricane with wind speeds maximizing at 138 mph (120 knots). Storm surge was measured on the southern coast of nearby New Providence Island and Grand Bahama Island as the storm passed to the west on October 6 at approximately 1:00 PM and 10:00 PM, respectively. Both islands experienced up to 8 ft of inundation on the southern coasts (Stewart, 2017). The close proximity to Great Stirrup Cay and similar distance to the center of Hurricane Matthew provides reasonable assurance that this level of inundation can be assumed to have occurred on the southern shoreline of GSC.

Hurricane Frances traveled approximately 27 miles (43 km) northeast of Great Stirrup Cay in the northwest direction on September 4, 2004 at approximately midnight. The storm at this time registered as a category 2 hurricane with wind speeds maximizing at 98 mph (85 knots). The storm continued northwest and made landfall at approximately 6:00 AM on September 5 near Stuart, Florida as a category 2 storm with windspeeds of 104 mph (90 knots). At the time of this hurricane, storm surge measurements were not available in the northern Bahamian islands. However, because the storm had approximately the same strength when it made landfall over Florida, similar conditions can be expected to have occurred at the Project site. The highest measured storm surge was measured just north of the eye in Port St. Lucie, Florida at 5.9 ft above Mean Sea Level (MSL). Additional storm surges were estimated north of Hurricane Frances in Vero Beach, Florida and Cocoa Beach, Florida at 8 ft and 6 ft, respectively (Beven II, 2005). Because Great Stirrup Cay was south of the hurricane where winds blow east towards the Atlantic Ocean rather than west from the Ocean, less storm surge is expected to impact the island. Therefore, it can be approximated that 4-5 ft of storm surge inundated the northern coast of GSC.

4.1.4.3.2 Simulated Storm Surge

The various hurricanes outlined in **Table 3** and **Table 4** were subsequently modeled and the associated storm surge analyzed. For the 13 theoretical hurricanes (i.e. six initial 100-year storms, 25, 50, 100, and 500-year storms for two worse case directions), the hurricane-generated wave fields and water levels were analyzed over the entire island as well as at selected points.

As previously mentioned, the two worst case scenario theoretical paths were investigated for 25-year, 50-year, 100-year, and 500-year return period design storms. The results of the model simulations presented in **Table 5** indicate the highest storm surge levels are experienced with easterly or south easterly hurricanes traveling north or east of the island. For the storm surge elevations on the northern side, an increase in the extreme water level should be added due to the effect of wave setup, which was observed to not be fully resolved in the model simulations for this Project site. A simulation of Hurricane Dorian with the track adjusted to travel over GSC appears to result in impacts close to a 500-year event relative to storm surge.

Table 5: Simulated storm surge at GSC

Storm Direction	**Storm Surge Elevation by GSC Region [m (ft), NAVD]**						
	Northwest	**North**	**Northeast**	**East**	**Southeast**	**South**	**Southwest**
25 Year **SE – East**	1.62 m (5.31 ft)	1.63 m (5.35 ft)	1.64 m (5.38 ft)	1.53 m (5.02 ft)	1.55 m (5.08 ft)	1.58 m (5.18 ft)	1.63 m (5.35 ft)
25 Year **E – North**	1.38 m (4.53 ft)	1.35 m (4.43 ft)	1.24 m (4.07 ft)	1.21 m (3.97 ft)	1.31 m (4.30 ft)	1.34 m (4.40 ft)	1.38 m (4.53 ft)
50 Year **SE – East**	1.73 m (5.68 ft)	1.74 m (5.71 ft)	1.76 m (5.77 ft)	1.63 m (5.35 ft)	1.67 m (5.48 ft)	1.69 m (5.54 ft)	1.75 m (5.74 ft)
50 Year **E – North**	1.63 m (5.35 ft)	1.58 m (5.18 ft)	1.34 m (4.40 ft)	1.36 m (4.46 ft)	1.57 m (5.15 ft)	1.63 m (5.35 ft)	1.67 m (5.48 ft)
100 Year **SW – West**	1.38 m (4.53 ft)	1.32 m (4.33 ft)	1.20 m (3.94 ft)	1.27 m (4.17 ft)	1.44 m (4.72 ft)	1.49 m (4.89 ft)	1.50 m (4.92 ft)
100 Year **SW – East**	1.43 m (4.69 ft)	1.45 m (4.76 ft)	1.48 m (4.85 ft)	1.43 m (4.69 ft)	1.34 m (4.40 ft)	1.30 m (4.26 ft)	1.31 m (4.30 ft)
100 Year **SE – West**	1.51 m (4.95 ft)	1.50 m (4.92 ft)	1.54 m (5.05 ft)	1.62 m (5.31 ft)	1.70 m (5.58 ft)	1.74 m (5.71 ft)	1.77 m (5.81 ft)
100 Year **SE – East**	**1.82 m** **(5.97 ft)**	**1.84 m** **(6.04 ft)**	**1.84 m** **(6.04 ft)**	**1.72 m** **(5.64 ft)**	**1.78 m** **(5.84 ft)**	1.80 m (5.90 ft)	1.85 m (6.07 ft)
100 Year **E – South**	1.56 m (5.12 ft)	1.59 m (5.22 ft)	1.66 m (5.45 ft)	1.63 m (5.35 ft)	1.54 m (5.05 ft)	1.52 m (4.99 ft)	1.48 m (4.85 ft)
100 Year **E – North**	1.78 m (5.84 ft)	1.74 m (5.71 ft)	1.45 m (4.76 ft)	1.48 m (4.85 ft)	1.77 m (5.81 ft)	**1.85 m** **(6.07 ft)**	**1.89 m** **(6.20 ft)**
500 Year **SE – East**	2.01 m (6.59 ft)	2.03 m (6.66 ft)	2.04 m (6.69 ft)	1.90 m (6.23 ft)	2.01 m (6.59 ft)	2.05 m (6.72 ft)	2.09 m (6.86 ft)
500 Year **E – North**	2.05 m (6.72 ft)	2.00 m (6.56 ft)	1.69 m (5.54 ft)	1.73 m (5.68 ft)	**2.23 m** **(7.32 ft)**	**2.33 m** **(7.64 ft)**	**2.34 m** **(7.68 ft)**
Modified **"Dorian"** **SE – E**	**2.25 m** **(7.38 ft)**	**2.20 m** **(7.22 ft)**	**2.16 m** **(7.09 ft)**	**1.98 m** **(6.50 ft)**	2.18 m (7.15 ft)	2.25 m (7.38 ft)	2.28 m (7.48 ft)

4.2 Coastal Processes

Great Stirrup Cay is exposed to coastal processes through waves, tidal hydrodynamics, and sediment transport during both normal and extreme conditions such as hurricanes. A detailed coastal engineering study was conducted by Cummins Cederberg, and the following section provides a summary of the coastal processes that dominate Great Stirrup Cay based on the study.

4.2.1 Tides

Tides in the Project vicinity are predominately semi-diurnal with a mean tide range of approximately 0.8 m (2.7 ft) and a period of approximately 12.4 hours. Tidal data was obtained from National Oceanographic Atmospheric Administration (NOAA) Station 9710441 at Settlement Point at Grand Bahamas Island (**Table 6**). As illustrated by **Figure 16**, there is a great variability in the tidal range on both a monthly and annual basis with a range from 0.9 m (3.0 feet) to 1.2 m (4.0 feet).

Table 6: Tidal water levels, Settlement Point, station 9710441

Water Level	Elevation (m, MLLW)	Elevation (feet, MLLW)
Mean Higher-High Water	0.93	3.07
Mean High Water	0.86	2.83
Mean Sea Level	0.45	1.47
Mean Low Water	0.03	0.09
Mean Lower-Low Water	0.00	0.00

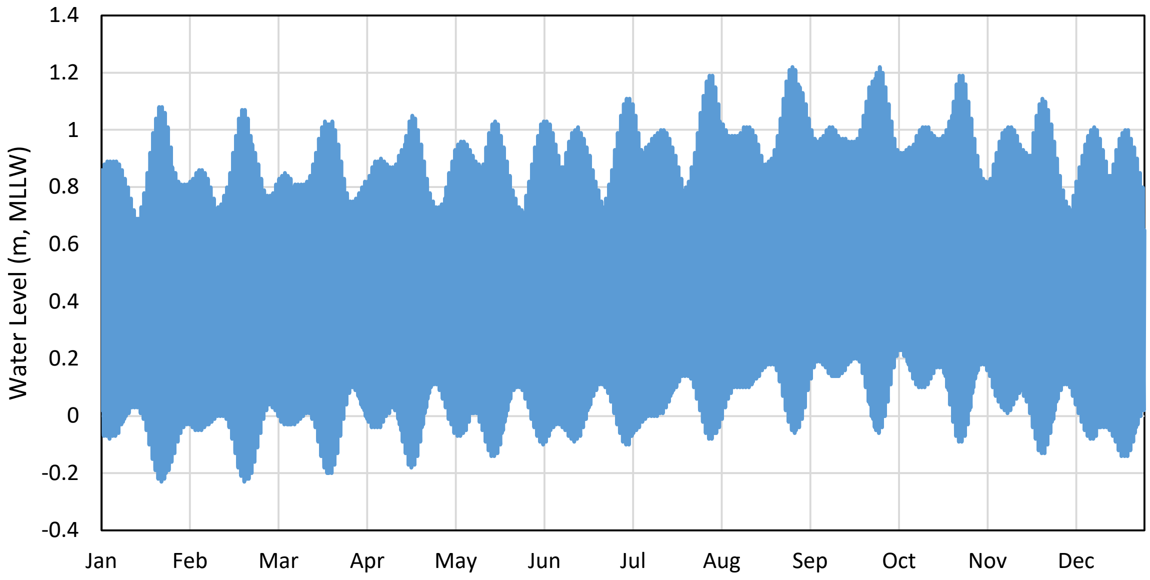


Figure 16: 2019 annual predicted tides at NOAA station 9710441, Settlement Point, The Bahamas

4.2.2 Waves

Great Stirrup Cay is exposed to both local wind-generated waves and long period swells developing over the Atlantic Ocean; however, each type of wave impacts different sides of the island. The southern portion is exposed primarily to the locally generated wind waves. The northern shoreline and location of the proposed piers is exposed to both local wind-generated waves and long period swells developing over the Atlantic Ocean.

Understanding the wave climate is a crucial component in the design and construction of a potential pier. The incoming waves must be considered when evaluating the orientation of the pier in relation to the internal wave agitation in the basin and the approach of the vessel towards the berth.

An analysis of the wave climate was conducted to understand the magnitude, direction, and any seasonal trends relating to the wave climate. Offshore wave data provided by NOAA during the period of January 1979 to December 2009 was extracted at grid point latitude 26°N and longitude 78°W located approximately 13 miles northwest of the Project site. A statistical analysis was conducted and percentage occurrences for various directions and wave heights are summarized in **Figure 17** as a wave rose.

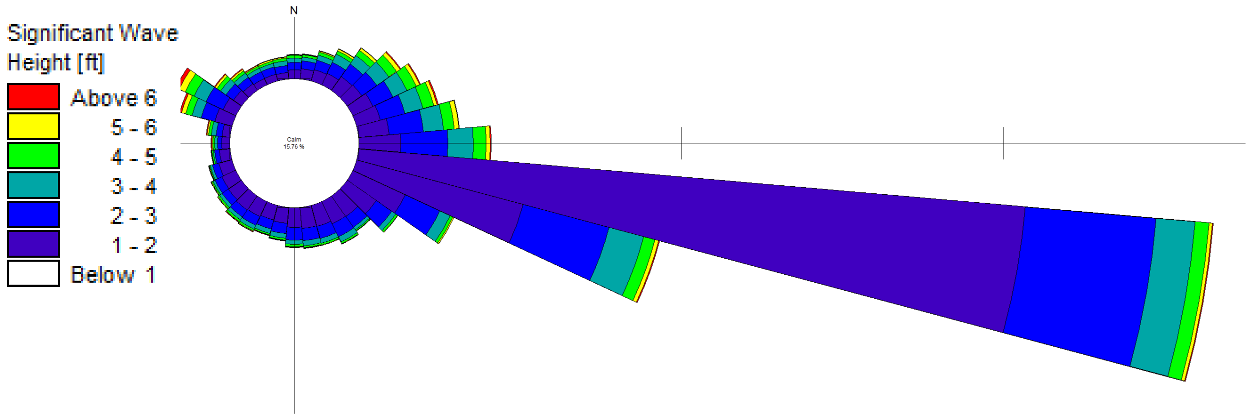


Figure 17: Annual wave rose plot for GSC

Based on the statistical analysis and developed rose plot, waves are predominantly from the southeast with some seasonal variation. The wave heights are less than 2 ft 60% of the time, and less than 3 ft 80% of the time. The waves in the winter months travel from the northwesterly direction which are generally higher in magnitude, while during the summer months the waves are low in magnitude and approach primarily from the southeast.

4.2.3 Currents

An investigation of the currents at the Project Site was conducted (Applied Technology and Management (ATM), 2017) by deploying two acoustic doppler current profilers (ADCPs) over a three-month period (March 8 – May 8, 2017). The ADCPs were installed water depths of approximately 45 ft. Based on the measurements collected at the Project Site, it appeared the current directions and speeds were not affected due to tides but rather driven by larger-scale ocean circulation patterns through the Northwest Providence channel.

In general, during the measurement period the currents appeared to flow in easterly and westerly directions. Since the current directions were not affected by the tides, it was not uncommon to see periods of time during the measurements where the current was traveling in a single direction for more than 4 days. Depth-averaged currents ranged from 0.3 ft per second (0.1 m/s) to 2 ft per second (0.65 m/s).

4.2.4 Sediment Transport

The sediment transport in the vicinity of the Project site was evaluated based on the results of the statistical wave analysis, current measurements, bathymetry, and field observations. Understanding the local sediment transport characteristics is essential when conducting work in the marine environment, such as the proposed pier structure, to ensure there are no adverse effects as a result of any potential changes to the sediment transport mechanisms. The following paragraphs offer a brief description of the general sediment transport mechanics in the coastal zones.

Breaking waves in the surf zone combined with nearshore currents induce sediment transport in the coastal zone. The magnitude and direction of sediment transport is a complex process and depends on many environmental factors such as winds, waves, tides, currents, bathymetry, sedimentology, shoreline configuration, sources of sediment, and manmade coastal structures. The detailed mechanism of sediment movement is subject to extensive research work, and prediction of sediment transport is typically associated with high degrees of uncertainty.

The island’s shorelines have been classified into three types: hard, soft, and vegetated. The shoreline assignment is presented in **Figure 18**. As observed in **Figure 18**, the eastern northern half of the island is characterized by a hard shoreline, specifically an ironshore bluff exposed to relatively large offshore waves. Limited sediment transport occurs in the northeastern half of the island due to the limited sediment supply and deeper water depths.

On the eastern-facing portion of the island, three pocket beaches are observed. Here the sediment transport is primarily wave driven, as the pocket beaches are oriented perpendicular to the predominant incoming wave direction. The southern portion of the island is characterized by a vegetated shoreline. Limited sediment transport occurs in this region due to the presence of high-density seagrass and shallow water depths, which result limited wave energy. The sediment transport in the sandy area in the northern portion of the island is mainly wave-driven. In this location the beaches are anchored by coastal structures (groins and breakwaters), which limit the longshore sediment transport and thus stabilizing the beaches.

Figure 18: GSC shoreline classifications

4.2.5 Sea Level Rise

Sea level rise (SLR) is typically defined as the average long-term global rise in the ocean surface. The long-term rise has been recorded and observed in data collected from tidal gauge stations along Florida's coasts by NOAA. Examples of sea level rise are seen in what is known as "Sunny day flooding" where the flooding is solely due to the contribution of tides. NOAA states there is a high confidence (9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6. feet) by the year 2100. The effects of sea level rise will not only have an impact on normal conditions but also on the extreme conditions experienced at the Project site. An increase in the water level will increase the water depth, which in turn will increase the magnitude of the waves that may impact the Project site during extreme conditions. Thus, when conducting infrastructure development projects, an evaluation of the future SLR should be conducted to ensure future impacts are considered.

4.2.5.1 Sea Level Rise Projections

Many projections for SLR have been published, but no single projection is accepted as the standard to be utilized for future water levels. For the purpose of the present analysis at Great Stirrup Cay, a comparison of 5 published SLR projections was conducted. The projections were: NOAA High, NOAA Intermediate High, NOAA Intermediate Low, USACE High, and the Intergovernmental Panel on Climate Change Fifth Assessment Report Representation Concentration Pathway 8.5 Median Curve (IPCC AR5 RCP8.5 Median). To adapt the projections for regional use in the area of Florida and The Bahamas, the average rate of mean SLR was adjusted from a global value of 0.0017 m/yr to a local value of 0.0022 m/yr as observed in the Key West tide gauge. **Figure 19** displays the sea level increase over time for the different projections. As observed in **Figure 19**, the difference between projections for the SLR increase over time, illustrating the uncertainty in future water levels.

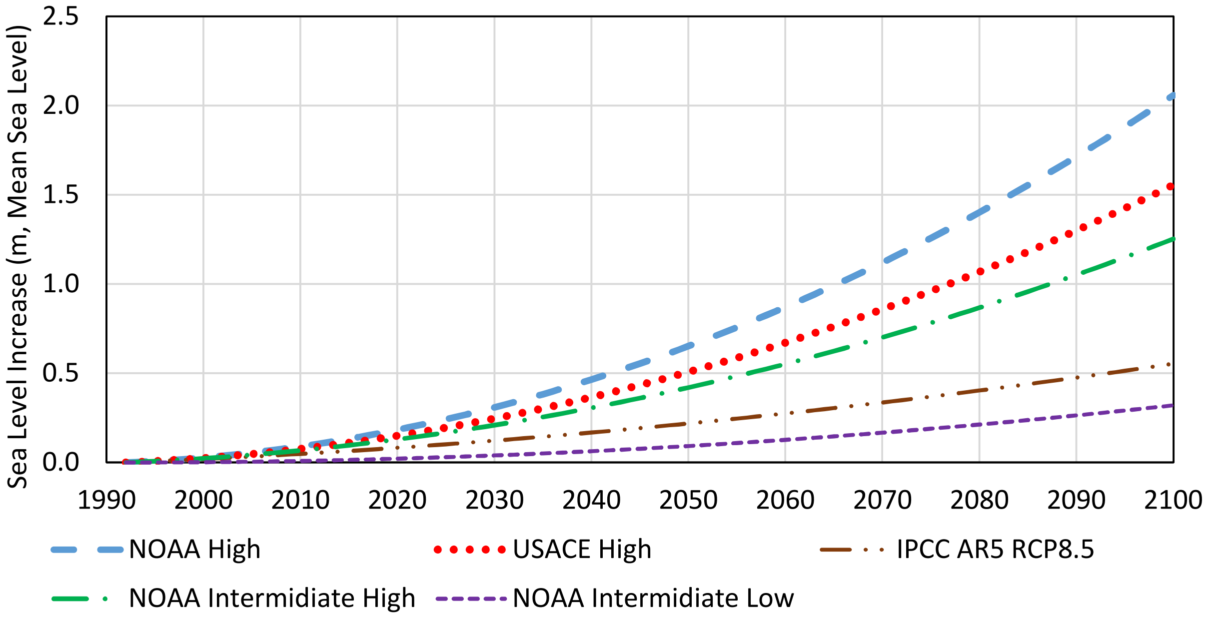


Figure 19: Sea level rise projections

Depending on the type of infrastructure and the risk associated with damages due to SLR impacts, the use of a different projection may be more appropriate. As an example, the design of a critical infrastructure element such as a nuclear plant where failure could be catastrophic, the use of the highest projection curve (NOAA High) may be more appropriate to reduce the risk of impacts due to SLR. For a structure that is easily replaceable, low cost, low service life, and whose failure does not pose a hazard, the use of the lowest projection curve may be more appropriate. Another consideration in the use of the projections is the incremental cost of selecting one projection over another. Depending on the type of infrastructure being constructed, the incremental cost to select a higher projection may be either minimal or economically unfeasible. For a general analysis of the impacts of SLR on extreme conditions at the Project site, the following assumptions were made: design life of 50 years, and the structure is difficult or costly to replace, but damage not catastrophic to the Project site. Based on these assumptions, the NOAA Intermediate High projection curve was adopted for subsequent analysis.

4.2.5.2 Storm Surge with Sea Level Rise

To analyze the impacts of sea level rise on the extreme conditions at the Project site, the SLR increase in the year 2070 from the NOAA Intermediate High projection curve was adopted. The SLR increase value of 0.70 m (2.3 ft) was added to the water levels used in the numerical simulations to observe the changes in the extreme conditions. The 100-year return period storms corresponding to the southeastern approaching storm path on the east side of the island and the east approaching storm passing on the north side of the island were modeled with the SLR increase. These storm scenarios exhibited the worse conditions around the Project site under non-SLR conditions. **Table 7** displays the modeled storm surge levels under the SLR conditions for the aforementioned storms for different regions within the Project site.

Table 7: Storm surge including sea level rise at GSC, The Bahamas

Storm Direction	Sea Level Rise Storm Surge Elevation by GSC Region [m (ft), NAVD]						
	Northwest	North	Northeast	East	Southeast	South	Southwest
100 Year SE – East	**2.49 m (8.17 ft)**	**2.52 m (8.27 ft)**	**2.52 m (8.27 ft)**	**2.41 m (7.91 ft)**	2.50 m (8.20 ft)	2.54 m (8.33 ft)	2.55 m (8.37 ft)
100 Year E – North	2.45 m (8.04 ft)	2.42 m (7.94 ft)	2.20 m (7.22 ft)	2.18 m (7.15 ft)	**2.51 m (8.23 ft)**	**2.59 m (8.50 ft)**	**2.60 m (8.53 ft)**

4.3 Environmental Qualities

4.3.1 Water Quality

The waters around Great Stirrup Cay are considered to be very good with excellent visibility. Flushing is efficient within the marine harbour and at the proposed Project site with no evidence of water degradation. Upland development to the island has not had significant negative impacts to the water quality and is not expected to cause future issues relative to runoff. Frequent travels by ferries to and from the anchored cruise ships have also not caused significant impacts to the water.

4.3.2 Air Quality and Noise

No in-situ measurements of air quality were conducted; however, The Bahamas as a whole exhibits good air quality with low elevations and prevailing winds. Due to the limited population on GSC composed largely of NCL employees to provide for guests, and due to the minimal development on the eastern portion of the island and emphasis on maintaining the tropical “getaway” environment, the air quality at GSC can be deemed good.

Existing noise levels vary on the island depending on the number of guests visiting and construction improvements needed at any given time. General vocal noises from high populations of people within the beach and bar areas add to the overall noise pollution, particularly on the western half of GSC. Additionally, if infrastructure repairs are needed or if new buildings such as bars or cabanas are being added, the construction equipment such as trucks, front loaders, vibrators, etc. add many decibels to the immediate vicinity. Less commonplace but still noteworthy is the loud cruise ship horns used in compliance with navigational rules or as a salute, which can still be heard on the island despite the ships anchoring offshore.

4.4 Geotechnical Characteristics

As discussed in **Sections 1.9.3** and **1.9.4**, subsurface information was provided by Ardaman and Associates, Inc. regarding the upland geotechnical and marine subsurface characteristics. The exploration uncovered soils and rock that is typically found throughout The Bahamas and was expected to be within the Project area.

4.4.1 Geology

Over millions of years through Bahamian history, the collection of organic life on the seabed floor in combination with precipitation of calcium carbonate (King, n.d.) produced the limestone soils found within The Bahamas today. Active limestone formation can be seen in aerials of the shallow water areas of The Bahamas, particularly west of Andros Island. The copious calcium carbonate skeletal debris from corals, shellfish, and other organisms cover the seabed and are continuing to build the large limestone area of The Bahamas.

Limestone contains 50% calcium carbonate as calcite by weight with the remaining material consisting of various minerals such as quartz, feldspar, etc. (King, n.d.). The upland limestone at the Project site varies from being very poorly cemented to well-cemented, providing differing levels of bearing capacity (see **Section 1.9.3**). Limestone is found throughout the Project site and within most of the upland 14 borings collected by Ardaman & Associates, Inc. This material provides solid foundations without much settlement for marine and upland structures such as piles, seawalls, revetments, and generic buildings.

The 2007 marine boring from Ardaman & Associates, Inc. indicates much of the earth below the seabed contains limestone as well (Ardaman & Associates, Inc., 2007). Albeit with different descriptions of characteristics for the 2007 study, the limestone ranges from moderately hard to hard material. The solid submerged limestone will also provide rigid foundations for the installation of steel sheet and pipe piles embodying the piers.

4.4.2 Soils

Bahamian soil is generally classified as sterile for crop cultivation (Bahamianology, n.d.). This is due to a shallow layer of topsoil from geologically young erosion of the limestone. Early limestone contains little nutrients to support plant growth. Additionally, the erosion of calcium carbonate within the limestone produces soils with high alkalinity, challenging the capacity for plants to absorb water. This led to early cultivators of the islands to utilize slash-and-burn techniques, producing a high quantity of crops for one year followed by many years of limited production.

The soils within Great Stirrup Cay reflect these historic conditions being largely comprised of sand and limestone. The sand and limestone are in a continuous process interacting with wind and waves that further erode the materials. The borings collected by Ardaman & Associates, Inc. show varying levels of sand and limestone within each boring, ranging from sand throughout the strata with limestone fragments to limestone throughout the strata cemented with small amounts of sand. This soil supports the native vegetation such as Caribbean pines, sea grapes, and lignum vitae but limits the capacity for farming cultivation (Bahamas Reef Environment Educational Foundation, 2013).

Limited sand was found within the marine borings. Fine-grained to very-fine grained sand was collected throughout the 68 ft of soil removed, but this was in small quantities and found within the pores of the limestone. The majority of soil aquatic components at the Project site includes limestone hardbottom to support corals and a thin layer of sand observed in person during biological analyses to support seagrasses.

4.5 Biological Baseline

Prior to conducting field site surveys, marine and terrestrial surveys conducted by Coastal Systems International, Inc. (CSI) for the island were reviewed (Coastal Systems International, Inc., 2008). Benthic survey maps of the coral reef and submerged aquatic vegetation (SAV) areas containing seagrasses and macroalgae did not include the habitats within the project footprint, and it was determined further mapping and characterization was needed to document sensitive resources in the area for subsequent assessment.

4.5.1 Marine Resource Survey and Marine Ecology

As presented in **Section 1.9.1,** a detailed marine resource survey and habitat mapping effort was conducted using a range of survey techniques to document, characterize, and quantify sensitive marine habitats within the Project area. Five benthic habitat types were characterized (**Table 8**) and mapped **Figure 20**. A summary of the baseline conditions is provided below, and the full survey methodologies and results can be found in **Appendix A**.

Table 8: Benthic habitat types and characteristics

Habitat Type	Description
Sloping Hardbottom	Nearshore hardbottom habitat that slopes down from the shoreline to pavement and hardbottom sparsely colonized by smaller hard and octocoral species with scoured barren areas of carbonate rock and sand channels.
Continuous Reef Ridge	Coral reef habitat that with high relief (>1m) oriented parallel to shore and dominated by hard corals, usually larger in size.
Reef Flat	Low relief (<1m) hardbottom habitat colonized by both hard corals and octocorals, but primarily dominated by octocoral species.
Aggregated Patch Reef Ridge	Cluster of coral reef habitat formations/patches that may be separated by a halo of bare substrate/sand area but are too close together to map separately as individual patch reefs.
Seagrass	Areas where seagrass is present, with varying percent coverages and densities; may be monospecific seagrass or be intermixed with macroalgae species.

4.5.1.1 Coral Reef and Associated Biota

Four distinct reef habitat types (**Figure 20Figure 20:** Coral reef, hardbottom, and seagrass habitats within the Project area) were documented and mapped within the submerged Project area surrounding GSC. They included sloping hardbottom, continuous reef ridge, reef flat, and aggregated patch reef ridge communities. Living hard coral was greatest along the aggregate patch reef and continuous reef ridge with a mean percent cover of 12%, and 11%, respectively. Both the reef flat and sloping hardbottom had a lower live hard coral cover of 4% and 1% and high coverage of sand and/or hardbottom (uncolonized substrate). By habitat type, the contiguous reef ridge and aggregate reef flat have the greatest mean hard coral densities at 4.8 and 3.6 colonies/sq m, respectively, with the larger colonies (10 to 30 cm [**Photo 1** and **Photo 2**]; density 2.0/sq m) and largest (>30 cm [**Photo 3** and **Photo 4**]; 0.7/sq m) on the contiguous reef ridge. **Figure 21** and **Figure 22** provide the percentage of substrata (and living coral) and mean density data by their respective habitat categories. The full benthic survey report is provided in **Appendix A,** including comprehensive species lists of all corals and octocorals observed.

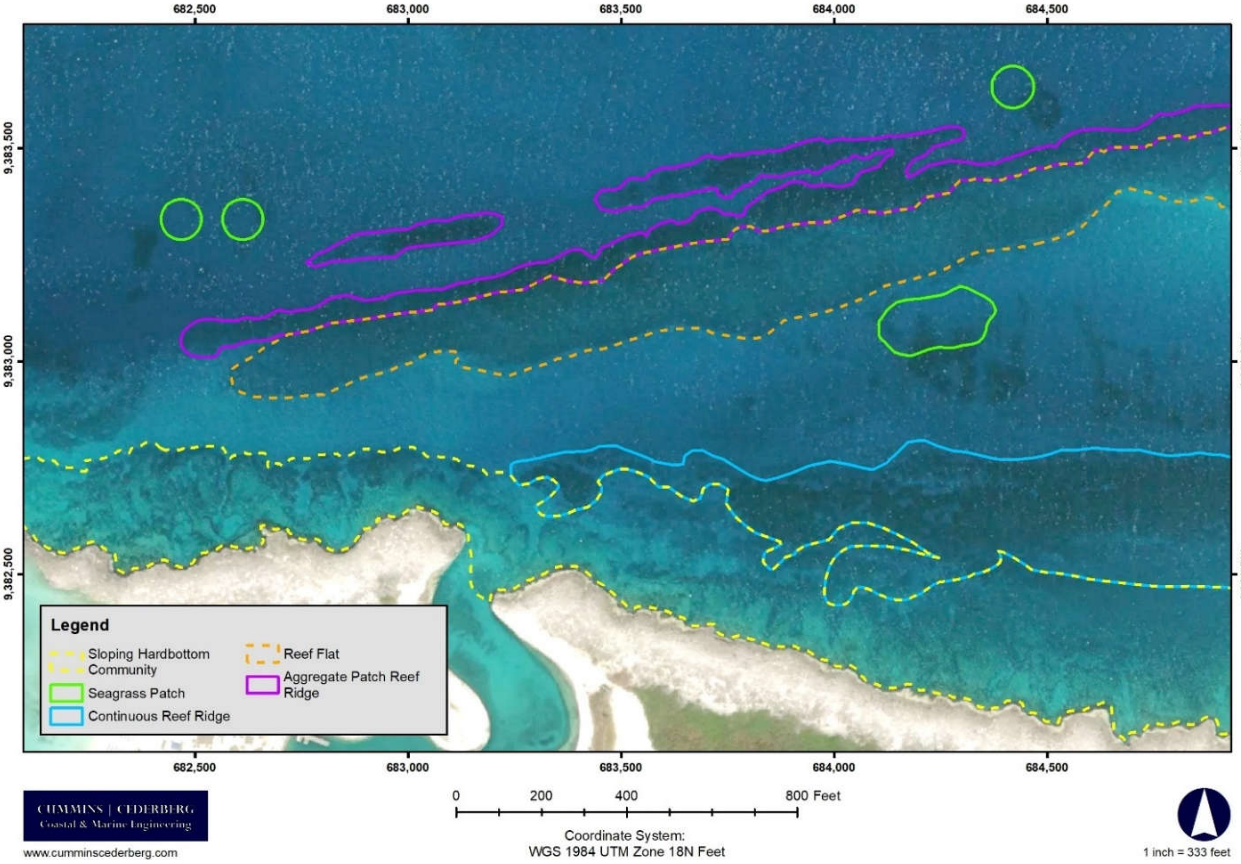


Figure 20: Coral reef, hardbottom, and seagrass habitats within the Project area

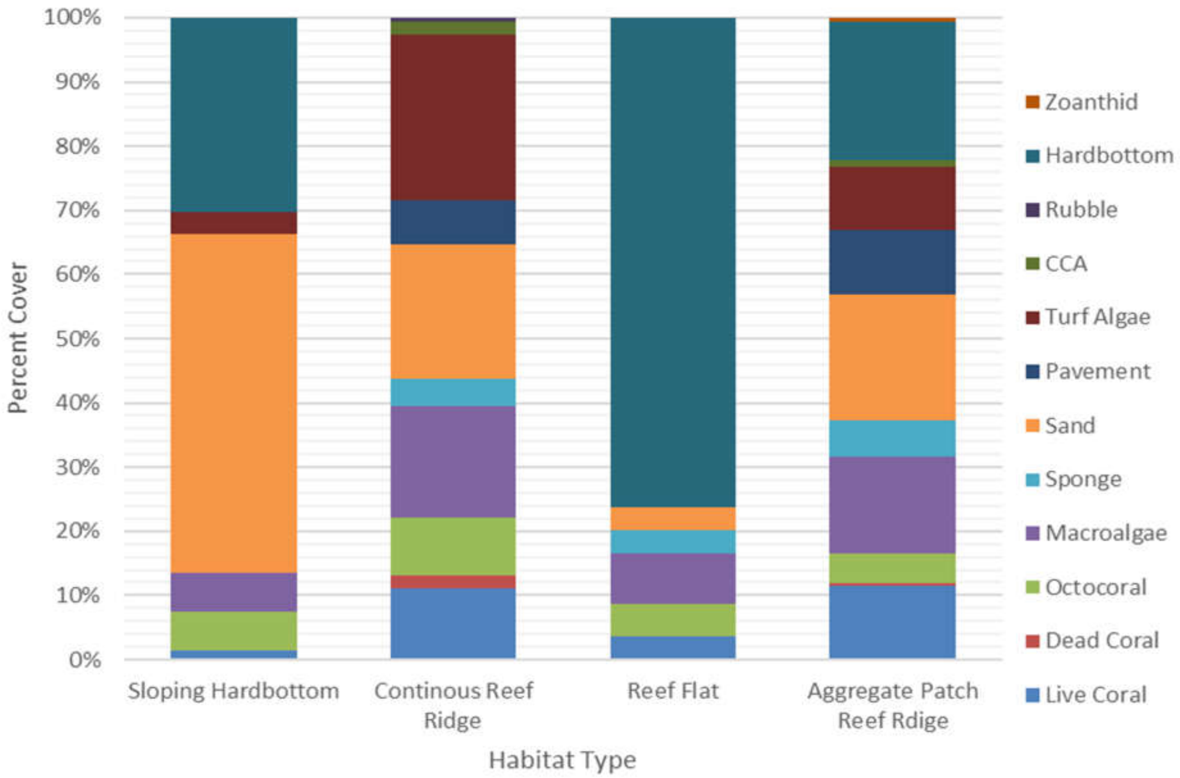


Figure 21: Percentage of substrata by habitat type

Photo 1: *Montastrea cavernosa* ~30 cm in diameter

Photo 2: *Diochocoenia stokesii,* ~15 cm in diameter

Photo 3: *Orbicella faveolata* (>3 m in diameter) located along the westernmost mapping transect

Photo 4: *Colpolphyllia natans*, > 30 cm in diameter

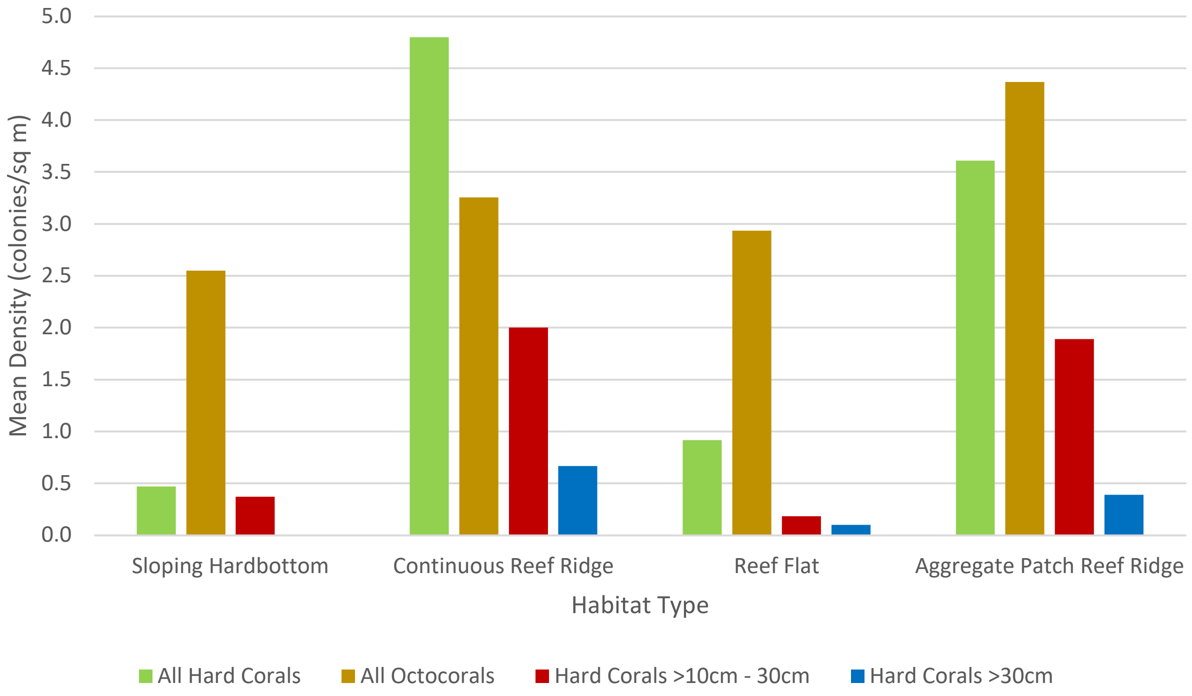


Figure 22: Mean hard coral and octocoral density data by habitat type and size category (hard corals only)

4.5.1.2 Seagrass and other Submerged Aquatic Vegetations

Seagrasses and associated macroalgae were documented as mixed SAV with varying coverage. **Figure 20** shows mapped seagrass communities within the Project area. A mix of *Syringodium filiforme, Halodule wrightii, Thalassia testudinum*, and numerous species of macroalgae (**Photo 5** and **Photo 6**) were found along the central portion of the survey area between the continuous reef ridge and reef flat communities.

Photo 5: Submerged aquatic vegetation dominated by the seagrass *Syringodium filiforme*

Photo 6: Mixed submerged aquatic vegetation comprised of the seagrasses *Thalassia testudinum, Syringodium filiforme,* and *Halodule wrightii*, and green macroalgae

4.5.1.3 Fish and Macroinvertebrates

During the survey period, a total of 52 species of fish were recorded. Commonly observed species within the Project area included sheepshead (Sapridae), butterflyfish (Cahetodontidae), yellowtail snapper (*Ocyurus chrysurus*), parrotfish (Scaridae), and grunts (Haemulon). These species were observed primarily in the reef habitat areas with higher relief. Nassau grouper (*Epinephelus striatus*), an ecologically and commercially important species listed as Critically Endangered on the IUCN Red List was observed within the Project area, as was the invasive lionfish (*Pterois volitans*).

Photo 7: Invasive lionfish, *Pterois volitans*

A few motile invertebrates, primarily smaller species, were observed during the marine resource survey. Urchins (Echinoidea), spiny lobster (*Panulirus argus*), arrow crabs (*Stenorhynchus seticornis*), brittle stars (Ophiuroidea), and cleaner shrimp (*Periclimenes perdersoni*) were noted during the survey, but none appeared in observable abundances. **Appendix A** includes the full species list of fish and macroinvertebrates observed during the survey.

4.5.1.3.1 Economically Important Species

The three most commercially important species in The Bahamas are the Caribbean spiny lobster (*Panulirus argus*), queen conch (*Strombus gigas*), and Nassau grouper (*Epinephelus striatus*). These species rely on the inshore marine environment for survival. Although all were observed, they were seen in very low numbers, likely due to overexploitation.

4.5.1.4 Marine Mammals

During the July 2020 marine resource survey, no marine mammals were observed. However, the Berry Islands are known to be home to manatees, whales, and dolphins.

4.5.1.5 Sea Turtles

During the July 2020 marine resource survey, only the loggerhead turtle (*Caretta caretta*) was observed on the surface. Although the green sea turtle (*Clelonia mydas*) is relatively common, it was not directly observed during the survey. Overexploitation and habitat loss have caused sea turtles to be recognized as endangered or critically endangered and subsequently listed on the International Union for the Conservation of Nature (IUCN) Red List.

4.5.1.6 Sharks and Rays

During the July 2020 survey, only the common nurse shark (*Ginglymostoma cirratum*) was observed in the nearshore environment (**Photo 8**) although anecdotally, several reef sharks have been observed from shore by the local inhabitants and crew on GSC. During an earlier informal dive that was not part of the marine resource survey, a solitary spotted eagle ray (*Aetobatus narinari*) was seen swimming just west of the survey area.

Photo 8: A nurse shark, *Ginglymostoma cirratum*, observed within the survey area

4.5.2 Terrestrial Flora and Fauna

4.5.2.1 Botanical Survey

Vegetation types were mapped by examining high-definition aerial drone photography and verified by walking along the shoreline and within the interior of the vegetation using existing cut lines and the main road. Specific locations were targeted based on examination of the aerial photography and areas of potential impact. Vegetation type taxonomy is based on (Areces-Mallea, 1999). Vascular plant species occurring in each vegetation type were recorded and used to compile an overall floral list. As the interior upland areas of the site were less accessible due to the dense vegetation, a portion of the assessment was conducted along the road in the general survey area that had similar vegetation. Plant taxonomy is based on (Correll, 1982). The presence, location and abundance of vascular species listed under the Conservation and Protection of the Physical Landscape Act, Protected Trees Order (1997) and the National Invasive

Species Strategy for The Bahamas, 2013 were noted when encountered. Percentage cover were recorded in the abundance categories of occasional (less than 20%), moderate abundance (20-50%), abundant (50-80%) and dominant (80-100%).

4.5.2.1.1 Vegetation Types

The surveyed areas consisted of a section of coastline and interior upland areas. Three (3) vegetation type classes were encountered within the survey limits - rocky shore, dry broadleaf evergreen formation (DBEF) and human altered, as described below. **Figure 23** shows the general survey area, areas of concentration, and vegetation types. Upland vegetation was either all DBEF or human disturbed areas that were previously DBEF.

4.5.2.1.1.1 Rocky Shore

The entire shoreline included in the survey is rocky shore. The rocky shore profile from the shoreline moving inland included a band of exposed rock with no vegetation that averaged ~fifty (50) feet in width and transitioned into an extensive area of *Rhachicallis americana* (Sandfly Bush) dominated vegetation that extends approximately fifteen to thirty (15 to 30) feet wide. Other vegetation present as occasional species include *Suriana maritima* (Bay cedar), *Conocarpus erectus* (Buttonwood), *Coccoloba uvifera* (Sea grape) and *Borrichia arborescens* (Bay Marigold). Vegetation height averaged less than one (1) foot. **Photo 9** and **Photo 10** show the rocky shoreline facing northwest and northeast.

Photo 9: Northern rocky shoreline profile (view facing North-West to existing channel entrance)

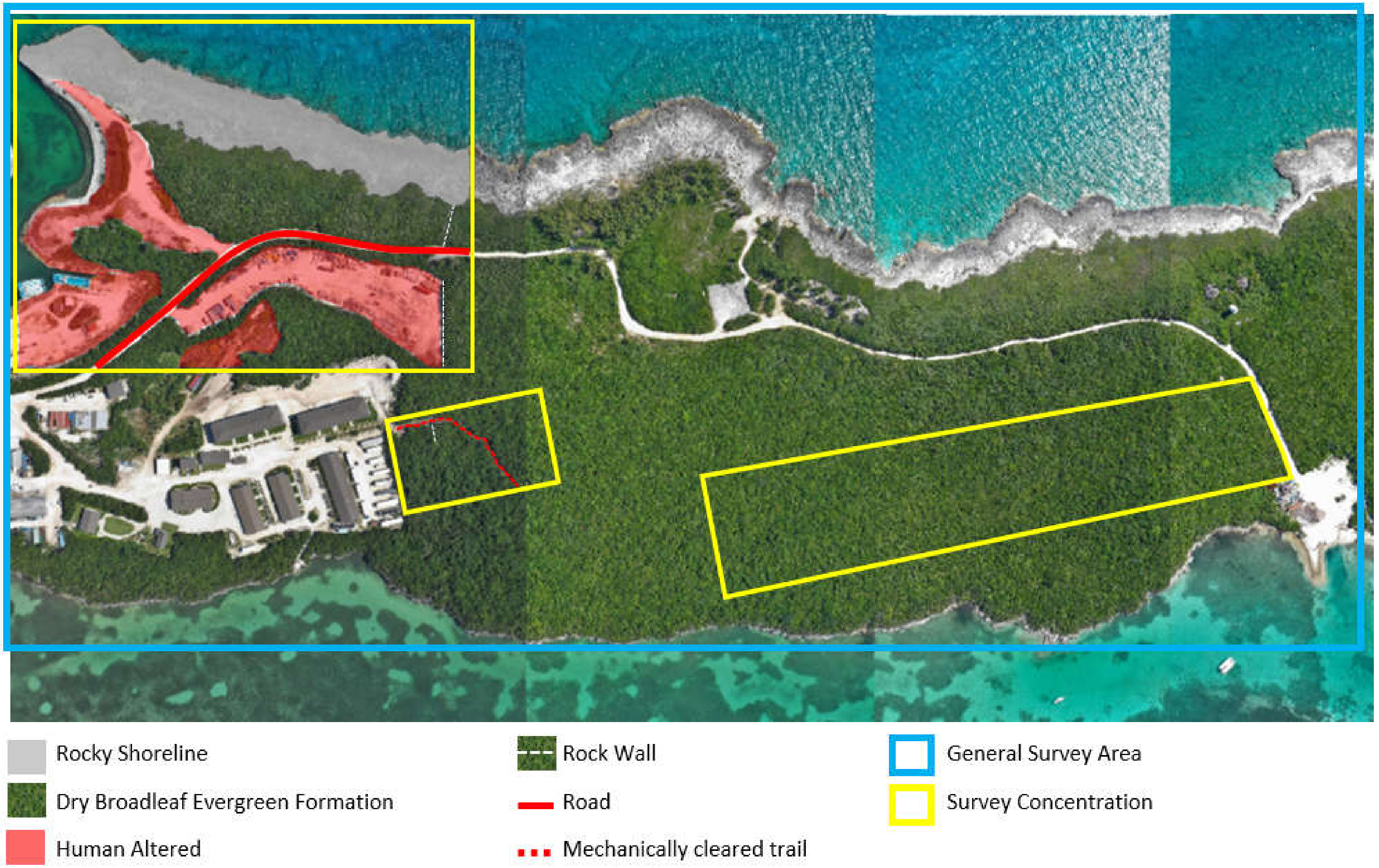


Figure 23: General survey area and habitat types

Photo 10: Northern rocky shoreline profile (view facing East)

4.5.2.1.1.2 Dry Broadleaf Evergreen Formation

Much of the survey area was DBEF in the form of dwarf shrubland and forest. Dwarf shrubland was present along the coastline immediately inland to the rocky shore vegetation. The vegetation was dense with a tight knitted, wind pruned, closed canopy and less than three to five (3-5) feet in height. The vegetation was almost exclusively *Coccoloba uvifera* (Sea grape) that extends an average of fifty (50) feet inland. **Photo 11** and **Photo 12** show the dominance of sea grape within the survey area. Other species present in significantly less quantity include *Suriana maritima* (Bay cedar), *Conocarpus erectus* (Buttonwood) and *Borrichia arborescens* (Bay Marigold).

Photo 11: *Coccoloba uvifera* (Sea grape) dominated DBEF (view facing south)

Photo 12: *Coccoloba uvifera* (Sea grape) dominated DBEF (view facing west)

The *Coccoloba uvifera* (Sea grape) dominated DBEF transitions into DBEF forest further inland in the northern section of the survey area. DBEF forest is also present in two other locations within the primary area of impact – the proposed disposal settlement ponds area and rear of the existing staff quarters. Species composition for DBEF forest were similar in all areas with a canopy layer consisted of trees including *Coccoloba argentata* (Silvertop Palm), *Bursera simarouba* (Gum Elemi) and *Coccoloba diversifolia* (Pigeon Plum); understory shrubs such as *Randia aculeata* (White Indigo Berry), *Erithalis fruticosa* (Blacktorch) and *Croton linearis* (Granny bush); and vines including *Passiflora sp.* (Passion fruit) and *Smilax s*p. (Smilax).

In the northern section of the DBEF forest, *Coccoloba argentata* (Silvertop Palm) and *Coccoloba uvifera* (Sea grape) were more common than the interior upland areas. Additionally, a rock wall was observed within the northern section of this area (**Photo 13** and **Photo 14**: **Rock wall in DBEF Forest in the northern section of survey area (rock wall location indicate by red line on aerial image).**

Photo 13 and **Photo 14:** Rock wall in DBEF Forest in the northern section of survey area (rock wall location indicate by red line on aerial image).

The interior DBEF forest in the southern portion of the survey area (**Figure 23**), where portions of the forest are proposed for use as a confined upland disposal area differ slightly in vegetation height. The dredge spoil site has a slightly wind-pruned canopy (**Photo 15**) with an average height of fifteen (15) feet while the back of staff housing has an average height of fifteen to twenty (15-20) feet. There is a recently mechanically cleared trail and rock wall in the back of staff housing area within DBEF (**Photo 16- 19**).

Photo 15: DBEF in proposed confined upland disposal area

Photo 16 and **Photo 17:** Trail in DBEF near existing staff quarters (arrow on aerial indicates location and size)

Photo 18 and **Photo 19:** Rock wall in DBEF near existing staff quarters (location of rock wall indicated on aerial image)

4.5.2.1.1.3 Human Altered Areas

Human altered areas within in the survey limits consist of clearings in the northern section (**Photo 20** and **21**). A rock wall is located along the boundary of a clearing used as a laydown yard (**Photo 22**).

Photo 20 and **Photo 21:** Recently cleared area for laydown yard (area outlined in aerial image)

Photo 22: Rock wall in DBEF near Laydown Yard

4.5.2.1.2 Vascular Plant Diversity

Three (2) species listed on National Invasive Species Strategy (2013) were recorded during the investigation (**Table 9**). *Casuarina equisetifolia* (Australian pine) and *Scaevola taccada* (White inkberry) were observed in the northern impact area (**Photo 23**) with large stands of *Leucaena leucocephala* (Jumbay) documented along the roadsides (**Photo 24**). Two species, *Guaiacum sanctum* (Lignum Vitae) *and Guapira discolor* (Longleaf Blolly*)* are listed on the Conservation and Protection of the Physical Landscape Act; Protected Trees Order (1997) (**Table 10**). A total of seventy-three (73) vascular plant species were observed during the investigation (**Table 11**). It is highly unlikely that this number represents all the plant species present within the vegetative communities within the survey areas as data collection was limited to a single field session. However, it is a fair representation of species common in the vegetation types recorded.

Table 9: Invasive plan species and recommendations based on National Invasive Species Strategy (2013)

Botanical Name	Common Name	Presence on Site	Recommendations for Control*
Casuarina equisetifolia	Australian Pine	An occasional species in northern area of direct impact. A large stand present in a section of the general survey area.	Control
Scaevola taccada	White Inkberry	Large stands in the northern area of impact.	Eradication
Leucaena leucocephala	Jumbay	Occasional species along the road in the areas of direct impact. Large stands present in a section of the general survey area.	Control

Table 10: Protected species recorded at selected survey areas on Great Stirrup Cay

Botanical Name	Common Name	Location	Observation / Occurrence
Guaiacum sanctum	Lignum Vitae	DBEF	Occasional in area of direct impact.
Guapira discolor	Long leaf Blolly	DBEF	Occasional in area of direct impact.

Occurrence: Occasional = less than 20%

Photo 23: Australian pine (*Casuarina equisetifolia*) tree amidst extensive patch of White Inkberry (*Scaevola taccada*) in northern area of impact

Photo 24: Stands of Jumbay (*Leucaena leucocephala*) on both sides of the road in general survey area

Table 11: Vascular plan species surveyed on Great Stirrup Cay

Botanical Name	Common Name	Vegetation Type			Botanical Name	Common Name	Vegetation Type		
		RS	DBEF	HA			RS	DBEF	HA
Acacia choriophylla	Cinnecord		✓		*Lantana involucrata*	Wild Sage		✓	
Agave sisalana	Sisal		✓		*Lantana sp.*	Sage		✓	
Amyris elmifera	Torch wood		✓		*Lasiacis divaricata*	Wild bamboo		✓	
Baccharis dioica	Broom bush		✓		*Leucaena leucocephala*	Jumbay			✓
Borrichia frutescens	Bay marigold	✓			*Manilkara jaimiqui subsp. emarginata*	Wild dilly		✓	
Bourreria ovata	Strongback		✓		*Metopium toxiferum*	Poison wood		✓	
Bursera simaruba	Gum elemi		✓		*Myriopus volubilis*	Solider vine		✓	
Casasia clusifolia	Seven-year apple		✓		*Oeceoclades maculata*	Spotted ground Orchid		✓	
Casuarina equisetifolia	Casuarina			✓	*Passiflora cupraea*	Red Passionflower		✓	
Cassia sp.	Cassia		✓		*Passiflora suberosa*	Juniper berry		✓	
Cassytha filiformis	Love vine		✓		*Piscidia piscipula*	Dogwood		✓	
Cenchrus incertus	Sand bur	✓		✓	*Pithecellobium keyense*	Ram’s horn		✓	
Centrosema angustifolium	Butterfly pea		✓		*Psychotria ligustrifolia*	Wild coffee		✓	
Chiococca alba	Snowberry		✓		*Randia aculeata*	White Indigo berry		✓	
Coccoloba diversifolia	Pigeon plum		✓		*Reynosia septentrionalis*	Darling plum		✓	
Coccoloba uvifera	Seagrape	✓	✓		*Rhachicallis americana*	Sandfly bush	✓		
Coccothrinax argentata	Silver Thatch		✓		*Scaevola taccada*	White Inkberry			✓
Cocos nucifera	Coconut		✓	✓	*Scleria lithosperma*	Scleria		✓	
Conocarpus erectus	Buttonwood	✓			*Sideroxylon americana*	Milkberry		✓	
Conocarpus erectus var. sericeus	Silver Buttonwood	✓			*Sideroxylon foetidissimum*	Mastic		✓	
Crossopetalum rhacoma	Wild cherry		✓		*Smilax auricalata*	Green China berry		✓	
Croton linearis	Granny bush		✓		*Smilax havanensis*	China brier		✓	
Echites umbelatta	Devil’s potato		✓		*Solanum bahamense*	Cankerberry			✓
Eleusine indica	Fowl foot grass			✓	*Sorghum halepense*	Johnson grass			✓
Erithalis fruticosa	Black torch		✓	✓	*Sporobulus virginicus*	Seashore rush grass	✓		
Ernodea littoralis	Beach creeper		✓		*Stachytarpheta jamaicensis*	Blue Flower			✓
Eugenia axillaris	White stopper		✓		*Strumpfia maritima*	Mosquito Bush	✓		
Eugenia foetida	Spanish stopper		✓		*Suriana maritima*	Bay cedar	✓		

Botanical Name	Common Name	Vegetation Type			Botanical Name	Common Name	Vegetation Type		
		RS	DBEF	HA			RS	DBEF	HA
Euphoria mesembrianthemifolia	Coast spurge	✓		✓	*Tabebuia bahamensis*	Five Finger		✓	
Ficus sp.	Fig		✓		*Tournefortia gnaphalodes*	Sea Lavender	✓		
Galactia rudolphioides	Red Milk pea		✓		*Urechites lutea*	Wild Allamanda		✓	
Guaiacum sanctum	Lignum Vitae		✓		*Waltheria indica*	Sleeping Morning		✓	
Guapira discolor	Longleaf blolly		✓		*Wedelia bahamensis*	Rong Bush		✓	
Gymnanthes lucida	Crabwood		✓		*Zanthoxylum coriaceum*	Hercules Club		✓	
Jacquemontia havanensis	Havana Cluster vine		✓		*Zanthoxylum fagara*	Wild lime		✓	
Jacquinia keyensis	Joewood		✓		*Zanthoxylum flavum*	Yellow wood		✓	
Krugiodendron ferreum	Black Ironwood		✓						

4.5.2.2 Avian Survey

The assessment comprised of five (5) hours of active avian and ecological observation. The avifauna of the area was assessed and recorded by walking through the vegetation, along existing trails and checking cleared areas of the vegetation at various locations. Species numbers were recorded in the abundance categories, Single, Few (2-10) and Many (11-100). Species recorded were compiled for final abundance estimates. Status is based on International Union for Conservation of Nature (IUCN). A total of eighteen (18) bird species were recorded during the investigation (**Table 12**).Table 12: Avifauna observed on a section of Great Stirrup Cay

Table 12: Avifauna observed on a section of Great Stirrup Cay

Genus Species	Common Name	Master Observation	Status / Range
Columbina passerina	Common ground dove	Few	LC/PRB
Calliphlox evelynae	Bahama Woodstar Hummingbird	Few	LC/PRB-E
Butorides virescens	Green Heron	Few	LC/PRB
Ardea alba	Great Egret	Single	LC/PRB
Fregata magnificens	Magnificent Frigatebird	Single	LC/PRB
Thalasseus maximus	Royal Tern	Single	LC/PRB
Sphyrapicus varius	Yellow-bellied Sapsucker	Single	LC/WRN
Falco columbarius	Merlin	Few	LC/WRN
Vireo crassirostris	Thick-billed Vireo	Few	LC/PBR
Seiurus aurocapilla	Ovenbird	Few	LC/WRN
Setophaga ruticilla	American Redstart	Few	LC/WRN
Setophaga tigrina	Cape May Warbler	Many	LC/WRN
Setophaga americana	Northern Parula	Few	LC/WRN
Setophaga palmarum	Palm Warbler	Many	LC/WRN
Setophaga discolor	Prairie Warbler	Few	LC/WRN
Coereba flaveola	Bananaquit	Many	LC/PRB
Tiaris bicolor	Black-faced Grassquit	Single	LC/PRB
Dumetella carolinensis	Gray Catbird	Single	LC/WRN

Range: PRB: Permanent Resident Breeding; WRN: Winder Resident Non-Breeding

Status: LC: Least Concern (Conservation – IUCN); E: Endemic

4.5.2.2.1 Range

The range of a species is the geographic areas where the birds can be consistently found, i.e., migrant birds have seasonal ranges while restricted range species remain on same island or in same region year-round. The species observed within the survey areas were comprised of a combination of Permanent Resident Breeding (PRB) species including Endemic species, and Winter Resident Non-Breeding (WRNB) species.

4.5.2.2.1.1 Permanent Resident Breeding Species

Permanent Resident Breeding (PRB) species refers to the resident species that live and breed year-round throughout the Bahama Islands. Eight (8) of the species recorded during the survey were PRB species. Bahama Woodstar Hummingbird - *Calliphlox evelynae* was the only endemic species recorded.

4.5.2.2.1.2 Winter Resident Non-Breeding Species

Winter Resident Non-breeding (WRN) species refers to the annual non-breeding fall/winter migrants to the Bahama Islands from North America. There was a good representation of fall/winter migrant species (Palm Warbler, Cape May Warbler, and American Redstart). Approximately 55% of the species recorded were WRNB species.

4.5.2.2.2 Conservation Status

All of the species observed are protected under the Wild Birds Protection Act Chapter 249 (Statue Law of The Bahamas). None of the species recorded are classed as endangered.

4.5.2.2.3 Habitat Utilization

The majority of the birds recorded were observed in the DBEF. The predominant avian species at the site was the Bananaquit - *Coereba flaveola* (**Photo 25**) which were often seen in groups of two or three chasing through the broadleaf vegetation. The resident Bananaquit and the migrant Cape May Warbler (*Setophaga tigrina*) (**Photo 26**) are both primary nectar feeders and use the inflorescences of the coconut palms as their main food source. The other migrant passerines and resident woodland birds foraged for seeds in the open areas and trails and small insects in the broadleaf vegetation. Heron and Egret species that hunt small fish and crustaceans and are typically sighted along the shoreline. **Photos 27** through **29** show the other avian species observed during the survey.

Photo 25. Bananaquit (*Coereba flaveola*) immature

Photo 26. Cape May Warbler (*Setophaga tigrina*) feeding on Ram's horn (*Pithecellobium keyense*)

Photo 27. Thick-billed Vireo (*Vireo crassirostris*)

Photo 28. Black-faced Grassquit (*Tiaris bicolor*) on Johnson grass (*Sorghum halepense*)

Photo 29: Merlin (*Falco columbarius*) perched on Australian Pine (*Casuarina equisetifolia*) to spot prey

4.6 Socioeconomic Conditions

A review of the existing socioeconomic conditions and how the proposed piers would influence those conditions for The Bahamas was conducted. In the following sections, this report presents an overview of Bahamian communities, economic baseline, tourism, transportation, marine dependencies, and regional influence.

4.6.1 Overview of Communities, Employment and Demographics

According to the most recent Bahamas Government Census of Population and Housing inquiry conducted in 2010, there were 351,461 people who were residents of The Bahamas (The Government of the Bahamas, 2013)The United Nations estimates the current population (2020) is estimated at 394,619, with the three most populous cities recorded as Nassau, Lucaya, and Freeport making up 76% of the population (United Nations, 2020). The population of the Berry Islands as a whole is considered to be under 1,000, as documented in the 2010 census (**Table 13**); the three most populated islands are New Providence, Grand Bahama, and Abaco, which make up 90% of the population.

Most of The Bahamas' $12.4 billion gross domestic product (GDP) is tourism (50%), financial services and agriculture (15%), and natural resources and mining (10%). Tourism employs half of the private sector through direct or indirect means as The Bahamas recorded a record-breaking 7.2 million tourists entering the country. Responses to COVID-19 including closing the country's borders to international flights has severely cut that number in 2020. As a result, unemployment has skyrocketed with over 37,000 people filing for unemployment benefits. It is estimated that 30% of the country's eligible workforce is unemployed, with the hardest hit industries being hospitals, hotels, and restaurants. For comparison, 215,000 people were employed by The Bahamas in May of 2019 when the last labor force understudy was taken, amounting to an unemployment rate of 9.5%. Most of the population was employed under public services with hospitality, wholesale and retail, construction, and transportation following.

Great Stirrup Cay, as a private island destination, employees some 150 persons on the Cay. The pier and expansion Project expects to employee some 85 construction workers during the buildout. Additionally, Bahamian owned and operated retail outlets service NCL's guests on the Cay.

In 2019 GSC welcomed 286,357 guests. Under pre-COVID-19 trends, NCL expects to see increased passenger volumes of 714,000 once the pier is operational. Due to increased efficiency of landing and boarding of passengers to the Cay, it is expected guests will spend an additional 2 – 3 hours on the cay once the pier is operational. This additional time on the Cay will allow additional patronizing of the local retailers and the opportunity to expand tour excursions to meet increased guests demand.

Table 13: The Bahamas population, Bahamas Government Census of Population and Housing, 2010

Island	Population
New Providence	246,329
Grand Bahama	51,368
Abaco	17,224
Eleuthera	8,202
Andros	7,490
Exuma and Cays	6,928
Long Island	3,094
Bimini	1,988
Harbor Island	1,762
Spanish Wells	1,551
Cat Island	1,522
San Salvador	940
Inagua	913
Berry Islands	807
Acklins	565
Crooked Island	330
Mayaguana	277
Rum Cay	99
Ragged Island	72
TOTAL:	**351,461**

4.6.2 Economic Baseline

The Bahamas contains the second highest GDP per capita in English-speaking Caribbean countries and is largely dependent on tourism. The service sector accounts for 90% of the total GDP while industry and agriculture make up the other 10%. The major industries include tourism, offshore banking, oil bunkering, maritime industries, transshipment and logistics, salt, aragonite, and pharmaceuticals, and export commodities include the spiny lobster, aragonite, crude salt, and polystyrene products. The island's limited manufacturing requires heavy importation with the United States of America as its largest trading partner.

National debt has been increasing in The Bahamas recently due to the financial impact of Hurricane Dorian in 2019 and the COVID-19 pandemic of 2020. It was estimated the debt could reach $8.8 billion for Dorian reparations, and an additional $1 billion has been borrowed to sustain the country during the border closings. Further losses in revenue are expected as global and local traveling restrictions continue.

The Central Bank of the Bahamas in its Quarterly Economic Review (2020 Q2) 2020/2021 budget highlights report confirmed that the country's national debt is expected to hit $9.5bn. This would represent 82% of the country's pre-Covid-19 GDP. This historic increase is due to the continued economic impact of Hurricane Dorian 2019 and Covid-19 2020.

The development of GSC is in keeping with the National Development Plan to have an anchor project in every family island. In addition to visitors' patronage of local entrepreneurs, The Bahamas Government levies a passenger tax on visitors to the country. A passenger tax of $29 is collected from all airline passengers, and a passenger tax of $18 is collected from all cruise ship passengers. It is anticipated that upon a return to pre-COVID 19 sailing trends, GSC expects to accommodate 714,000 visitors post expansion with a 10-15% increase in passengers per annum as passenger usage stabilizes.

4.6.3 Tourism/Recreation

As previously discussed, Great Stirrup Cay is a private island owned and operated by Norwegian Cruise Lines. The several beaches, snorkeling, kayaking, paddleboarding, and ziplining opportunities draw many guests to the island and therefore NCL. In addition to physical activities, amenities such as villas, cabanas, bars, restaurants, and a spa provide for a full out-of-island destination.

Private island destinations are common in today's cruise industry, as there are six private islands in The Bahamas alone. These include Coco Cay (Royal Caribbean), Half Moon (Holland America/Carnival), Princess Cay (Princess), Castaway Cay (Disney), Ocean Cay (Mediterranean Shipping Company Cruises), and GSC. In total, 2,114,111 people visited the islands in 2019. No Sail Orders from the Center for Disease Control (CDC) have greatly cut these numbers in 2020.

4.6.4 Air and Water Transportation

The Bahamas are easily accessible by air and vessel due to the proximity to the southeastern United States. There are 33 international airports throughout 18 of the islands and another 30 various airports within the country. Most flights arrive from the eastern United States with Toronto, Canada and Heathrow, London offering direct service. Bahamasair is the national carrier, but other airlines to The Bahamas include American, JetBlue, United, Delta, and Southwest Airlines. Demand for private charters is high as well, as an interest to reach remote places in the archipelago promotes smaller specific aircraft travel. GSC contains a helipad in its northwest corner and is accessible from the Great Harbor Cay Airport (GHC). In 2019, air travel accounted for 1.6 million of The Bahamas' 7.2 million visitors.

During 2011-2014, Lynden Oscar Pindling International Airport in New Providence, Nassau was transformed into a world class international airport at a cost of $400M. The Government of The Bahamas is currently looking at the expansion and restoration of other family islands airports as well, as demand for these remote destinations is on the rise.

Water transportation is common within The Bahamas as well. Aside from the six cruise ship lines mentioned above that regularly port in Nassau and Freeport, many private boats and yachts sail in Bahamian waters. Abaco, Bimini, Eleuthera, New Providence, and Exuma are the most commonly visited islands by these private ships. There are 37 private marinas registered with the Association of Bahamas Marinas with many more unregistered marinas throughout the islands. Of the 7.2 million Bahamian visitors in 2019, 5.4 million arrived via cruise ship and 200,000 others arrived via other sea travel methods.

4.6.5 Fishing and Marine Dependencies

Agriculture and fisheries account for only approximately 7% of The Bahamas' GDP. The main fishery exports include the spiny lobster, grouper, and conch. Regulatory conservation measures have been implemented by The Bahamas to help the sustainability of the spiny lobster and grouper by ensuring the harvested species are of a mature age and outside of spawning season. Conservation groups are currently working to pass similar measures for the conch. Additional regulations include cruise and sportfishing permits for visitors on private vessels, limits on the quantity of fish harvested at any time and prohibiting the unregulated export of marine resources.

Fresh seafood is a staple of Bahamian culture and culinary experience. "Fish fry" locations throughout the islands allow people to enjoy the day's fresh catch and is a top destination for both locals and tourists.

4.6.6 Regional Influence

The Bahamas gained its independence from Britain on July 10, 1973 and is one of the richest countries in the region in terms of GDP per capita. The Bahamian Dollar is on par with the US Dollar, and the Central Bank of The Bahamas maintains foreign currency reserves to maintain this parity. The Bahamas is the top visited destination in the Caribbean with the World Tourism Organization ranking it as one of the top five destinations among Caribbean nations.

The country's shipping and logistics are advantageous due to the proximity to Florida's Port Everglades. Cargo vessels enter Bahamian ports frequently supplying needed machinery and transporting equipment, medicine, food, chemicals, and materials for manufacturing.

4.6.7 Cultural Resources

The first known settlers to The Bahamas were the Lucayan Indians, relatives of the Arawak's who populated the Caribbean around 600 A.D. Spanish immigrants collected over 40,000 Lucayans and shipped them to Hispaniola for slave labor. This decimated the population, and The Bahamas was essentially uninhabited for most of the sixteenth century and the first half of the seventeenth (Cruise Point Insider, n.d.). Great Stirrup Cay then became a pirate hideout while the British began to settle in Nassau and the larger islands until 1815. This time marks the first documented settlers of GSC, and many of the structures from this settlement still stand today. Charts of this era show simply "Stirrup's Cay."

The Berry Islands were initially inhabited in 1836 by Governor Colebrook and a group of freed slaves at GSC. It is believed that the islands were given their name because of the abundance of thatch berry trees found there. Historic sites include two lighthouses, old churches, and abandoned villages. In 1863, the Imperial Lighthouse Service erected the lighthouse on GSC. The lighthouse site was manned for many years but is now fully automated and solar powered, making it self-sufficient. The structure stands nearly 80 ft, and its light is visible for over 20 miles.

"Stirrup's Cay" remained active during the American Civil War, as the Confederates wished to continue to export cotton to Europe. The island was used as a landfall for provisioning while Federal warships patrolled the area to thwart their efforts. After the abolition of slavery, the British began to slowly withdraw from the out-island colonies, and the plantation at Great Stirrup was abandoned.

During World War II, in an effort to protect its eastern shores, the United States came to the Bahamas and Great Stirrup with a wide array of observational and defensive equipment. Among these were submersible cables, which were run along the ocean floor to listen for enemy submarines. Two "cable houses" still stand on the southeastern shore of the island, now overgrown by jungle. The United States Air Force later constructed a LORAC (Long Range Accuracy) radio-navigation station for use during the early space shuttle launches. This facility was later leased to Motorola and other private sector companies as contractors to the United States Air Force out of Patrick AFB near Satellite Beach, Florida. New, more accurate GPS technology made the station obsolete, and it was closed in 1991. The associated antenna, equipment, and radials were removed.

As previously discussed, Belcher Oil Company of Miami staked claim to the north section of the island for many years. Their interests there included real estate speculation, oil exploration, and a possible site for a corporate retreat. In 1977, Norwegian Caribbean Lines (later Norwegian Cruise Lines) leased this section from Belcher Oil, marking the first time a cruise line had exclusive control of a private island. Norwegian Caribbean Line bought the island in 1986. In 1990, Norwegian Cruise Line spent $1 million on upgrades to the island and, for a few years, started marketing the island as Pleasure Island. Additional improvements began in 2010 and included a new marina basin carved through the island, a dining facility, bars, picnic pavilions, an expanded beach area, private cabanas, and a straw market. NCL further improved the island in 2017 to 2018 with another expansion of the beach area, new shoreline stabilization structures, and private villas (Sloan, 2017)

5 IMPACT IDENTIFICATION AND EVALUATION

Impact is defined as a change in conditions from baseline and can be positive providing a benefit or negative, adversely affecting the subject. Impacts can vary in their severity from low (insignificant or small changes), moderate (median between significant and insignificant), and high (significant with large changes). Impacts can be further expressed as either direct, which occur as an immediate result of the action and typically at the same time and location, indirect impacts, which are secondary and reasonably foreseeable as a result of the action but occur later in time or further away from the action, and cumulative, which are a result of the combination of the evaluated project consequences along with other past, present, and future projects effects. Impacts can also be described in terms of the duration or length of time in which the effect is experienced. Short term impacts are temporary and occur over a relatively brief period, whereas long term impacts are permanent. The following sections describe the potential environmental impacts to the baseline conditions outlined in **Section 4** that may result from the proposed dredging, dredge material disposal, and two cruise ship piers during the construction and operation phases, and how those impacts were determined.

5.1 Methodology

Impacts were assessed by ranking activities according to their environmental impact, and through a consultation process with the EIA team consisting of several terrestrial and marine scientists, coastal engineers, and socio-economic experts. Each impact source and project component was reviewed and evaluated relative to potential impacts to baseline conditions described in **Section 4**. Ranking can be defined as follows:

- Significant: a high impact corresponds to an effect upon any environmental or socioeconomic condition or area that can generate significant change and is largely irreversible by natural means.
- Moderate: a moderate impact is an effect upon a portion of any environmental or socioeconomic condition or area. The effect occurs for a limited period and is naturally reversible in the mid to short term.
- Minimal: a low impact corresponds to an effect that is barely perceptible, is of short duration, and does not diminish or alter any environmental or socioeconomic condition or area.

5.2 Sources of Impact

5.2.1 Dredging and Material Disposal

Dredging of the seabed will result in the direct removal of coral reef and hardbottom habitats and the suspension of sediments within the water column. Dredge material disposal is proposed to occur within a confined upland disposal area as a series of three settlement ponds. Creation of the settlement ponds will require removal of native terrestrial flora and fauna and result in a change in topography.

5.2.2 Pier Construction

Within the footprint of the piers and mooring dolphins, construction will permanently alter portions of the ironshore shoreline and seabed, including seagrass, coral reef, and hardbottom habitats. The East Pier is approximately 1,500 ft by 50 ft and will include both solid and open sections with a 100-ft concrete slab-on-grade at the shoreline (see **Section 2.2.3.3**). The West Pier is approximately 1,110 ft by 50 ft and will be an open, pile-supported design with mooring dolphins and cat walks beyond the traversable area. Similar to the East Pier, a 48-ft concrete slab-on-grade is to be placed at the shoreline. As discussed in **Section 2.5**, the construction of the piers will be done using the top-down method. The construction itself and the materials used during construction are sources of direct and indirect impacts to the surrounding surface waters. Construction materials for the piers will primarily be concrete and steel, which can change the pH levels of seawater and introduce higher levels of iron into the surrounding waters.

5.2.3 Operations

Cruise operations will involve consistent impacts to the Project area and general northern portion of GSC during regular visits to the island. Vessel traffic will be a regular occurrence from the potential of two daily cruise ships, barges, and smaller miscellaneous vessels including fire safety and security. These vessels, particularly the cruise ships due to the associated large propellers and deep hulls, have the potential to resuspend sediment from prop wash and waves when entering and existing the mooring locations for the proposed piers. Potential discharges of ballast water, airborne emissions, and spills/leakages of oily substances from within the ship and on deck are possible as well, as the cruise ships will be moored for multiple hours during the day before continuing to the next destination.

Human interaction at the Project site also has the potential to impact northern GSC. The construction of two extending piers allows for safer entry to the island than currently anchoring offshore and using ferries as transportation. This will create the opportunity for more guests to enter the island and create more pedestrian traffic and utility strain on GSC. This will also increase the need for equipment and cargo handling for the amenities on the island, which could affect the amount of maritime imports and miscellaneous services needed for docking ships. This could become particularly relevant at the ro-ro docking station, where equipment and resources will be loaded and unloaded as necessary, creating the potential for various materials such as electrical, oil, and other non-natural material to enter the water.

5.3 Impacts to Shoreline/Nearshore

5.3.1 Pier Construction

Both proposed piers will involve covering and the removal of existing ironshore bluff found at the Project site. A 100 ft by 50 ft concrete slab-on-grade is proposed to lead into the East Pier covering 5,000 SF of earth fill and concrete footing that will cut into the ironshore. Approximately 2,060 SF of additional ironshore will be impacted by the initial 34 ft on the west side and 50 ft on the east side of the pile-supported section of the East Pier, which is to cover the existing ironshore with 4 steel pipe piles proposed to be driven through the upland.

The West Pier will impact slightly less area of the ironshore bluff than the East. A 48 ft by 50 ft concrete slab-on-grade is proposed to lead into the West Pier covering 2,400 SF of earth. Approximately 2,630 SF of additional ironshore will be impacted by the initial 15 ft on the east side to 64 ft on the west side of the pier, which is to cover the existing ironshore like the East Pier with 6 steel pipe piles proposed to be driven through the upland.

5.3.2 Runoff

Runoff, or the flow or drainage of water over a land surface (ScienceDaily, n.d.), can result naturally from precipitation or artificially through pumping and disposal of fluids such as dredge slurry. Runoff has the potential to collect loose soil and potential pollutants such as nutrients, bacteria, petroleum byproducts, pesticides, metals, miscellaneous debris, and other materials. Construction sites can be a significant source of potential pollutants that can be transported offsite by runoff. Additionally, excessive runoff due to land changes and earthworks can result in erosion and scouring of the landscape with the potential to deposit into nearby waters causing sedimentation and turbidity.

Implementing and maintaining effective Best Management Practices (BMPs) and erosion control measures can prevent runoff from impacting the shoreline and nearshore region. Therefore, minimal impacts to the shoreline or nearshore area are to be anticipated with the adherence of BMPs.

5.4 Impacts to Surface Waters

Potential impacts to surface waters include local circulation patterns and general features such as localized temperature, salinity, pH, and transparency; turbidity caused by resuspension of bottom sediments or discharge; changes to dissolved oxygen (DO), nitrogen (N) and phosphorous (P) levels; and potential introduction of metals, species, and bacteria.

5.4.1 Local Circulation and Currents

The initial pier layouts considered was two solid (earth-filled) piers east of the entrance to the marine harbour (see **Section 2.2.3.1** and **Section 2.2.3.2**). However, to reduce impacts to the seabed and littoral currents, modifications to the preliminary designs were made in the interest of the aquatic ecosystem.

The northern 1,200 feet of the proposed East Pier is to be of steel sheet and pipe piles along the perimeter and filled with compacted earth below a cast-in-place concrete slab. The West Pier and first 200 feet of the East Pier will be of steel pipe piles supporting a precast concrete pile cap and cast-in-place concrete slab. This design reduces the fill needed to create the piers and minimize impacts to the seabed while allowing littoral currents alongside the island to continue in the existing patterns. Increased current speeds immediately around the piles are expected to occur, but the impacts are anticipated to be minimal to water quality. Due to the open gap on the East Pier and the pile supported nature of the West Pier, the nearshore sediment transport is not anticipated to result in major changes after installation, as the circulation in the nearshore region (within 100 ft) is not impeded. At the tip of the East and West Pier, localized scour may be present. However, based on site observations, the majority of the seabed in this region is hardbottom or has a limited sediment thickness, and thus it is anticipated the scour related sediment transport is limited.

As previously discussed, scour is not expected to be major issue due to the hardbottom found throughout the Project site and minimal sand depths thus minimal impacts are anticipated to local circulation and current patterns.

5.4.2 Discharges and Leachate

Potential discharges from construction equipment and long-term operations of the cruise ships and ro-ro barge include bilge water, ballast water, oily waste runoff (from lubricants, fuels, or other liquids), sewage, and other residues. Oil or oily residues spread on the surface into a thin layer that impacts large areas beyond the immediate discharge location. In general, cruise ships do not discharge in the nearshore areas around Great Stirrup and typically offload their wastes at appropriate facilities when in major ports. Following BMPs and spill prevention plans, discharge from cruise ship operations and construction equipment should be negligible and temporary.

Concrete and steel will be the most common components of the piers. Concrete is composed of coarse and fine aggregates, water, and cement. While the aggregates present little threat to the aquatic ecosystem (depending on the material used), cement can raise pH levels of seawater (Stark, 1995). Steel is an alloy of approximately 96% iron, 2% carbon, and 1% manganese, with trace amounts of silicon, phosphorus, sulphur, and oxygen. The composition can vary slightly depending on the type of steel. Iron is a corrosive material that reacts with oxygen to rust; thus, steel sheet and pipe piles interact with the oxygen in the salt water and corrode the piles. Corrosion is particularly high when exposed to salt water and in humid environments (Rodriguez, 2018), much like the conditions of the Project site. Therefore, it can be expected that the piles will experience corrosion, introducing higher levels of iron into the water around the piers. Concentrations of iron above 0.1 mg/L have the potential to cause irritation and damage fish gills, which can lead to bacterial and fungal infections (Dryden Aqua). Although these materials have the potential to cause release and potential impacts to seawater and release of higher iron levels, the area is highly dynamic and it is anticipated that there will be minimal impacts due to flushing and currents diluting these small releases.

5.4.3 Oil Spills

Oil spills, or the accidental release of petroleum products, in coastal waters are a concern anytime vessels enter this environment. Cruise ships are extremely large and thus burn more heavy fuel oil. Additionally, the fuel cruise ships use tends to be high in sulfur, heavy metals, and other contaminants, making it one of the dirtiest fossil fuels available. Heavy fuel oil persists for extensive periods in the environment, leading to significant impacts from any potential spill.

Fueling will not be offered on Great Stirrup Cay, so the potential for oil spills is greatly reduced. Potential spills would more likely result from accidental fuel discharges, runoff from heavy rains combined with oil leaks from machinery on the vessel, or vessel accidents. Adherence to standard cruise industry BMPs in oil spill prevention, control, and countermeasures helps prevent discharges of oil and provides worst case solution methods in the event of a discharge. Cruise ships have been accessing GSC for years, so the potential impact from oil spills is minimal.

5.5 Impacts to Terrestrial Flora and Fauna

5.5.1 Upland Impacts

5.5.1.1 Dry Broadleaf Evergreen Formation

Direct impacts to DBEF include the complete removal of approximately 21.1 acres of vegetation to facilitate the creation of the confined material disposal areas (settlement ponds) and other Project components. There is also the potential for indirect impacts to DBEF outside the primary area of impact defined by clearing limits. Secondary potential impacts to DBEF vegetation are associated with the proposed site for the settling basin within the DBEF. Erosion from precipitation, breach of a containment wall or failure of a wall can result in spillage of sediment directly onto vegetation in the retained area, which can cause vegetation dieback. Sediment and salt laden water released as a result of failure of wall, and leaks from breaches in walls can result in flooding in retained vegetation. Prolonged exposure to standing water can result in plant death. Land use impacts are associated with the introduction of salt water that can alter soil pH and an increase in soil saturation and lead to habitat alteration.

Additionally, secondary potential impacts to vegetation may also include buildup of dust on vegetation from land clearing. Excessive dust on plants can reduce photosynthetic ability and gas exchange which can result in die back and death of plants.

5.5.1.2 Rocky Shore

Impacts to the rocky shore will be negligible to none. There will be no shoreline or substrate alterations associated with the proposed works.

5.5.1.3 Human Altered

Human altered areas on the site to be utilized during construction include sections of an existing road which will house dredge pipes leading to settling basin. There is no removal of vegetation needed, and this activity is not anticipated to impact human altered or surrounding vegetation.

5.5.1.4 Wetland

There are no wetland features within the survey limits for the proposed activities. Three (3) wetland features have been identified outside the area of activity. There will be no impact to wetlands as a result of proposed activities.

5.5.1.5 Summary of Upland Impacts

Direct impacts to terrestrial habitats that are likely to occur as a result of the construction of the proposed project include habitat loss as summarized in **Table 14**. Impacts to the upland areas are considered moderate with some remaining permanently altered where future construction projects are slated and others being re-vegetated with native plants. The overall EMP will provide details on the BMPs and mitigation opportunities for the Project.

Table 14. Upland Impacts within area of proposed works, Great Stirrup Cay, The Bahamas

Vegetation Type Impacted	Activity	Impacted Area (acres)	Percentage (%) of total Impacted Area
DBEF	Extension of the staff quarters clearing	0.5	2.4
	Laydown yard clearing	0.5	2.4
	Dredge settling basin clearing	17.6	83.4
	Roadways and Paths	2.5	11.8
	Total DBEF	21.1	100
Rocky Shore		Nil	Nil
Human Altered	Placement of dredge pipe	Nil	Nil
Wetlands	No activity at or near wetlands	Nil	Nil

5.6

5.7 Impacts to Marine Flora and Fauna

5.7.1 Seabed and Habitat Alteration

To create an appropriate water depth for cruise ship mooring, dredging will have to occur alongside and under the piers in locations with depths that are ≥-34 ft at MLLW. In addition to the direct removal of the seabed (coral reef habitat and associated organisms) and habitat alteration during dredging, the construction of the East pier will permanently fragment and cover hardbottom and reef habitat such that organisms cannot recolonize those areas or freely move from the east to west without obstruction. The removal of seabed will suspend particulates and remove existing corals and seagrasses, which create marine ecosystems and provide habitats for fish, crustaceans, and other aquatic life. Impacts from seabed removal and habitat alteration are considered significant and permanent.

5.7.1.1 Coral Reef and Seagrass

Drawings of the pier and proposed dredge footprint were overlain on the marine resource habitat maps as shown in (**Figure 24**). The total proposed dredge footprint covers an area of ~12.7 acres across the hardbottom and reef habitats but does not intersect any of the mapped seagrass areas. The total areas of the West and East Piers cover ~3.1 acres across each of the four primary habitat types. The East Pier footprint also intersects an area of seagrass centrally located between the continuous reef ridge and the reef flat habitats. **Table 15** provides the areas of the proposed pier and dredge footprints.

The total area of potential direct impact from the piers and the dredge footprint by habitat type is provided in **Table 16.** It is estimated that ~7 acres of reef will be impacted from the dredging, with another 0.07 acre of submerged aquatic vegetation (seagrass) from the pier construction. Final design criteria and specific details on construction methods may alter these estimates.

Table 15: Overall dredge and pier footprint areas

Footprint Location	Square Feet (SF)	Square Meters (sq m)
Dredge Footprint	554,846	50,618
Pier Footprints	136,436	12,675

TOTAL:	**681,282**	**63,293**

Table 16: Areas of marine habitat within the dredge and pier footprints

Habitat	Within Dredge Footprint		Within Pier Footprints	
	SF	sq m	SF	sq m
Sloping Hardbottom Community	213,193	19,806	31,359	2,913
Seagrass Patch	--	--	2,964	275
Continuous Reef Ridge	95,873	8,906	19,569	1,818
Reef Flat	210,023	19,511	16,239	1,508
Aggregate Patch Reef Ridge	2,155	200	5,078	472
TOTAL:	**308,053**	**28,619**	**40,887**	**3,798**

5.7.1.2 Coral Colony Enumeration

Mean hard coral density estimates were calculated as part of the marine habitat characterization and mapping (**Table 17**) for the four reef community habitats types: sloping hardbottom, continuous reef ridge, reef flat, and aggregate patch reef ridge. **Appendix A** includes the full marine survey report. Mean coral density of hard corals (all sizes) ranged from 0.9 colonies/sq m in the reef flat community to 4.8 colonies/sq m in the continuous reef ridge community. Larger coral colonies (> 10 cm) were similarly most prominent along the continuous reef ridge with density estimates of 2.0 colonies/sq m for colonies 10 cm to 30 cm and 0.7 colonies/sq m for colonies > 30 cm. Using the mean density estimates and habitat areas (sq m) within the footprint of the dredge and pier construction areas, the number of individual coral colonies by size category (i.e., all, 10-30 cm, and > 30 cm) were enumerated. It is projected that 118,250 hard coral colonies will be directly and permanently impacted by the project, with 36,016 colonies estimated to be 10-30 cm (maximum diameter) and 33,580 colonies greater than 30 cm in diameter. **Table 17** summarizes density, areas, and total estimated coral colonies within the impact area.

5.7.1.3 Sediment Plume Impacts

One of the main concerns when using a cutter suction dredge (CSD) is fine sediment plumes generated at the cutterhead; suspended sediments are typically confined to the immediate vicinity of the cutterhead (LaSalle, 1991) and at the site of discharge. Turbidity, siltation, and sedimentation during construction and operations can cause temporary or permanent burial that can be lethal or have sub-lethal effects. Short-term increases in turbidity can also cause a decrease in light penetration and smothering of nearby coral colonies downstream of the dredging. Dredging operations have, in many cases, contributed to the loss or degradation of coral reef habitats either directly due to the removal or burial of reefs, or indirectly as a consequence of elevated turbidity and sedimentation (Erftemeijer, 2012). This burial may be detrimental to the productivity, growth, and survival of coral reef organisms, particularly filter-feeding organisms. The scale of the impacts will depend on the duration of the dredging, prevailing currents and waves, water depth, sediment characteristics (i.e. grain size), coral species, and frequency of disturbance. Chronic resuspension of sediments does not typically cause mortality but can lead to stress responses such as bleaching, excess mucus production, and partial mortality. Additionally, coral recruitment can be affected by smothering of substate or increased mortality of juvenile corals. Turbidity and sedimentation impacts are anticipated to be moderate occurring during dredging and immediately afterward. It is anticipated that following completion of the dredging, turbidity will subside, and sediments will be resuspended by waves and currents and settle into deeper, sand-dominated grooves. No chronic source of sedimentation is anticipated due to lack of sediment and excellent water circulation on the north side of GSC. The EMP will include a dredge operations plan (DOP) and BMPs for managing turbidity and sedimentation during dredging and pier construction.

5.7.1.4 Runoff and Deposition

Dredging and construction of the piers will be performed primarily from waterside equipment with no anticipated runoff from supporting land-based equipment. Dredging will be conducted by barge with the removed seabed to be pumped via pipelines upland and to the filled East Pier. Construction of the piers will be done utilizing the top-down method, which reduces impacts to the uplands and aquatic ecosystem by limiting the construction area to within the confinements of the piers themselves. Minimal impacts are expected from runoff of upland sources from the pier construction off the northern shoreline of Great Stirrup Cay. BMPs will be developed and instituted to minimize runoff and discharge of debris or waste.

On the southern shoreline, the final discharge pipe will be situated in a previously disturbed area where an out-of-service Ro-Ro/service dock is located. From the shoreline, a double silt boom will be situated approximately 50 ft from shore with a second silt boom at 75 feet from the discharge. With the discharge having already flowed through three settling ponds, it is anticipated that the effluent will contain minimal fines prior to entry into the nearshore waters on the south side of the island. Any additional fine materials should be encapsulated by the booms, thus causing minimal impact to surrounding waters, marine flora or fauna. Turbidity monitoring will be done according to the EMP's turbidity monitoring plan to ensure levels do not exceed allowable limits.

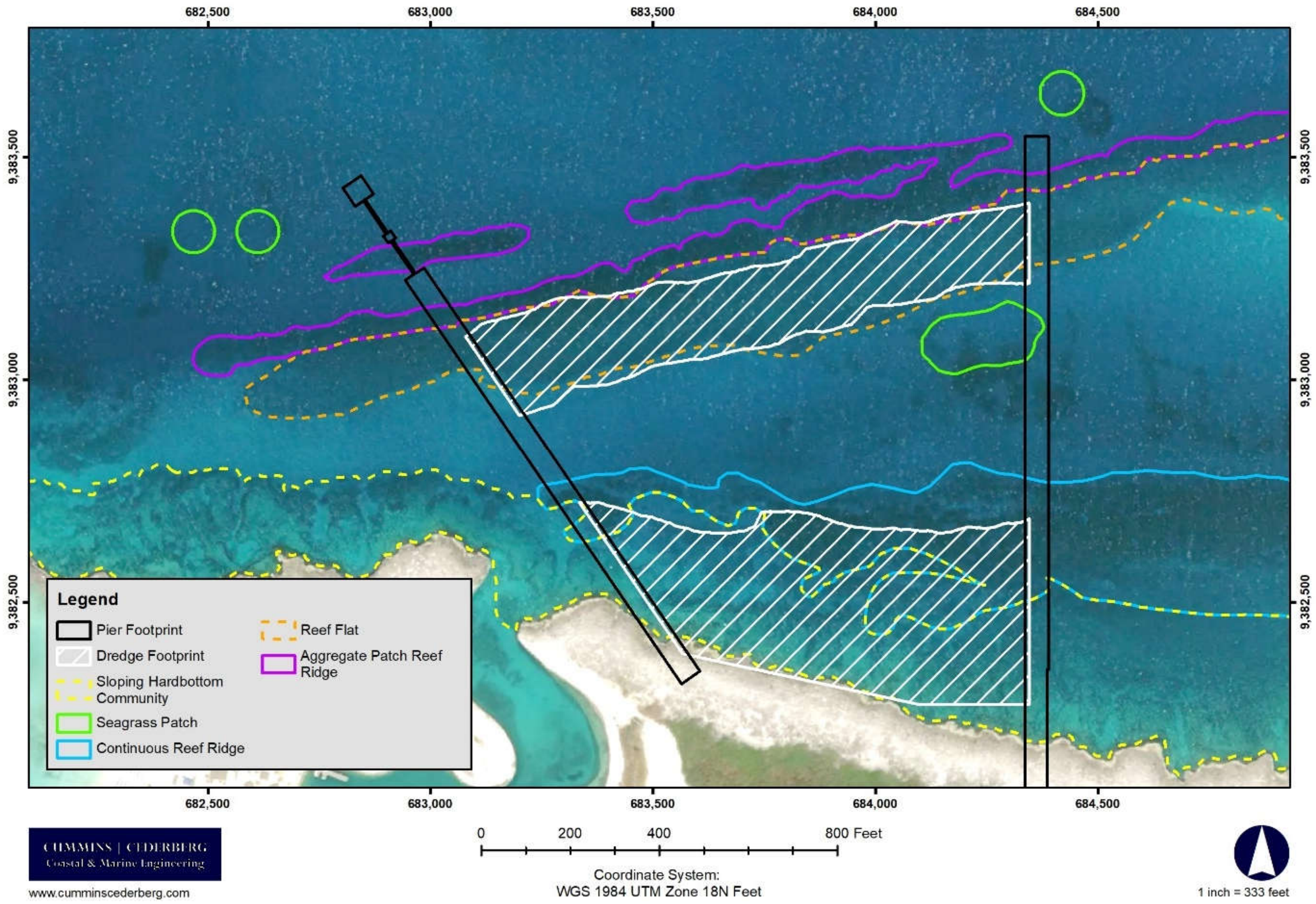


Figure 24: Pier and dredge footprint over habitat areas

Table 17: Estimated habitat impact by area, mean coral density estimates, and total number of hard coral colonies to be impacted within the dredge footprint and pier construction footprint

Habitat	Impact Area by Habitat (sq m)	Mean Density Total Hard Coral Colonies/sq m	Total Hard Coral Colonies	Mean Density Hard Coral Colonies/sq m (10-30 cm)	Total Hard Coral Colonies (10-30 cm)	Mean Density Hard Coral Colonies/sq m (>30 cm)	Total Hard Coral Colonies (>30 cm)
Within Dredge Footprint							
Sloping Hardbottom Community	19,806	2.0	39,612	0.4	7,922	0.0	0
Continuous Reef Ridge	8,906	4.8	42,749	2.0	17,812	0.7	29,924
Reef Flat	19,511	0.9	17,560	0.2	3,902	0.1	1,756
Aggregate Patch Reef Ridge	200	3.6	720	1.9	380	0.4	288
		Subtotals:	100,641		30,017		31,968
Within Pier Footprint							
Sloping Hardbottom Community	2,913	2.0	5,826	0.4	1,165	0.0	0
Continuous Reef Ridge	1,818	4.8	8,726	2.0	3,636	0.7	1,273
Reef Flat	1,508	0.9	1,357	0.2	302	0.1	151
Aggregate Patch Reef Ridge	472	3.6	1,699	1.9	897	0.4	189
		Subtotals:	17,609		6,000		1,612
		TOTAL:	**118,250**		**36,016**		**33,580**

5.8 Air Quality Impacts and Noise Levels

5.8.1 Nuisance Odors

A temporary decrease in air quality may be anticipated while construction is ongoing due to a presence of the cutter suction dredge conducting dredging operations, and support vessels. Additionally, while the pipeline is being laid, the confined material disposal sites are being construction, and the piers are being constructions, additional trucks and heavy machinery will be running their engines and releasing noxious odors into the atmosphere. Impacts will be short-term and minimal due to overall good air quality in the Bahamas, prevailing winds, and temporary nature of the construction activities.

While ships are in port, a decrease in air quality may be anticipated, as they often run diesel engines while moored to provide electrical power to passengers and crew. Emissions from these engines include nitrogen oxides, sulfur oxides, carbon dioxide, black carbon, diesel particulate matter, and microscopic soot known for damaging human health (Friedrich, Heinen, Kamakate, & Kodjak, 2007). Among other health and environmental impacts, these emissions contribute significantly to serious cardiovascular problems, premature death, acid rain, habitat destruction, and climate change (Environmental Protection Agency Clear Skies, 2002). Scientists estimate that by 2030, air pollution from ocean-going vessels in U.S. waters will increase by 100 to 200 percent (Friends of the Earth, 2012).

Some cruise lines have adopted a technology with the potential to greatly reduce dirty air emissions from ships at port. Known as cold ironing, this technology will likely be further developed in the future and potentially considered for all mooring opportunities. Cold ironing allows cruise ships to plug in to shoreside power and receive electricity to operate refrigeration, cooling, heating, and lighting systems without having to burn dirty fuel within the diesel engines. As an alternative, ships can burn cleaner fuel with lower sulfur contents.

5.8.2 Construction Dust

Dust from construction activities is an additional source of pollution. Upland activities associated with earthworks and clearing vegetation during placement of the dredging pipelines and creation of the confined disposal facilities will cause short-term dust pollution.

5.8.3 Noise from Heavy Equipment

Short-term noise and vibration impacts may occur during development due to earthmoving and related construction activities. This issue is temporary and expected to dissipate upon Project completion. **Table 18** contains estimated noise levels to be anticipated during construction (Bolt & Bolt, 1971). Transmission of noise and vibration are limited by the distance from their sources. Long-term adverse noise impacts are dependent on the frequency and duration of cruise ships in port.

Table 18: Noise level ranges of typical construction equipment

Equipment	Levels in dBA at 50 ft[a]
Front Loader	73-86
Trucks	82-95
Cranes (Moveable)	75-88
Cranes (Derrick)	86-89
Vibrator	68-82
Saws	77-82
Pneumatic Impact Equipment	83-88
Jackhammers	81-98
Pumps	68-72
Generators	71-83
Compressors	75-87
Concrete Mixers	75-88
Concrete Pumps	81-85
Back Hoe	73-95
Pile Driving (Peaks)	95-107
Tractor	77-98
Scraper/Grader	80-93
Paver	85-88

[a] Machinery equipped with noise control devices or other noise-reducing design features does not generate the same level of emissions as that shown in this table.

5.9 Impacts to Utilities and Local Infrastructure

As discussed in **Section 2.3**, there are provisions for upgrades to the existing infrastructure of the island amenities, including the wells, storage areas, water distribution methods, wastewater treatment equipment, power generation, data and communication methods, and fueling stations. Utilities lines, including power, water, data and communication, and fuel will be installed from the existing back of house area to the piers and the ro-ro ramp. Benefits from these upgrades are anticipated to be long-term and will enhance future cruise ship operations, safety and security, guest amenities, on-island transportation, and back-of-house operations.

5.10 Overview of Communities, Demographics, and Employment

5.10.1 Economic Impacts

Great Stirrup Cay (GSC) is cruise ship private island destination in the Bahamas. Its owner and operator, Norwegian Cruise Lines (NCL), proposes to undertake a $91M development of the island to include a pier ($75M) and additional water and wastewater capacity ($16M) to meet the demand of increased visitors to the island. NCL currently employees 150 persons on the Cay. During construction, an additional 85 persons are expected to be employed as well as the charter of local water taxis for interisland travel.

Post construction NCL expects to increase visitors to the private island from 286,357 in 2019 to 714,000. This increase drives economic stimuli in the form of Bahamas Government passenger tax of $18.00 per person, additional hire of boat captains and tour operators to meet increased demand, and the increased patronage of Bahamian owned and operated retail outlets on the island. NCL is desirous to establish a reliable and sustainable supply of local produce and seafood and engage local service providers where possible.

6 ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) will be developed in coordination with DEPP to ensure that there are adequate and appropriate management systems in place, specific BMPs for various components of the project are developed, and mitigation and monitoring measures are in place to comply with legislative requirements. The EMP is a living document that will be developed and implemented prior to, during, and following construction (i.e., during long-term operations). The EMP will generally address the following areas:

- Environmental Management System
- Construction Management Plans
- Environmental Mitigation
- Environmental Monitoring

Some of the material will be used as reclaimed and used fill for the proposed closed-cell East Pier, while the remainder is intended to serve as a base for a future solar farm project. All marine work, including dredging, shall not impede navigational marine traffic. Following is an outline of the types of information to be included in the EMP for this Project.

1. Environmental Management System
    1.1. Environmental Policy Statement
    1.2. Structure and Framework
    1.3. Environmental Management Tools
    1.4. Roles and Responsibilities
2. Project Permits and Documents
3. Schedule and Milestones
4. Construction Management Plans
    4.1. Dredging Operations and Methods
    4.2. Dredge Material Management
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7 CONCLUSIONS AND RECOMMENDATIONS

This EIA has been carried out to comply with the EIA Regulations, 2020 and seek a Certificate of Environmental Clearance (CEC) from DEPP for the dredging of seabed, construction of piers, and upland clearing for the confined disposal areas and to accommodate construction and future roadways. The project is necessary to reduce missed ports of call for cruise passengers, increase economic opportunities, and provide additional employment for local residents during construction and long-term operations of GSC.

To prepare this EIA, detailed studies were conducted to document marine and terrestrial baseline conditions. Additional prior studies including geotechnical, bathymetric, and topographic surveys were reviewed and incorporated into this EIA. From an impact perspective, there will be a significant direct impact to marine resources through the removal of ~8 acres of coral reef and seagrass habitat. Upland earthworks and clearing will remove approximately 17.6 acres of vegetation for creation of the settlement ponds and another 3.5 acres for a construction laydown area and for future roadways and back-of-house infrastructure/staff housing.

With proper planning and a detailed development and application of a EMP where mitigation and best management practices are created to offset to the greatest extent possible, many of the impacts generated during construction and operations should be minimized or eliminated for the proposed Project. Mitigation opportunities to be incorporated into the EMP may include coral relocation, opportunities for education and outreach, artificial reef creation, removal of invasive exotic vegetation and planting of native plants. Secondary impacts will be mitigated through adherence best management practices and standards that will be included in the EMP.

In addition, the capital investment will positively impact the local community and the region by providing employment and occupational opportunities for skilled labor while expanding sales and service income from increased tourism.

It is recommended that due to the positive socio-economic impact and the development and adherence to a robust EMP and mitigation plan, the Project should move forward as proposed. Although environmental impacts are identified in the marine and terrestrial environments as both permanent and temporary, they have been minimized through a review of the alternatives and careful planning, and the application of environmental standards and requirements, and should be considered acceptable relative to the benefits gained and mitigation approaches.

The following recommendations are based on the assessment of impacts, short-term and long-term, to this Project site on Great Stirrup Cay. The proposed recommendations include:

a) Development of a robust Environmental Monitoring Plan (EMP) with detailed plans on each phase of the project to include standard practices and alternative means to mitigate and offset impacts during construction and long-term operations.

b) Alternative Energy Sources. Great Stirrup Cay is ideal for the introduction of alternative sources, namely, passive solar and photovoltaic array. It is recommended that conventional energy sources such as diesel and gas be supplemented by alternative energy sources or achieved by high efficiency standards.

c) Reduction of waste and land-based pollution. Limiting the production of land-based waste through recycling, composting, and incineration reduces the transportation of waste items to local landfills under capacity pressure.

d) Use of a local Bahamian workforce with minimal environmental impacts through the use of renewable energy technology, smart building design, and high efficiency products.

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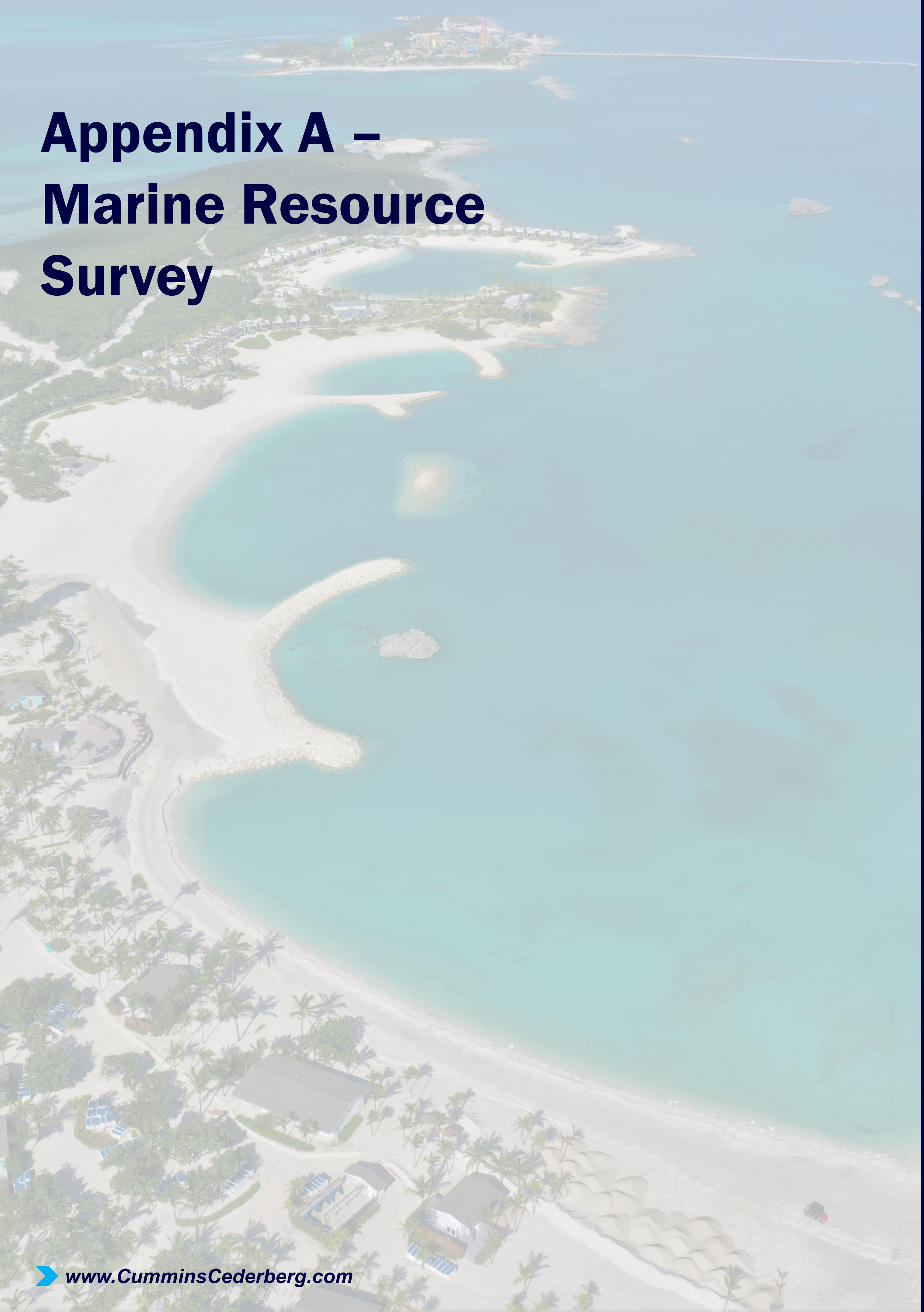
APPENDICES



Appendix A – Marine Resource Survey

Appendix A

CUMMINS | CEDERBERG
Coastal & Marine Engineering

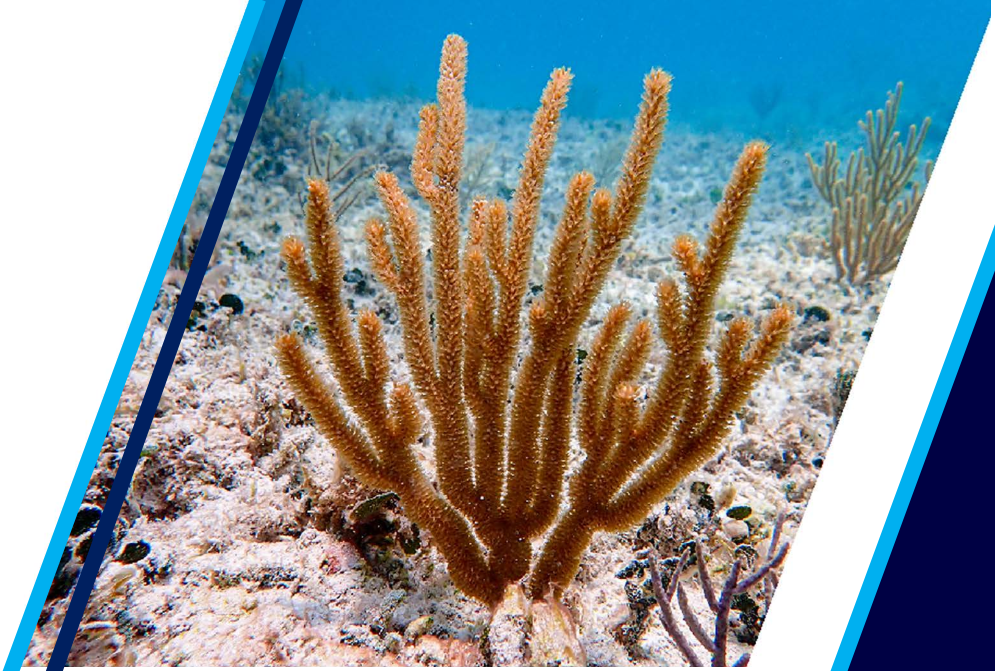
Marine Resource Survey

Proposed Cruise Ship Piers
DRAFT

Great Stirrup Cay

The Bahamas

October 2020



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1 INTRODUCTION

This benthic survey report was prepared for Bermello Ajamil & Partners, Inc., for the Proposed Cruise Ship Piers (Project) in Great Stirrup Cay, following a detailed mapping and characterization field effort conducted during July 2020. The survey was performed to characterize and map the distribution of marine resources within the vicinity of the proposed piers and dredge footprint. **Figure 1** shows the location of the approximate marine resource survey area (Project site) and its proximity to Great Stirrup Cay. This report presents the results of the marine survey in support of the overall effort to document background conditions and serve as a basis to determine environmental impacts during the Environmental Impact Assessment (EIA) process.

1.1 Project Background

Norwegian Cruise Lines (NCL) is proposing to construct a “new harbor” with piers for berthing two cruise ships along with beach improvements for an existing out-island destination for cruise tourists. In support of an EIA required for authorization of the berthing by the Bahamas Department of Environmental Protection and Planning (DEPP), a benthic survey in the area of proposed pier works was necessary to document the baseline conditions and marine environmental resources present.

The current survey was designed to assess the density of hard corals (Scleractinian) and soft corals (octocorals), determine the condition and quantity of submerged aquatic vegetation, map the habitat transitions from the shoreline waterward, and document the presence of other marine resources. Additionally, fish and invertebrate species observed during the survey were noted to create a qualitative list of notable species within the survey area.

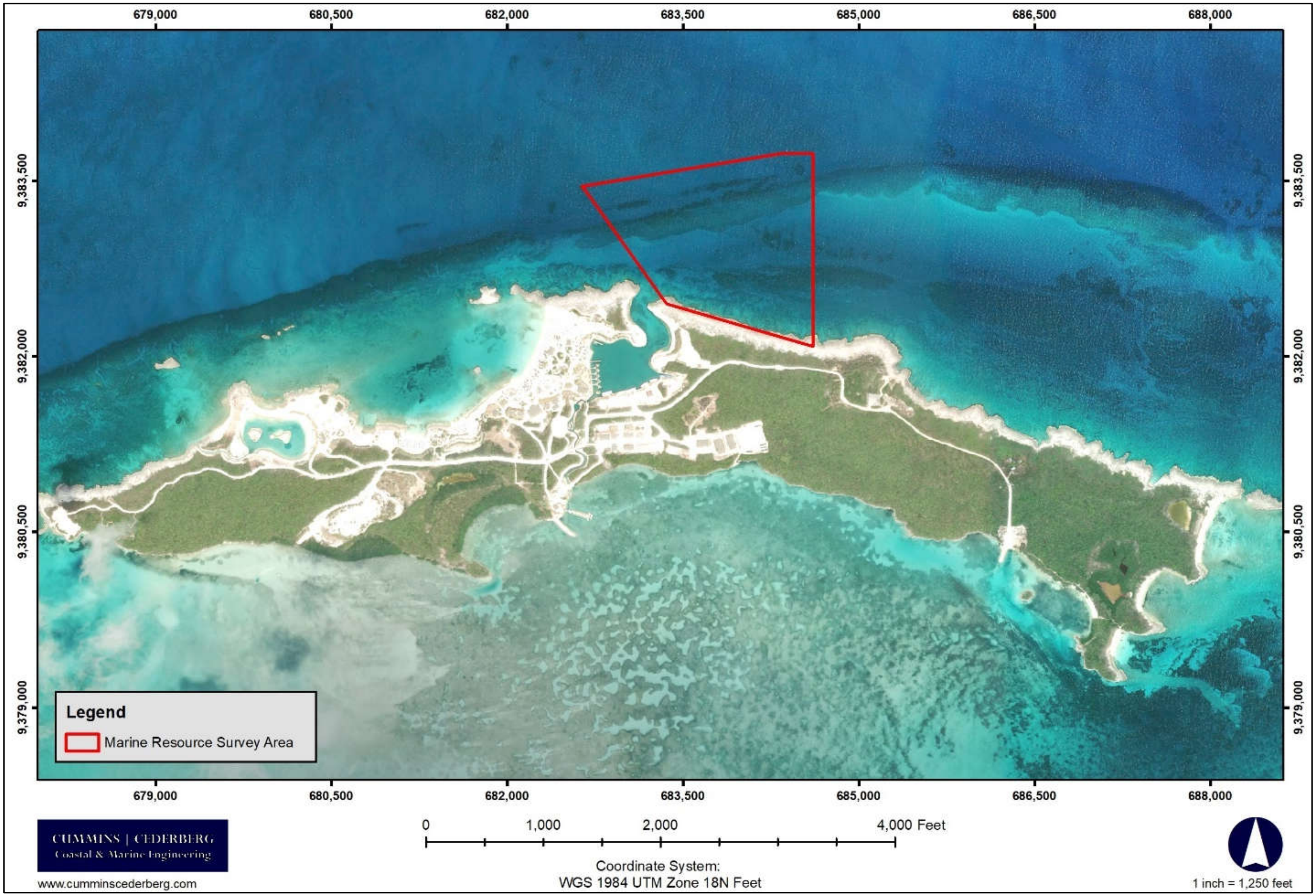

FIGURE 1 – APPROXIMATE MARINE RESOURCE SURVEY AREA

2 HABITAT MAPPING AND CHARACTERIZATION

2.1 Survey Methodology

The survey methodology was developed to include cross-habitat mapping transects and habitat characterization transect and ground-truthing points, as shown in **Figure 2**. Investigation sites were selected based on preliminary mapping of habitat types utilizing aerial imagery in ArcMap 10.7.1 (GIS software), habitat descriptions from the 2008 EIA conducted by Coastal Systems International (CSI)[1] , and planned locations of the proposed piers and dredging footprint to provide adequate sampling of potential direct and indirect areas of impact. All pre-plotted survey transects and points were uploaded in the HYPACK hydrographic software and utilized daily in the field for navigation and locating data collection transects and points.

2.2 Mapping Transects

Three (3) cross-habitat mapping transects (T1 – T3 in **Figure 2**) were used to map the transition of habitats from onshore to offshore. In the field, the beginning, midpoints, and the end points of each transect were located from the survey vessel using HYPACK integrated with an onboard Global Positioning System (GPS) with sub-meter accuracy, and marked with temporary surface buoys. Biologists would obtain a heading for the transect from HYPACK and enter the water as close as possible to the nearshore beginning point of each pre-planned transect.

The scientific dive team conducted a line-intercept survey along each of the cross-habitat transects to document marine habitat transitions and qualitatively describe characteristics and conditions. While towing a surface buoy, the divers stopped at each beginning and ending of a habitat transition (onshore to offshore) and signaled the vessel operator and navigator to record the location (geographic coordinates) in HYPACK. Each position collected was sequentially numbered so that each point could be correlated with the appropriate habitat transition point during post-processing in ArcMap. While the lead diver was signaling the vessel operator and noting the habitat transition that correlated with each point, the second diver collected representative photographs and/or video segments of each habitat type and recorded observations about species present, water depths, habitat relief (i.e. max height), and other physical observations.

2.3 Characterization Transects and Ground Truthing Points

A series of eleven (11) habitat characterization transects and ten (10) ground-truthing points (**Figure 2**) were pre-selected to characterize each preliminary mapped habitat type. The type of data collection that was anticipated to be conducted at each site is provided in **Table 1**, followed by a detailed description of the methodologies.

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[1] Coastal Systems International, Inc. 2008. Environmental Impact Assessment, Great Stirrup Cay, Berry Islands, Commonwealth of the Bahamas. Prepared for Norwegian Cruise Lines. 152 pp.

TABLE 1 – PLANNED DATA COLLECTION METHODOLOGY

Anticipated Habitat	Point/Transect	Method	Radius or Length	Video/Photo
Groundtruthing Points				
Nearshore/Ironshore (IS)	Points 1-3	Percent Cover (Quadrats) and Radial Swims	10 m	Photos
Patchy Community (PC)	Points 4-5		10 m	
Offshore Patches (OP)	Points 8, 9		Edge of patch	
Transects				
Slope Community (SC)	Transects 1-2	Point intercept, Belt Transects for Coral and Octocoral Counts	50 m	Video, Photos
Hardbottom (HB)	Transects 3-5		30 m	
Reef Flat (RF)	Transects 6-8		50 m	
Reef – Deep (RD)	Transects 9-11		50 m	
Offshore Patches (OP)	Points 6, 7, 10		10 m	

2.3.1 Characterization at Groundtruthing Points

Temporary surface buoys were placed at each pre-determined ground-truthing point and divers descended the buoy line to the seafloor. One biologist collected percent cover data while the second diver collected representative photographs and qualitative data of the surrounding area (i.e. habitat type, fish species observed, etc.). Percent area cover by each substratum (e.g., live coral, dead coral, pavement, macroalgae, etc.) making up at least one percent of a 1 m^2 quadrat, along with the maximum relief (in cm) was recorded. Each hard coral colony was identified to species, measured, and described relative to any instances of predation, disease, bleaching, or mortality. All octocorals were identified to genus and maximum height was measured (in cm). Each quadrat and representative species were photographed.

After the quadrat data was collected, a transect tape was extended north from the point, out 10 meters or to the edge of the habitat area. The two divers conducted a radial swim with one diver at the end of the transect and another positioned at a mid-point. The divers conducted a full 360-degree swim, with both divers taking qualitative notes on the primary habitat type, dominant species, and habitat transitions.

2.3.2 Point Intercept Transects

Transect lines were deployed on all habitat characterization transects and at several ground-truthing points (**Table 1**) for the collection of point intercept data. Using a weighted buoy, divers deployed transects from a starting point for 10 m for points, and 30 m or 50 m for transects, along a predetermined heading. An experienced biologist conducted the point-intercept survey noting the substratum below every half-meter (0.5 m). Substrata categories included live coral, dead coral, octocoral, sponge, pavement, rubble, sand, macroalgae, turf algae, crustose coralline algae (CCA) or other (e.g., anemone, annelid, etc.). For all hard corals or octocorals intercepting the transect line, divers recorded organisms to either genus (octocorals) or species level (hard corals). All other organisms along the transect line were recorded to their corresponding benthic category (e.g., tunicates, hydroids, bryozoan, etc.). Qualitative notes were also taken on observed fish species, invertebrates, and notable observations.

2.3.3 Coral Belt Transects

Along the same transects where point-intercept data was collected, divers conducted a belt-transect survey for all corals (hard and soft) within 0.5 meters of either side of the transect line. Each octocoral encountered was identified to genus and the approximate maximum height (by size category) of each octocoral was recorded. All hard coral colonies >10 cm were documented by species and placed into size categories along with notes on the general condition if colony was notably afflicted by recent mortality, bleaching, disease, or signs of predation. Photographs of each colony were taken, with a ruler included for scale. Photographs included close-up views of any bleaching, disease, or other perturbations if present. It was noted if the colony was loose, fallen, and reoriented if detached.

2.3.4 Video Data

Video data was collected at an approximate 45° angle along the entirety of each transect. A slate or clipboard with the project name, date, reef zone, and site number were recorded at the beginning of the video segment followed by a panoramic view of the start of the transect. A diver swam the length of the transect line and recorded video at an oblique angle approximately 40 cm from the seafloor. At the end of the transect line, another panoramic shot was taken before turning off the camera.

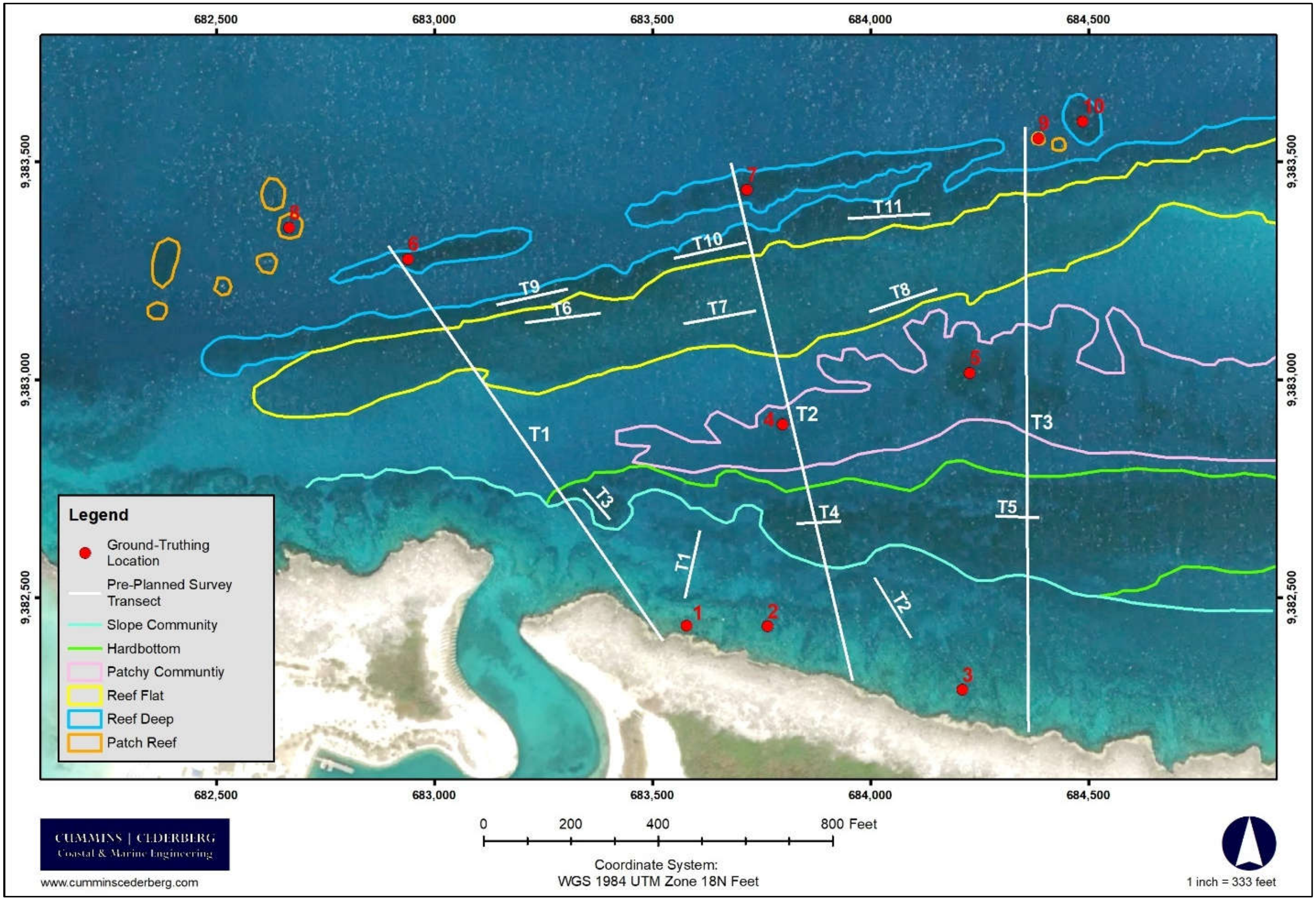

FIGURE 2 – PRE-PLANNED SURVEY TRANSECTS, GROUND TRUTHING POINTS, AND ANTICIPATED HABITAT TYPES

3 RESULTS

The field survey and data collection were performed 18 – 22 July 2020 from a support vessel (**Photo 1**) by experienced marine biologists (**Photo 2**) and a HYPACK operator/navigator. Due to extensive resources (i.e. hard and soft corals) within the area, the coral belt-transect field methodology was altered slightly during surveying to accommodate the completion of all transects and points. Belt-transect data was collected for shorter distances along the transect lines (between 10 and 35 meters), rather than the full length of the transect line (30 to 50 m); video and point-intercept data were still collected the entire length of the transect lines.

Transect and ground-truthing point locations were also adjusted to represent accurate field locations. As shown in Figure 3, a total of fourteen (14) transects (T1 – T14) were surveyed, including eleven (11) characterization transects (T1 – T11) and three (3) mapping transects (T12 – T14). Additionally, a total of eleven (11) ground-truthing points were surveyed. In addition to transect surveys, biologists collected representative photographs (**Appendix A**) and compiled a list of all species observed (**Appendix B**), including all hard and soft coral colonies, submerged aquatic vegetation, macroinvertebrates and fish. A total of twenty-seven (27) species of hard corals and fourteen (14) genera of octocorals were documented (**Appendix B**), with numerous coral colony specimens exceeding 1-m in either width, height, or both (**Photos A-7**, **A-9**, and **A-13**).

PHOTO 1 – SURVEY VESSEL STAGED AT THE NORTH HARBOUR DOCKS

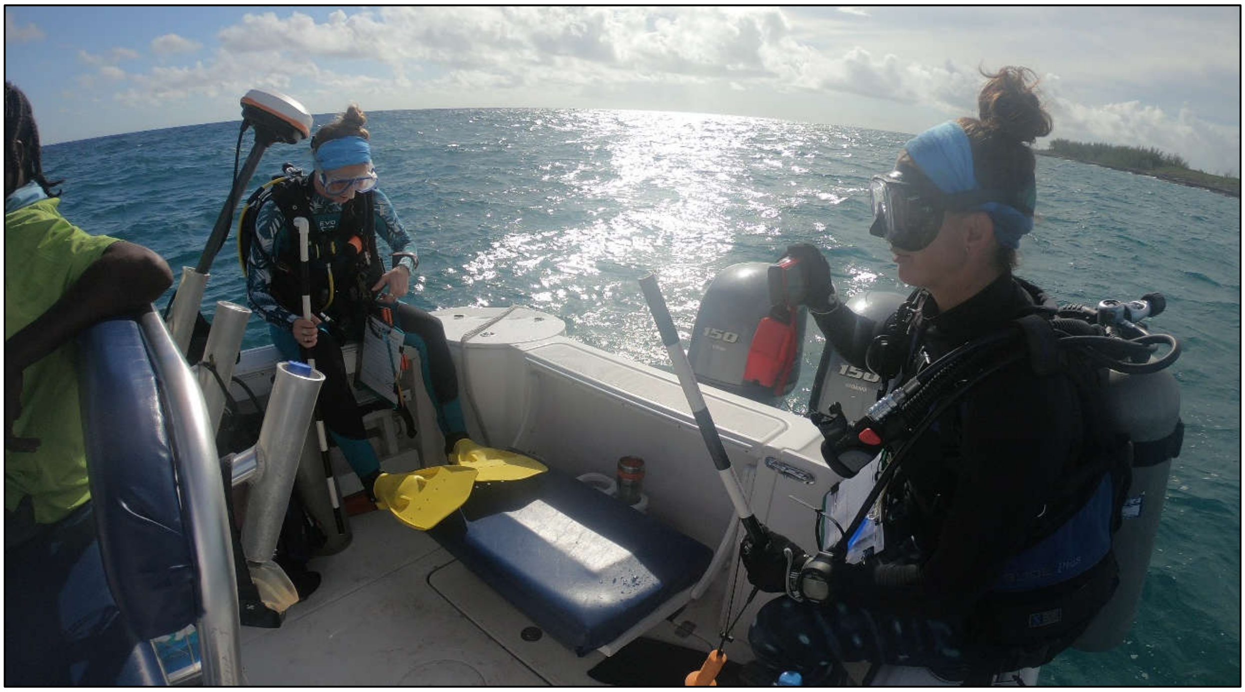

PHOTO 2 – MARINE BIOLOGISTS PREPARING TO DIVE ON SURVEY LOCATION

3.1 GIS Mapping and Characterization

3.1.1 Habitat Mapping

To create a detailed habitat map and define the varying marine habitat types, existing information was reviewed, and survey data collected in the field was analyzed. First, all data by the divers on habitat transitions along the mapping transects (T12 - T14 in **Figure 3**) and the associated geospatial data collected along these same transects was processed. Initially, all geospatial data gathered in HYPACK were downloaded into ArcMap to display points of habitat transitions, starts and stops of transect lines (if differing from the pre-planned lines), and areas of interest. Using field-collected notes and photos/video, biologists performed a desktop analysis cross-referencing specific habitat characteristics and data with the latitude/longitudes and specific locations. The points of transitions along T12 - T14 were overlain on aerial imagery allowing biologists to visually interpret habitat transitions in a spatial context. Resulting initial maps showed specific transitions between areas and outlined patches of reef and submerged aquatic vegetation. To determine specific characteristics, data from the habitat characterization transects (T1 – T11) and ground truthing points (P1 – P11) were analyzed and interpreted and along with current aerial imagery, and best professional judgement, the different habitat areas were described and final boundaries interpolated.

3.1.2 Habitat Characterization

Habitat types were characterized in detail based up on field observations and to some degree a standardized habitat characterization method developed in Florida[2]; habitat types within the survey area were recategorized and renamed from the pre-survey naming system to more accurately what was observed in the field and reflect the quantitative data collected. The final habitat characterization types and descriptive definitions used for the purposes of this report are provided in **Table 2**. **Figure 4** shows the final interpolated habitats within and adjacent to the marine resource survey area.

TABLE 2 – BENTHIC HABITAT TYPES AND CHARACTERISTICS

Habitat Type	Description
Sloping Hardbottom	Nearshore hardbottom habitat that slopes down from the shoreline to pavement and hardbottom sparsely colonized by smaller hard and octocoral species with scoured barren areas of carbonate rock and sand channels.
Continuous Reef Ridge	Coral reef habitat that with high relief (>1m) oriented parallel to shore and dominated by hard corals, usually larger in size.
Reef Flat	Low relief (<1m) hardbottom habitat colonized by both hard corals and octocorals, but primarily dominated by octocoral species.
Aggregated Patch Reef Ridge	Cluster of coral reef habitat formations/patches that may be separated by a halo of bare substrate/sand area but are too close together to map separately as individual patch reefs.
Seagrass	Areas where seagrass is present, with varying percent coverages and densities; may be monospecific seagrass or be intermixed with macroalgae species.

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[2] Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute (2017). Coordinated Coral and Hardbottom Ecosystem Mapping, Monitoring and Management, Year 5. DEP AGREEMENT NO. CM619. 35 pp

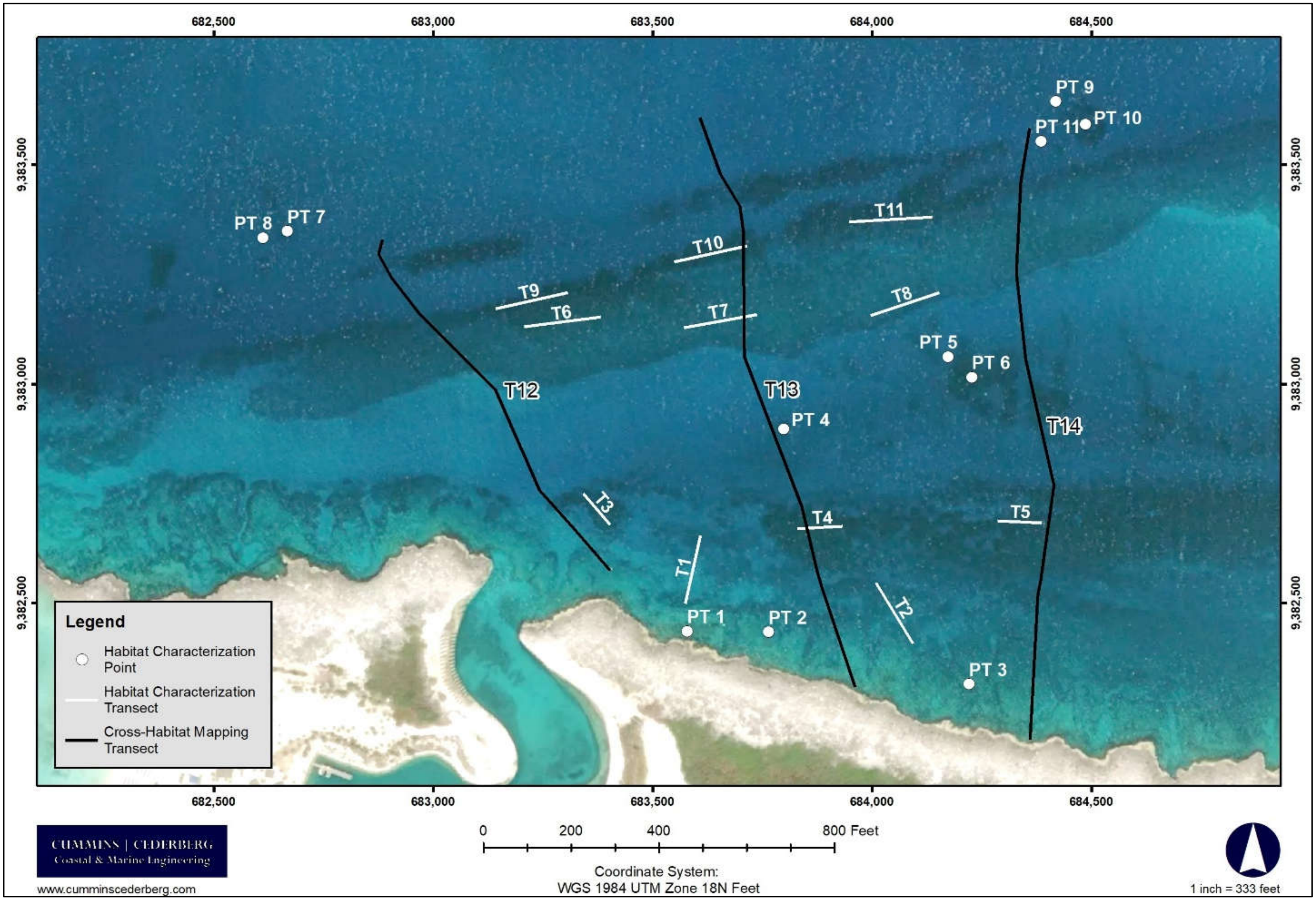

FIGURE 3 – TRANSECT AND POINT LOCATIONS COMPLETED DURING BENTHIC HABITAT SURVEY

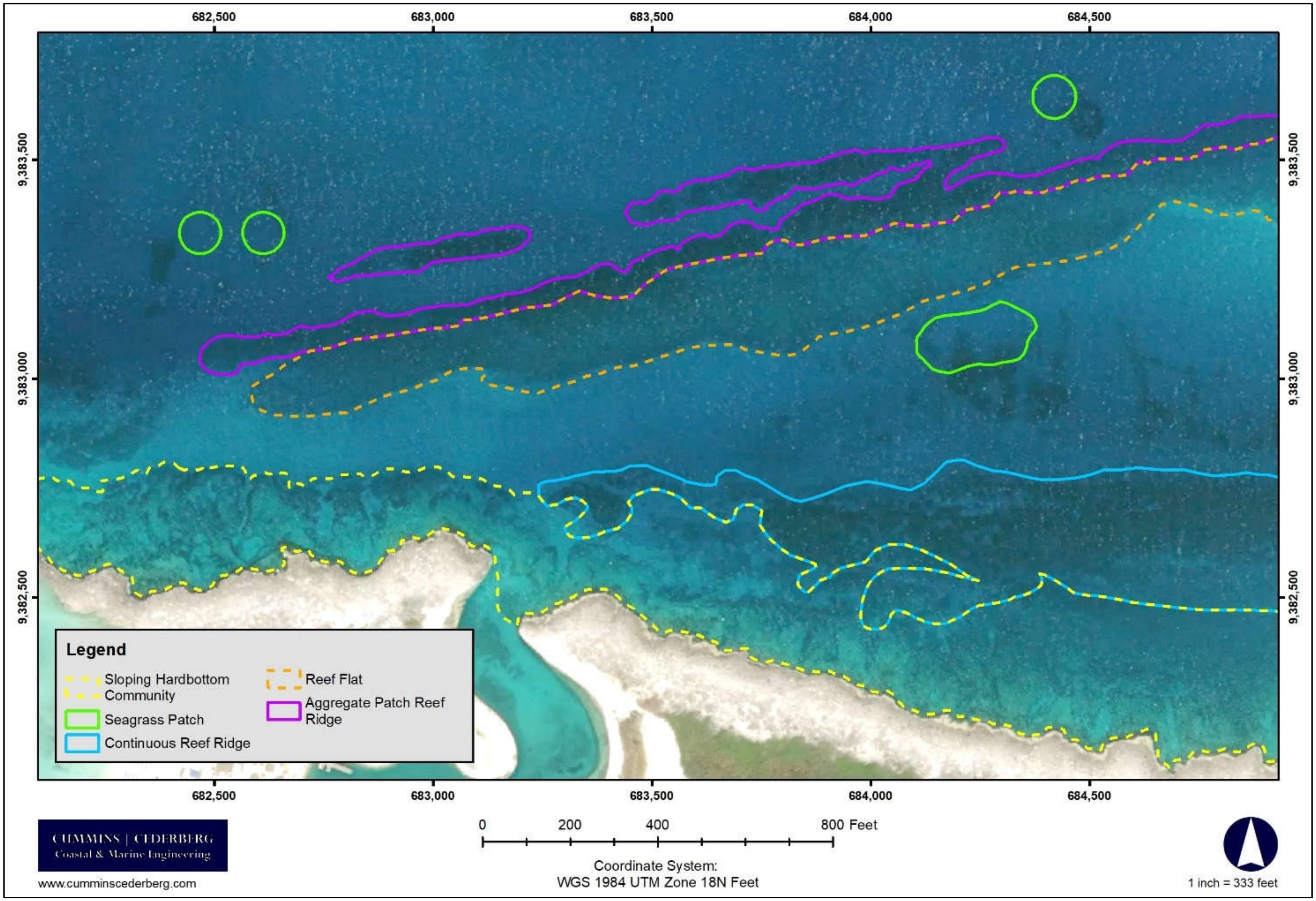

FIGURE 4 – BENTHIC HABITAT TYPES WITHIN SURVEY AREA

3.1.2.1 Groundtruthing Points

At each of the groundtruthing points, percent cover data and representative photographs, and descriptions of the surrounding area (i.e. habitat type, fish species observed, etc.) were collected. Points P1 – P3 were located within the sloping hardbottom community and were primarily colonized by sediment, or turf algae with low percentages (1%) of hard corals and octocorals and sponges (1-2%). Points P5, P8, and P9 were either dominated by seagrass and macroalgae (P5/6) or were sparsely colonized by seagrass (P8 and P9). **Table 3** provides the percent cover data from the quadrat analysis. Points P4, P6 and P7 had only sand within the entire radius surveyed around the point.

TABLE 3 – PERCENT COVER FROM GROUNDTRUTHING POINTS

Point #	Percent Cover							
	Sediment	Hard Coral	Octocoral	Macro-algae	Turf Algae	Sponge	Seagrass	Other
1	91	1	1	5		1		1
2	1	1	1	5	90	2		
3	97		1	1	1			
4	100							
5	15			15			70	
6	100							
7	100							
8	84			1			15	
9	85						15	

3.1.2.2 Percent Cover Data

Along each of habitat characterization transects, divers conducted a line intercept survey and assessed what substratum was present every 0.5 meters. **Table 4** and **Figure 5** show the percent cover of each individual substratum (i.e. live coral, sand, etc.) along each of the eleven (11) transects (T1 – T11) surveyed. Live coral coverage ranged from 0% (T2) to 15% (T5 and T10) with octocoral coverage ranging from 0% (T3) to 21% (T4), on average. Transect 2, located within the sloping hardbottom community, closest to shore, had the highest percentage of sand of all the transects, and lower percentages of living organisms.

TABLE 4 – PERCENT COVER OF HABITAT SUBSTRATA BY TRANSECT NUMBER

Habitat Substrata	Transect Number										
	1	2	3	4	5	6	7	8	9	10	11
Live Coral	3%	0%	7%	11%	15%	9%	1%	1%	11%	15%	9%
Dead Coral	0%	0%	0%	5%	2%	0%	0%	0%	0%	1%	0%
Octocoral	4%	8%	0%	21%	7%	5%	3%	7%	4%	6%	4%
Macroalgae	5%	8%	28%	10%	15%	17%	4%	3%	19%	13%	14%
Sponge	0%	0%	2%	5%	5%	3%	5%	3%	6%	7%	4%
Sand	33%	71%	31%	2%	33%	8%	0%	3%	10%	16%	33%
Pavement	0%	0%	21%	0%	0%	0%	0%	0%	1%	10%	20%
Turf Algae	3%	6%	10%	41%	23%	0%	0%	0%	0%	30%	0%
CCA	0%	0%	0%	5%	2%	0%	0%	0%	1%	0%	2%
Rubble	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
Hardbottom	52%	7%	0%	0%	0%	58%	87%	83%	48%	2%	15%
Zoanthid	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%

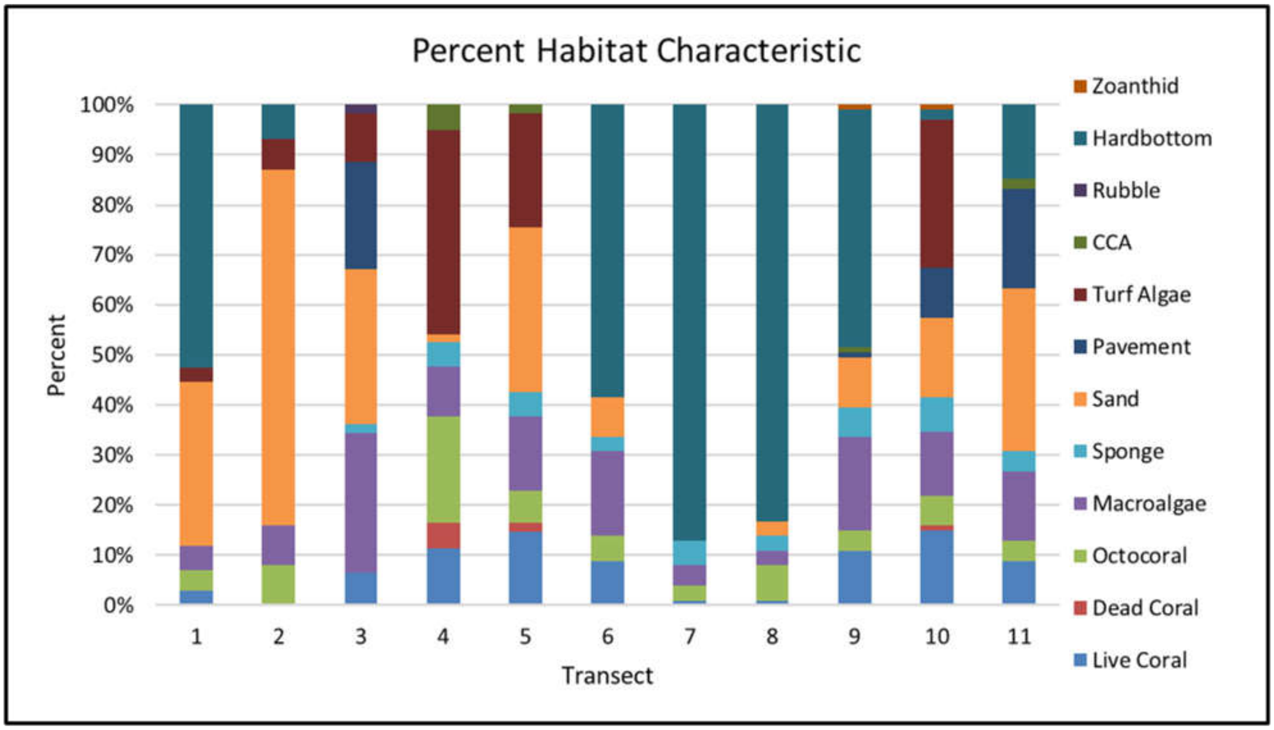

FIGURE 5 – PERCENT COVER OF HABITAT SUBSTRATA BY TRANSECT NUMBER

Using the overlay of the transects locations (**Figure 3**) on the overall habitat map (**Figure 4**), data from the transects that fell into the four habitat types (sloping hardbottom, continuous ridge reef, reef flat, and aggregate patch reef ridge) were analyzed collectively to get a holistic picture of percent cover of the substrata by habitat type. **Table 5** and **Figure 6** present the overall percentages for each habitat. Living hard coral was greatest along the aggregate patch reef and continuous reef ridge, with a mean percent cover of 12%, and 11% respectively. Both the reef flat and sloping hardbottom had lower live hard coral cover of 4% and 1%, and high coverage of sand and/or hardbottom (uncolonized substrate). Octocoral coverage was less than 10% in all habitats, although this may be a bit misleading because surface area for these organisms is greatest above the substrate where the plumage is within the water column, whereas for other organisms such as hard corals and sponges that spread both horizontally and vertically from the substrate.

TABLE 5 – PERCENTAGE OF SUBSTRATA BY HABITAT TYPE

Habitat Substrata	Habitat Type			
	Sloping Hardbottom	Continuous Reef Ridge	Reef Flat	Aggregate Patch Reef Ridge
Live Coral	1%	11%	4%	12%
Dead Coral	0%	2%	0%	0%
Octocoral	6%	9%	5%	5%
Macroalgae	6%	17%	8%	15%
Sponge	0%	4%	4%	6%
Sand	53%	21%	4%	19%
Pavement	0%	7%	0%	10%
Turf Algae	4%	26%	0%	10%
CCA	0%	2%	0%	1%
Rubble	0%	1%	0%	0%
Hardbottom	30%	0%	76%	21%
Zoanthid	0%	0%	0%	1%

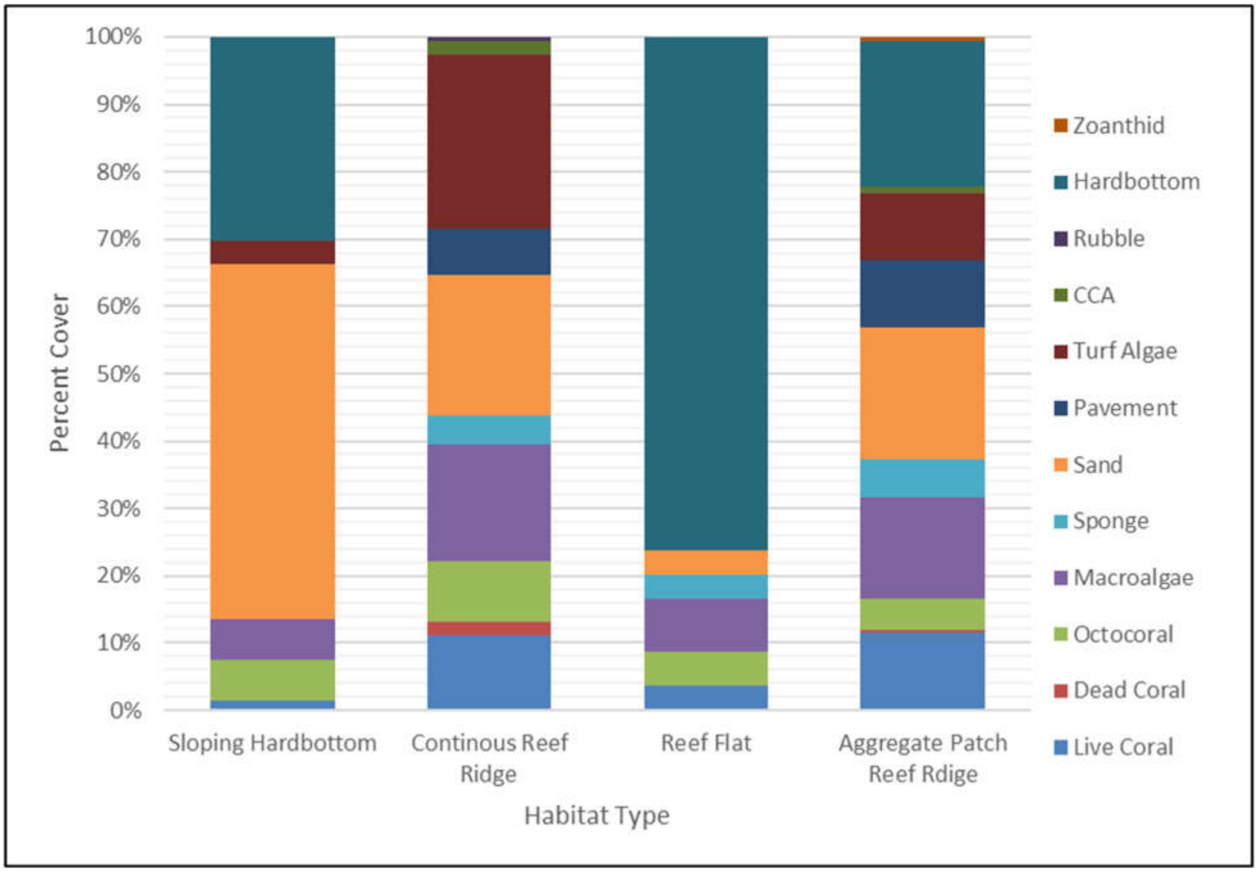

FIGURE 6 – PERCENTAGE OF SUBSTRATA BY HABITAT TYPE

3.1.2.3 Coral Density Data

As described in **Section 2.3.2.** biologists surveyed and documented all hard coral and octocoral colonies within a 1-m swath along lengths of each of the characterization transects. Data was compiled and analyzed to determine density estimates along each transect and within each of the four habitat types described in **Table 2** of **Section 3.1.2**.

Table 6. and **Figure 7** and **Figure** 8 show hard coral densities by transect and by size categories of hard coral colonies. Density estimates are greatest for all coral colonies along T4 and T10, at 7.9 colonies/m^2 and 4.9 colonies/m^2. Larger hard coral colonies between 10 cm and 30 cm were most prevalent along T5 and T10, with the largest hard coral colonies (>30 cm) recorded along T4 with 1.3 hard coral colonies >30cm per m^2.

Table 6 – Hard Coral and Octocoral Density by Transect, and Size Category (Hard Corals Only)

Transect	Hard Coral Density (per m^2)	Octocoral Density (per m^2)	Hard Corals 10cm - 30cm (per m^2)	Hard Corals >30cm (per m^2)
1	3.1	2.0	0.7	0.0
2	0.9	3.1	0.0	0.0
3	2.3	2.1	1.7	0.3
4	7.9	4.4	1.2	1.3
5	4.2	3.3	3.1	0.4
6	2.2	2.2	0.4	0.3
7	0.5	3.0	0.1	0.0
8	0.1	3.6	0.1	0.0
9	3.9	5.0	1.0	0.3
10	4.9	4.1	3.1	0.5
11	2.0	4.0	1.6	0.4

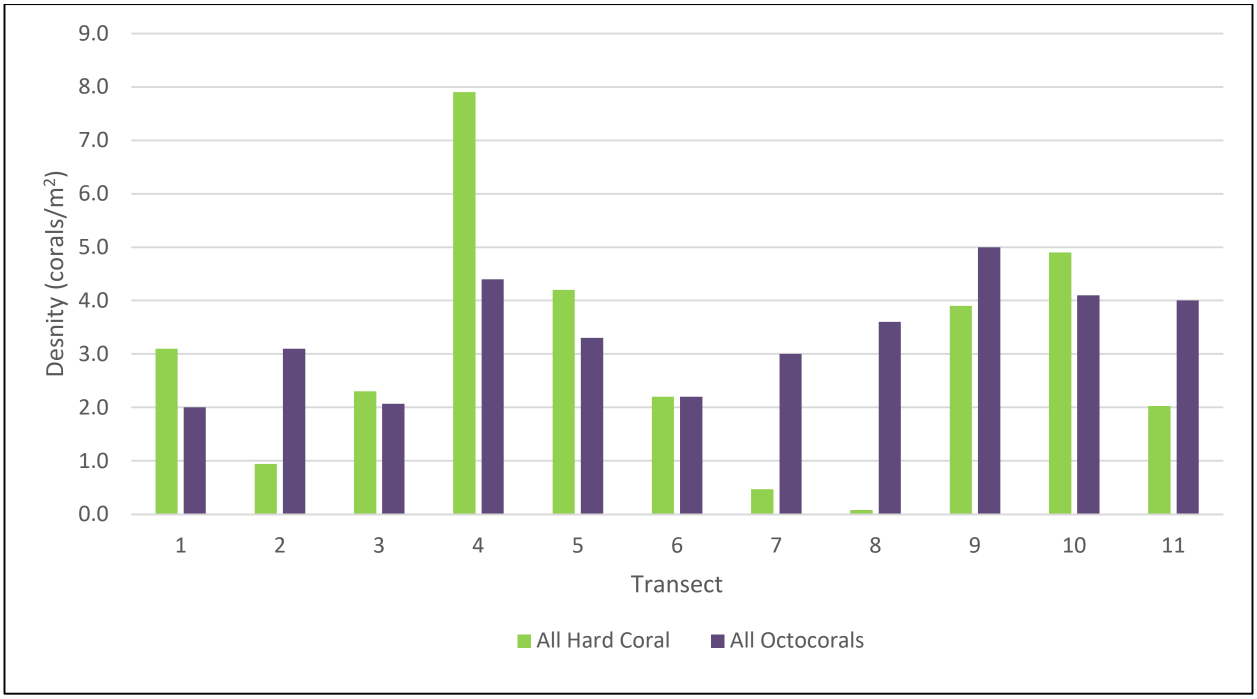

FIGURE 7 – OVERALL HARD CORAL AND OCTOCORAL DENSITIES BY TRANSECT

By habitat type, the contiguous reef ridge and aggregate reef flat have the greatest mean hard coral densities at 4.8 and 3.6 colonies/m^2, respectively, with the larger colonies (10 to 30 cm; density 2.0/m^2) and largest (>30cm; 0.7/m^2) on the contiguous reef ridge. **Table 7** and **Figure 9** provide the density data by transect within their respective habitat categories, and the mean densities within each habitat.

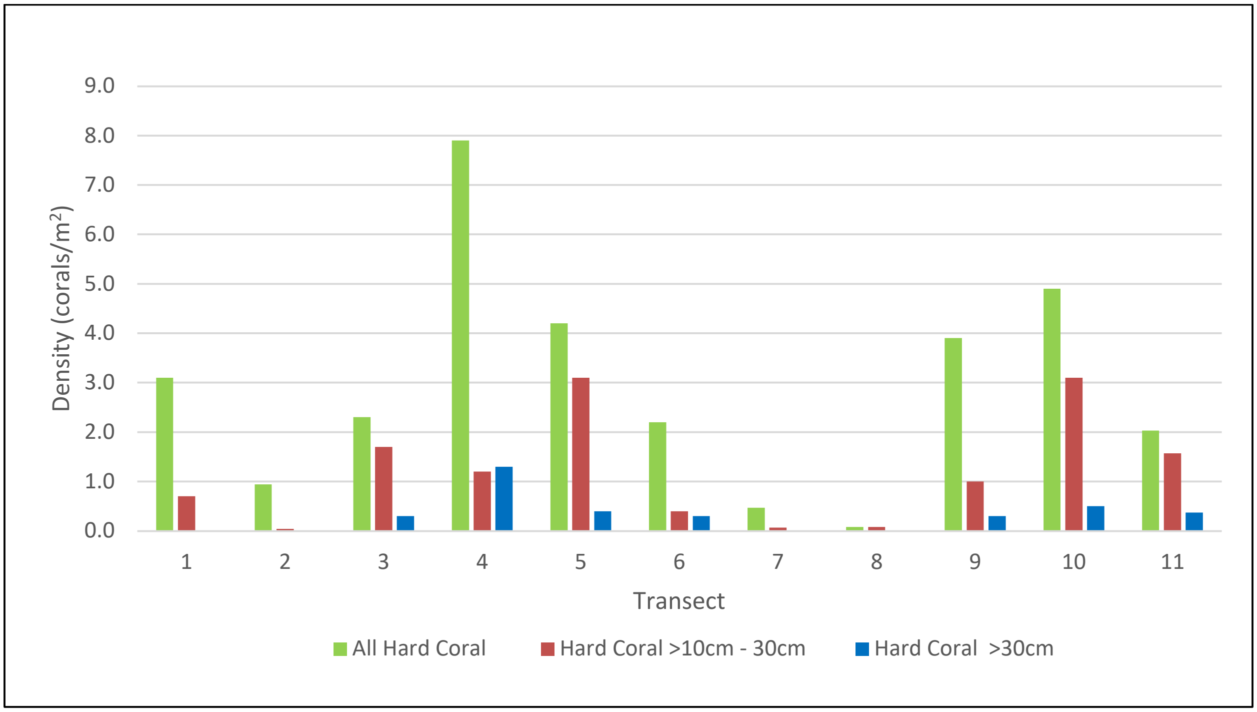

FIGURE 8 – OVERALL HARD DENSITIES BY TRANSECT AND SIZE CATEGORY

TABLE 7 – HARD CORAL AND OCTOCORAL DENSITY BY HABITAT TYPE, AND SIZE CATEGORY (HARD CORALS ONLY)

Habitat Type	Transect	Hard Coral Density (per m^2)	Octocoral Density (per m^2)	Hard Corals 10cm - 30cm (per m^2)	Hard Corals >30cm (per m^2)
Sloping Hardbottom	1	3.1	2.0	0.7	0.0
	2	0.9	3.1	0.04	0.0
	Mean	2.0	2.6	0.4	0.0
Continuous Reef Ridge	3	2.3	2.1	1.7	0.3
	4	7.9	4.4	1.2	1.3
	5	4.2	3.3	3.1	0.4
	Mean	4.8	3.3	2.0	0.7
Reef Flat	6	2.2	2.2	0.4	0.3
	7	0.5	3.0	0.1	0.0
	8	0.1	3.6	0.1	0.0
	Mean	0.9	2.9	0.2	0.1
Aggregate Patch Reef Ridge	9	3.9	5.0	1.0	0.3
	10	4.9	4.1	3.1	0.5
	11	2.0	4.0	1.6	0.4
	Mean	3.6	4.4	1.9	0.4

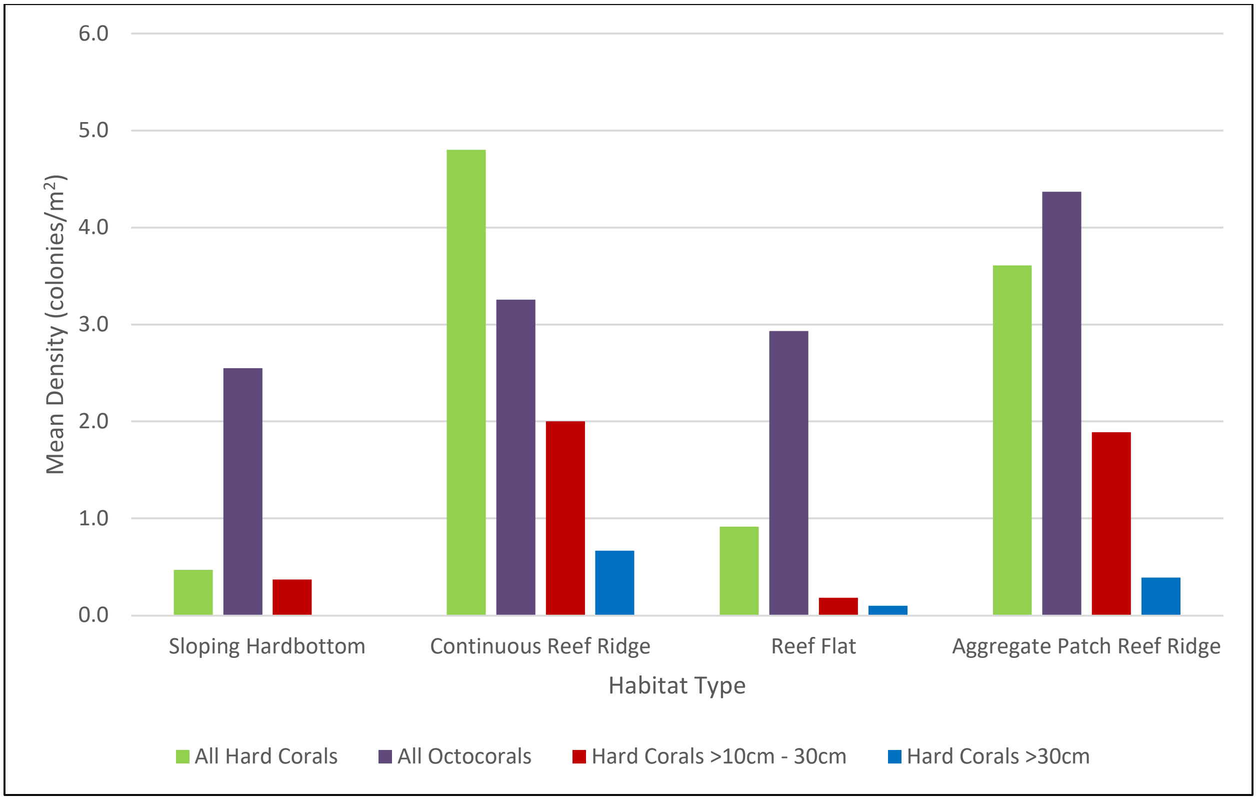

FIGURE 9- MEAN HARD CORAL AND OCTOCORAL DENSITY BY HABITAT TYPE AND SIZE CATEGORY (HARD CORALS ONLY)

3.1.2.4 Habitat Areas within Project Footprint

Drawings of the pier and proposed dredge footprint were overlain on the marine resource habitat maps as shown in **Figure 10**. The total proposed dredge footprint covers an area of 544,846 ft^2 (50,618 m^2) across the hardbottom and reef habitats but does not intersect any of the mapped seagrass areas. The total areas of the west and east piers cover 136,436 ft^2 (12,675 m^2) across each of the four primary habitat types. The east pier footprint also intersects an area of seagrass, centrally located between the continuous reef ridge and the reef flat habitats. **Table 8** provides the areas of the proposed pier and dredge footprints.

Within ArcMap, areas were calculated to determine the total area of potential direct impact (**Table 9**) from the piers and the dredge footprint by habitat type. It is estimated that 308,053 ft^2 (28,619 m^2) of reef and submerged aquatic vegetation (seagrass) could be impacted from the dredging, with another 40,887 ft^2 (3,798 m^2) from the pier construction. Final design criteria and specific details on construction methods will likely alter these estimates.

TABLE 8 – OVERALL DREDGE AND PIER FOOTPRINT AREAS

Area	ft²	m²
Dredge Footprint	544,846	50,618
Pier Footprint	136,436	12,675

TABLE 9 – AREAS OF MARINE HABITAT WITHIN THE DREDGE AND PIER FOOTPRINTS

Habitat	Within Dredge Footprint		Within Pier Footprint	
	ft²	m²	ft²	m²
Sloping Hardbottom Community	213,193	19,806	31,359	2,913
Seagrass Patch	--	--	2,964	275
Continuous Reef Ridge	95,873	8,906	19,569	1,818
Reef Flat	210,023	19,511	16,239	1,508
Aggregate Patch Reef Ridge	2,155	200	5,078	472
Total	308,053	28,619	40,887	3,798

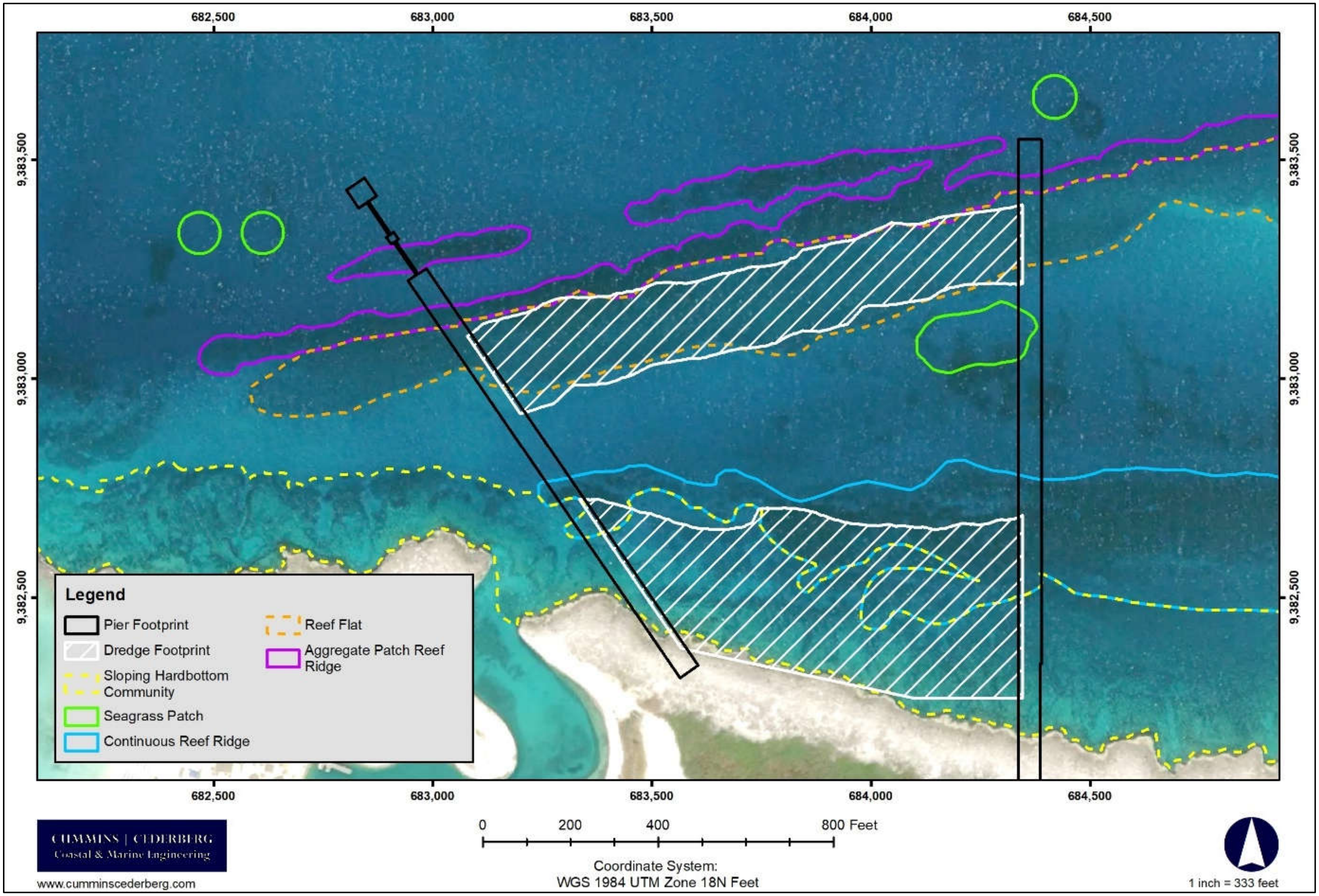

FIGURE 10 – PIER AND DREDGE FOOTPRINT OVER HABITAT AREAS

4 DISCUSSION

This marine resource survey was conducted to serve as a baseline assessment of the reef communities within the Project area on the north side of Great Stirrup Cay. The baseline survey will provide important information for use during the assessment of the potential direct and indirect impacts from the project during the EIA development. The overall spatial extent of impacts and coral density information will allow for an estimate of the number of individual coral and octocoral colonies within the footprints (project impacts), and potential impacts outside of the direct footprints associated with the dredging and construction process.

The marine habitat within the survey area transitioned from a sloping hardbottom community comprised of uncolonized hard substrate and only sparsely colonized by hard corals and octocoral colonies. Progressing offshore is the higher-relief (>1-m) contiguous reef ridge with the highest coverage and density of hard corals (including larger boulder colonies). Northward of the contiguous reef ridge is a prominent sand gap feature that transitions into the reef flat habitat, a lower-relief habitat with a lesser number hard coral colonies than the neighboring aggregate patch reef ridge to the north or the contiguous reef ridge to the south. The aggregate patch reef ridge was documented to have a slightly higher percent cover of living corals but a slightly lower density of large colonies than the continuous reef ridge, although both habitat types were documented as the predominant reef features harboring a range of species and size of hard corals and octocoral colonies within the survey area.

As shown in **Appendix A**, there are a variety of hard coral species of varying shape and sizes with many exceeding >1 m in diameter, and numerous species of octocorals, fish, and macroinvertebrates within the survey area. Despite the wide-spread loss of living coral within the Caribbean basin, healthy coral colonies were found within each of the habitat types, with coverage exceeding 10% on both the continuous and aggregate path reef ridges. Minimal to no disease or bleaching was observed on the coral colonies.

Photo A.1: Photo of large *Montastraea cavernosa* observed Transect 11.

Photo A.2: Photo of *Undaria agaricites* observed along Transect 11.

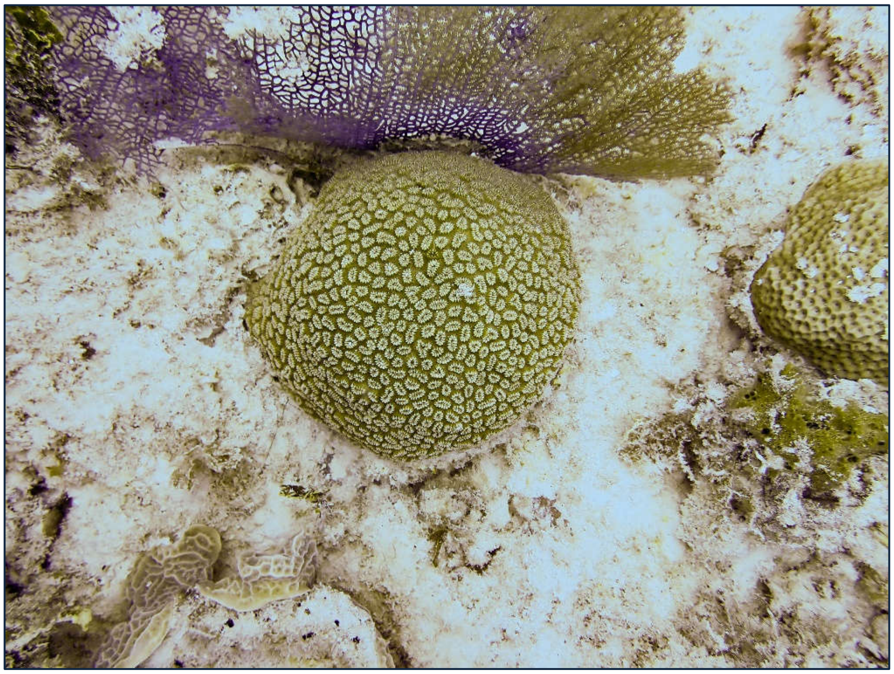

Photo A.3: Photo of *Dichocoenia stokesi* observed along Transect 11 with *Gorgonia ventalina* adjacent.

Photo A.4: Photo of *Porites porites* observed along Transect 11.

Photo A.5: Photo of *Eusmilia fastigiata* observed along Transect 11.

Photo A.6: Photo of *Agaricia fragilis* observed along Transect 12.

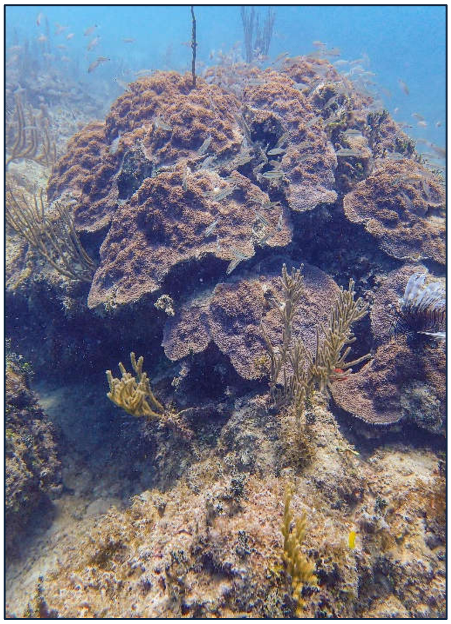

Photo A.7: Photo of large *Orbicella faveolata* observed along Transect 12.

Photo A.8: Photo of *Dichocoenia stokesi* observed along Transect 12.

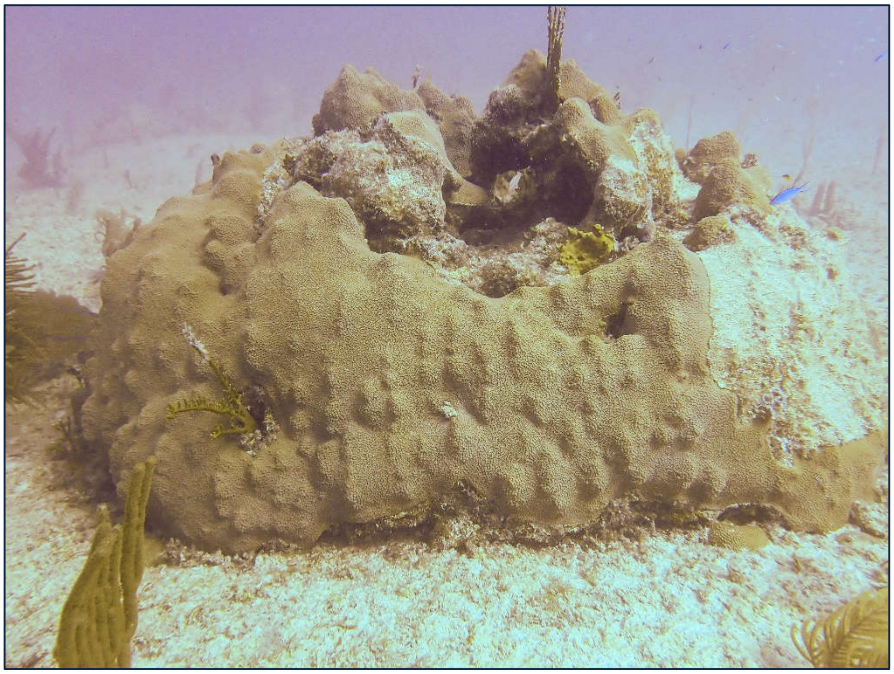

Photo A.9: Photo of large *Orbicella faveolata* colony observed along Transect 13.

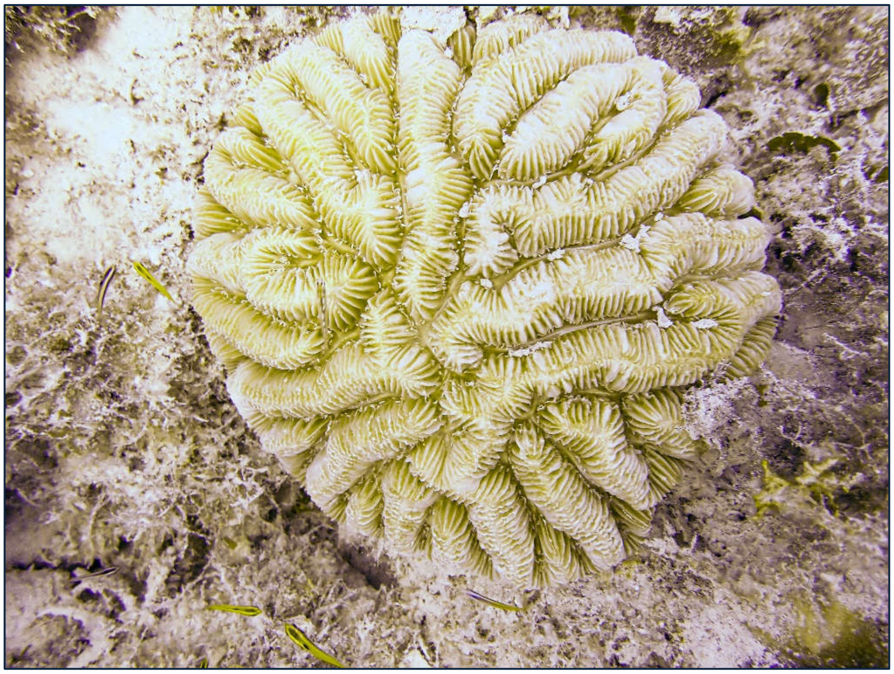

Photo A.10: Photo of *Meandrina meandrites* observed along Transect 13.

Photo A.11: Photo of *Solenastrea intersepta* observed along Transect 13.

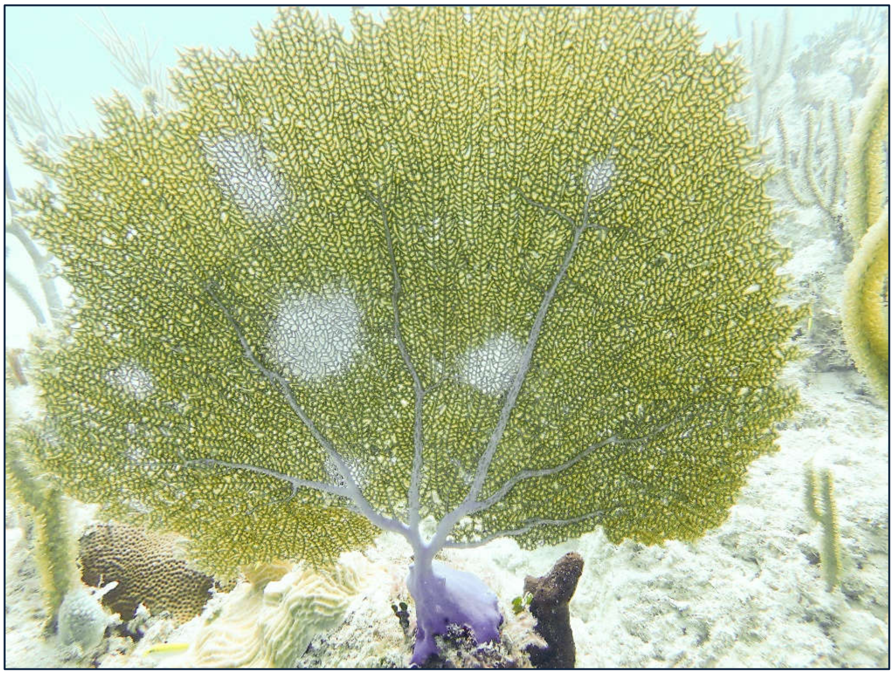

Photo A.12: Photo of *Gorgonia ventalina* observed along Transect 13.

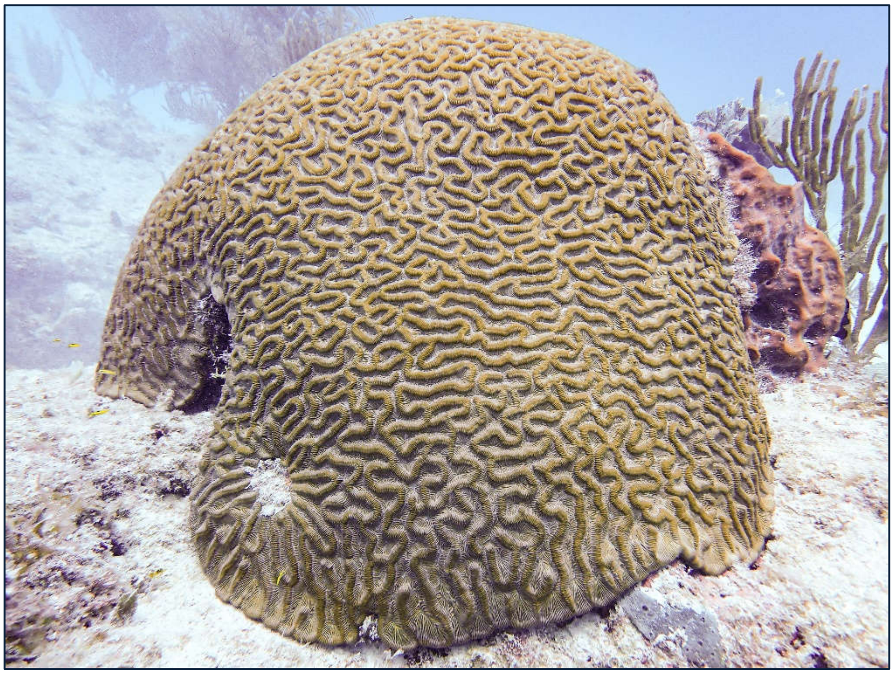

Photo A.13: Photo of large *Colpophyllia natans* observed along Transect 13.

Photo A.14: Photo of *Periclimenes pedersoni* in foreground and *Batholomea annulata* in background between hardbottom, observed along Transect 13.

Photo A.15: Photo of *Muricea* sp. Observed along Transect 14.

Photo A.16: Photo of *Porites porites* observed along Transect 14.

Photo A.17: Photo of *Isophyllia rigida* observed along Transect 14.

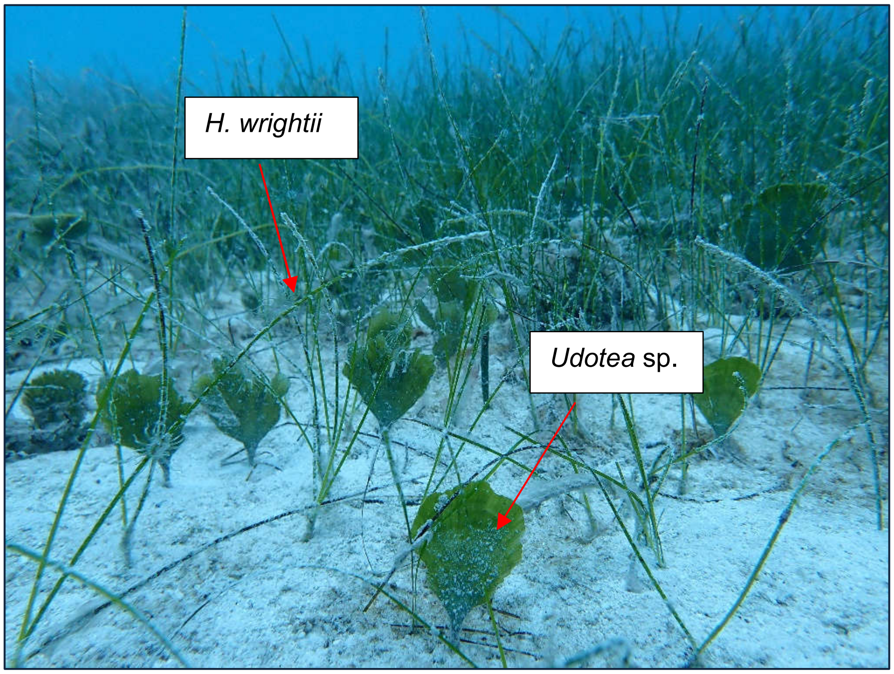

Photo A.18: Photo of *Udotea* sp. intermixed with shoal grass *Halodule wrightii*, observed along Transect 14.

Photo A.19: Photo of *Antillogorgia bipinnata* observed along Transect 14.

Photo A.20: Photo of invasive *Pterois volitans* observed along Transect 14.

Photo A.21: Photo of *Diadema antillarum* observed between hardbottom along Transect 4.

Photo A.22: Photo of *Cyphoma gibbosum* observed on *Pseudoplexaura* sp. along Transect 4.

Photo A.23: Photo of *Hypoplectrus puella* (above) and *Haemulon flavolineatum* (below) observed along Transect 4.

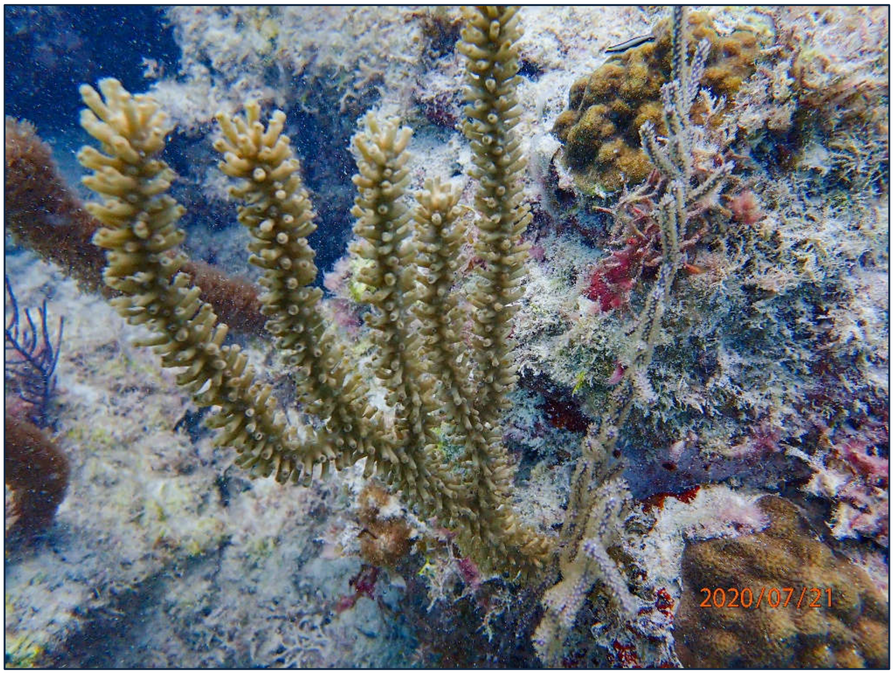
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Photo A.24: Photo of *Eunicea* sp. observed along Transect 5.

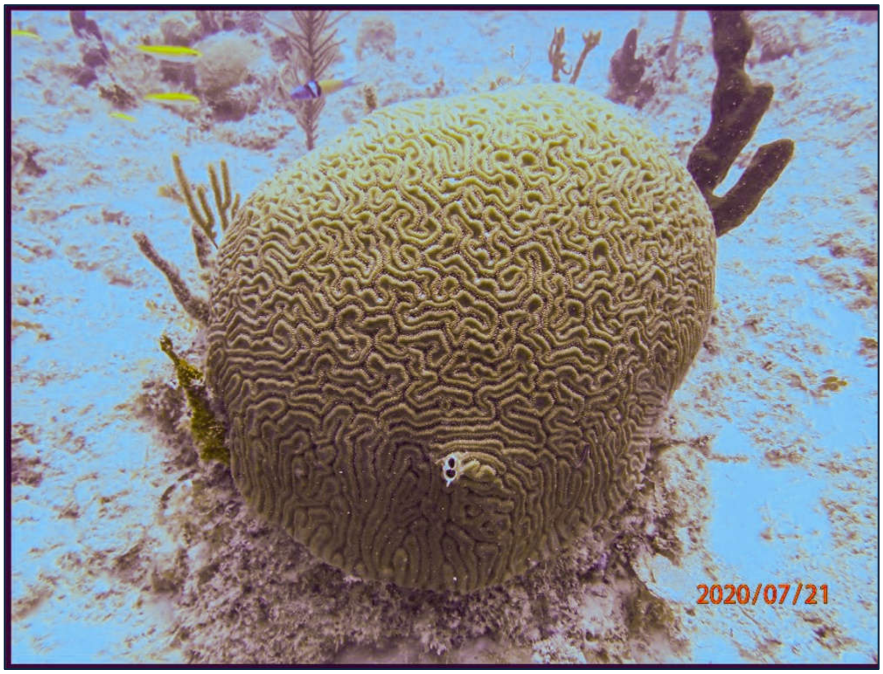


Photo A.25: Photo of large *Diploria labyrinthiformis* observed along Transect 9.

Photo A.26: Photo of *Meandrina meandrites* (foreground) and *Agaricia fragilis* (background) observed along Transect 9.

Table B1. Hard (Scleractinian) corals and octocoral species observed during the marine resource survey

Genus	Species	Common Name	Genus	Species	Common Name
Hard corals					
Agaricia	*fragilis*	Fragile Saucer Coral	*Pseudodiploria*	*clivosa*	Knobby Brain Coral
Colpophyllia	*natans*	Boulder Brain Coral	*Scolymia*	*cubensis*	Artichoke Coral
Dichocoenia	*stokesii*	Elliptical Star Coral	*Siderastrea*	*siderea*	Massive Starlet Coral
Diploria	*labyrinthiformis*	Grooved Brain Coral	*Solenastrea*	*bournoni*	Smooth Star Coral
Eusmilia	*fastigiata*	Eusmilia fastigiata	*Stephanocoenia*	*intersepta*	Blushing Star Coral
Favia	*fragum*	Golfball Coral	*Undaria*	*agaricites*	Lettuce Coral
Helioceris	*cucullata*	Sunray Lettuce Coral	**Octocorals**		
Isophyllia	*sinuosa*	Sinuous Cactus Coral	*Antillogorgia*	*americana*	Slimy Sea Plume
Isophyllia	*rigida*	Rough Star Coral	*Antillogorgia*	*bipinnata*	Bipinnate Sea Plume
Madracis	decactis	Ten-Ray Star Coral	*Briareum*	*asbestinum*	Corky Sea Finger
Manicina	*areolata*	Rose Coral	*Eunicea*	spp.	Knobby Sea Rods
Meandrina	*meandrites*	Maze Coral	*Eunicea*	*succinea*	Shelf-Knob Sea Rod
Montastrea	*cavernosa*	Great Star Coral	*Gorgonia*	sp.	Sea Fan
Musa	*angulosa*	Spiny Flower Coral	*Gorgonia*	*ventalina*	Common Sea Fan
Mycetophyllia	sp.	Cactus Coral	*Muricea*	sp.	Spiny Sea Rod
Mycetophyllia	*lamarckiana*	Riged Cactus Coral	*Muriceopsis*	*flavida*	Rough Sea Plume
Orbicella	*faveolata*	Mountainous Star Coral	*Plexaura*	sp.	Sea Rod
Orbicella	*annularis*	Boulder Star Coral	*Plexaurella*	*nutans*	Giant Split-Pore Sea Rod
Porites	*porites*	Finger coral	*Pseudoplexaura*	sp.	Porous Sea Rods
Porites	*aestreoides*	Mustard Hill Coral	*Pterogorgia*	*citrina*	Yellow Sea Whip
Pseudodiploria	*strigosa*	Symmetrical Brain Coral	*Pterogorgia*	sp.	Sea Whip

Table B2. Submerged aquatic vegetation (SAV) species observed during the marine resource survey

Genus	Species	Common Name	Genus	Species	Common Name
Macroalgae					
Acetabularia	*crenulata*	White Mermaid's Wine Glass	*Neomaris*	*annulata*	Fuzzy Tip Algae
Acetabularia	*calyculus*	Green Mermaid's Wine Glass	*Padina*	*pavonica*	White Scroll Algae
Avrainvillea	sp.	--	*Penicillus*	sp.	Brush Algae
Avrainvillea	*nigricans*	--	*Phormidium*	*sp*	Phormidium Cyanobacteria
Avrainvillea	*longicaulis*	Paddle Blade Algae	*Rhipocphalus*	*phoenix*	Pinecone Algae
Caulerpa	sp.	--	*Rhipocphalus*	*brevifolius*	Elongated Pinecone Algae
Dasycladus	*vermicularis*	Fuzzy Finger Algae	*Sargassum*	sp.	Sargassum
Dictyota	sp.	Y Branched Algae	*Sargassum*	*natans*	Sargasso Weed
Galaxaura	sp.	Tubular Thicket Algae	*Udotea*	sp.	Mermaid's Fans
Halimeda	sp.	--	*Udotea*	*cyathiformis*	Mermaid's Teacup
Halimeda	*simulans*	Branching Leaf Algae	--	--	Turf Algae (various)
Halimeda	*incrassata*	Three Finger Leaf Algae	--	--	Cyanobacteria
Halymenia	*duchassaingii*	Rubbery Sheet Algae	--	--	Crustose Coralline Algae
Laurencia	sp.	--	Seagrass		
Laurencia	*papillosa*	--	*Halodule*	*wrightii*	Shoal Grass
Lobophora	*variegata*	Encursting Fan-Leaf Algae	*Syringodium*	*filiforme*	Manatee Grass
Lophocladia	*trichoclados*	--	*Thalassia*	*testudinum*	Turtle Grass

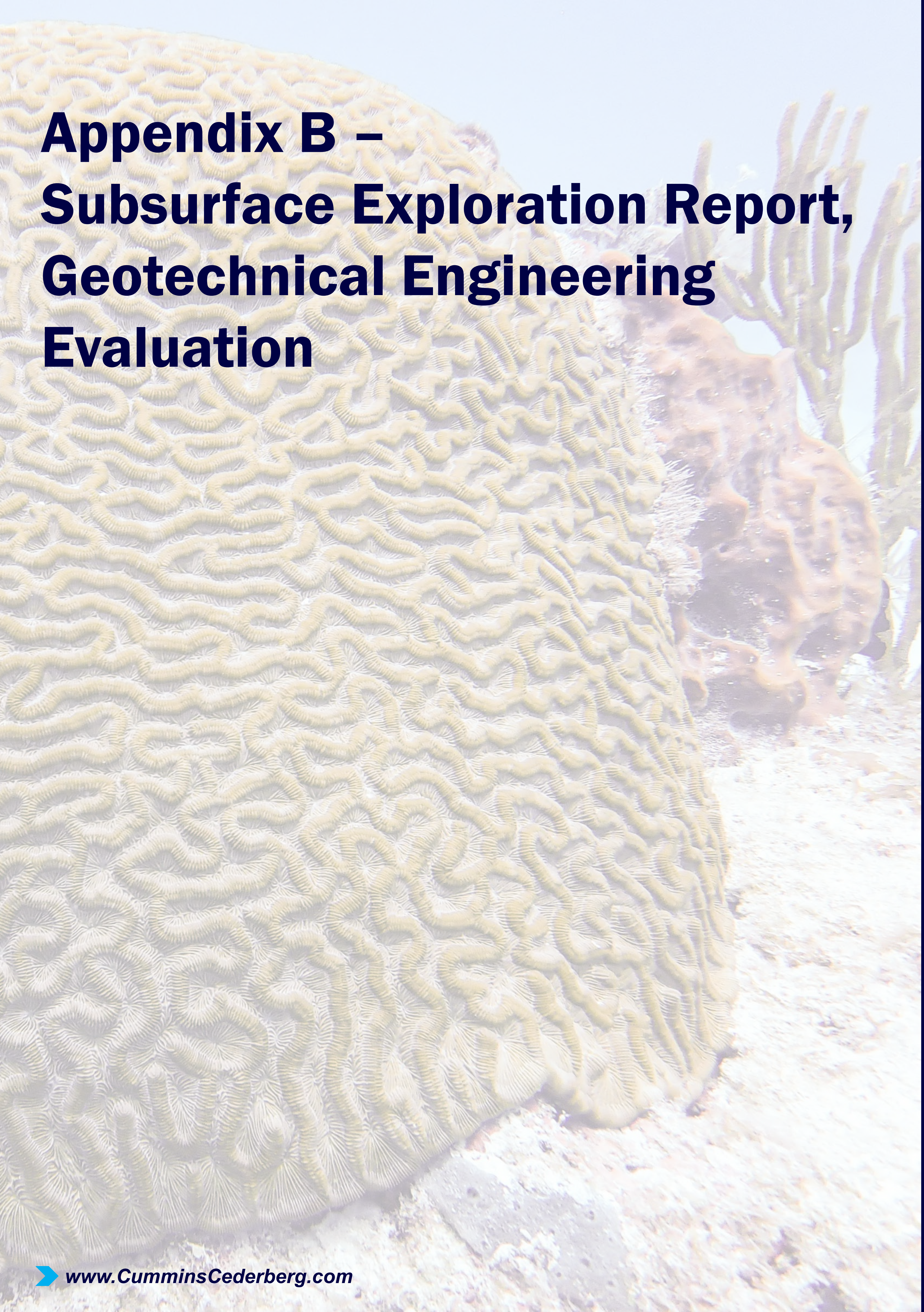
Table B3. Macroinvertebrate species observed during the marine resource survey

Genus	Species	Common Name	Genus	Species	Common Name
Macroinvertebrates					
Actinoporus	*elegans*	Elegant Anemone	*Neopetrosia*	*proxima*	Brown Encrusting Sponge
Aaptos	*pernucleata*	Pernucleata Sponge	*Niphates*	*erecta*	Lavender Rope Sponge
Aplysina	*fistularis*	Yellow Tube Sponge	*Niphates*	*digitalis*	Pink Vase Sponge
Batholomea	*annulata*	Corkscrew Anemone	*Ophiothrix*	*suensonii*	Sponge Brittle Star
Bispira	*brunnea*	Social Feather Duster	*Palythoa*	*caribaeorum*	White Encrusting Zoanthid
Callyspongia	*vaginalis*	Branching Vase Sponge	*Panulirus*	*argus*	Caribbean Spiny Lobster
Callyspongia	*vaginalis*	Branching Vase Sponge	*Parazoanthus*	*catenularis*	Brown Sponge Zoanthids
Calyx	*podatypa*	Dark Volcano Sponge	*Periclimenes*	*pedersoni*	Pederson Cleaner Shrimp
Cinachyra	sp.	Orange Ball Sponge	*Plakina*	*jamaicensis*	Melted Sponge
Cliona	sp.	Boring Sponge	*Plakortis*	*angulospiculatus*	Brown Variable Sponge
Cliona	*delitrix*	Red Boring Sponge	*Ricordea*	*florida*	Florida Corallimorph
Cribrochalina	*vasculum*	Brown Bowl Sponge	*Sabellastarte*	*magnifica*	Magnificent Feather Duster
Ctenoides	*scaber*	Rough Fileclam	*Spirobranchus*	*giganteus*	Christmas Tree Worms
Cyphoma	*gibbosum*	Flamingo Tongue	*Stenorhynchus*	*seticornis*	Yellowline Arrow Crab
Diadema	*antillarum*	Long-Spined Urchin	*Stichodactyla*	*helianthus*	Sun Anemone
Echinometra	*lununter lucunter*	Rock-Boring Urchin	*Strombus*	*gigas*	Queen Conch
Ectyoplasia	*ferox*	Brown Octopus Sponge	*Verongula*	*rigida*	Pitted Tube Sponge
Iotrochota	*birotulata*	Green Finger Sponge			Corallimorphs
Ircinia	*strobilina*	Black-Ball Sponge			Bryozoans
Millepora	*alcicornis*	Branching Fire Coral			Brittle Stars
Millepora	*complanata*	Blade Fire Coral			Comb Jelly

Table B4. Fish species observed during the marine resource survey

Fish Species					
Genus	Species	Common Name	Genus	Species	Common Name
Acanthurus	*bahianus*	Ocean Surgeonfish	*Haemulon*	*flavolineatum*	French Grunt
Acanthurus	*coeruleus*	Blue Tang	*Haemulon*	*macrostromum*	Spanish Grunt
Acanthurus	*chirurgus*	Doctorfish	*Halichoeres*	*garnoti*	Yellowheaded Wrasse
Anisotremus	*virginicus*	Porkfish	*Halichoeres*	*bivittatus*	Slippery Dick
Apogon	*quadrisquamatus*	Sawcheek Cardinalfish	*Holacanthus*	*tricolor*	Rock Beauty
Archosargus	*probatocephalus*	Sheepshead	*Holocentrus*	*adscensionis*	Squirrelfish
Aulostomus	*maculatus*	Trumpetfish	*Hypoplectrus*	*puella*	Indigo Hamlet
Balistes	*vetula*	Queen Triggerfish	*Lachnolaimus*	*maximus*	Hogfish
Bodianus	*rufus*	Spanish Hogfish	*Lutjanus*	*griseus*	Gray Snapper
Calamus	*calamus*	Saucereye Porgy	*Lutjanus*	*jocu*	Dog Snapper
Canthidermis	*sufflamen*	Ocean Triggerfish	*Lutjanus*	*apodus*	School Master
Canthigaster	*rostrata*	Sharpnose Puffer	*Microspathodon*	*chrysurus*	Yellowtail Damselfish
Caranx	*ruber*	Blue Runner	*Mycteroperca*	*venenosa*	Yellowfin Grouper
Caranx	*hippos*	Crevalle Jack	*Ocyurus*	*chrysurus*	Yellowtail Snapper
Cephalopholis	*cruentatus*	Graysby	*Pomacanthus*	*arcuatus*	Gray Angelfish
Chaetodon	*striatus*	Banded Butterflyfish	*Pomacanthus*	*paru*	French Angelfish
Chaetodon	*capistratus*	Foureye Butterflyfish	*Pseudupeneus*	*maculatus*	Spotted Goatfish
Chromis	*viridis*	Blue Chromis	*Pterois*	*volitans*	Lionfish
Chromis	*cyanea*	Brown Chromis	*Scarus*	*taeniopterus*	Princess Parrotfish
Epinephelus	*striatus*	Nassau Grouper	*Sparisoma*	*viride*	Stoplight Parrotfish
Epinephelus	*adscensionis*	Rock Hind	*Sparisoma*	*aurofrenatum*	Redband Parrotfish
Equetus	*punctatus*	Spotted Drum	*Sphyraena*	*barracuda*	Great Barracuda
Gerres	*cinereus*	Yellowfin Mojarra	*Stegastes*	*planifrons*	Threespot Damselfish
Ginglymostoma	cirratum	Nurse Shark	*Stegastes*	*diencaeus*	Longfin Damsel
Gramma	*loreto*	Fairy Basslet	*Stegastes*	*variabilis*	Cocoa Damselfish
Gymnothorax	*moringa*	Spotted Morray	*Stregastes*	*partitus*	Bicolor Damselfish
Haemulon	*sciurus*	Bluestriped Grunt	*Thalassoma*	*bifasciatum*	Bluehead Wrasse

Appendix B – Subsurface Exploration Report, Geotechnical Engineering Evaluation



SUBSURFACE EXPLORATION REPORT
GEOTECHNICAL ENGINEERING EVALUATION
GREAT STIRRUP CAY
THE BAHAMAS
JULY 14, 2020
FILE NO.: 20-2543

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.
Geotechnical, Environmental and
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July 14, 2020
File No.: 20-2543

NV2A Group, LLC
9100 Dadeland Blvd., Suite 600
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ATTN: Mr. Gilberto Neves

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION GREAT STIRRUP CAY, THE BAHAMAS

INTRODUCTION

In accordance with your request and authorization, Ardaman & Associates, Inc. has completed a preliminary geotechnical engineering evaluation of the soil borings completed to date for the above referenced project. Our work included Standard Penetration Test (SPT) borings, laboratory testing, and engineering analyses. This report describes the field exploration, reports its findings, and summarizes our preliminary conclusions and recommendations.

SITE LOCATION AND DESCRIPTION

The project site is located on the Great Stirrup Cay in The Bahamas. The project site extends for about 1.9 miles east to west along the island. Most of the new development effort will be completed in the central part of the island in the proximity of the proposed new port. However, development of some facilities are planned on the west, east and south parts of the island.

PROJECT DESCRIPTION

It is our understanding that the proposed project will consist of improvements to the entertainment complex with the construction of new roadways, dormitories, bathrooms administration and retail facilities.

FIELD EXPLORATION PROGRAM

To explore the subsurface conditions at the site, fourteen (14) Standard Penetration Test (SPT) borings were performed at the locations selected by our client and shown on the Boring Location Plan, Figure 2. The SPT borings were advanced to a depth of 25 to 50 feet below the existing ground surface. using the methodology outlined in ASTMD-1586. Two additional borings are planned to complete the landside soil investigation. In addition, rock cores were retrieved from twelve (12) borings to define the limestone properties. Rock cores were performed using a core barrel that retrieves rock samples with a 2-inch diameter. A description of our drilling and testing procedures are included in the Appendix.

The boring locations were laid out at the approximate location shown in the boring location plan shown in Figure 2. Our engineer examined the soil recovered from the SPT borings, that were completed by others, and prepared a log for each boring. Selected soil samples were tested in our laboratory and classified by an engineer in accordance with the USCS (ASTM D-2487). The soil classifications and other pertinent data obtained from our explorations are reported in the boring logs in the Appendix.

GEOLOGY OF THE BAHAMAS

The Bahamian Archipelago consists of two carbonate banks which were formed by a chain of carbonate platforms. These platforms developed in the Late Jurassic under shallow water conditions. The carbonate banks are approximately 5 km deep. There are five types of sediments that have accumulates on the islands during the last 12,000 years; peloidal, oolitic, coralgal, grapestone and aggregate, and mud. These sediments were deposited on the karsted top of the Pleistocene deposits that developed approximately 120,000 years ago when the banks were well above the sea level during the glacial low stand.

SUBSURFACE CONDITIONS

The boring logs in the Appendix present a detailed description of the soils encountered at the locations at the depths explored. The soil stratification shown on the boring logs is based on examination of recovered soil samples and interpretation of the field logs. It indicates only the approximate boundaries between soil types. The actual transitions between adjacent soil strata may be gradual and indistinct.

The results of our test borings indicate the following general soil profile:

Depth Below Ground Surface (feet)	Description
0 – 4	Sand, fine grained, medium dense to dense
4 – 13	Limestone poorly cemented to very poorly cemented
13-15	Limestone well cemented
15-38	Limestone poorly to well cemented
38-50	Limestone, well cemented

Table 1. Soil Profile

The above soil profile is outlined in general terms only. Please refer to the boring logs for soil profile details.

The results of the soil borings indicate that the area between the beach to the west and the artificial bay to the east that was studied by borings B2, B3, B4, B5, B7and B8, presents a near surface sand layer that extends 15 to 20 feet below grade. Although, some near surface sand might be expected within this area in the upper 4 to 6 feet, the logged depth of sand at these borings may be result of the drilling method that crushed a very poorly cemented limestone that is recovered from the sampler as sand. The results of boring B6, completed using continuous cores and located in the middle of the area covered by these borings, show limestone from the surface. This reinforce the doubts over the presence of sand down to 15 to 20 feet in this area and this question should be clarified with the planned borings B25 and if required additional borings.

Borings B1, B9, B10, B11, B12, B13 and B14 completed in other areas of the island present limestone under one to two feet of sand. Pictures of the cores taken from the limestone formation at different depths are shown in the Figures 4 through 7 below. Notice the low recovery of the samples from 2 to 7 feet presented in Figure 4 that corresponds to boring B6. This limestone, if sampled with the SPT spoon could be recovered as sand.

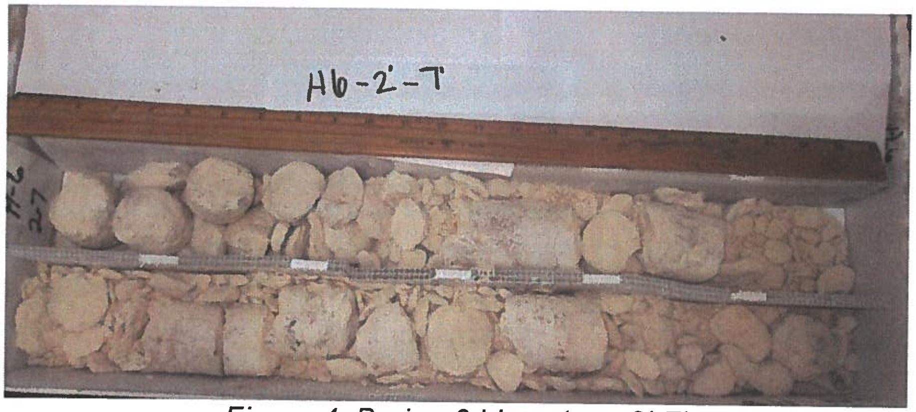

Figure 4. Boring 6 Limestone 2'-7'

Figure 5. Boring 9 Limestone 10'-13'

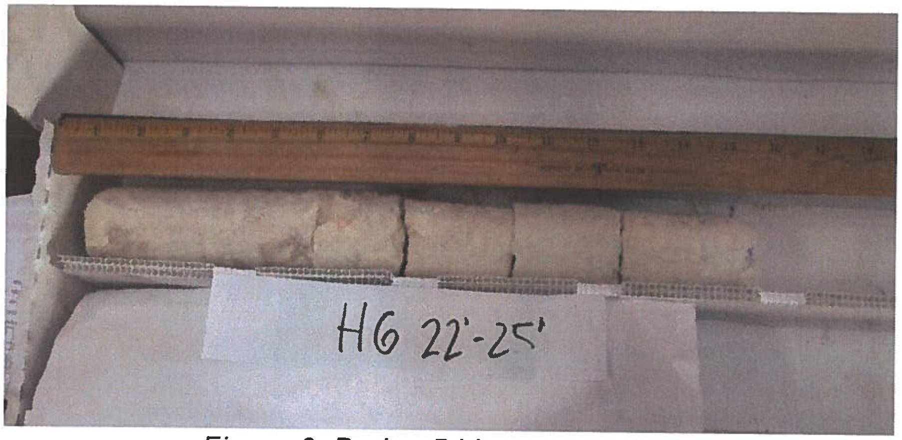

Figure 6. Boring 5 Limestone 30'-35'

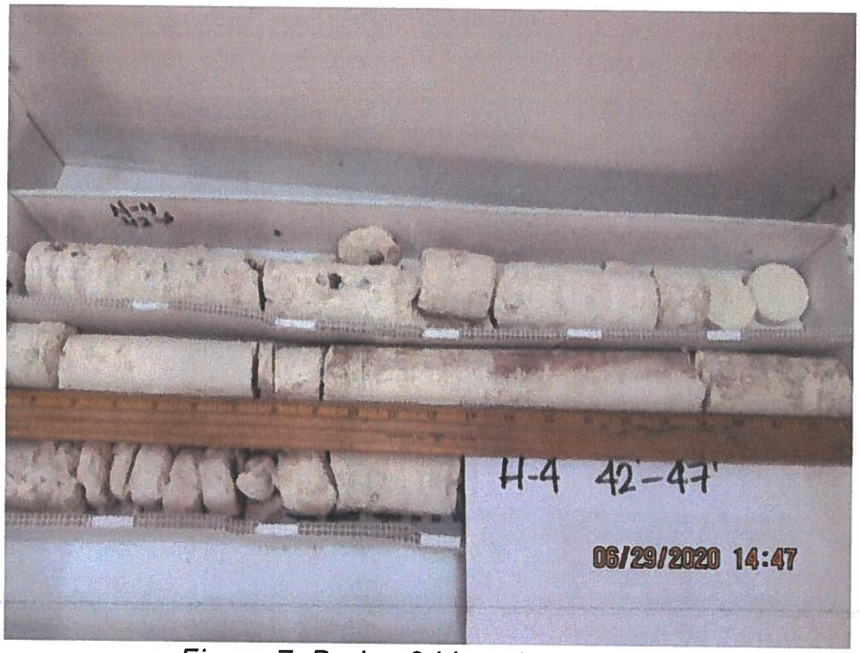

Figure 7. Boring 9 Limestone 13'-15'

Figure 8 presents the average drilling rate during core retrieval. The drilling rate provides a continuous assessment of the rock strength represented by the time it takes to drill one foot at a boring location. Notice that across the island hard limestone layers were found between 13 and 15 feet and 38 feet and 50 feet below grade.

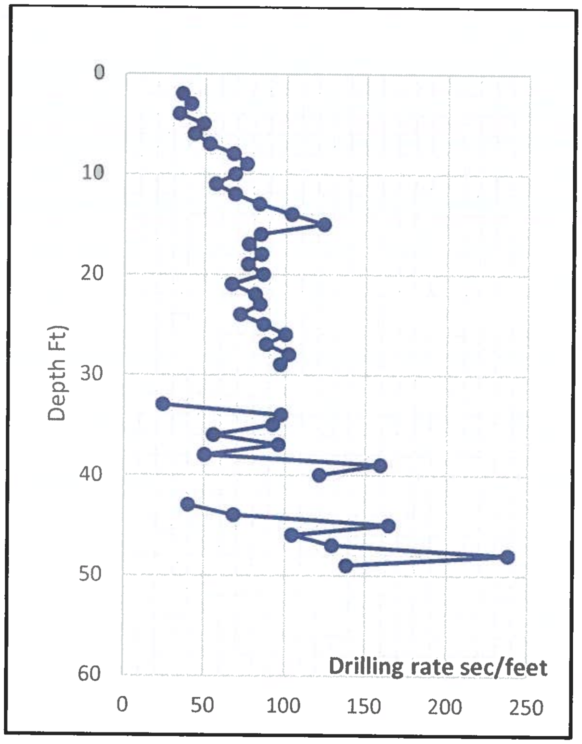

Figure 8. Average drilling rate for all the core borings.

GROUNDWATER CONDITIONS

Groundwater was not recorded by the drillers and was not reflected on the boring logs.

LABORATORY TESTING

In order to aid in classifying and estimating engineering characteristics of the subsurface soils encountered, laboratory classification tests were performed on representative soil samples obtained from the borings. The laboratory testing program included the following:

- 6 Sieve Analysis including fine content
- 7 Unconfined Compressive Strength of Intact Rock Core
- 7 Split Tensile Tests
- 7 Unit Weight Tests

The results of the laboratory tests are included in the boring logs and soil profiles. The sieve analysis results are also attached in the Appendix.

Unconfined Compression Test Results

A total of seven (7) samples of limestone were broken for unconfined compression strength. Notice the high unconfined compression strength values found at the near surface limestone from boring B13 and also below 36 feet at borings B4 and B8.

Description	Boring	Elevation (ft)	Unit Weight (pcf)	Unconfined Compression (psi)
Limestone	B13	4-9	131	1273
Limestone	B6	12-16	126.1	509
Limestone	B12	12-17	118.1	828
Limestone	B10	10-15	118.8	955
Limestone	B1	19-24	116.4	637
Limestone	B4	42-47	118.2	1146
Limestone	B8	36-40	119	1114

Table 2. Unconfined Compression Test Results

Split Tensile Strength Test Results

A total of seven (7) samples of limestone were broken for split tensile strength in accordance with ASTMC-496.

Description	Boring	Elevation (ft)	Split Tensile (psi)
Limestone	B13	4-9	127
Limestone	B14	5-10	116
Limestone	B12	12-17	191
Limestone	B10	10-15	107
Limestone	B1	19-24	204
Limestone	B4	42-47	199
Limestone	B8	36-40	212

Table 3. Split Tensile Strength

The results of the split tensile tests follow the tendency described above that suggest higher limestone strength for the limestone below 36 feet below grade.

Corrosion Test Results

Table 3 presents the results of a sample of the near surface soils tested for corrosion. The results indicate an extremely aggressive soil. "Extremely aggressive soil" is the highest degree of corrosivity defined for soils in the FDOT's Structural Design Guidelines section 1.3.

Description /boring	Depth (ft)	Ph	Resistivity (ohm-cm)	Sulfate (ppm)	Chloride (ppm)	Environmental Classification
Sand/B4	4-8	8.06	30	231	5985	Extremely Aggressive

Table 4. Corrosion Test Results

ENGINEERING EVALUATION AND RECOMMENDATIONS

General

The results of our exploration indicate that, the existing soils are suitable for supporting the proposed structures on conventional shallow foundation systems.

The following are our recommendations for overall site preparation and foundation support which we feel are best suited for the proposed complex and existing soil conditions. The recommendations are made as a guide for the design engineer and/or architect, parts of which should be incorporated into the project's specifications.

Evaluation of Existing Soils as Fill Material

The character of the near surface soils indicates that cuts from these soils may be used as fill at other locations in this project. The limestone within the upper 10 feet of the soil profile is poorly to medium well cemented and in general will break in small to large rock fragments or as sand. Excavation planning shall consider a technique that maximizes excavated rock breakdown into small sizes for future use as fill material throughout the project. Rock fragments larger than 3 inches should be broken down to be used as building pad material. Larger rock fragments would leave voids between the rock fragments that can lead to structure settlement as finer soils erode into those voids.

Proof-rolling

We recommend proof-rolling the cleared surface to locate any unforeseen soft areas or unsuitable surface or near-surface soils, to increase the density of the upper soils, and to prepare the existing surface for the addition of the fill soils (as required). Proof-rolling of the building areas should consist of at least 10 passes of a compactor capable of achieving the density requirements described in the next paragraph. (Proof-rolling of the building areas should consist of at least 10 passes of a self-propelled vibratory compactor capable of delivering a minimum impact force of 30,000 to 35,000 pounds per drum to the soils.) Each pass should overlap the preceding pass by 30 percent to achieve complete coverage. If deemed necessary, in areas that continue to "yield", remove all deleterious material and replace with clean, compacted sand backfill. The proof-rolling should occur after cutting and before filling.

A density equivalent to or greater than 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value for a depth of one foot in the building and parking/drive areas must be achieved beneath the stripped and grubbed ground surface. Additional passes and/or overexcavation and recompaction may be required if these minimum density requirements are not achieved. The soil moisture should be adjusted as necessary during compaction.

Suitable Fill Material and the Compaction of Fill Soils

All fill materials should be free of organic materials, such as roots and vegetation. As a general guide to aid the contractor, we recommend using fill with 3 to 10 percent by dry weight of material passing the U.S. Standard No. 200 sieve size.

All structural fill should be placed in level lifts not to exceed 12 inches in uncompacted thickness. Each lift should be compacted to at least 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value. The filling and compaction operations should continue in lifts until the desired elevation(s) is achieved. If hand-held compaction equipment is used, the lift thickness should be reduced to 6 inches.

Foundation Support by Spread Footings and Foundation Compaction Criteria

Excavate the foundations to the proposed bottom of footing elevations and, thereafter, verify the in-place compaction for a depth of one foot below the footing bottoms. If necessary, compact the bottom of the excavations to achieve a minimum dry density equivalent to 95 percent of the modified Proctor maximum dry density (ASTM D-1557) for a depth of 1 foot below the footing bottoms. Based on the preliminary investigation results and, assuming the above outlined proof-rolling and compaction criteria is implemented, an allowable soil bearing pressure of 3500 pounds per square foot (psf) may be used in the foundation design for footings bearing on compacted fill. Footings bearing on the natural limestone may be designed with an allowable bearing pressure of 7000 psf.

Foundations bearing on fill may be designed using a modulus of subgrade reaction of 120 pci.

If bottom of the foundation will bear directly over the existing natural limestone, we recommend that Ardaman & Associates, Inc. performs inspection of the bottom of the footing.

With the site prepared and the foundations designed and constructed as recommended, we anticipate total settlements of one inch or less, and differential settlements between adjacent footings less than 0.25 inches. The majority of the settlements should occur during construction.

All bearing wall foundations should be a minimum of 16 inches wide and columns foundations 24 inches wide. A minimum soil cover of 14 inches should be maintained from the bottom of the exterior foundations to the adjacent outside finished grades.

The Great Stirrups Cay conditions are similar to those existing in the Florida Keys where storm surge is a design concern. To ensure the structures stability is customary to anchor the structures into the bed rock by installing augured anchors into the rock. The anchors are normally designed to resist the horizontal forces imposed by storm surge water. The anchors at this site (if required) should be augured into the limestone a minimum depth of 6 feet and reinforced by a minimum of four number 4 vertical rods extending into the foundation a minimum of eighteen inches and tied to the vertical steel of the foundation. For a structure constructed on a building pad, the length of the anchor piles will extend through the fill to reach the socket lengths into the rock as defined above. For an augured anchor 14 inches in diameter installed as recommended above, shall provide allowable compression capacity of 20 tons and tension capacity of 10 tons and a shear capacity of 4 tons.

DESIGN PARAMETERS

Based on the results of our field investigation and testing and our experience with the soils encountered during the investigation, we recommend the following properties:

TABLE 5
SOIL PROPERTIES

	Unit	Sand	Fill (limerock)	Limestone
Unit Weight	lb/ft^3	110	125	118
Cohesion	K/ft^2	-	-	5
Friction	°	32	38	38
Deformation Modulus	K/ft^2	250	800	5000
Modulus of Subgrade	pci	80	120	200

* Fill is defined as imported soils used to raise the building pad to grade (if required).

Lateral Earth Pressure

Regardless of type, retaining walls will be subjected to lateral earth pressures due to backfill and potential surcharge loads. In the following Table are presented recommended design values required for a vertical faced retaining wall/foundation design.

Fill or Soil Type	**Moist Unit Weight (pcf)**	**Buoyant Soil Unit Weight (pcf)**	**Friction Angle**	**Active Pressure Coefficient**	**Passive Pressure Coefficient**	**At rest Pressure Coefficient**
Sand	110	55	32	0.31	3.3	0.47
Limerock/ Limestone	120	60	38	0.23	4.2	0.38

Table 6. Earth Pressure Coefficients

Please notice that a conservative assumption regarding the friction angle between the retaining wall and the backfill material has been used to define the earth pressure coefficient.

Factors of safety against sliding, overturning and bearing capacity must be included in all earth pressure analysis. We recommend the following factors of safety:

1. Sliding 1.5
2. Overturning 2.0
3. Bearing Capacity 2.5

CLOSURE

The analysis and recommendations submitted herein are based upon the data obtained from the soil borings presented in the Appendix. This report does not reflect any variations which may occur adjacent to or between the borings. The nature and extent of the variations between the borings may not become evident until during construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report after performing on-site observations during the construction period and noting the characteristics of the variations.

This report has been prepared for the exclusive use of NV2A Group LLC., and their representatives in accordance with generally accepted soil and foundation engineering practices. In the event any changes occur in the design, nature, or location of the proposed facility, we should review the applicability of conclusions and recommendations in this report.

We also recommend a general review of final design and specifications by our office to make sure that earthwork and foundation recommendations are properly interpreted and implemented in the design specifications.

We are pleased to be of assistance to you on this phase of your project. When we may be of further service to you or should you have any questions, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
FL Certificate No.: 0005950

Gabriela Gonzalez, E.I.
Staff Engineer

Evelio Horta Jr., M.S.C.E, P.E
Project Engineer
FL Reg. No. 82209

Evelio Horta, Ph.D., P.E., G.E.
Principal Engineer
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SITE PLAN
AND
BORING LOGS

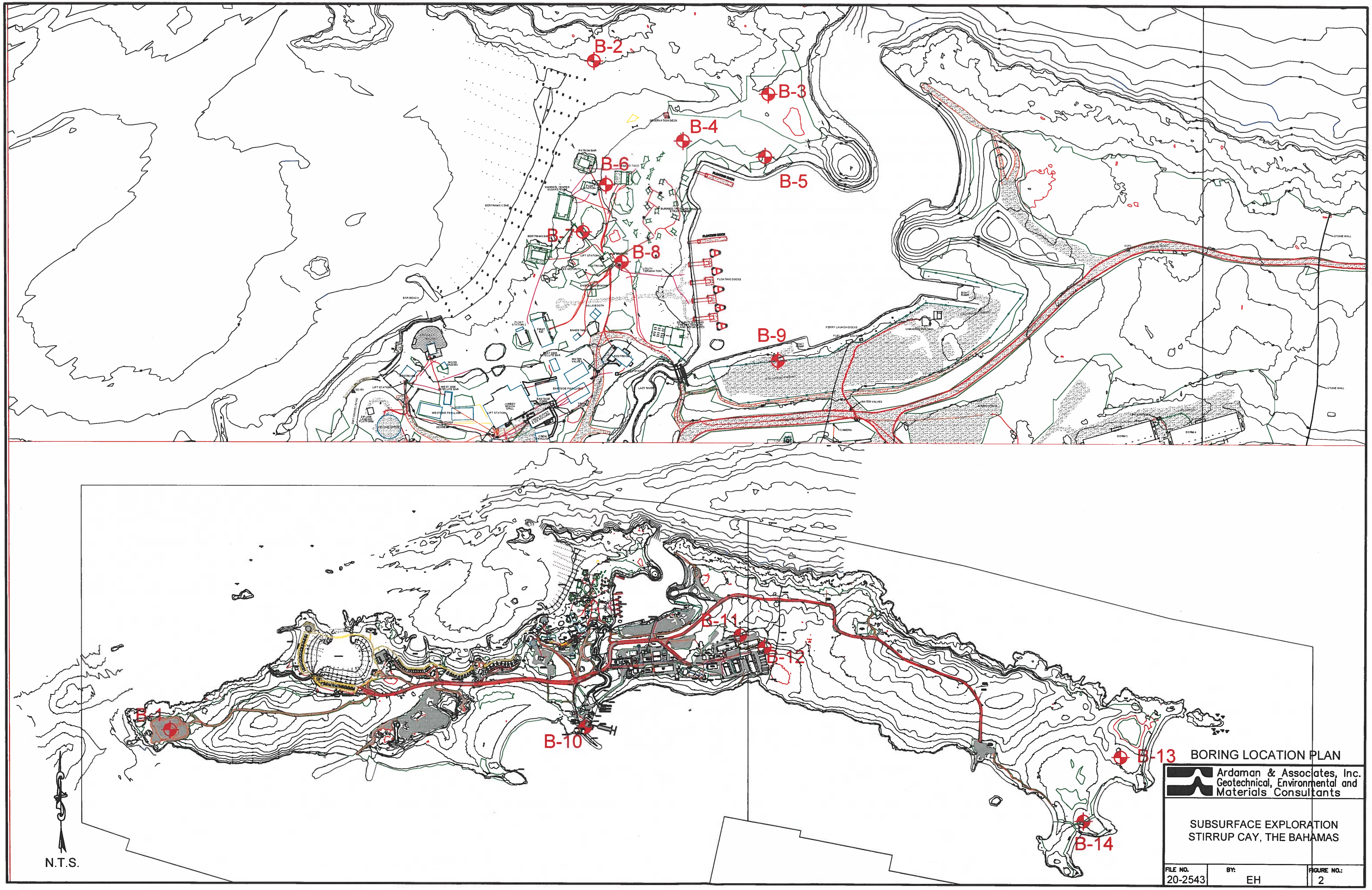
Ardaman & Associates, Inc.
Geotechnical, Environmental and
Materials Consultants

SUBSURFACE EXPLORATION
GREAT STIRRUP CAY
THE BAHAMAS

SITE
LOCATION PLAN

Figure No. 1

File No.:	20-2543
Prepared By:	EHJr
Date:	7/15/20



BORING LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and
Materials Consultants

SUBSURFACE EXPLORATION
STIRRUP CAY, THE BAHAMAS

FILE NO.	BY:	FIGURE NO.:
20-2543	EH	2

APPENDIX

STANDARD PENETRATION TEST BORING LOGS

Our borings describe subsurface conditions only at the locations drilled and at the time drilled. They provide no information about subsurface conditions below the bottom of the boreholes. At locations not explored, surface conditions that differ from those observed in the borings may exist and should be anticipated.

The information reported on our boring logs is based on our drillers' logs and on visual examination in our laboratory of disturbed soil samples recovered from the borings. The distinction shown on the logs between soil types is approximate only. The actual transition from one soil to another may be gradual and indistinct.

The groundwater depth shown on our boring logs is the water level the driller observed in the borehole when it was drilled. These water levels may have been influenced by the drilling procedures, especially in borings made by rotary drilling with bentonitic drilling mud. An accurate determination of groundwater level required long-term observation of suitable monitoring wells. Fluctuations in groundwater levels throughout the year should be anticipated.

The absence of a groundwater level on certain logs indicates that no groundwater data is available. It does not mean that no groundwater will be encountered at the boring location.

STANDARD PENETRATION TEST BORINGS

The Standard Penetration Test is a widely accepted method of testing foundation soils in place. The N-Value obtained from the test has been correlated empirically with various soil properties. These empirical correlations allow satisfactory estimates to be made of how the soil is likely to behave when subjected to foundation loads. Tests are usually performed in the boreholes at intervals of five feet. In addition, our Firm performs tests continuously in the interval directly below the expected foundation bearing grade where the soils will be most highly stressed.

Boreholes where Standard Penetration Tests will be performed are drilled with a truck-mounted CME 45A drill rig. The boreholes are advanced by rotary drilling with a winged bit that makes a hole about three inches in diameter. A bentonitic drilling mud is recirculated in order to remove the cuttings and support the walls of the borehole. The drag bit is specially modified to direct the mud upward and reduced disturbance of the soil ahead of the bit.

Occasionally, running or squeezing ground is encountered that cannot be stabilized by the drilling mud alone. In addition, drilling mud may be lost into the soil or rock strata that are unusually pervious. In such cases, flush-coupled steel casing with an outside diameter of about 3.5 inches is driven as a liner for the borehole.

After the borehole has been advanced to the depth where a Standard Penetration Test will be performed, the soil sampler used to run the test is attached to the end of the drill rods and lowered to the bottom of the borehole. The testing procedure used conforms closely to the methods recommended in ASTM D-1586. The sampler used has a split-barrel 24 inches long and an outside diameter of 2.0 inches. It is driven into the ground below the bottom of the borehole using a hammer that weighs 140 pounds and falls 30 inches. The driller records the number of hammer blows need to advance the sampler the second and third six-inch increments constitutes the test result; that is, the N-Value at the depth. The test is completed after the sampler has been driven not more than 24 inches or when refusal is encountered, whichever occurs first. Refusal occurs when 50 hammer blows advance the sampler six inches or less. After the test is completed, the sampler is removed from the borehole and opened.

The driller examined and classified the soil recovered by the sampler. He places representative soil specimens from each test in closed glass jars and takes them to our laboratory. In the laboratory, additional evaluations and tests are performed, if needed. The driller's classifications may be adjusted, if necessary, to conform more closely to the United Soil Classification systems, ASTM D-2487. Jar samples are retrained in our laboratory for sixty days, then discarded unless our clients request otherwise.

After completion of a test boring, the water level in the borehole is recorded.

STANDARD PENETRATION TEST BORING LOG

BORING 1

PROJECT: Great Stirrup Cay Island
Grand Bahama

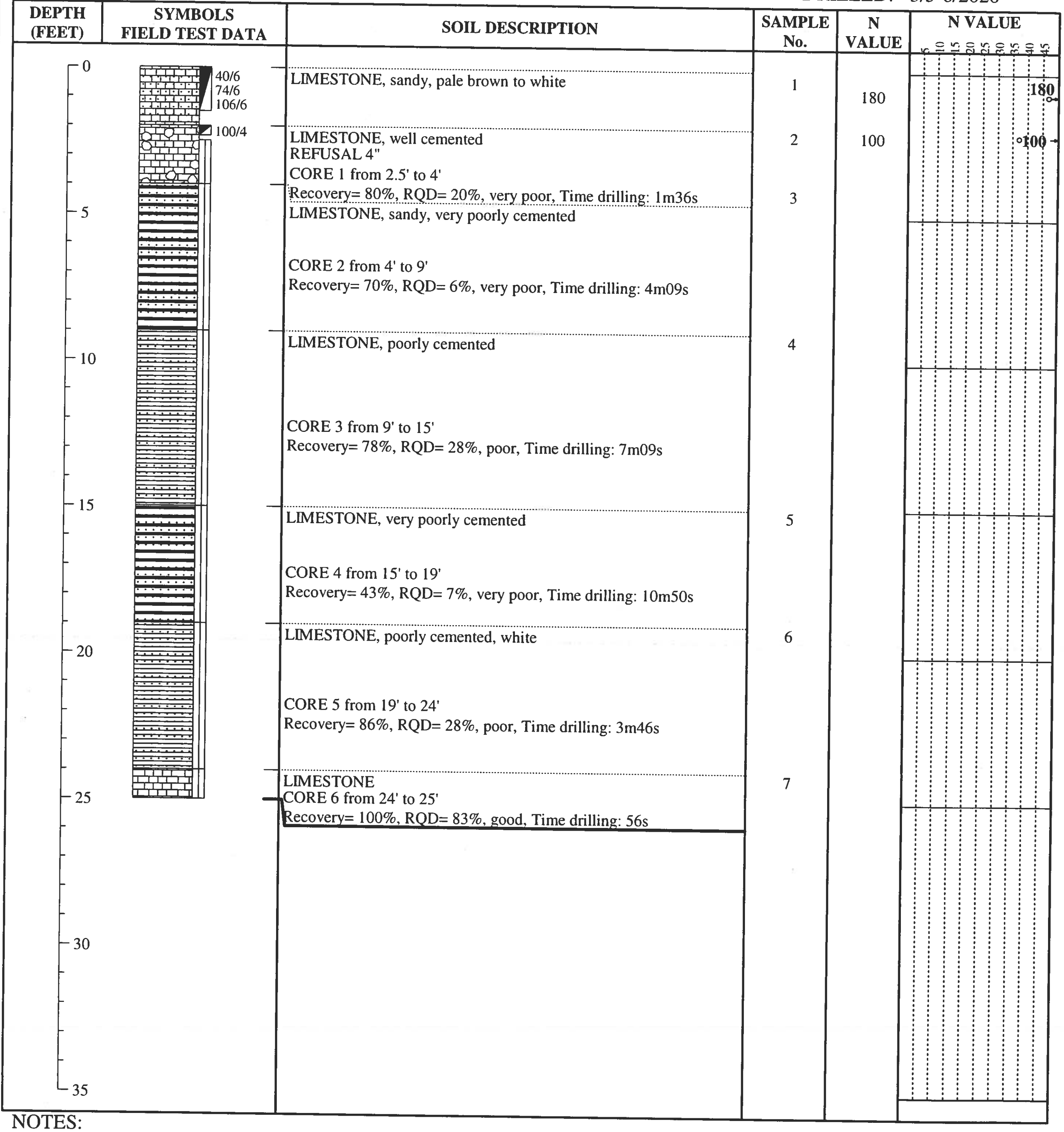
FILE No.: 20-2543

BORING LOCATION: E: 682,87o-N:9,381,11o (Marina)

DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/5-6/2020



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
	40/6 74/6 106/6	LIMESTONE, sandy, pale brown to white	1	180
	100/4	LIMESTONE, well cemented REFUSAL 4" CORE 1 from 2.5' to 4' Recovery= 80%, RQD= 20%, very poor, Time drilling: 1m36s	2	100
		LIMESTONE, sandy, very poorly cemented CORE 2 from 4' to 9' Recovery= 70%, RQD= 6%, very poor, Time drilling: 4m09s	3	
		LIMESTONE, poorly cemented CORE 3 from 9' to 15' Recovery= 78%, RQD= 28%, poor, Time drilling: 7m09s	4	
		LIMESTONE, very poorly cemented CORE 4 from 15' to 19' Recovery= 43%, RQD= 7%, very poor, Time drilling: 10m50s	5	
		LIMESTONE, poorly cemented, white CORE 5 from 19' to 24' Recovery= 86%, RQD= 28%, poor, Time drilling: 3m46s	6	
		LIMESTONE CORE 6 from 24' to 25' Recovery= 100%, RQD= 83%, good, Time drilling: 56s	7	

NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG

BORING 2

PROJECT: Great Stirrup Cay Island
Grand Bahama

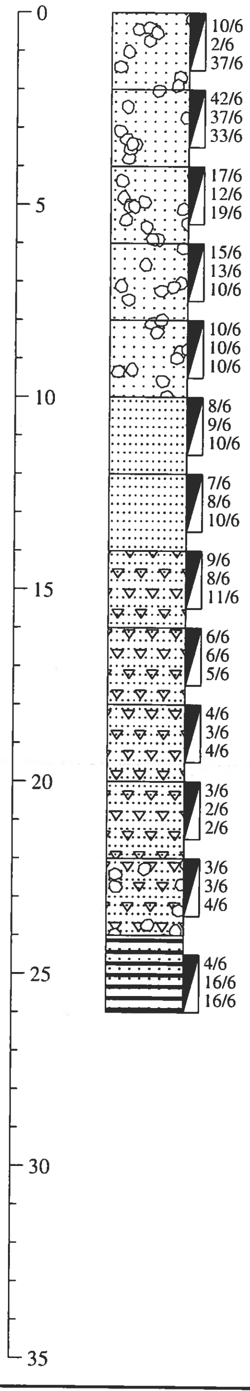
FILE No.: 20-2543

BORING LOCATION: E682,690-N9,381,580

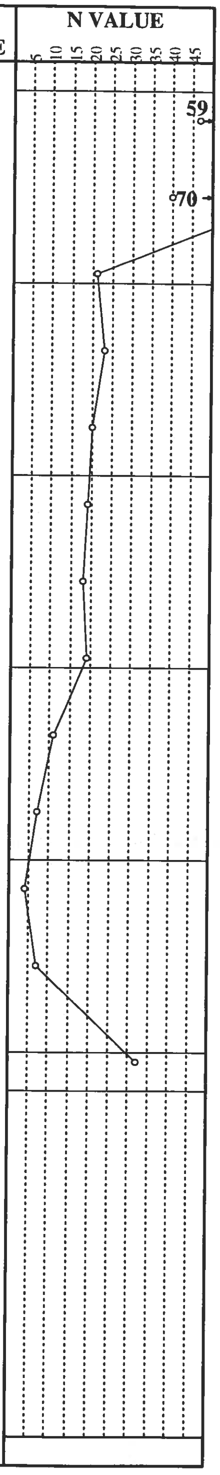
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/7/2020



FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
10/6 2/6 37/6	SAND, fine grained with some limestone fragments, grey to white (SW)	1	59
42/6 37/6 33/6	SAND, fine grained with limestone fragments, white (SW)	2	70
17/6 12/6 19/6	SAND, fine grained with limestone fragments, white (SW)	3	21
15/6 13/6 10/6	SAND, fine grained with limestone fragments, grey (SW)	4	23
10/6 10/6 10/6	SAND, fine grained with limestone fragments, grey (SW)	5	20
8/6 9/6 10/6	SAND, medium dense, poorly graded, fine grained, white (SP-SM)	6	19
7/6 8/6 10/6	SAND, medium dense, fine grained, white to grey (SP)	7	18
9/6 8/6 11/6	SAND, medium dense, fine grained with a few shell fragments (SW)	8	19
6/6 6/6 5/6	SHELLY sand, medium dense, well graded, pale brown to grey (SW-SM)	9	11
4/6 3/6 4/6	SHELLY sand, medium dense, pale brown to grey (SW)	10	7
3/6 2/6 2/6	SHELLY sand, medium dense, pale brown to grey (SW)	11	4
3/6 3/6 4/6	SHELLY sand with some poorly cemented limestone fragments (SW)	12	7
4/6 16/6 16/6	LIMESTONE, very poorly cemented with pockets of sand and shell fragments	13	32



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG
BORING 3

PROJECT: Great Stirrup Cay Island
Grand Bahama

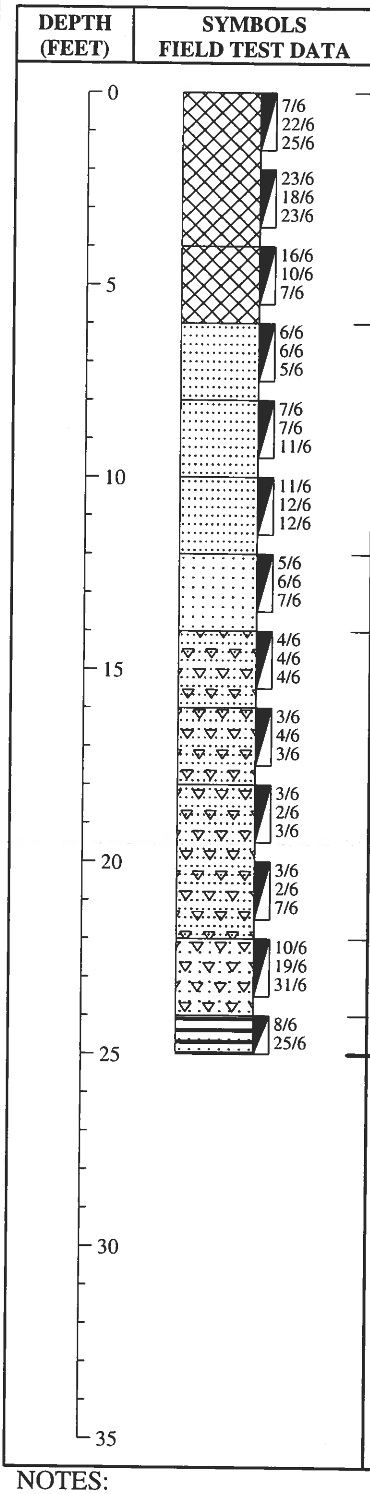
FILE No.: 20-2543

BORING LOCATION: E682,520 N9,381,630

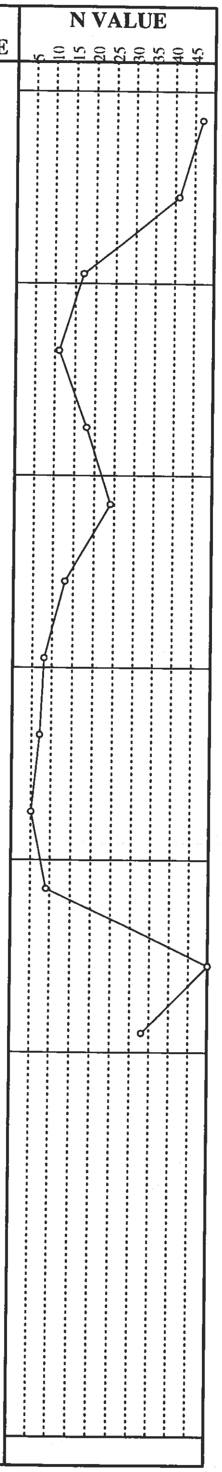
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/8/2020



SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
7/6 22/6 25/6	SAND with some rock fragments, pale brown (SW)	1	47
23/6 18/6 23/6			41
16/6 10/6 7/6	SAND with some rock fragments, pale brown (SW)	2	17
6/6 6/6 5/6	SAND, medium dense, fine grained, brown (SP)	3	11
7/6 7/6 11/6	SAND, medium dense, fine grained, pale brown to white (SP)	4	18
11/6 12/6 12/6	SAND, medium dense, fine grained, pale brown to white (SP)	5	24
5/6 6/6 7/6	SAND, fine grained with some rock fragments (SW)	6	13
4/6 4/6 4/6	SAND, medium dense, shelly with some rock fragments (SW)	7	8
3/6 4/6 3/6	SAND, medium dense, shelly with some rock fragments (SW)	8	7
3/6 2/6 3/6	SAND, medium dense, shelly with some rock fragments (SW)	9	5
3/6 2/6 7/6			9
10/6 19/6 31/6	SHELLY sand, medium dense (SP)	10	50
8/6 25/6	LIMESTONE, sandy, very poorly cemented	11	33



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG

BORING 4

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

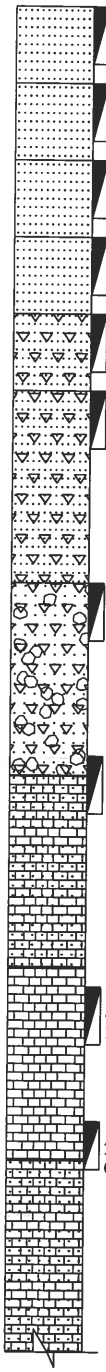
BORING LOCATION: E682,360 N9,381,800

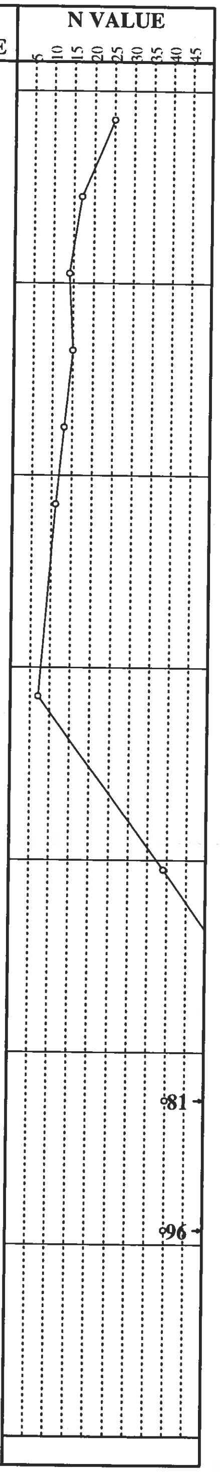
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/8-9/2020

DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
0	5/6 12/6 13/6	SAND, medium dense, well graded, fine grained, grey (SW)	1	25
	11/6 9/6 8/6	SAND, medium dense, fine grained, grey (SP)	2	17
5	7/6 6/6 8/6	SAND, medium dense, fine grained, grey (SP)	3	14
	7/6 8/6 7/6	SAND, medium dense, fine grained, grey (SP)	4	15
	3/6 7/6 6/6	SAND, medium dense with some shell fragments, well graded, light grey (SW-SM)	5	13
10	10/6 4/6 7/6	SAND, medium dense with some shell fragments, grey (SW) Boring advanced from 12' to 15' with wash drilling	6	11
15	4/6 4/6 3/6	SAND, with some limestone fragments and shells, grey (SW) Boring advanced from 17' to 20' with wash drilling	7	7
20	10/6 16/6 23/6	LIMESTONE, sandy, white Boring advanced from 22' to 25' with wash drilling	8	39
25	29/6 42/6 39/6	LIMESTONE, white Boring advanced from 27' to 30' with wash drilling	9	81
	15/6 28/6 68/3	REFUSAL 3"		96
30		LIMESTONE, sandy, white Boring advanced from 32' to 35' with wash drilling	10	
35				





NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 4

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

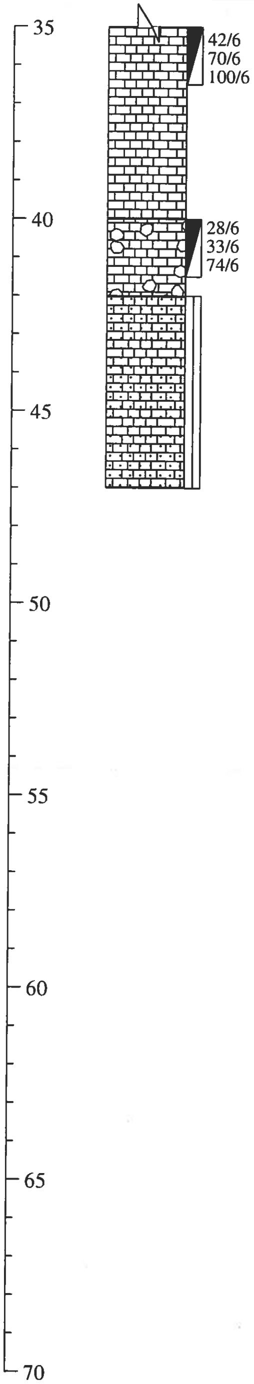
BORING LOCATION: E682,360 N9,381,800

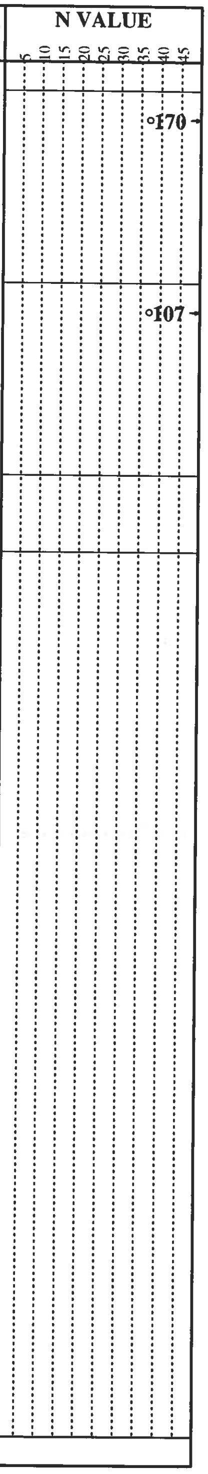
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/8-9/2020

DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
35	42/6 70/6 100/6	LIMESTONE, white Boring advanced from 37' to 40' to wash drilling	11	170
40	28/6 33/6 74/6	LIMESTONE, well cemented, white	12	107
		LIMESTONE, sandy, white CORE 7 from 42' to 47' Recovery=100%, RQD=64%, fair, Time drilling: 1m46s	13	





NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN". 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 5

PROJECT: Great Stirrup Cay Island
Grand Bahama

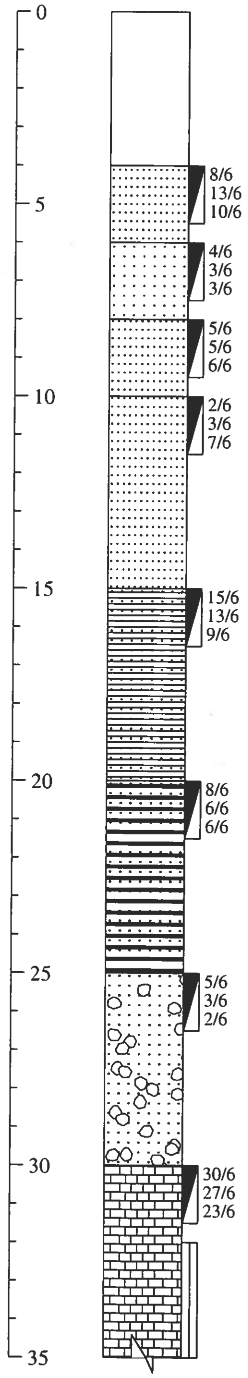
FILE No.: 20-2543

BORING LOCATION: E 682,320 N 9,381,460

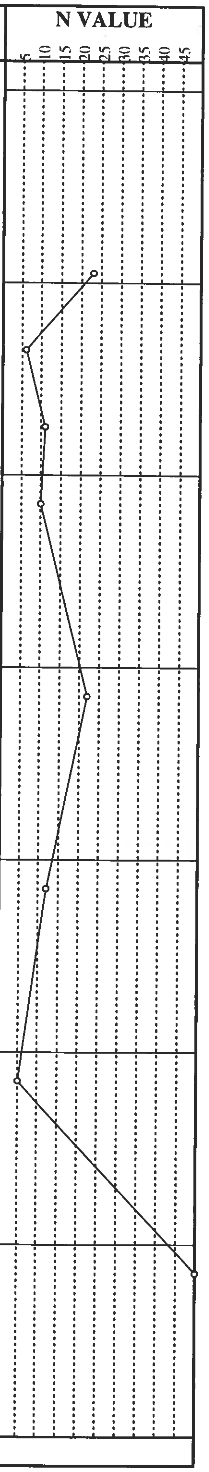
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/9-10/2020



SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
	Boring advanced from 0' to 4' using a hand auger equipment		
8/6 13/6 10/6	SAND, medium dense, fine grained, brown (SP)	1	23
4/6 3/6 3/6	SAND, fine grained, loose, yellow to white (SP)	2	6
5/6 5/6 6/6	SAND, medium dense, fine grained, yellow to white (SP)	3	11
2/6 3/6 7/6	SAND, medium dense, fine grained, yellow to white (SP) WASH	4	10
15/6 13/6 9/6	LIMESTONE, poorly cemented, sandy, white WASH	5	22
8/6 6/6 6/6	LIMESTONE, very poorly cemented, sandy, white WASH	6	12
5/6 3/6 2/6	SAND, loose with some rock fragments, grey (SP) WASH	7	5
30/6 27/6 23/6	LIMESTONE, white CORE 1 from 32' to 37' Recovery=16%, RQD=6%, very poor, Time Drilling: 8m 41s	8	50



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG

BORING 5

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

BORING LOCATION: E 682,320 N 9,381,460

DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/9-10/2020

DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE	N VALUE 5 10 15 20 25 30 35 40 45
35	▨				
40					
45					
50					
55					
60					
65					
70					

NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN". 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG
BORING 6

PROJECT: Great Stirrup Cay Island
Grand Bahama

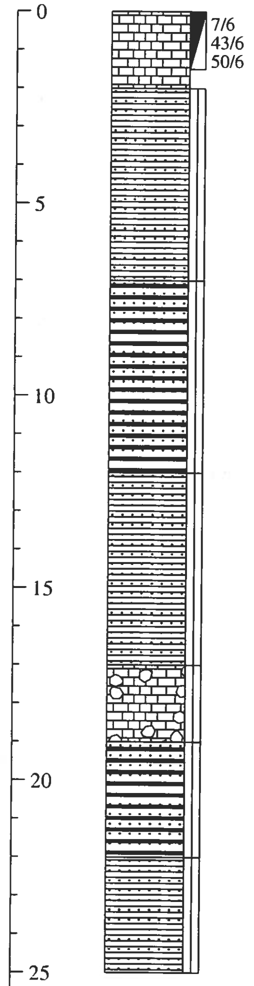
FILE No.: 20-2543

BORING LOCATION: E682,770 N9,381,800

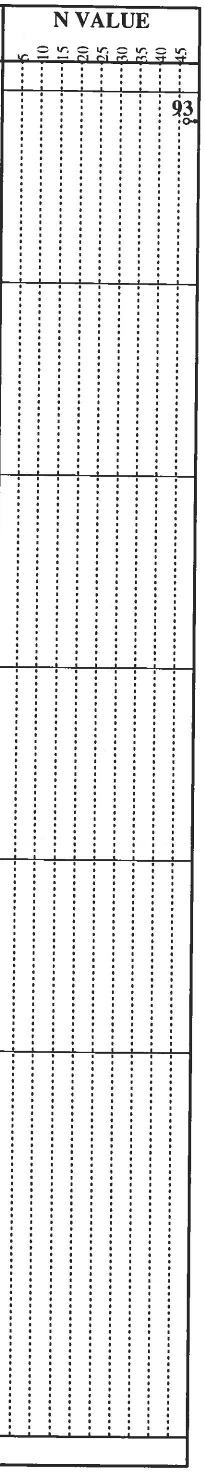
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/10/2020



SOIL DESCRIPTION	SAMPLE No.	N VALUE
LIMESTONE, white	1	93
LIMESTONE, very poorly cemented, white CORE 1 from 2' to 7' Recovery=40%, RQD=0%, very poor, Time drilling: 2m 20s	3	
LIMESTONE, very poorly cemented, sandy, white CORE 2 from 7' to 12' Recovery=20%, RQD=0%, very poor, Time drilling: 8m 47s	4	
LIMESTONE, poorly cemented, white CORE 3 from 12' to 17' Recovery=40%, RQD=25%, poor, Time drilling: 15m 37s	5	
LIMESTONE, well cemented, white CORE 4 from 17' to 19' Recovery=92%, RQD=92%, excellent, Time drilling: 3m 24s	6	
LIMESTONE, very poorly cemented, white CORE 5 from 19' to 22' Recovery=38%, RQD=0%, very poor, Time drilling: 4m 11s	7	
LIMESTONE, poorly cemented, white CORE 6 from 22' to 25' Recovery=40%, RQD=40%, poor, Time drilling: 3m	8	



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG

BORING 7

PROJECT: Great Stirrup Cay Island
Grand Bahama

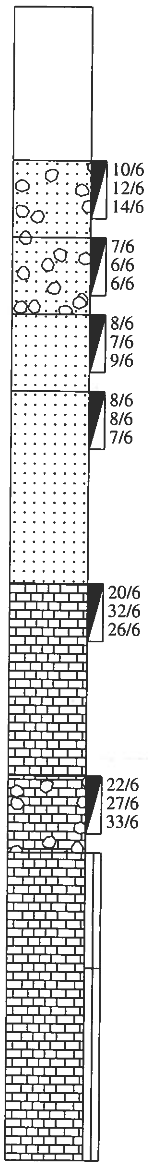
FILE No.: 20-2543

BORING LOCATION: e 682,500 N 9,381,350

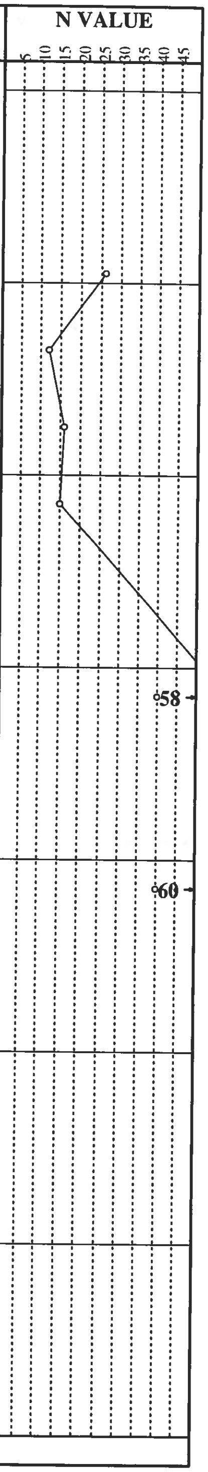
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/11/2020



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
0		Boring advanced from 0' to 4' using a hand auger equipment		
5	10/6 12/6 14/6	SAND with some rock fragments, white (SW)	1	26
	7/6 6/6 6/6	SAND with some rock fragments, white (SW)	2	12
	8/6 7/6 9/6	SAND, fine grained, brown to white (SP)	3	16
10	8/6 8/6 7/6	SAND, fine grained, brown to white (SP) WASH	4	15
15	20/6 32/6 26/6	LIMESTONE, white WASH	5	58
20	22/6 27/6 33/6	LIMESTONE, well cemented, white	6	60
		LIMESTONE, white CORE 1 from 22' to 25' Recovery=56%, RQD=28%, poor, Time drilling: 4m 2s		
25		LIMESTONE, white CORE 2 from 25' to 30' Recovery=100%, RQD=56%, fair, Time drilling: 5m 8s		
30				
35				



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG
BORING 8

PROJECT: Great Stirrup Cay Island
Grand Bahama

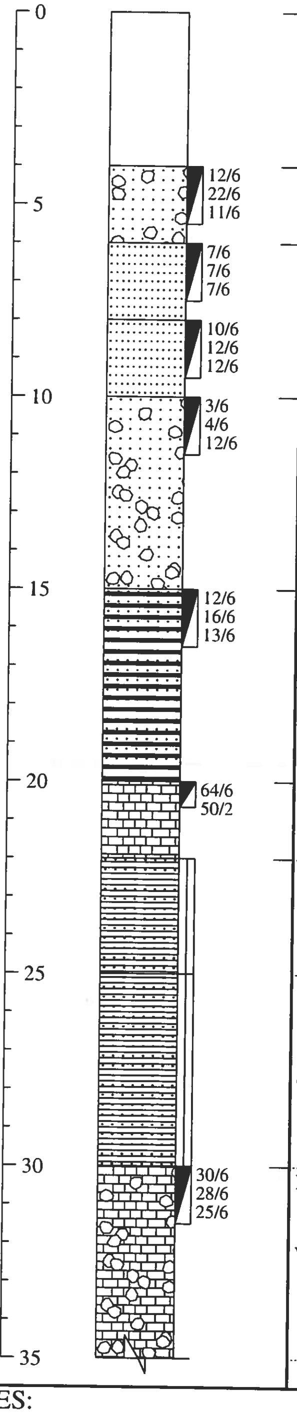
FILE No.: 20-2543

BORING LOCATION: E682,240 N9,381,340

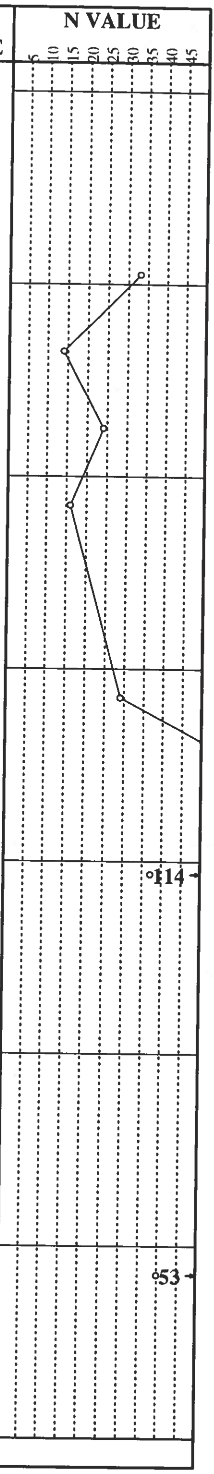
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/12/2020



FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
	Boring advanced from 0' to 4' using a hand auger equipment		
12/6 22/6 11/6	SAND, fine grained with some rock fragments, grey (SW)	1	33
7/6 7/6 7/6	SAND, medium dense, fine grained, white (SP)	2	14
10/6 12/6 12/6	SAND, medium dense to dense, fine grained, yellow to white (SP)	3	24
3/6 4/6 12/6	SAND, with some poorly cemented limestone fragments, white (SW)	4	16
12/6 16/6 13/6	LIMESTONE, very poorly cemented, white	5	29
64/6 50/2	LIMESTONE, white CORE 1 from 22' to 25' Recovery=42%, RQD=0%, very poor, Time drilling: 12m 24s	6	114
	LIMESTONE, poorly cemented, white	7	
	LIMESTONE, poorly cemented, white CORE 2 from 25' to 30' Recovery=26%, RQD=6%, very poor, Time drilling; 9m 27s	8	
30/6 28/6 25/6	LIMESTONE, well cemented, white WASH	9	53



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 8

PROJECT: Great Stirrup Cay Island
Grand Bahama

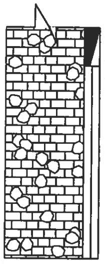
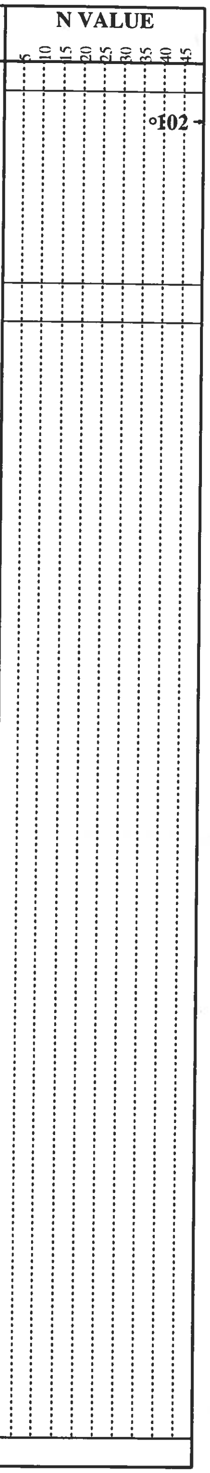
FILE No.: 20-2543

BORING LOCATION: E682,240 N9,381,340

DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/12/2020

DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE	N VALUE
35	 35/6 42/6 60/6	LIMESTONE, well cemented, white CORE 3 from 36' to 41' Recovery=75%, RQD=26%, poor, Time drilling: 7m 18s	10	102	
40					
45					
50					
55					
60					
65					
70					

NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN". 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 9

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

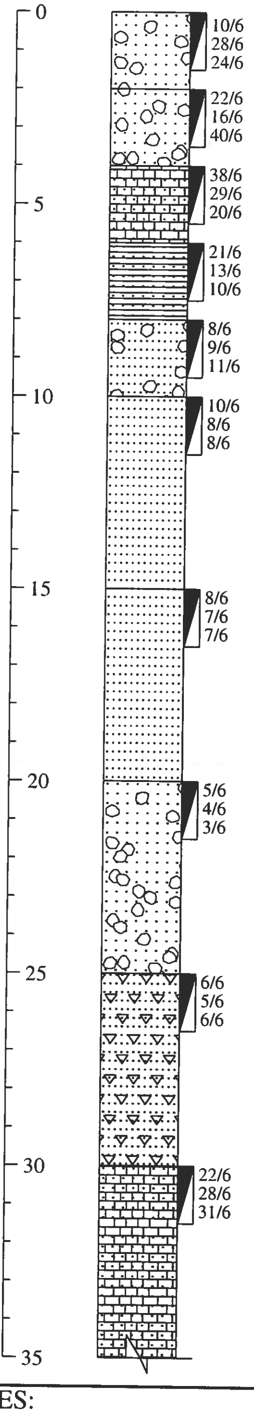
BORING LOCATION: N/A

DRILL CREW: TD

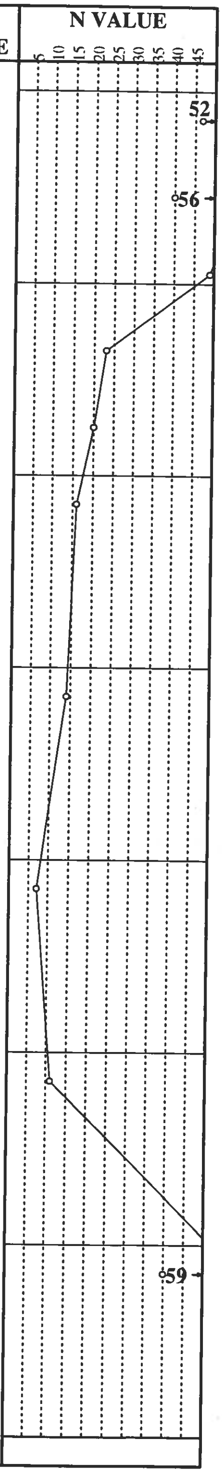
WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/13/2020

DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
0	10/6 28/6 24/6	SAND, fine grained with some limestone fragments, white (SW)	1	52
	22/6 16/6 40/6	SAND, fine grained with some limestone fragments, white (SW)	2	56
5	38/6 29/6 20/6	LIMESTONE, very sandy, white	3	49
	21/6 13/6 10/6	LIMESTONE, poorly cemented	4	23
	8/6 9/6 11/6	SAND, medium dense, fin agrained with some limestone fragments, grey (SW)	5	20
10	10/6 8/6 8/6	SAND, medium dense, fine grained, grey (SP) Boring advanced from 12' to 15' with wash boring	6	16
15	8/6 7/6 7/6	SAND, medium dense, fine grained, yellow to white (SP) Boring advanced from 17' to 20' with wash boring	7	14
20	5/6 4/6 3/6	SAND, loose, fine grained with some shell fragments (SP) Boring advanced from 22' to 25' with wash boring	8	7
25	6/6 5/6 6/6	SAND, fine grained, medium dense with shell fragments (SP) Boring advanced from 27' to 30' with wash boring	9	11
30	22/6 28/6 31/6	LIMESTONE, very sandy, white Boring advanced from 32' to 35' with wash boring	10	59
35				



N VALUE



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 9

PROJECT: Great Stirrup Cay Island
Grand Bahama

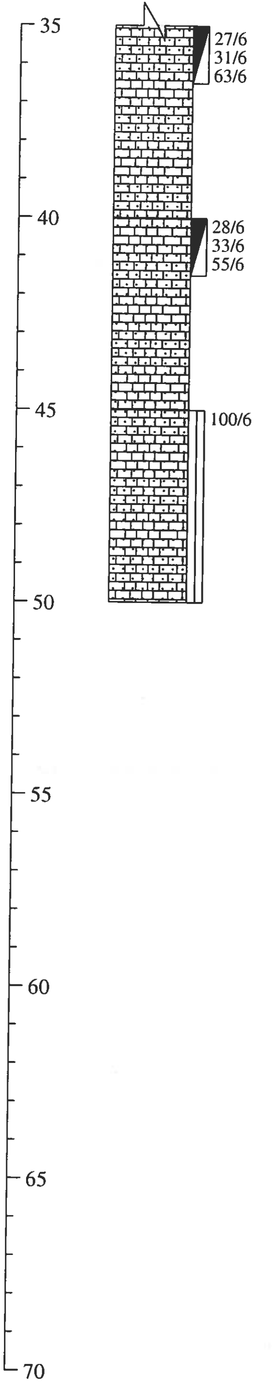
FILE No.: 20-2543

BORING LOCATION: N/A

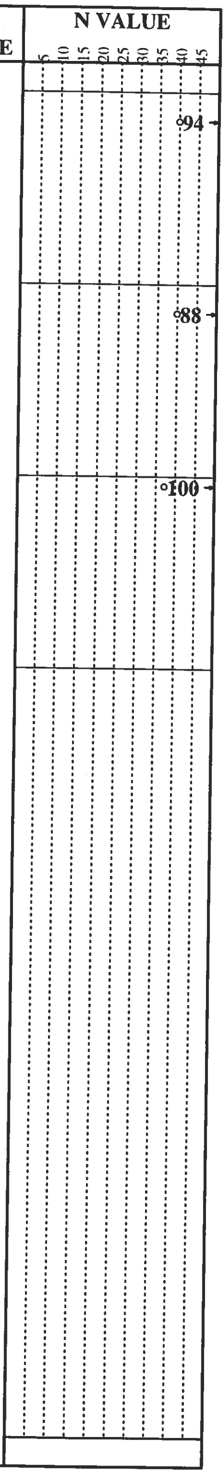
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/13/2020



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
35	27/6 31/6 63/6	LIMESTONE, very sandy, white Boring advanced from 37' to 40' with wash boring	11	94
40	28/6 33/6 55/6	LIMESTONE, with cemented sand, white Boring advanced from 42' to 45' with wash boring	12	88
45	100/6	REFUSAL 6" LIMESTONE, with cemented sand CORE 1 from 45' to 50' Recovery=100%, RQD=85%, good, Time drilling: 14m 49s	13	100



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN". 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 10

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

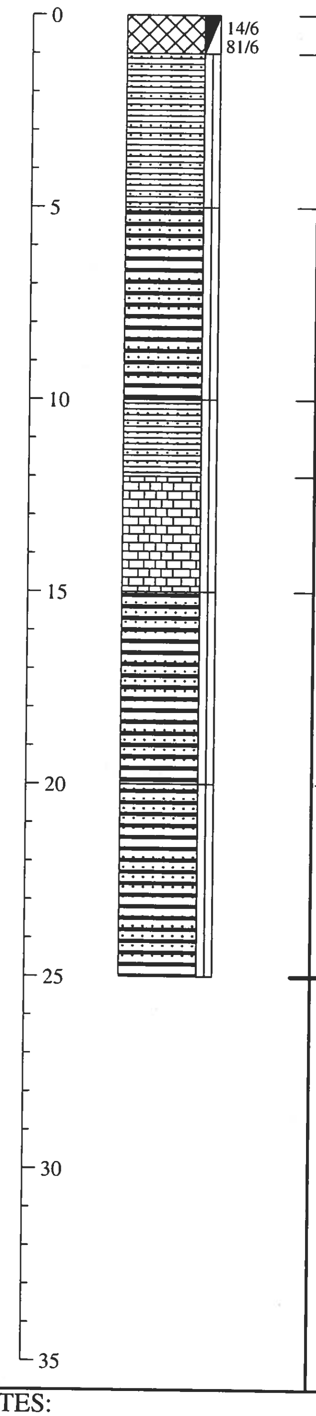
BORING LOCATION: E683,800 N9,380,900

DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

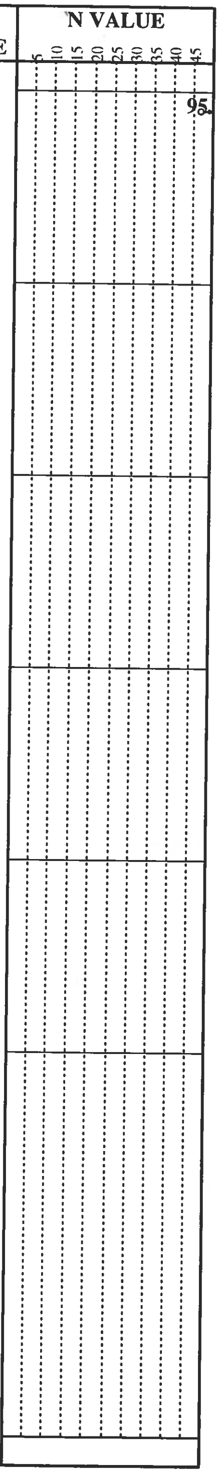
DATE DRILLED: 3/14/2020

DEPTH (FEET) / SYMBOLS FIELD TEST DATA



SOIL DESCRIPTION	SAMPLE No.	N VALUE
SAND, with rock fragments (SW)	1	95
LIMESTONE, poorly cemented CORE 1 from 1' to 5' Recovery=94%, RQD=15%, very poor, Time drilling: 3m	2	
LIMESTONE, very poorly cemented, white CORE 2 from 5' to 10' Recovery=48%, RQD=6%, very poor, Time drilling: 4m 46s	3	
LIMESTONE, poorly cemented	4	
LIMESTONE, white CORE 3 from 10' to 15' Recovery=63%, RQD=40%, poor, Time drilling: 5m 55s	5	
LIMESTONE, very poorly cemented CORE 4 from 15' to 20' Recovery=46%, RQD=8%, very poor, Time drilling: 6m 43s	6	
LIMESTONE, very poorly cemented CORE 5 from 20' to 25' Recovery=42%, RQD=0%, very poor, Time drilling: 6m 36s	7	

N VALUE



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG

BORING 11

PROJECT: Great Stirrup Cay Island
Grand Bahama

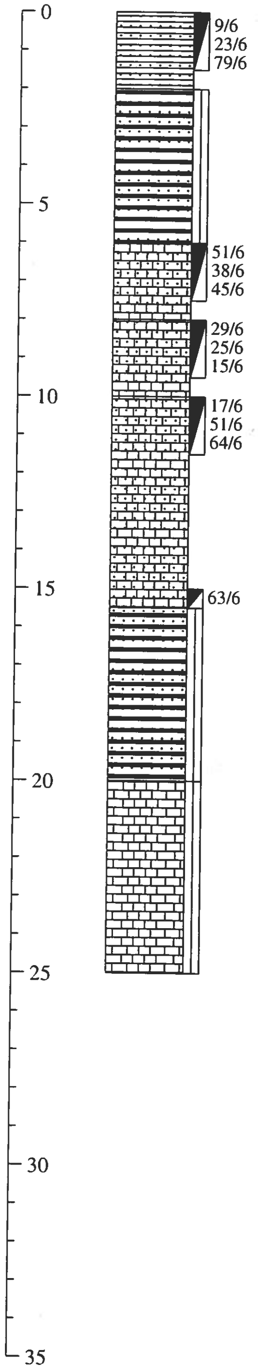
FILE No.: 20-2543

BORING LOCATION: E684,040 N9,380,760

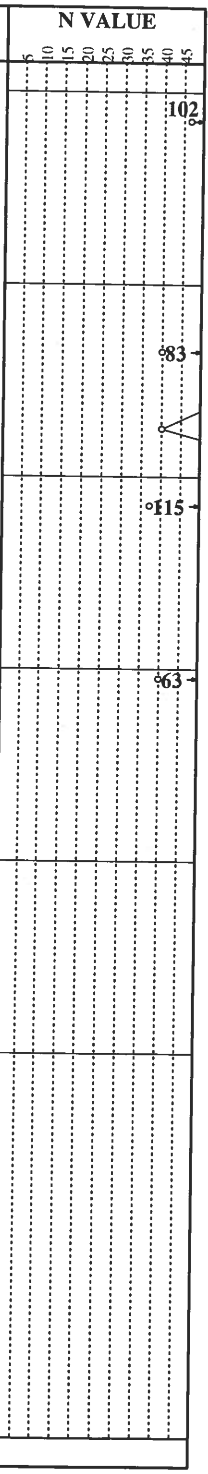
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/15/2020



SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
9/6 23/6 79/6	LIMESTONE, poorly cemented with pockets of sand	1	102
	LIMESTONE, very poorly cemented CORE 1 from 2' to 6' Recovery=12%, RQD=0%, very poor, Time drilling: 4m 33s	2	
51/6 38/6 45/6	LIMESTONE, sandy, white to grey	3	83
29/6 25/6 15/6	LIMESTONE, sandy, white to grey	4	40
17/6 51/6 64/6	LIMESTONE with pockets of sand, white Boring advanced from 12' to 15' with wash boring	5	115
63/6	LIMESTONE, very poorly cemented CORE 2 from 15.5' to 20' Recovery=90%, RQD=10%, very poor, Time drilling: 5m	6	63
	LIMESTONE, fair CORE 3 from 20' to 25' Recovery=93%, RQD=70%, good, Time drilling: 5m 35s	7	



NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" **140-LB HAMMER, 30-INCH FALL.** **(ASTM D-1586)**

STANDARD PENETRATION TEST BORING LOG

BORING 12

PROJECT: Great Stirrup Cay Island
Grand Bahama

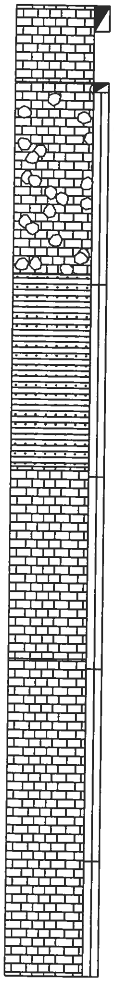
FILE No.: 20-2543

BORING LOCATION: N/A

DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/16/2020



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE	N VALUE
0	34/6 61/2	LIMESTONE, white REFUSAL 2" WASH boring from 0' to 2'	1	101	101
	70/3	LIMESTONE, well cemented, white REFUSAL 3" CORE 1 from 2.25' to 7.25' Recovery=100%, RQD=93%, excellent, Time drilling: 3m 4s	2	70	70
5		LIMESTONE, poorly cemented, sandy CORE 2 from 7.25' to 12.25' Recovery=63%, RQD=26%, poor, Time drilling: 3m 33s	3		
10		LIMESTONE, white CORE 3 from 12.25' to 17.25' Recovery=100%, RQD=80%, good, Time drilling: 3m 46s	4		
15		LIMESTONE, white CORE 4 from 17.25' to 22.25' Recovery=83%, RQD=58%, fair, Time drilling: 5m	5		
20		LIMESTONE, white CORE 5 from 22.25' to 25.25' Recovery=85%, RQD=53%, fair, Time drilling: 3m 45s	6		
25					
30					
35					

N VALUE scale: 5 10 15 20 25 30 35 40 45

NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG

BORING 13

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

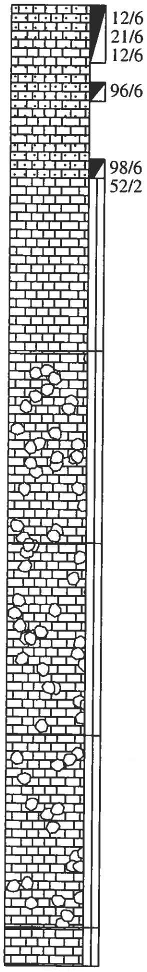
BORING LOCATION: E687,300 N9,379,060

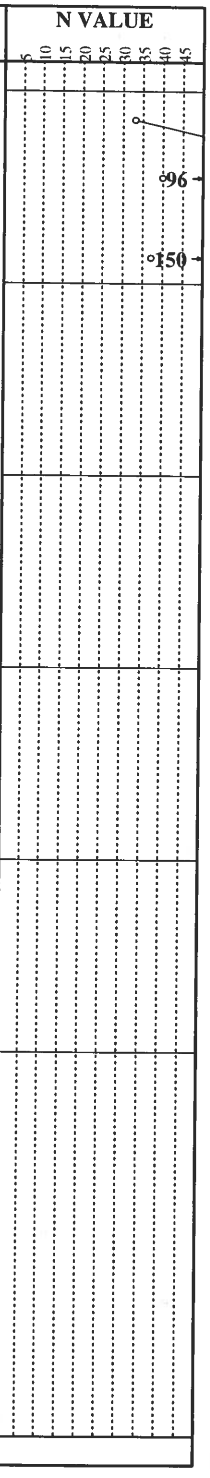
DRILL CREW: TD

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/17/2020

DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
0	12/6 21/6 12/6	LIMESTONE, sandy, pale brown	1	33
	96/6			96
	98/6 52/2	Boring advanced from 2.5' to 4' using wash drilling REFUSAL 2"		150
5		LIMESTONE, white CORE 1 from 4.5' to 9' Recovery=77%, RQD=64%, fair, Time drilling: 4m 22s	2	
10		LIMESTONE, well cemented, white CORE 2 from 9' to 14' Recovery=100%, RQD=80%, good, Time drilling: 4m 32s	3	
15		LIMESTONE, well cemented CORE 3 from 14' to 19' Recovery=100%, RQD=86%, good, Time drilling: 4m 41s	4	
20		LIMESTONE, well cemented CORE 4 from 19' to 24' Recovery=95%, RQD=80%, good, Time drilling: 3m 16s	5	
25		LIMESTONE, white CORE 5 from 24' to 25' Recovery=100%, RQD=60%, fair, Time drilling: 48s	6	
30				
35				





NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

STANDARD PENETRATION TEST BORING LOG
BORING 14

PROJECT: Great Stirrup Cay Island
Grand Bahama

FILE No.: 20-2543

BORING LOCATION: E687,700 N9,379,560

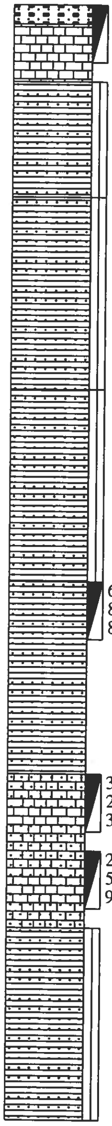
DRILL CREW: TD

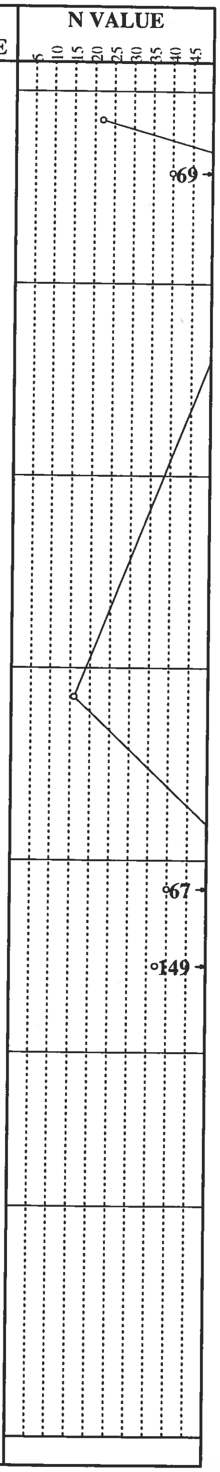
WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 3/17-18/2020

SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
	SAND with some roots (SW)	1	
4/6 6/6 16/6	LIMESTONE, pale brown to white	2	22
69/3	REFUSAL 3"	3	69
	LIMESTONE, poorly cemented, pale brown to white CORE 1 from 2' to 5' Recovery=50%, RQD=8%, very poor, Time drilling: 1m 11s		
	LIMESTONE, poorly cemented, pale brown to white CORE 2 from 5' to 10' Recovery=23%, RQD=0%, very poor, Time drilling: 4m 59s	4	
	LIMESTONE, poorly cemented, pale brown to white CORE 3 from 10' to 15' No Recovery, Time drilling: 5m 42s	5	
6/6 8/6 8/6	LIMESTONE, poorly cemented, sandy, white Boring advanced from 17' to 20' with wash boring	6	16
36/6 29/6 38/6	LIMESTONE, sandy, white	7	67
20/6 59/6 90/6			149
	LIMESTONE, poorly cemented, white CORE 4 from 24' to 29' Recovery=53%, RQD=41%, poor, Time drilling: 6m	8	

DEPTH (FEET): 0, 5, 10, 15, 20, 25, 30, 35



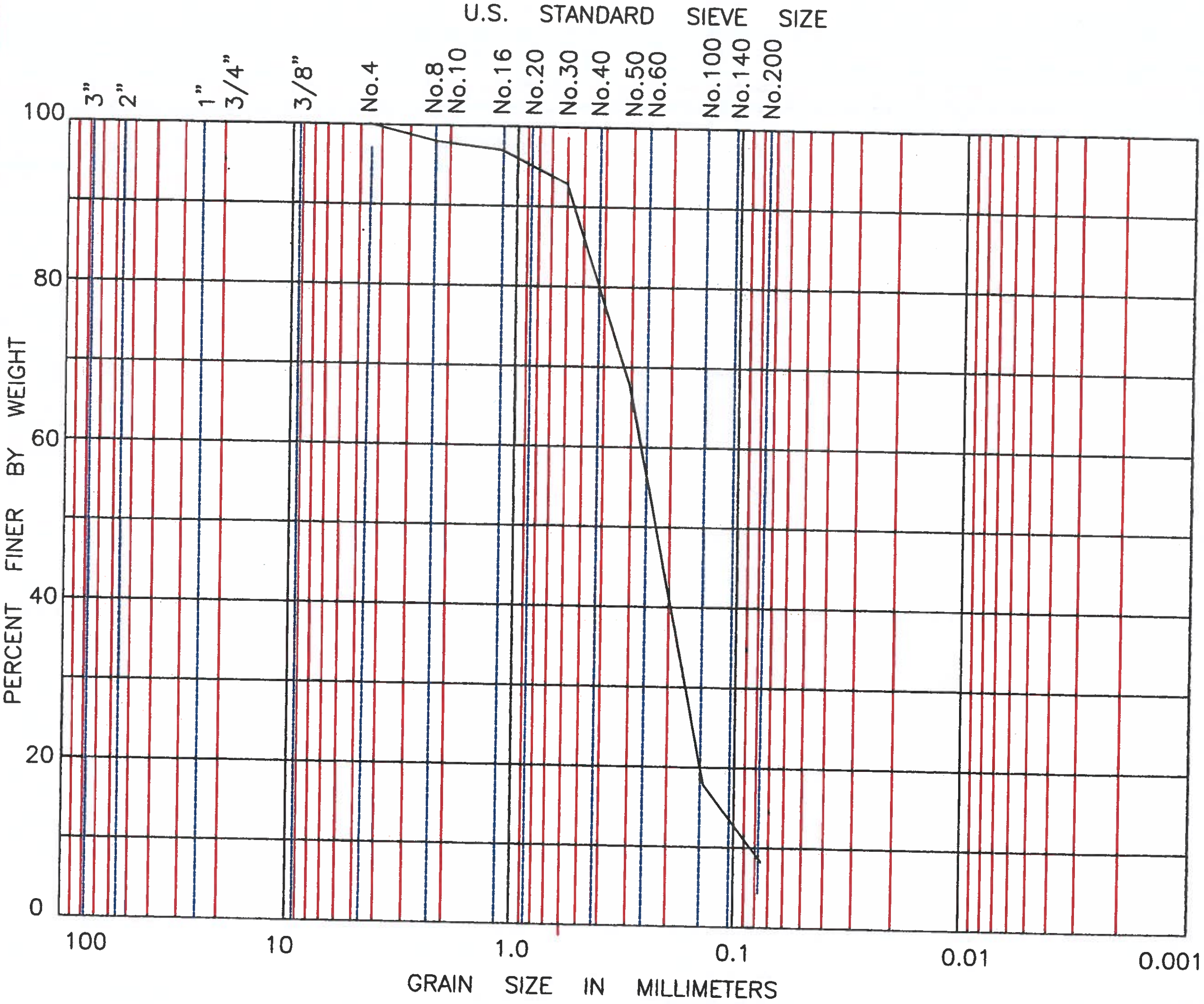


NOTES:

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN" 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

GRAIN SIZE DISTRIBUTION

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. SIEVE SIZE	% PASSING
2	100
11/2	100
1	100
3/4	100
1/2	100
3/8	100
No4	100
No8	99
No16	98
No30	94
No50	68
No100	17.8
No200	9

SAMPLE LOCATION :H2-S6 (10'-12')
TESTED BY JR
SAMPLE DESCRIPTION:SP-SMPOORLY GRADED SAND & SILT

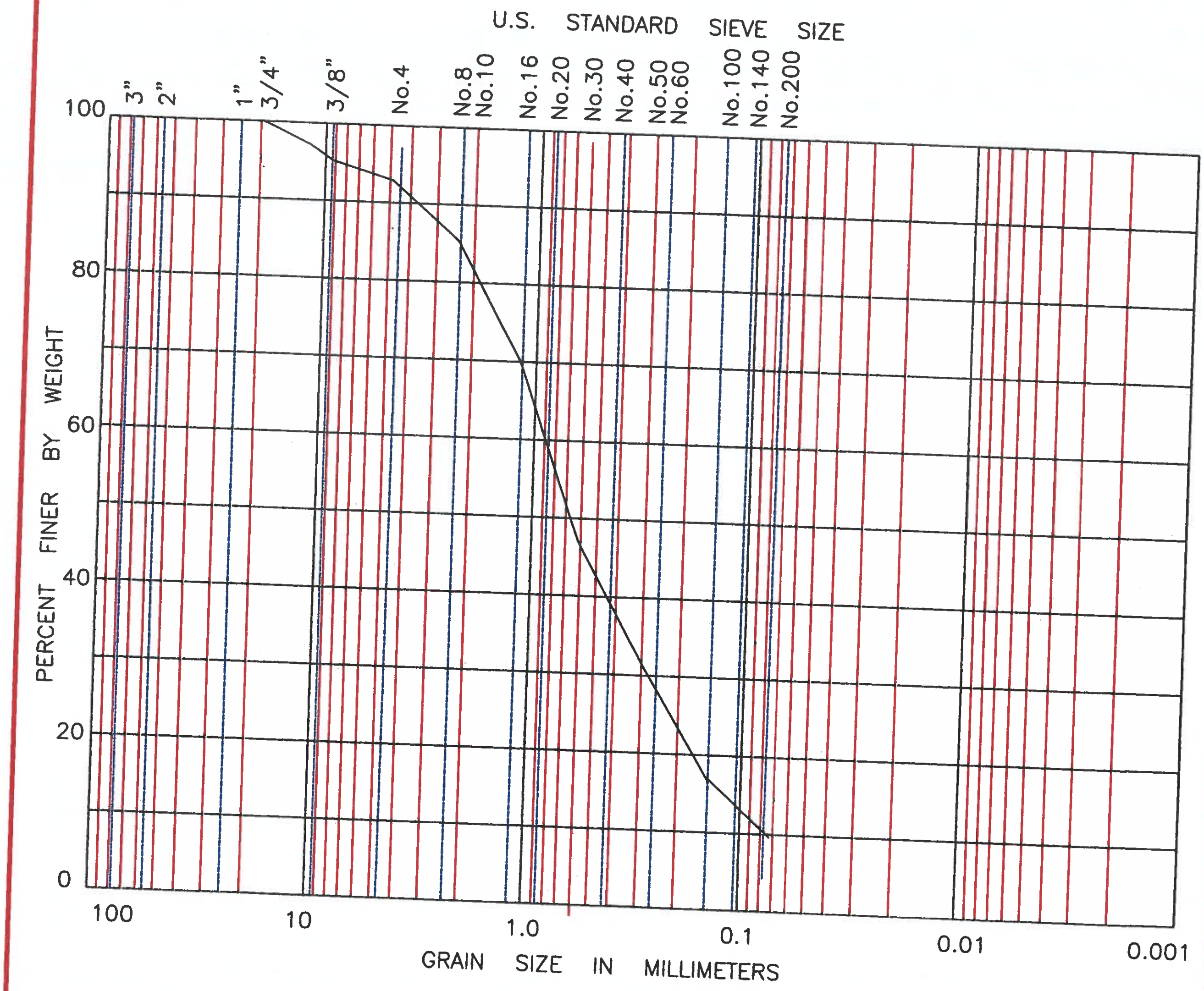
Ardaman & Associates Inc.
Consulting Engineers in Soils, Hydrology,
Foundations and Material Testing.

GREAT STIRRUP CAY

BAHAMA

DRAWN BY:	JR	CHECKED BY:	E.H.	DATE:	7-2-20
FILE No:	20-2543	APPROVED BY:	E.H.		

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. SIEVE SIZE	% PASSING
2	100
11/2	100
1	100
3/4	100
1/2	98
3/8	96
No4	93
No8	85
No16	70
No30	48
No50	31
No100	17.7
No200	10

SAMPLE LOCATION:H2-S9 (16'-18')
TESTED BY JR
SAMPLE DESCRIPTION: SW-SM WELL GRADED SAND WITH SILT

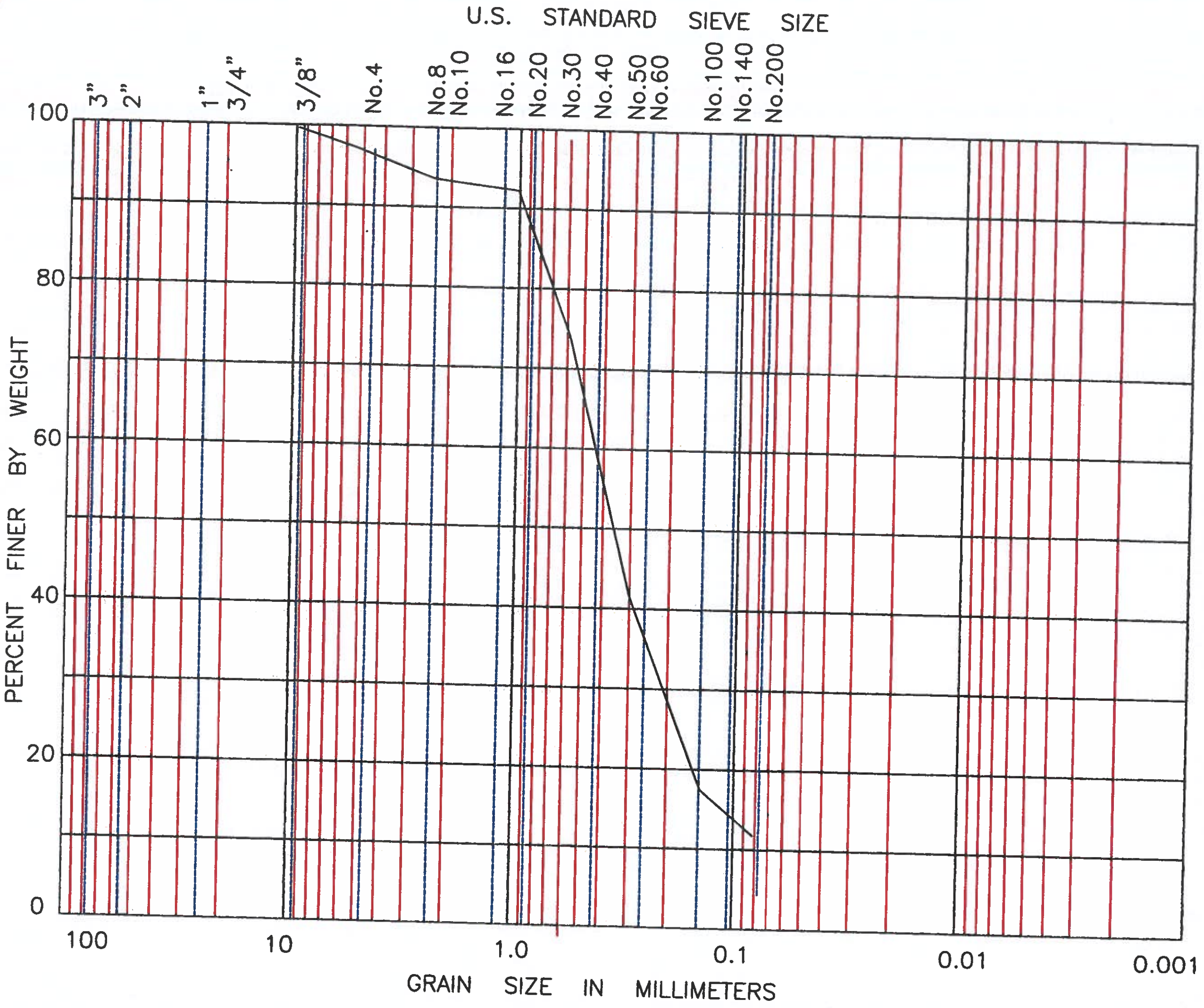
Ardaman & Associates Inc.
Consulting Engineers in Soils, Hydrology,
Foundations and Material Testing.

GREAT STIRRUP CAY

BAHAMA

DRAWN BY: JR
CHECKED BY: E.H.
DATE: 7-2-20
FILE No: 20-2543
APPROVED BY: E.H.

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. SIEVE SIZE	% PASSING
2	100
11/2	100
1	100
3/4	100
1/2	100
3/8	100
No4	98
No8	95
No16	92
No30	74
No50	41
No100	17.6
No200	11.4

SAMPLE LOCATION; H4-SI (0'-2')
TESTED BY JR
SAMPLE DESCRIPTION: SW-WELL GRADED SAND

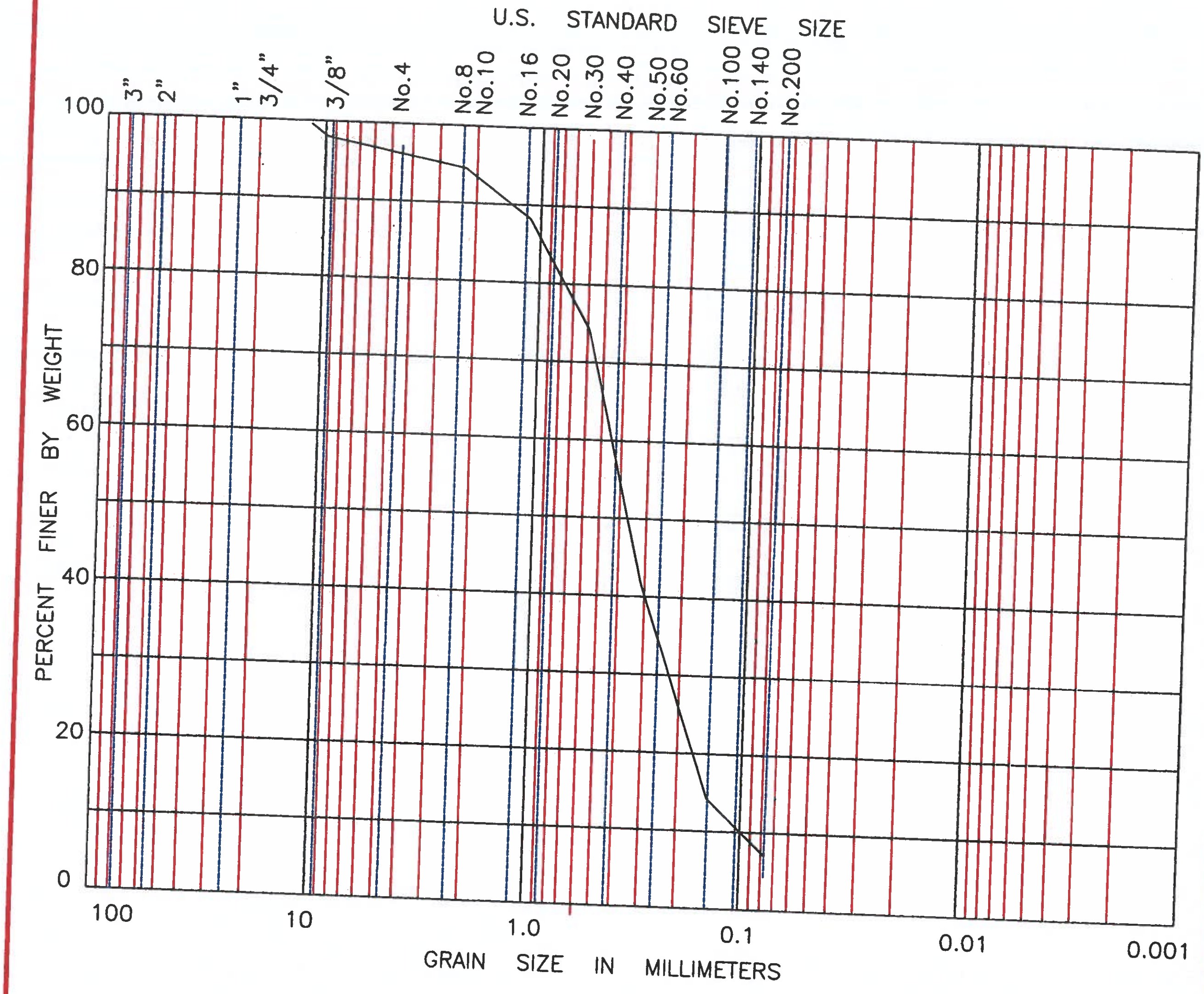
Ardaman & Associates Inc.
Consulting Engineers in Soils, Hydrology,
Foundations and Material Testing.

GREAT STIRRUP CAY

BAHAMA

DRAWN BY: JR	CHECKED BY: E.H.	DATE: 7-2-20
FILE No: 20-2543	APPROVED BY: E.H.	

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. SIEVE SIZE	% PASSING
2	100
11/2	100
1	100
3/4	95
1/2	100
3/8	99
No4	97
No8	95
No16	90
No30	75
No50	41
No100	14
No200	7.8

SAMPLE LOCATION: H4-S5 (8'-10')
TESTED BY JR
SAMPLE DESCRIPTION: SW-SM WELL GRADED SAND WITH SIL

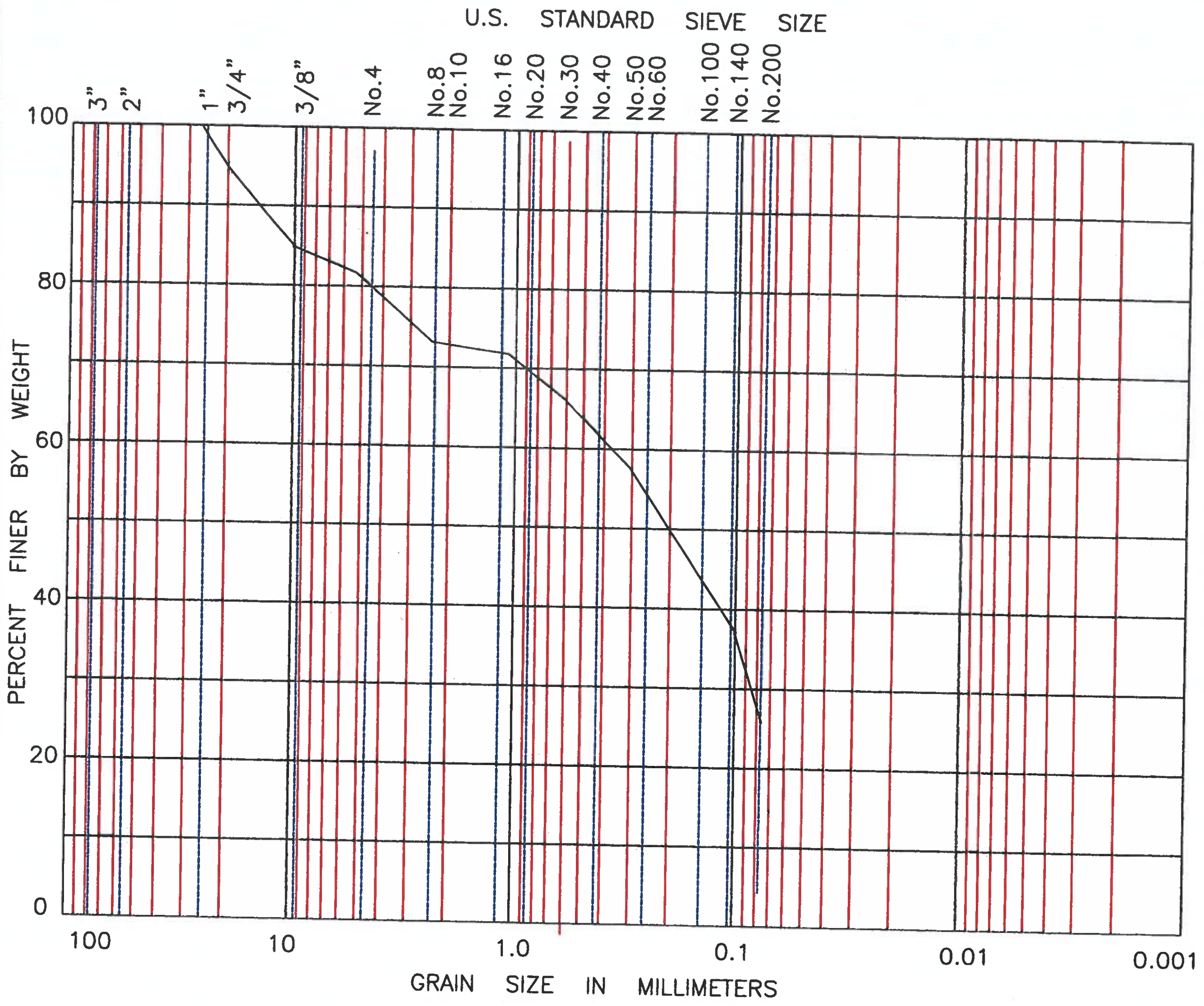
Ardaman & Associates Inc.
Consulting Engineers in Soils, Hydrology,
Foundations and Material Testing.

GREAT STIRRUP CAY

BAHAMA

DRAWN BY: JR	CHECKED BY: E.H.	DATE: 7-2-20	
FILE No: 20-2543	APPROVED BY: E.H.		

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. SIEVE SIZE	% PASSING
2	100
11/2	100
1	100
3/4	95
1/2	89
3/8	85
No4	81
No8	74
No16	71
No30	67
No50	58
No100	38
No200	26

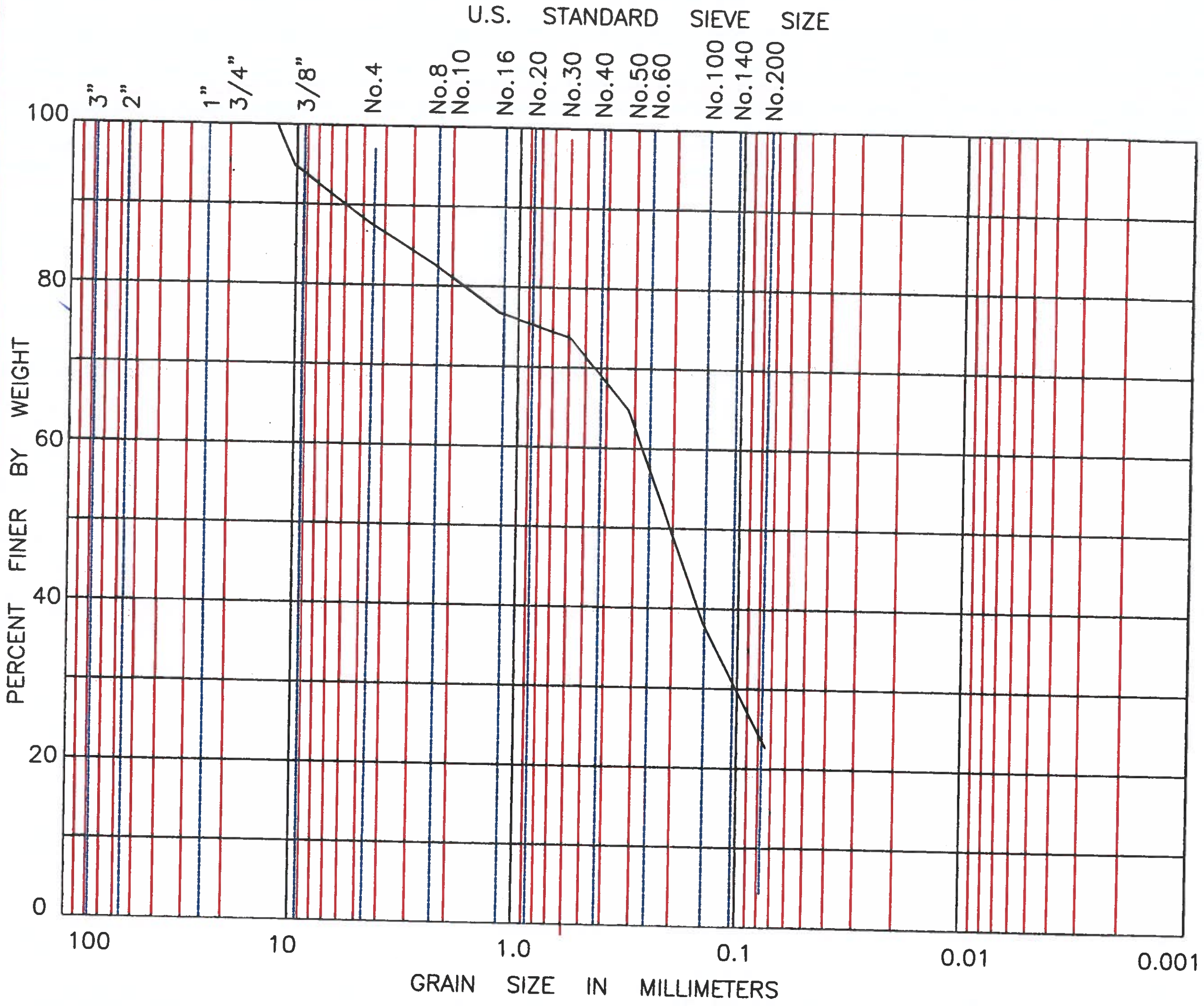
SAMPLE LOCATION: H9-S3 (4'-6')
TESTED BY JR
SAMPLE DESCRIPTIOM: SM-SILTY SAND WITH GRAVEL

Ardaman & Associates Inc.
Consulting Engineers in Soils, Hydrology,
Foundations and Material Testing.

GREAT STIRRUP CAY
BAHAMA

DRAWN BY: JR	CHECKED BY: E.H.	DATE: 7-2-20
FILE No: 20-2543	APPROVED BY: E.H.	

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

U.S. SIEVE SIZE	% PASSING
2	100
11/2	100
1	100
3/4	100
1/2	100
3/8	94
No4	89
No8	82
No16	77
No30	74
No50	66
No100	39
No200	22

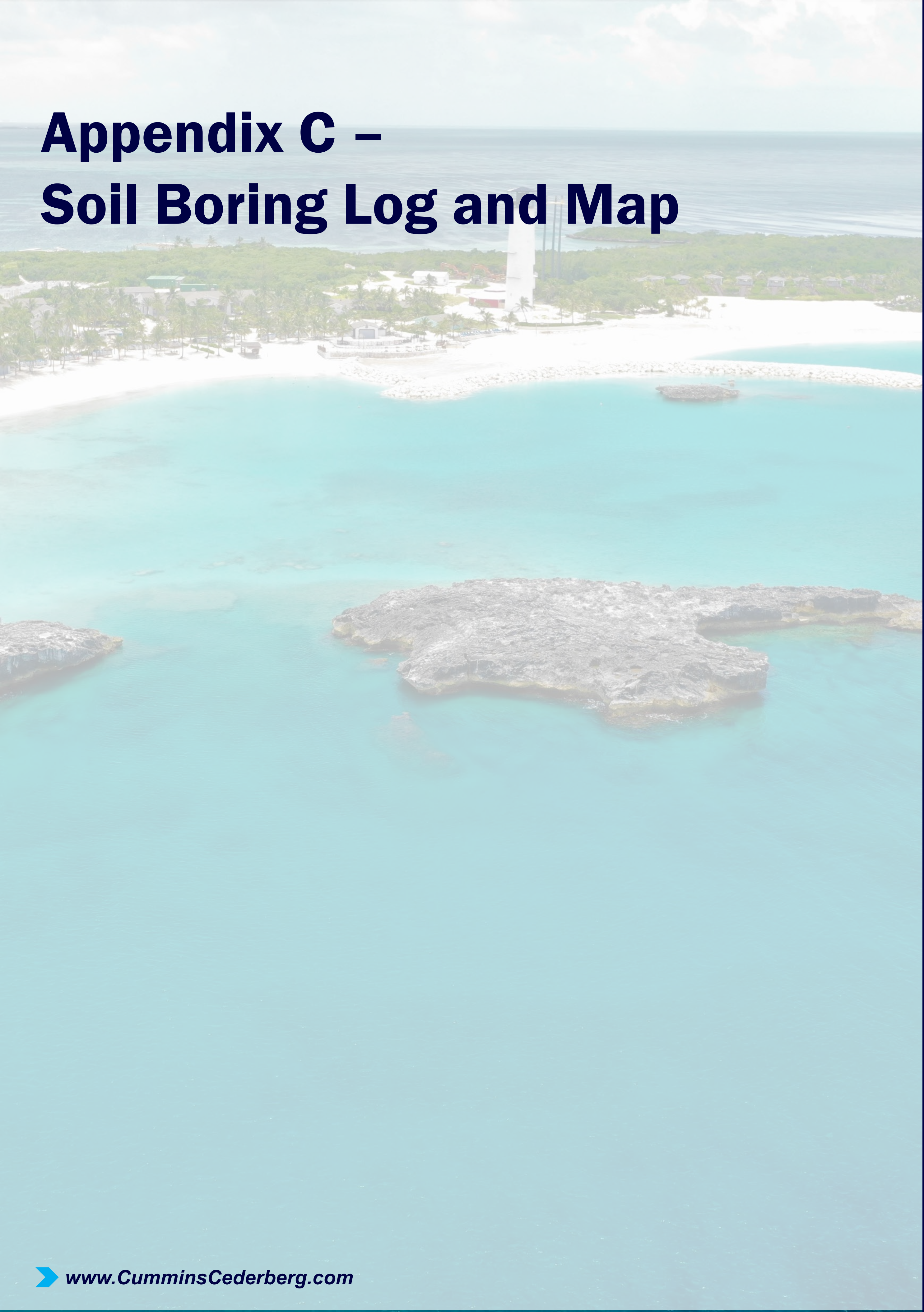
SAMPLE LOCATTION: H9-S12 (40'-42')
TESTED BY JR
SAMPLE DESCRIPTION: SW-SM WELL GRADED SAND WITH SILT

Ardaman & Associates Inc.
Consulting Engineers in Soils, Hydrology,
Foundations and Material Testing.

GREAT STIRRUP CAY

BAHAMA

DRAWN BY: JR
CHECKED BY: E.H.
DATE: 7-2-20
FILE No: 20-2543
APPROVED BY: E.H.



Appendix C –
Soil Boring Log and Map

Appendix C

Ardaman & Associates, Inc.

SOIL BORING LOG

BORING C-13

PROJECT: Great Stirrup Cay - Cruise Ship Destination

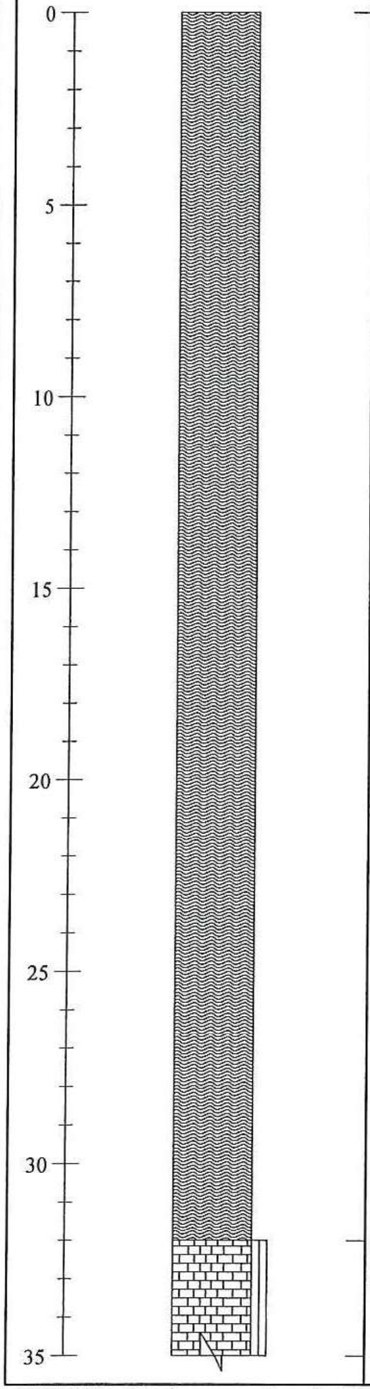
FILE No.: 07-2115

BORING LOCATION: N 25° 49' 43.4"
W 77° 54' 41.1"

DRILL CREW: TDS

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 10/24/2007



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
		Water level measured at 32 feet at 9:30 am on 10/24/2007		
		Core Run 1: 32'-36' ; REC=69% ; RQD=44% ; 2min05sec @ 300psi Light brown, moderately hard, fine grained, porous, fragmented, oolitic limestone	C1	

NOTES: Boring completed at 100 feet below water level

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN"   140-LB HAMMER, 30-INCH FALL.   (ASTM D-1586)

SOIL BORING LOG

BORING C-13

PROJECT: Great Stirrup Cay - Cruise Ship Destination

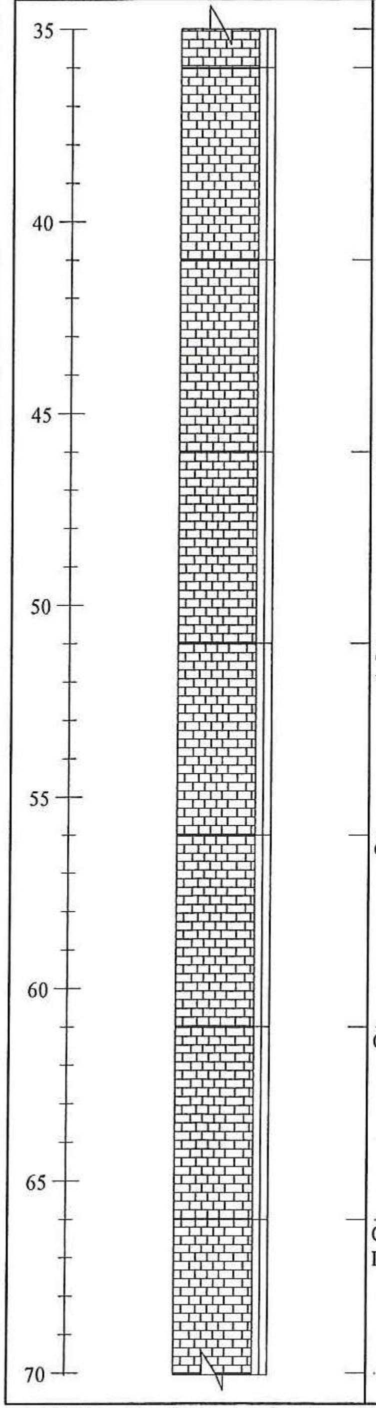
FILE No.: 07-2115

BORING LOCATION: N 25° 49' 43.4"
W 77° 54' 41.1"

DRILL CREW: TDS

WATER OBSERVED AT DEPTH N/A

DATE DRILLED: 10/24/2007



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
		Light brown, moderately hard, fine grained, porous, fragmented, oolitic limestone		
		Core Run 2: 36'-41' ; REC=45% ; RQD=0% ; 2min30sec @ 300psi	C2	
		Core Run 3: 41'-46' ; REC=17% ; RQD=0% ; 3min50sec @ 300psi	C3	
		Core Run 4: 46'-51' ; REC=37% ; RQD=0% ; 2min25sec @ 300psi	C4	
		Core Run 5: 51'-56' ; REC=73% ; RQD=0% ; 5min35sec @ 300psi Very light brown, hard, fine grained, vuggy, fragmented, oolitic limestone	C5	
		Core Run 6: 56'-61' ; REC=80% ; RQD=14% ; 5min35sec @ 200psi	C6	
		Core Run 7: 61'-66' ; REC=32% ; RQD=0% ; 8min50sec @ 200psi	C7	
		Core Run 8: 66'-71' ; REC=22% ; RQD=0% ; 3min55sec @ 200psi Light brown, hard, very fine grained, vuggy, fragmented, oolitic limestone	C8	

NOTES: Boring completed at 100 feet below water level

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN". 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

Ardaman & Associates, Inc.

SOIL BORING LOG

BORING C-13

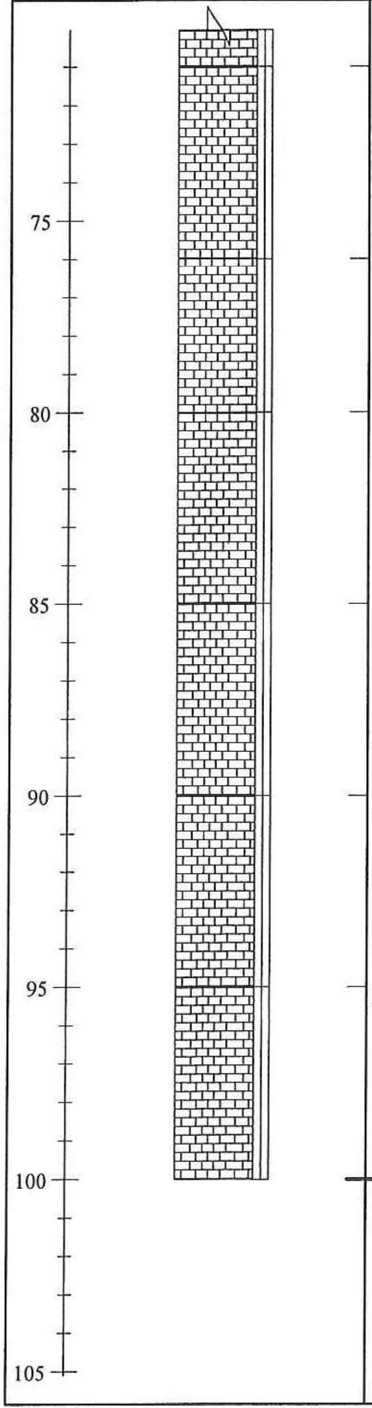
PROJECT: Great Stirrup Cay - Cruise Ship Destination FILE No.: 07-2115

BORING LOCATION: N 25° 49' 43.4"
W 77° 54' 41.1"

DRILL CREW: TDS

WATER OBSERVED AT DEPTH N/A

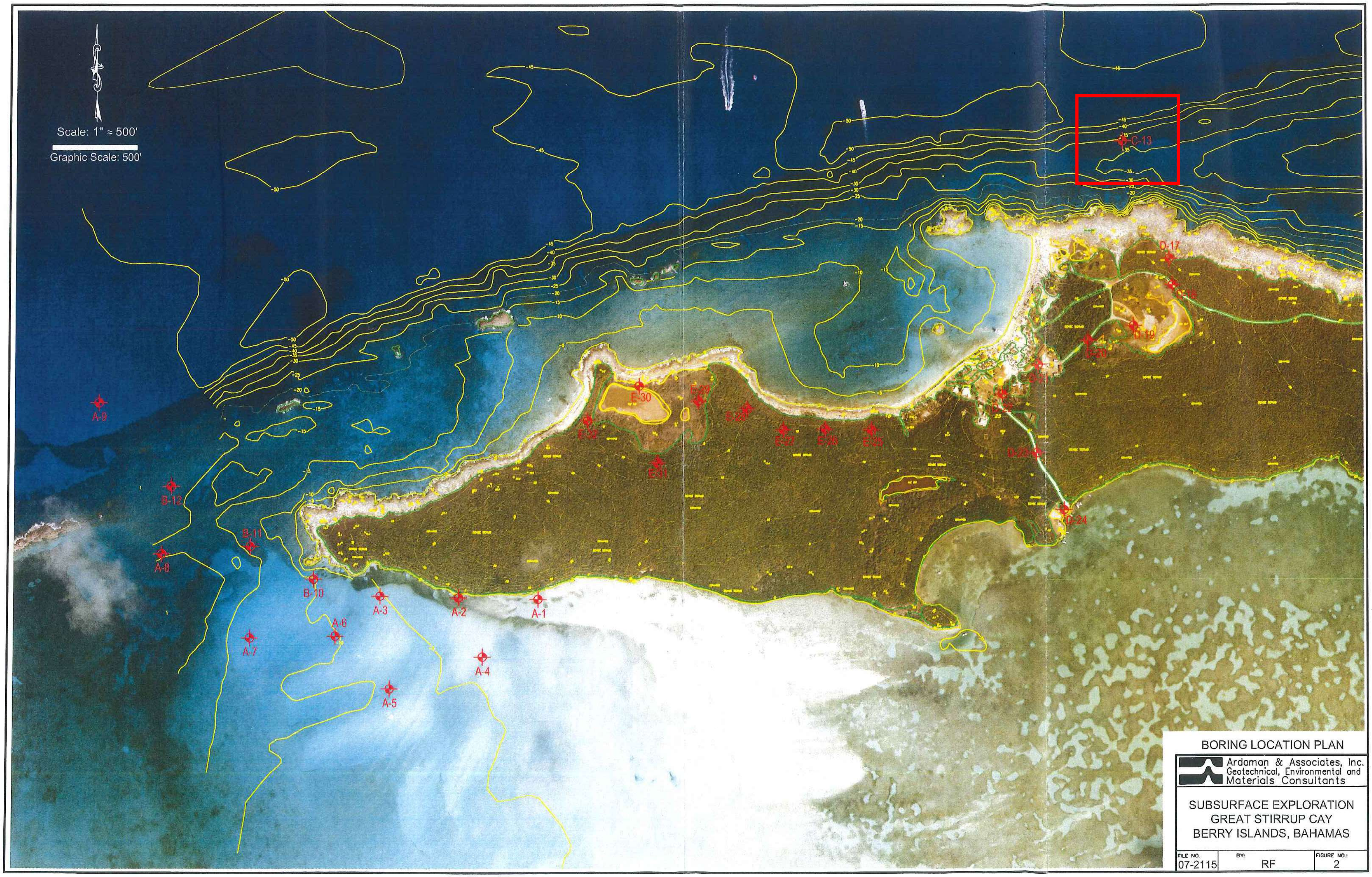
DATE DRILLED: 10/24/2007



DEPTH (FEET)	SYMBOLS FIELD TEST DATA	SOIL DESCRIPTION	SAMPLE No.	N VALUE
		Light brown, hard, very fine grained, vuggy, fragmented, oolitic limestone Core Run 9: 71'-76' ; REC=31% ; RQD=0% ; 4min50sec @ 200psi	C9	
		Core Run 10: 76'-80' ; REC=94% ; RQD=19% ; 9min05sec @ 300psi	C10	
		Core Run 11: 80'-85' ; REC=100% ; RQD=88% ; 12min40sec @ 200psi Light brown, hard, very fine grained, vuggy, oolitic limestone	C11	
		Core Run 12: 85'-90' ; REC=93% ; RQD=87% ; 12min40sec @ 200psi 85'-90': Qu=721 psi ; Qt=203 psi	C12	
		Core Run 13: 90'-95' ; REC=40% ; RQD=15% ; 7min45sec @ 200psi	C13	
		Core Run 14: 95'-100' ; REC=73% ; RQD=50% ; 14min00sec @ 300psi	C14	

NOTES: Boring completed at 100 feet below water level

FIELD TEST DATA ARE "BLOWS"/"INCHES DRIVEN". 140-LB HAMMER, 30-INCH FALL. (ASTM D-1586)

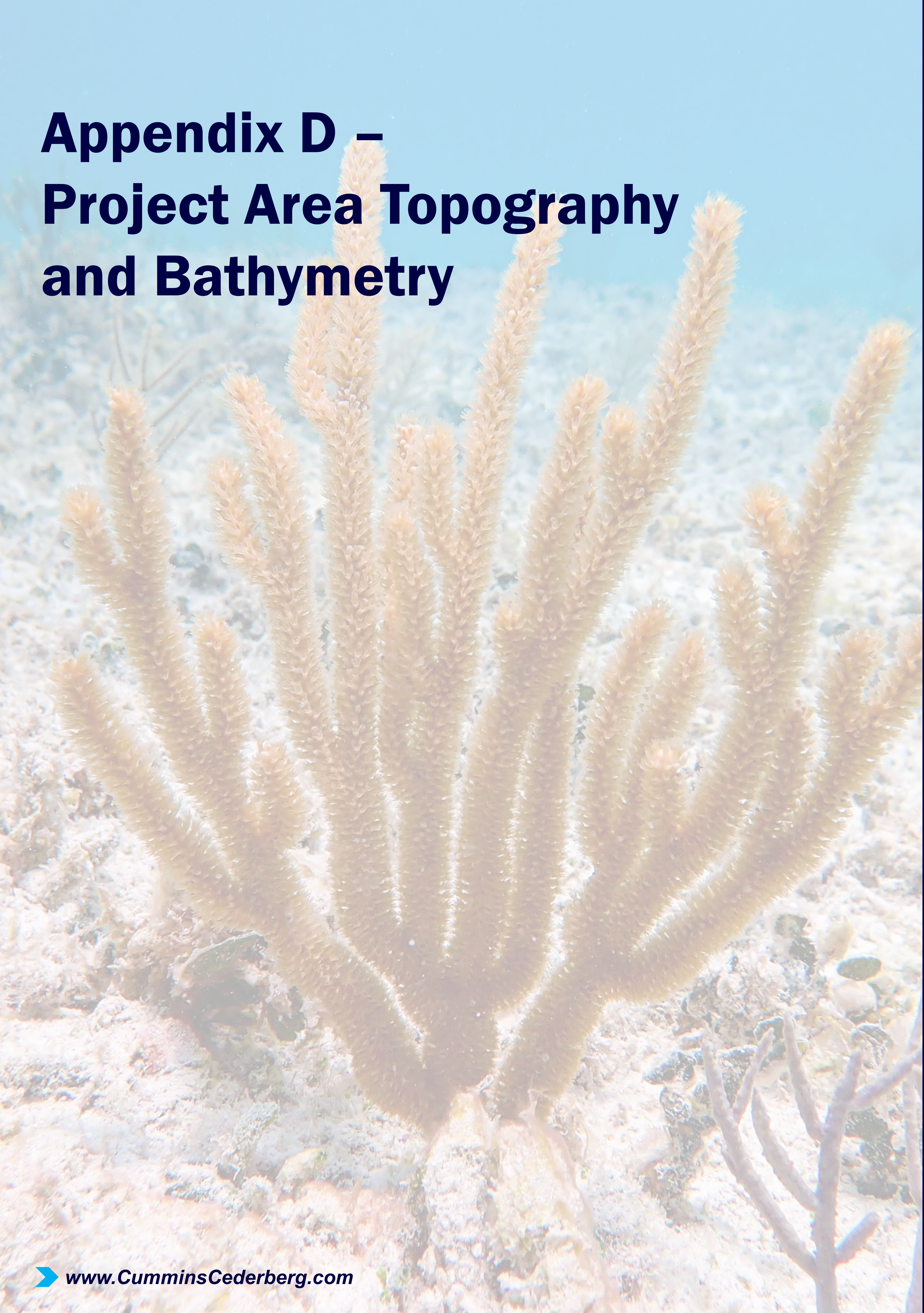


BORING LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and
Materials Consultants

SUBSURFACE EXPLORATION
GREAT STIRRUP CAY
BERRY ISLANDS, BAHAMAS

FILE NO.	BY:	FIGURE NO.:
07-2115	RF	2

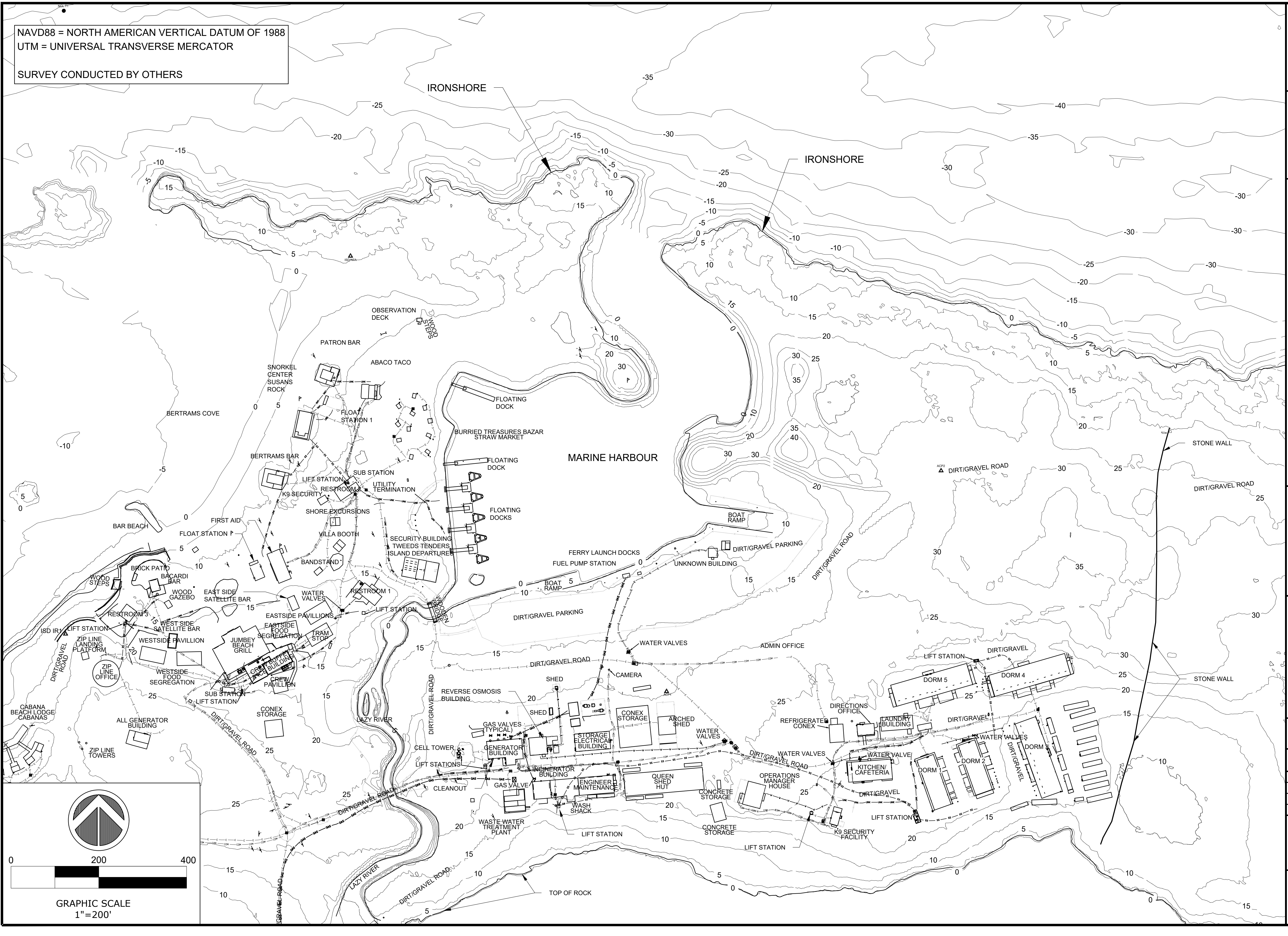


Appendix D – Project Area Topography and Bathymetry

Appendix D

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
UTM = UNIVERSAL TRANSVERSE MERCATOR

SURVEY CONDUCTED BY OTHERS



PROJECT:
GREAT STIRRUP CAY
ENVIRONMENTAL
IMPACT ASSESSMENT

ADDRESS:
BERRY ISLANDS, THE BAHAMAS

CLIENT:
NORWEGIAN CRUISE LINE

ADDRESS:
7665 N.W. 19TH STREET
MIAMI, FL 33126

ENGINEER:
CUMMINS CEDERBERG
COASTAL & MARINE ENGINEERING

7550 RED ROAD, SUITE 217
SOUTH MIAMI, FLORIDA 33143
TEL: +1 305 741-6155 FAX: +1 305-974-1969
WWW.CUMMINSCEDERBERG.COM
COA # 29062

BERMELLO AJAMIL & PARTNERS, INC.

ADDRESS:
2601 S. BAYSHORE DRIVE, SUITE 1000
MIAMI, FL 33133

SEAL:

ISSUE	DATE	SUBMISSION / REVISION
1	01/23/2020	TRANSECT LINES

CC PROJECT NO:	61600
DRAWN	GK
CHECKED	CKM
SCALE	AS SHOWN

SHEET TITLE

PROJECT AREA TOPOGRAPHY

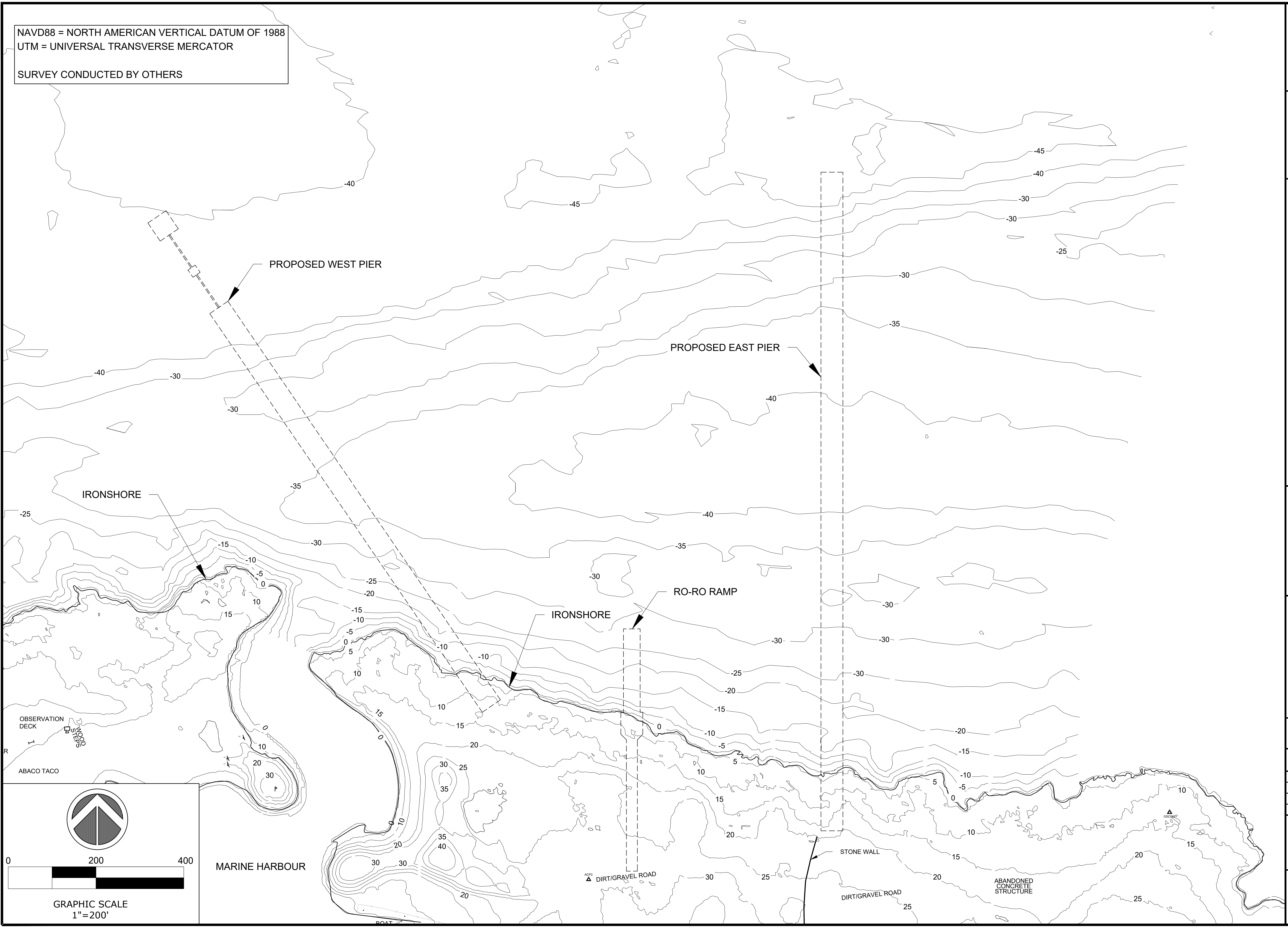
SHEET 1 OF 2

CM-1

J:\Projects\61600 Great Stirrup Cay\Drawing\Working\(2020-11-06)_CSC_Survey.dwg

NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
UTM = UNIVERSAL TRANSVERSE MERCATOR

SURVEY CONDUCTED BY OTHERS



PROJECT:
GREAT STIRRUP CAY
ENVIRONMENTAL
IMPACT ASSESSMENT

ADDRESS:
BERRY ISLANDS, THE BAHAMAS

CLIENT:
NORWEGIAN CRUISE LINE

ADDRESS:
7665 N.W. 19TH STREET
MIAMI, FL 33126

ENGINEER:
CUMMINS CEDERBERG
COASTAL & MARINE ENGINEERING

7550 RED ROAD, SUITE 217
SOUTH MIAMI, FLORIDA 33143
TEL: +1 305 741-6155 FAX: +1 305-974-1969
WWW.CUMMINSCEDERBERG.COM
COA # 29062

BERMELLO AJAMIL &
PARTNERS, INC.

ADDRESS:
2601 S. BAYSHORE DRIVE, SUITE 1000
MIAMI, FL 33133

SEAL:

ISSUE	DATE	SUBMISSION / REVISION
1	01/23/2020	TRANSECT LINES

CC PROJECT NO:	61600
DRAWN	GK
CHECKED	CKM
SCALE	AS SHOWN

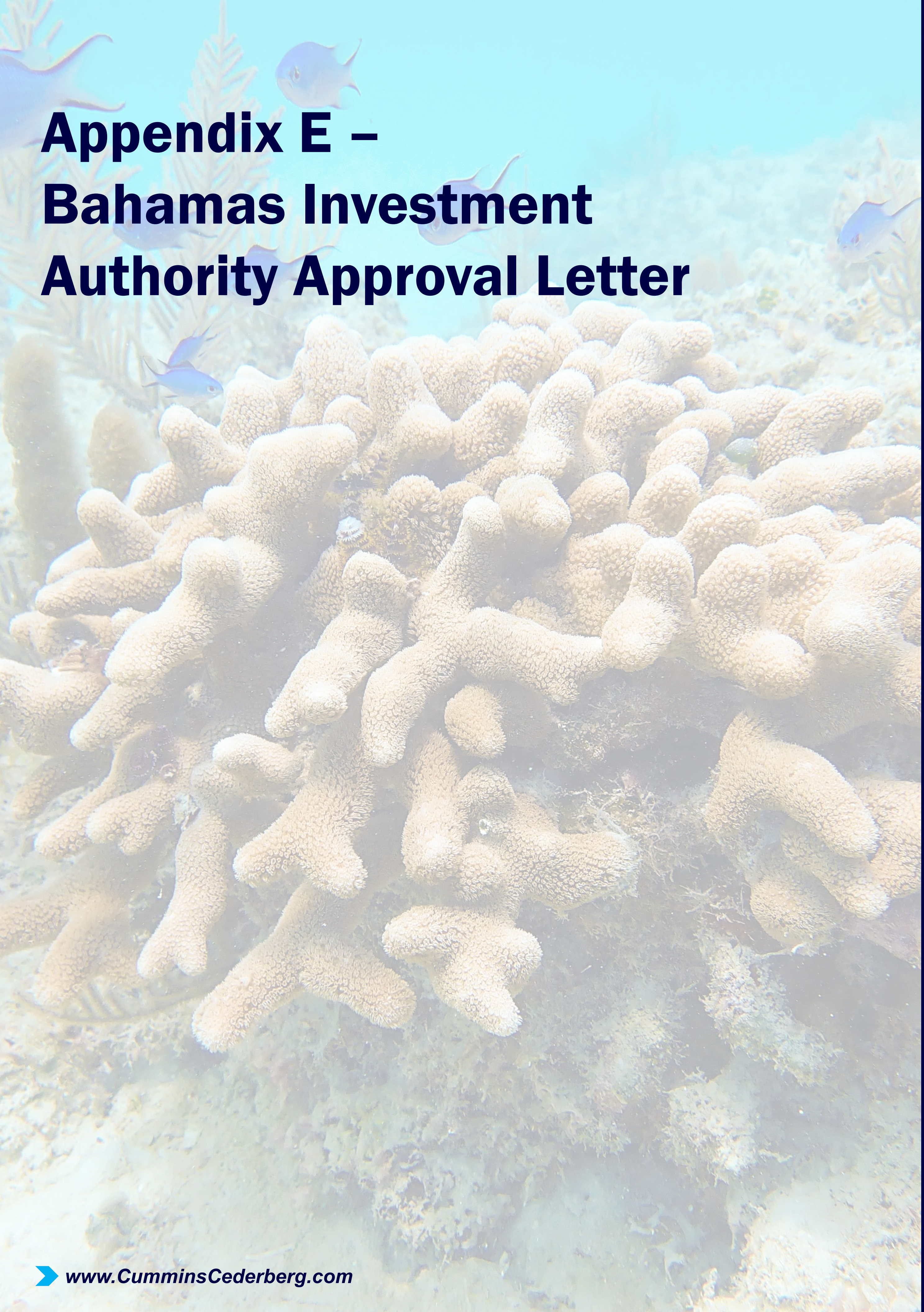
SHEET TITLE

PROJECT AREA BATHYMETRY

SHEET 2 OF 2

CM-2

J:\Projects\61600 Great Stirrup Cay\Drawing\Working\(2020-11-06)_GSC_Survey.dwg



Appendix E – Bahamas Investment Authority Approval Letter

Appendix E

BAHAMAS INVESTMENT AUTHORITY

Cecil Wallace Whitfield Centre, Cable Beach
P. O. Box CB - 10980
Nassau, N.P., The Bahamas
Tel: (242) 327-5826-9; Fax: (242) 327-5806

Your ref:
Our ref: OPM/PRJ/Berry Island/04

2nd January, 2020

Erica Paine
Graham Thompson
Star General Insurance Building
2nd Floor,
P. O. Box F-42451,
Freeport, Grand Bahama
The Bahamas

Dear Ms. Paine,

Re: NCL (Bahamas) Ltd.

Reference is made to the above-captioned, and the application submitted on behalf of NCL (Bahamas) Ltd. requesting approval to, *inter alia*, conduct significant renovations and improvements to Great Stirrup Cay.

I am directed to advise that the National Economic Council, at its recent meeting, concluded as follows:

(i) **Approved** NCL (Bahamas) Ltd. to conduct significant renovations and improvements to Great Stirrup Cay by the construction of a pier and dredging/ excavation of a deep water basin, together with the construction of additional amenities and facilities, subject to review and approval of the Environmental Impact Assessment (and any other required environmental report or study) by the BEST Commission and all other relevant Government agencies **prior to** commencement of any construction or other works, and further subject to meeting the due diligence and necessary requirements of the Bahamas Investment Authority, the Ministry of Public Works, the Port Department, the Department of Physical Planning, the Ministry of the Environment, the BEST Commission, the Ministry of Tourism, and all other relevant Government agencies;

(ii) **Approved** the grant of a seabed lease to NCL (Bahamas) Ltd. for a square footage to be determined, to accommodate the deep water basin and pier on the north-central side of Great Stirrup Cay, subject to meeting the necessary requirements and due diligence of the Department of Lands & Surveys, the Office of the Attorney-General & Ministry of Legal Affairs, and all other relevant Government agencies;

(iii) **Agreed to recommend** to the Department of Immigration, the issuance of eight (8) annual term work permits for construction and four (4) annual work permits for operations to NCL (Bahamas) Ltd., subject to its normal due diligence and meeting the requirements of the Ministry of Labour; and

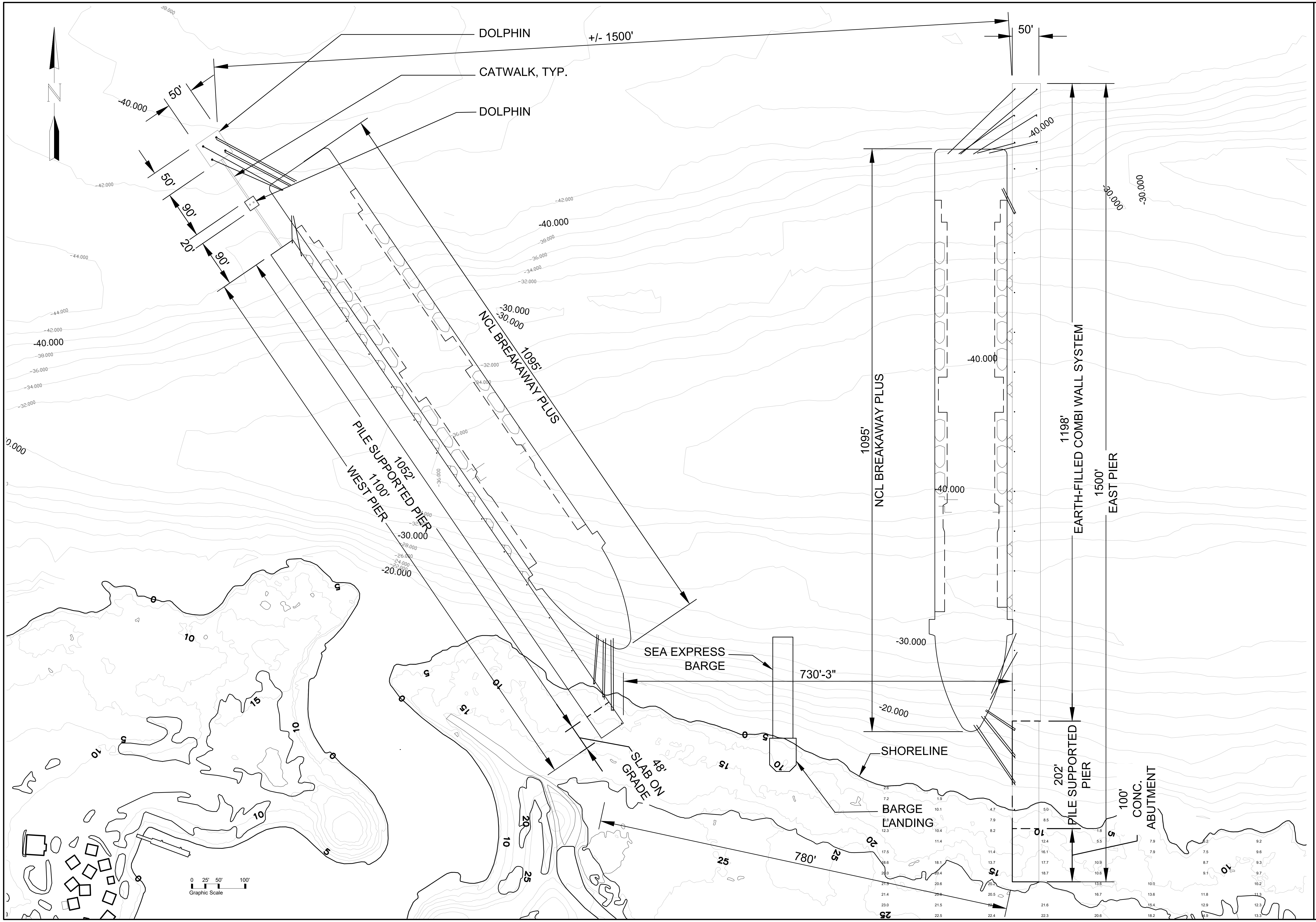
(iv) **Agreed to recommend** to the Minister responsible for Hotels Encouragement to enter into a Hotels Encouragement Act Agreement with NCL (Bahamas) Ltd.

Please do not hesitate to contact the undersigned should you have any queries or concerns.

Shari M. Moxey
(for) Director of Investments

Cc: Director of Legal Affairs, Office of the Attorney-General & Ministry of Legal Affairs
Director-General, Ministry of Tourism
Controller, Port Department
Director, Ministry of Works
Director, Department of Physical Planning
Director, BEST Commission
Director, Department of Immigration
Director, Department of Labour
Director, Department of Lands & Surveys
Deputy Permanent Secretary, Land Unit, Office of the Prime Minister
Administrator, Department of Local Government, Berry Islands

Appendix F –
30% Design Plans



CLIENT:

NCL
NORWEGIAN
CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

BA Bermello Ajamil & Partners

Bermello Ajamil & Partners, Inc.
2601 S. Bayshore Drive, Suite 1000
Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

30% DESIGN

REVISION:

#	DATE	DESCRIPTION
1	1/14/2020	REVISIONS

BA PROJECT #: 18060.002
SCALE: AS NOTED
DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

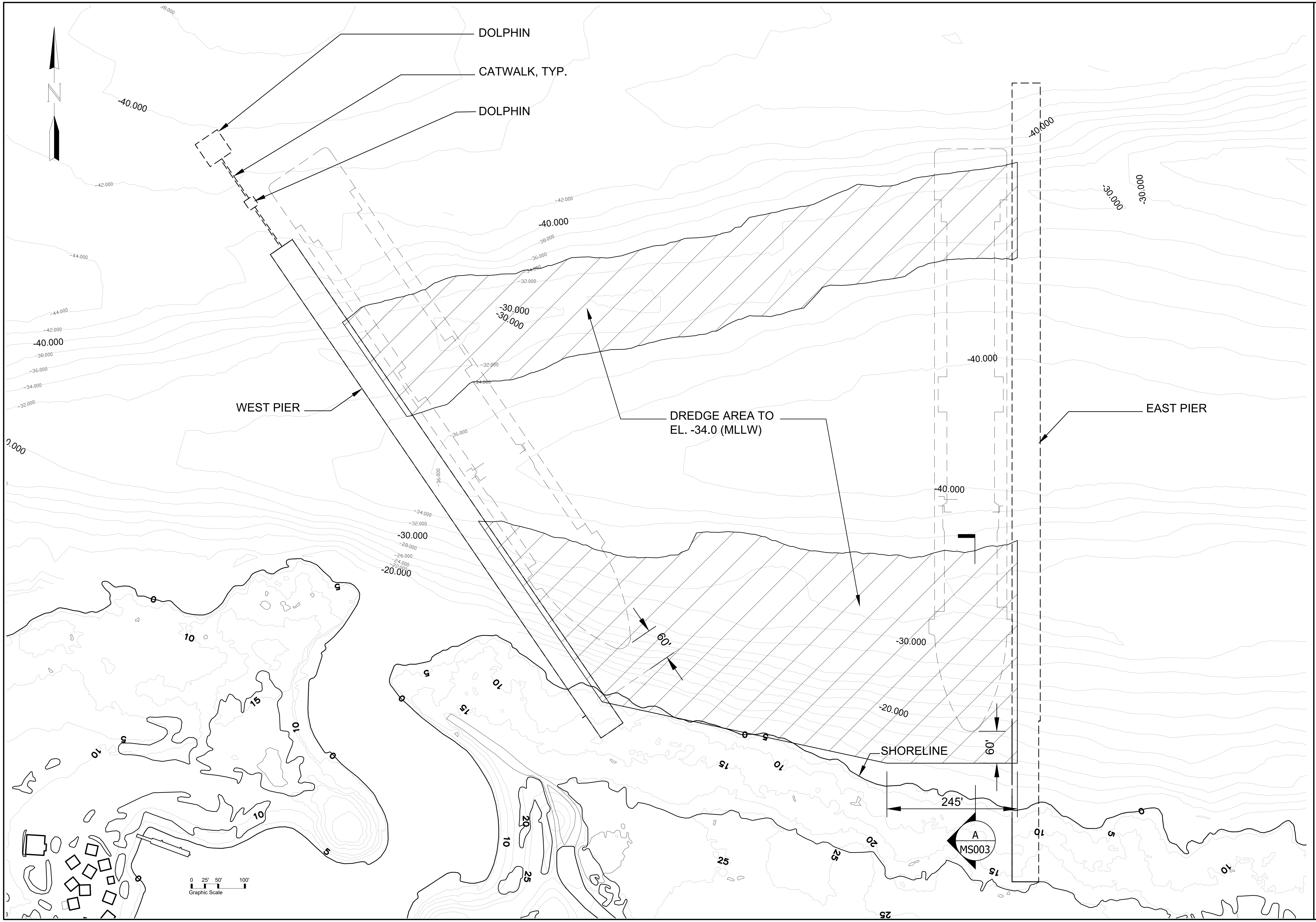
TITLE:

SITE PLAN

DRAWING #:

MS001

SHEET 1 OF 10



CLIENT:

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

Bermello Ajamil & Partners, Inc.
2601 S. Bayshore Drive, Suite 1000
Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

30% DESIGN

REVISION:

#	DATE	DESCRIPTION

BA PROJECT #: 18060.002
SCALE: AS NOTED
DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

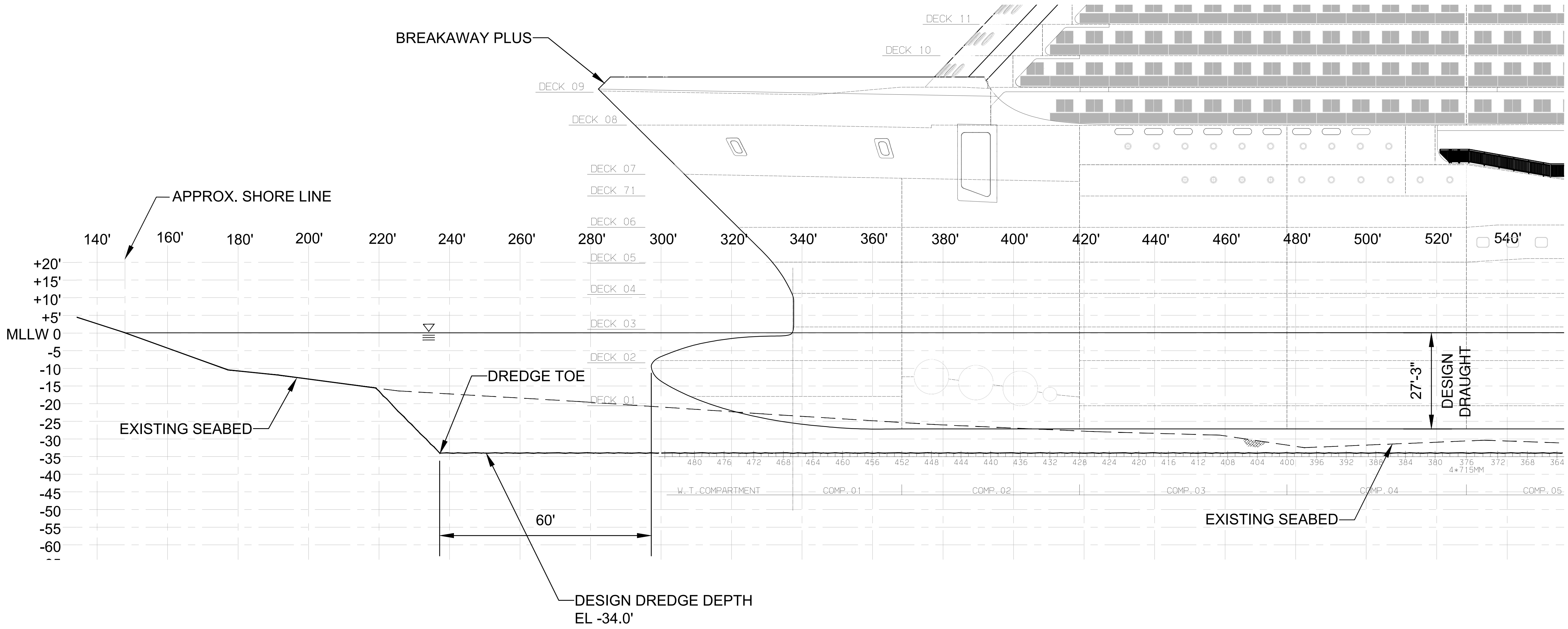
TITLE:

DREDGING PLAN

DRAWING #:

MS002

SHEET 2 OF 10



CLIENT:

NCL
NORWEGIAN
CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

BA Bermello Ajamil & Partners

Bermello Ajamil & Partners, Inc.
2601 S. Bayshore Drive, Suite 1000
Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

30% DESIGN

REVISION:

#	DATE	DESCRIPTION

BA PROJECT #: 18060.002
SCALE: AS NOTED
DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

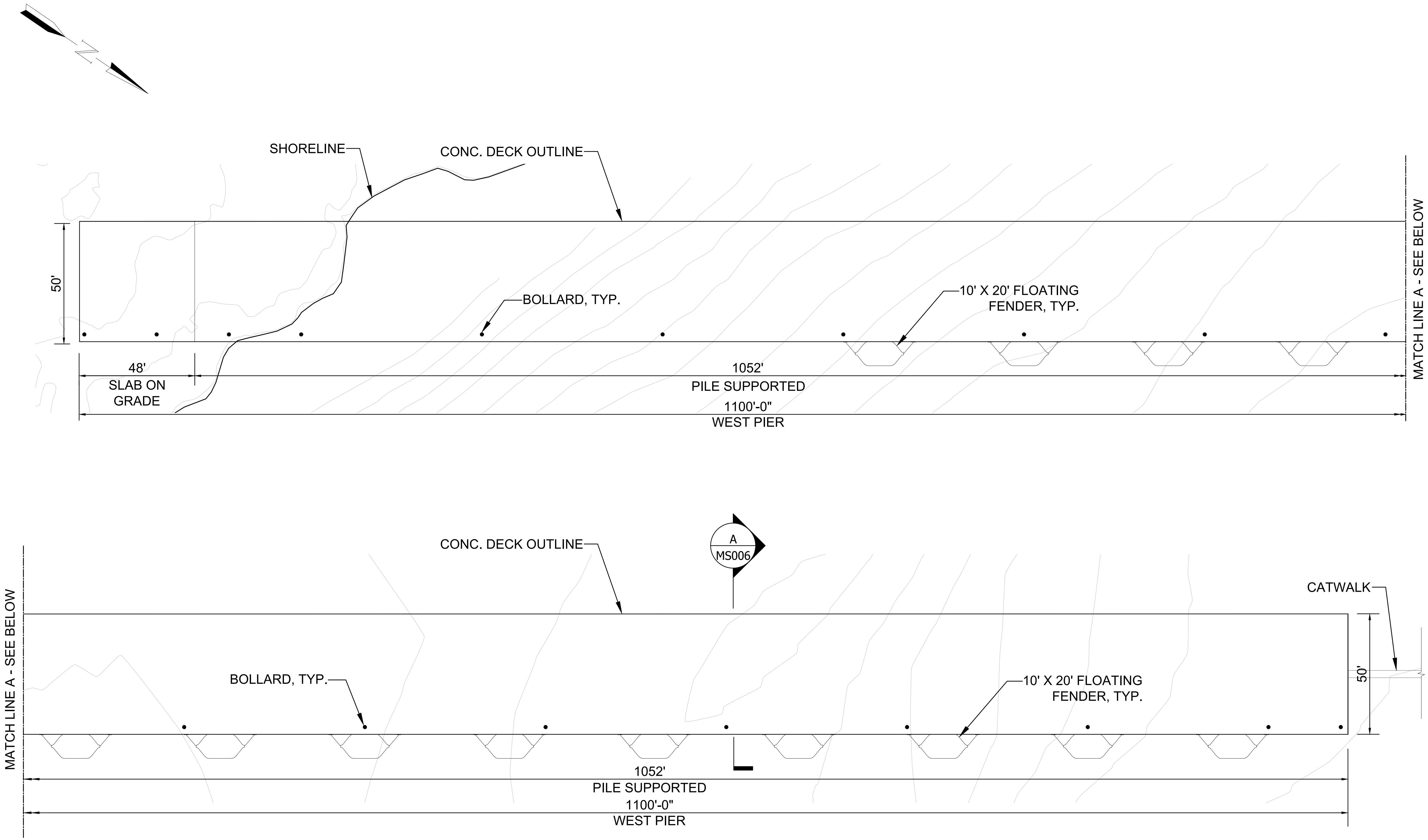
TITLE:

EAST PIER DREDGE SECTION PROFILE

DRAWING #:

MS003

SHEET 3 OF 10



WEST PIER - DECK PLAN

SCALE : 1=500

CLIENT:

NCL
NORWEGIAN
CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

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2601 S. Bayshore Drive, Suite 1000
Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

30% DESIGN

REVISION:

#	DATE	DESCRIPTION
1	1/14/2020	REVISIONS

BA PROJECT #: 18060.002
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REVIEWED BY: DR
DATE: 10/31/2019

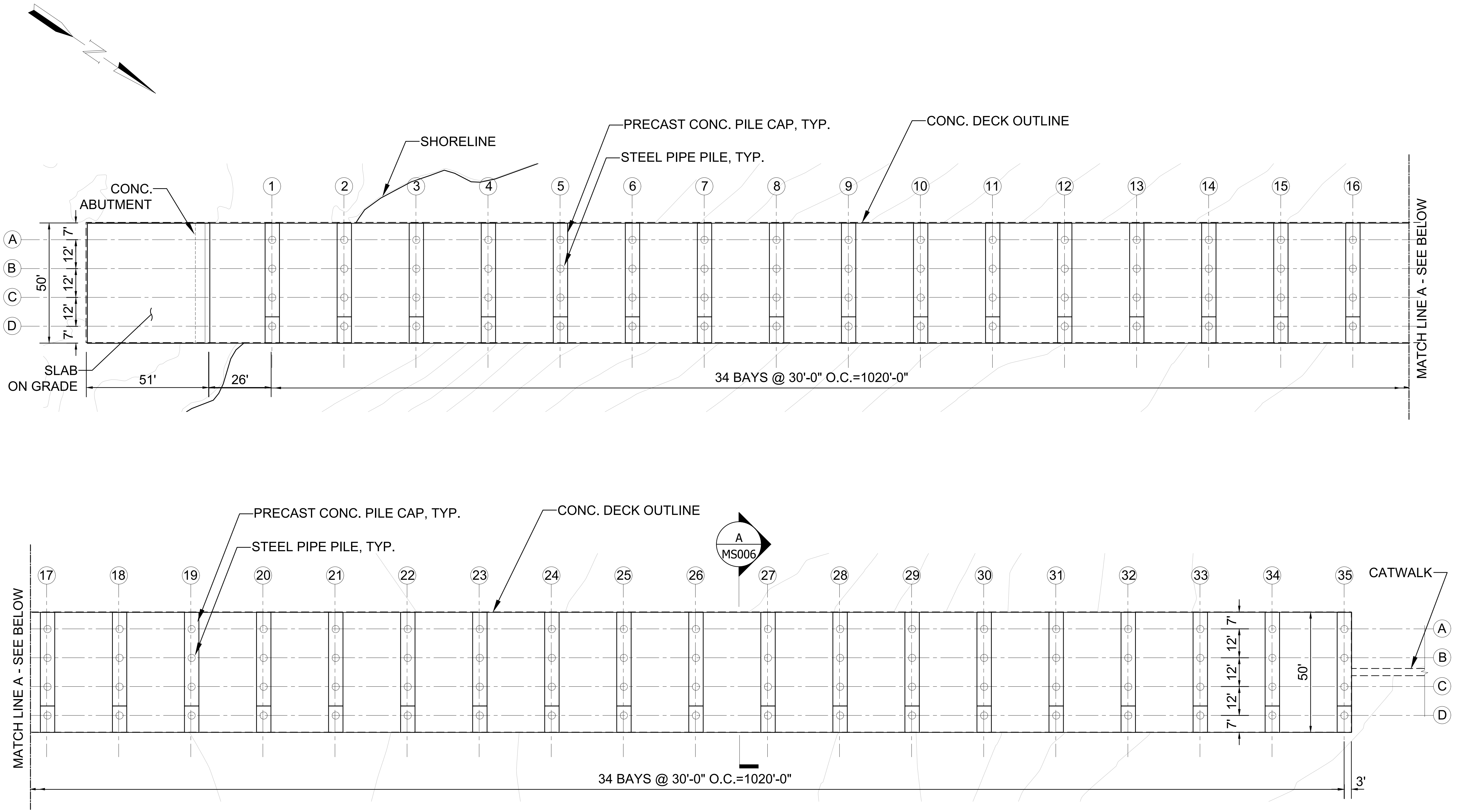
TITLE:

WEST PIER
DECK PLAN

DRAWING #:

MS004

SHEET 4 OF 10



WEST PIER - PILE AND CAP PLAN

SCALE : 1=500

CLIENT:

NCL
NORWEGIAN
CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

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Tel: 305-859-2050

SUBMITTAL/MILESTONE:

30% DESIGN

REVISION:

#	DATE	DESCRIPTION
1	1/14/2020	REVISIONS

BA PROJECT #: 18060.002
SCALE: AS NOTED
DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

TITLE:

WEST PIER
PILE AND CAP
PLAN

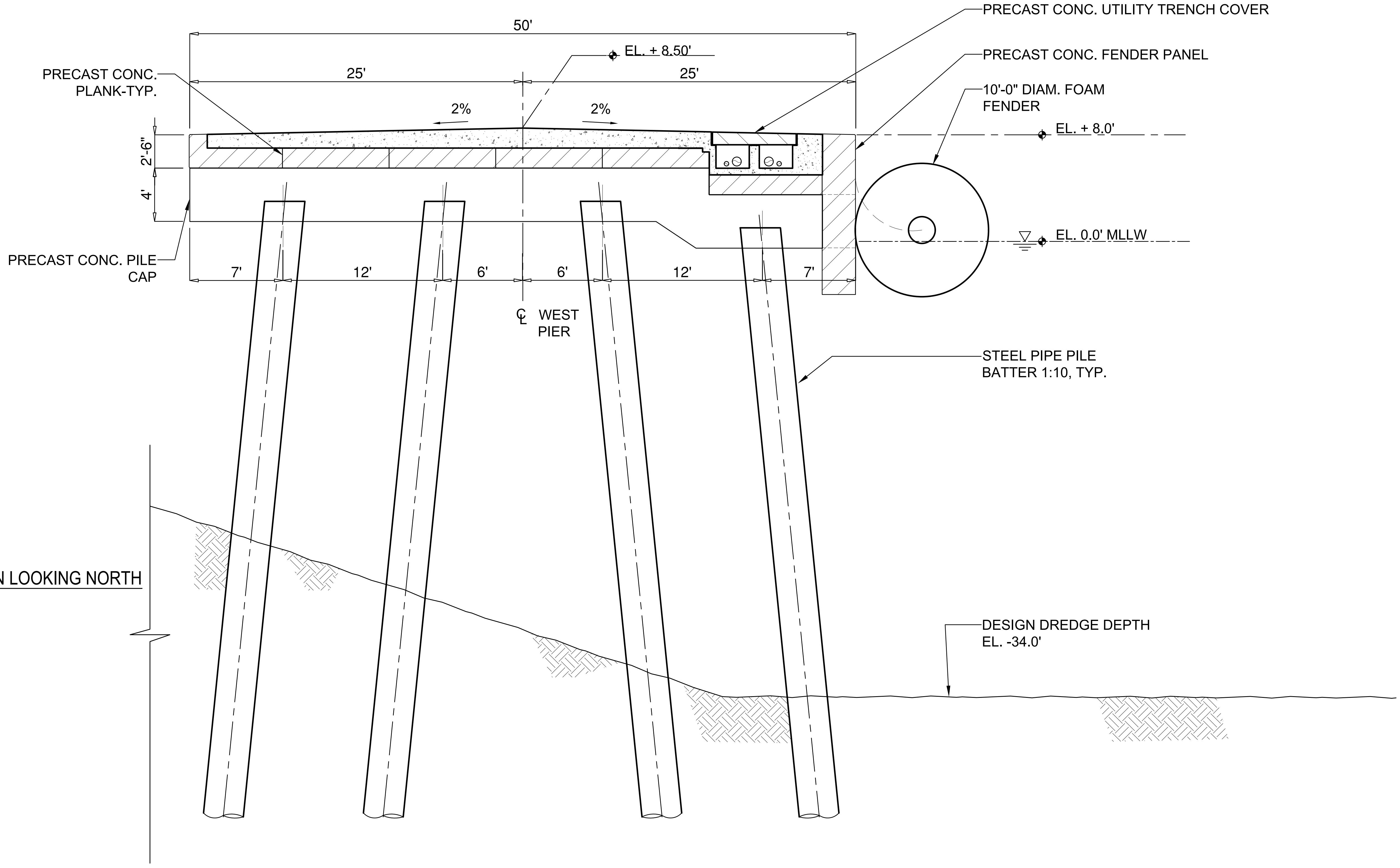
DRAWING #:

MS005

SHEET 5 OF 10

NOTES:

1. SLOPE DREDGING UNDER THE DECK IS REQUIRED FOR SECTION NEAR SHORE LINE.
2. SLOPE OF DREDGING DEPENDS ON SOIL TYPE TO BE CONFIRMED.



TYPICAL SECTION LOOKING NORTH

SCALE : 1/8" = 1'-0"

CLIENT:

NCL NORWEGIAN CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

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2601 S. Bayshore Drive, Suite 1000
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SUBMITTAL/MILESTONE:

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REVISION:

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SCALE: AS NOTED
DRAWN BY: RM
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DATE: 10/31/2019

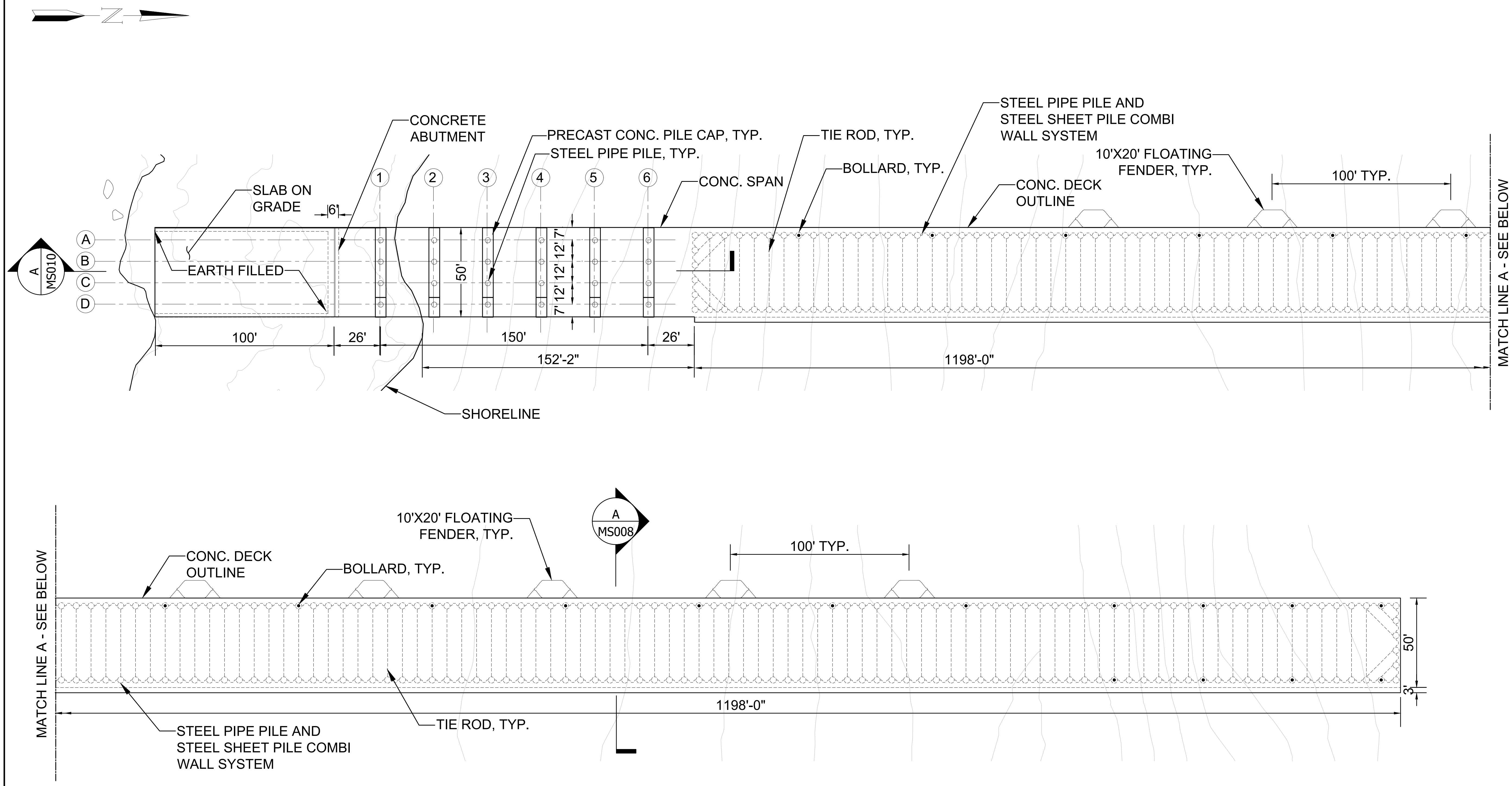
TITLE:

WEST PIER
TYPICAL SECTION

DRAWING #:

MS006

SHEET 6 OF 10



EAST PIER - DECK PLAN

SCALE : 1=700

CLIENT:

NCL
NORWEGIAN
CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

BA Bermello Ajamil & Partners

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2601 S. Bayshore Drive, Suite 1000
Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

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BA PROJECT #: 18060.002
SCALE: AS NOTED
DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

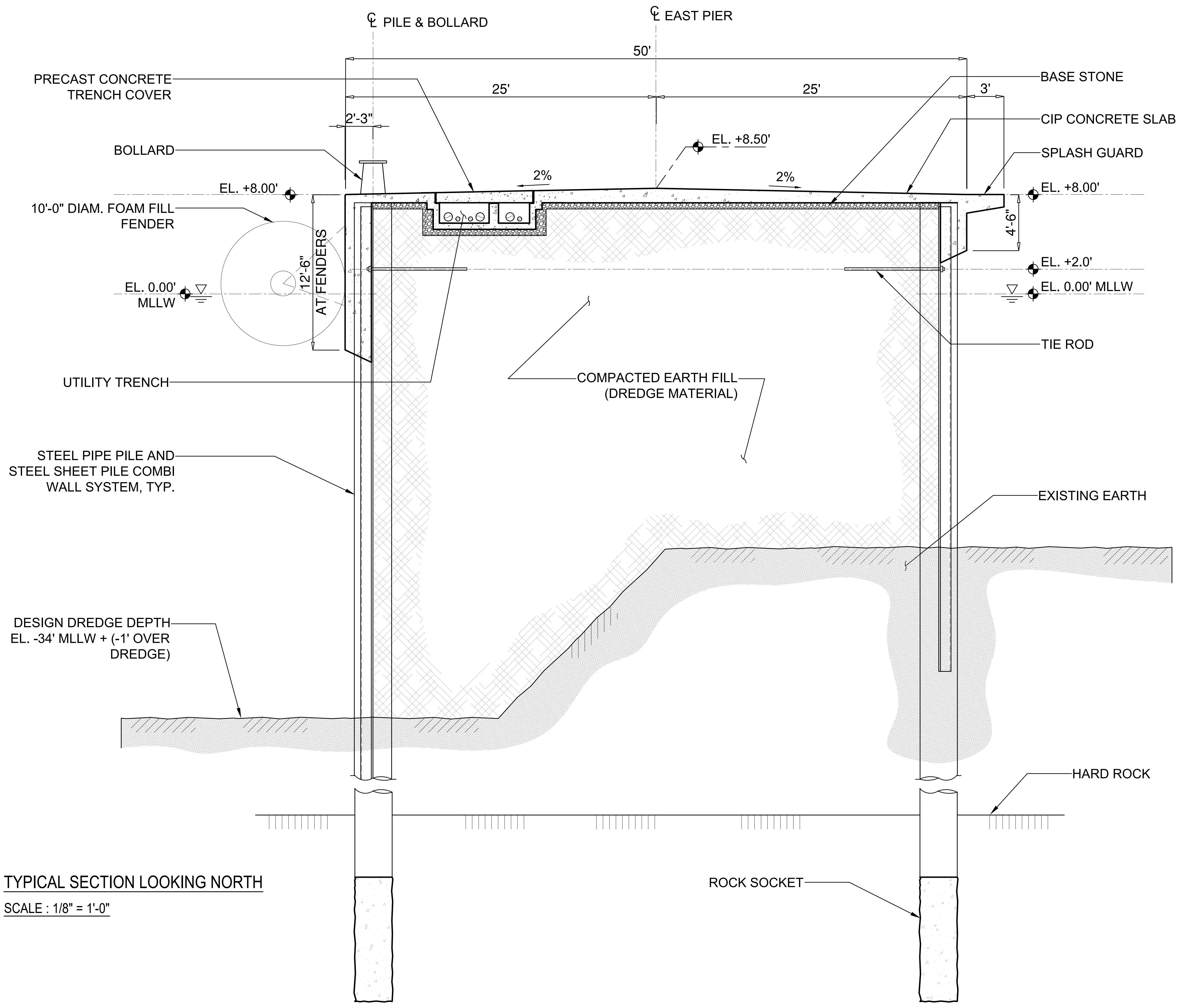
TITLE:

EAST PIER
DECK PLAN

DRAWING #:

MS007

SHEET 7 OF 10



TYPICAL SECTION LOOKING NORTH

SCALE : 1/8" = 1'-0"

CLIENT:

NCL
NORWEGIAN
CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

BA Bermello Ajamil & Partners

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2601 S. Bayshore Drive, Suite 1000
Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

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REVISION:

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BA PROJECT #: 18060.002
SCALE: AS NOTED
DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

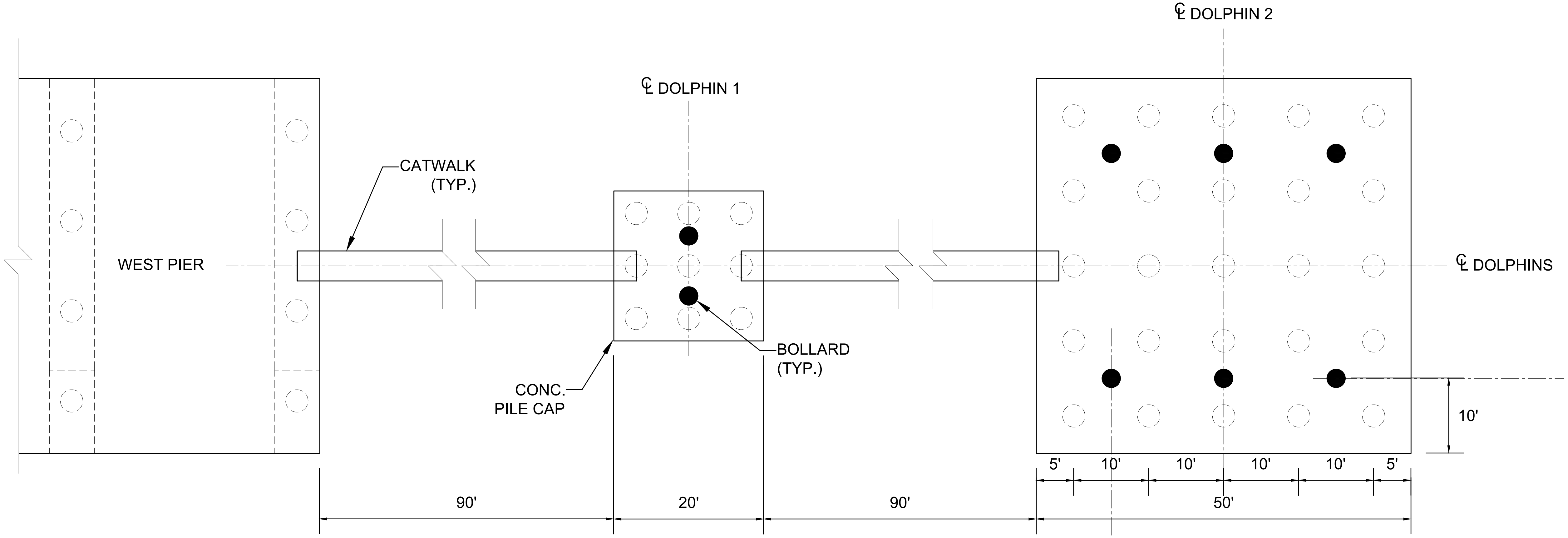
TITLE:

EAST PIER
TYPICAL SECTION

DRAWING #:

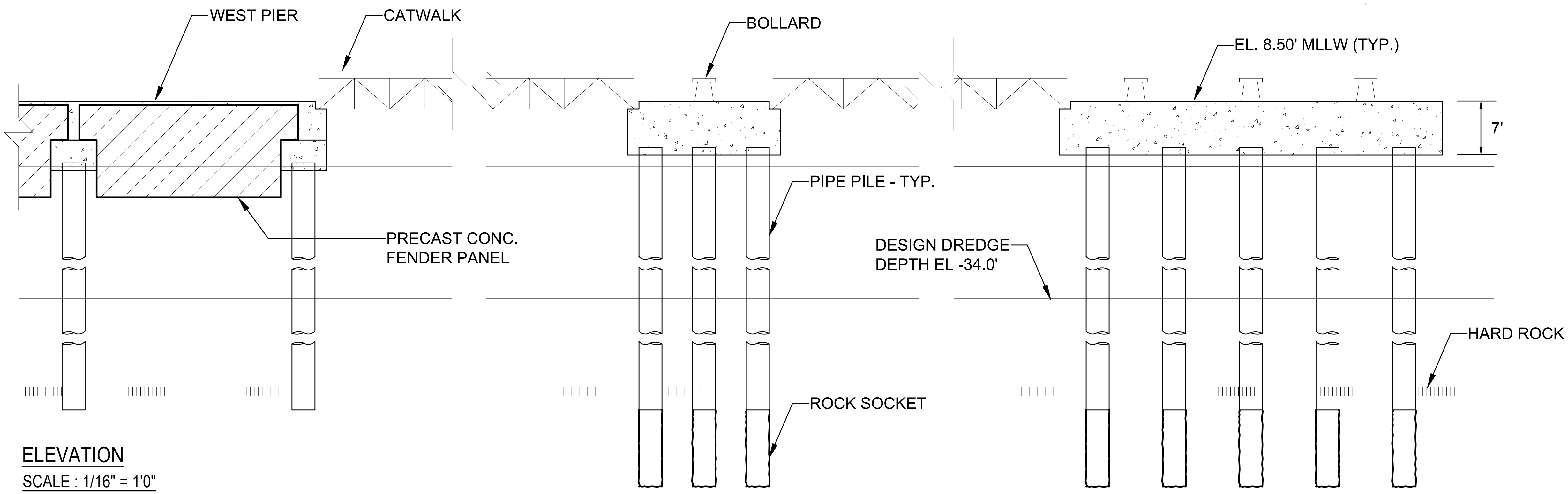
MS008

SHEET 8 OF 10



PLAN

SCALE : 1/16" = 1'0"



ELEVATION

SCALE : 1/16" = 1'0"

NOTES:

1. NUMBERS OF PILES SHOWN ARE INDICATIVE, PENDING DETAIL DESIGN

CLIENT:

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Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

Bermello Ajamil & Partners, Inc.
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Miami, FL 33133
Tel: 305-859-2050

SUBMITTAL/MILESTONE:

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REVISION:

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REVIEWED BY: DR
DATE: 10/31/2019

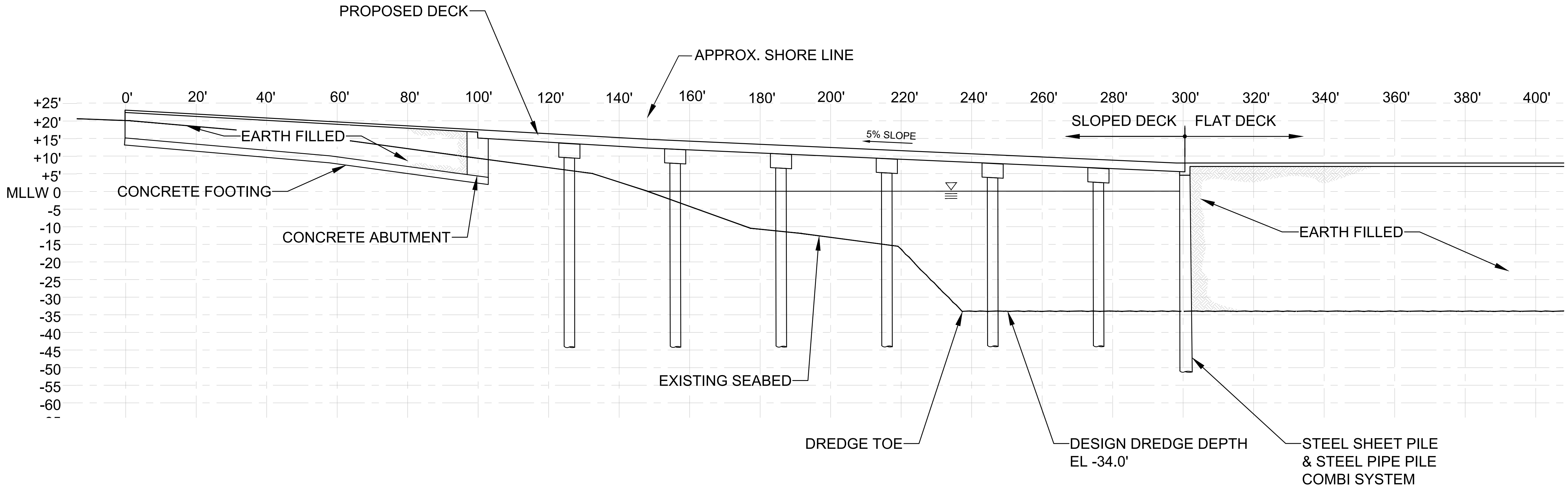
TITLE:

MOORING DOLPHINS - DECK AND PILE PLAN

DRAWING #:

MS009

SHEET 9 OF 10



CLIENT:

NORWEGIAN CRUISE LINE

Norwegian Cruise Line
7665 Corporate Center Drive
Miami, FL 33126

PROJECT:

GREAT STIRRUP CAY

PRIME CONSULTANT:

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30% DESIGN

REVISION:

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BA PROJECT #: 18060.002
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DRAWN BY: RM
REVIEWED BY: DR
DATE: 10/31/2019

TITLE:

EAST PIER
DREDGE SECTION

DRAWING #:

MS010

SHEET 10 OF 10